Studying and Supporting Activity Awareness in Collaborative Learning Groups: Using a Persuasive Social Actor

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Dedication

I would like to dedicate this work to my late father;

I am really indebted to him more than he knows.

This one is for you dad!

Acknowledgements

First and foremost, I would like to praise and thank our God the Almighty Allah for giving me the strength, knowledge, ability and opportunity to undertake this research study and to persevere and complete it successfully. Without His blessings, this achievement would not have been possible.

This work owes to many people who have supported me to complete the research work directly or indirectly. First, I would like to thank and express my gratitude and appreciation to my first supervisor Stephanie Wilson for her generous guidance and support throughout this research. Her invaluable guidance helped me from the early stage of the research until the writing of this thesis, without her assistance I would have never been able to bring it to an end. It was a pleasure working with her. I could not have imagined having a better advisor and mentor for my PhD study.

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Last but not least, I would like extend my deepest gratitude to my loving family and friends, who helped and supported me in different ways and showed special understanding through all this time. Most importantly I would like to thank my mother for her love, prayers, patience, and continuous support, my brothers, Mohammad, Abdulaziz, Khaled, and Badr, and my sisters, Tarfa and Noura, for their love, prayers, encouragement and support. Also, special thanks go to Juju, Abby, Sara and Nehal for their love, constant support and motivation.

Declaration

The work described in this thesis is based on research carried out at the Centre for Human-Computer Interaction Design at City, University of London, London, United Kingdom. No part of this thesis has been submitted elsewhere for any other degree or qualification. All work is my own unless otherwise stated.

_____ _____

Reem Al Ashaikh Date

Abstract

Collaborative learning is known as an effective learning method and various different kinds of technologies have been developed to support and facilitate collaborative learning. Many of these technologies are used to support the functional activities of a group of learners by enabling students to communicate, share documents and materials, track the work of the group, or distribute and allocate tasks.

One factor that influences the success of collaborative groups is the awareness that members have of each others' activities i.e. activity awareness (Gutwin et al., 2004). Limited attention has been paid to promoting activity awareness in the collaborative learning literature. The work that does exist has focused on enhancing activity awareness by capturing and sharing details of the activity (e.g. Ganoe et al., 2003; Carroll et al., 2003). In contrast, there are no technologies that focus on the learners' attitudes and behaviours with regard to activity awareness without considering the functional aspects of the group's work.

This PhD hypothesises that persuasive technologies can offer a novel way of promoting activity awareness by changing learners' attitudes and behaviours and persuading them to be more aware of fellow group members' activities. This approach to enhancing activity awareness was investigated by using a persuasive social actor to change the attitudes and behaviours of learners who were working on collaborative learning projects over extended periods of time.

Four studies were conducted: a pilot study to explore collaborative learning groups, an exploratory study to understand collaboration and activity awareness, a follow-up study to study activity awareness in depth, and a main study where a persuasive social actor for activity awareness in collaborative learning groups was developed and tested. All of these studies focused on a specific collaborative learning setting, in which small numbers of students (3 to 5) worked together in collaborative groups to complete real learning projects over approximately 6 weeks.

This thesis makes four contributions to the fields of HCI and collaborative learning. The main contribution is a novel approach to enhance activity awareness in collaborative learning groups by changing learners' attitudes and behaviours using a persuasive technology i.e. a persuasive social actor. The second contribution is a new method to evaluate activity awareness in collaborative learning groups. The third contribution is insight into how the Persuasive Systems Design (PSD) model (Oinas-kukkonen & Harjumaa, 2009) can be used in the design and evaluation of a persuasive social actor. The fourth contribution is an analysis of how students collaborate in long-term collaborative learning projects in naturalistic settings.

Abbreviations

Abbreviation	Full form
BCSS	Behaviour Change Support Systems
CSCL	Computer-Supported Collaborative Learning
CSCW	Computer-Supported Collaborative Work
FBM	Fogg's Behavioural Model
PSD	Persuasive Systems Design

Chapter 1: Introduction

1.1 Background and Motivation

Learning is an ongoing process that occurs when people gain new knowledge or skills either as a result of education or life experience. It can be defined as "the acquisition of knowledge or skills through study, experience, or being taught"[1]. It can also be defined as "a process of change that occurs as a result of an individual's experience" (Mazur, 1998). Knowles (1973) defines learning as "the process of gaining knowledge and expertise", while Ambrose et al. (2010) define learning as "a process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning". Researchers have argued that learning is not only a process, but it is also a product. It is a process where learning takes place; and it is a product in terms of the outcome of the learning experience (Mazur, 1998).

In higher education, learning requires opportunities for exploration and practice, some space for thinking and reflecting, the potential for interaction with others, and learning with and from colleagues and professionals. Many students continue to higher education after finishing high school to carry on their learning journeys, with the hope of getting better careers in future. For instance, there were over two and a quarter million students in higher education in the UK for the year 2014/2015 (Higher Education Statistics Agency, 2015), and around one million and a half students in higher education in Saudi Arabia for the same year (Observatory on Education, 2015). Given these large numbers of students in higher education, there is significant interest in different methods that could enhance their learning experience and learning outcomes. Unsurprisingly many research publications and conferences are dedicated to the latest research and practice in education (e.g. Teaching and Learning, E-learning, and Technology-Enhanced Learning, Association for Learning Technology (ALT)).

[1] From Oxford dictionary: http://www.oxforddictionaries.com/definition/english/learning

Learning is an important research area that has been investigated through history. Many theories and models have been created to identify how learning happens and many tools and technologies have been developed to support learning.

1.1.1 Collaborative Learning

In education, people study different subjects and acquire different qualifications, and educational institutes use different techniques and methods to facilitate knowledge building, from very direct informative methods to more complex ones such as collaborative learning.

Collaborative learning has been identified as an effective approach to supporting the learning process (Smith & Macgregor, 1992; Dillenbourg, 1999; and Anderson & Lin, 2009). Alavi (1994) defines collaborative learning as the situation in which a small group of students work together as a team to complete an academic problem-solving task designed to support their learning. Smith and Macgregor (1992) describe collaborative learning as "an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together". On the other hand, Gokhale (1995) defines collaborative learning as "an instruction method in which students at various performance levels work together in small groups toward a common goal" and Dillenbourg (1999) describes collaborative learning as the situation in which a group of learners work together to complete a common task. Tiessen and Ward (1999) define collaboration in learning as "the process of creating new knowledge and involves communication through a shared artifact for the sake of creating a new understanding that the participants could not have achieved on their own". All these definitions of collaborative learning have the same concept in terms of the number of learners, which should be at least two learners, and what they do which is working together to complete some work.

In collaborative learning, the teacher usually becomes a facilitator instead of being the primary source of knowledge or control. Collaborative learning also has benefits for generic skills, such as the development of general communication abilities, empathy, and social skills (Bower & Richards, 2006).

There are different learning theories and approaches that can support and explain collaboration such as constructivist theory, project-based learning and the active learning method. Constructivist theory suggests that learners learn and construct their own knowledge from their experience; it is one of the most common learning theories and is a core concept of

many other learning approaches and methods (Schunk, 2012). Project-based learning is a student-centred pedagogical approach that has become popular and well-received in higher education. Project-based learning and collaborative learning are interrelated and important to each other for effective work in university courses (Lou & MacGregor, 2004). In active learning, students are involved in the learning process, while in traditional lectures they are likely to be passive learners (Hakimzadeh et al., 2011).

Dillenbourg et al. (1996) suggested three different learning theories that could be used to develop collaborative learning systems: socio-constructivist theory, socio-cultural theory, and shared cognition theory. Socio-constructivist theory focuses on the development of individual cognition through social interactions. This allows the individual to construct new cognitive levels by interacting with others and participating in particular social interactions. The socio-cultural approach concentrates on the relationship between social interaction and individual cognitive change. In shared cognition theory, the environment is an essential part of the cognitive activity and it involves both social and physical contexts and it takes into account the social communities of the collaborators.

In collaborative learning, students are responsible for their learning and for each other's learning, and the success of one student facilitates the success of the other students (Gokhale, 1995). Research has shown that collaborative learning has advantages over individual learning. For instance, Tiessen and Ward (1999) report that collaborative learning has more potential to facilitate knowledge construction than individual learning. Gokhale (1995) found that students achieved better scores in critical thinking in collaborative learning than individual learning. Moreover, according to Dillenbourg (1999), collaborative learning activates more learning mechanisms than individual learning such as knowledge elicitation, internalisation, and reduced cognitive load; these mechanisms can be activated by performing activities that require two learners or more, such as explanation, disagreement and mutual regulation.

On the other hand, some researchers have highlighted possible difficulties of collaborative learning. Bower and Richards (2006) identified drawbacks of collaborative learning including the fear of plagiarism or freeloading from inactive members in a group or the challenge of identifying individual efforts. Other difficulties from the lecturers' side were recognised such as it takes a lot of effort to design assignments that promote interaction and collaboration and becomes more difficult to manage if a group gets into trouble. Also, it is hard to know the

contribution of each student accurately and to be fair when allocating the marks (Bower & Richards, 2006).

Some literature has reported factors that influence success in collaborative learning. For example, Crook (1998) asserts that successful collaborations occur through three social interaction features: closeness and understanding among participants; full access to external resources (e.g. computers); and histories of joint activity between participants (i.e. friendship status). Similarly, Dillenbourg (2002) reports that the effectiveness of collaborative learning depends on several factors, such as the group structure, the task characteristics, and the communication media. One factor that has been reported as influencing the success of collaborative groups (i.e. not just in learning settings) more generally is the awareness that members have of each others' activities, known as "activity awareness" (Gutwin et al., 2004). This notion of activity awareness in collaborative learning is the focus of the research undertaken in this PhD. One of the difficulties of collaborative learning is when awareness of the activities of the group members is lacking specially in long-term collaboration (Carroll et al., 2003). In this thesis, I focus on solving the problem of lacking activity awareness in long-term collaboration.

Long-term collaboration is an elastic expression; it could refer to a week, several weeks, a month, several months, a year, or even longer. Lindstaedt and Schneider (1997) conducted two case studies of long-term collaboration: one for 9 months and the other one for 2 months. Convertino et al. (2004) conducted a study of long-term collaboration for 4 weeks. On the other hand, Blumen and Stern (2011) conducted a comparative study between short-term and long-term collaborations, where short-term collaboration was for around 30 minutes and long-term collaboration was for one week. Trochim (2002) states that a longitudinal study is one that takes place over time, with at least two (and often more) waves of measurement in a longitudinal design. A number of studies were conducted with at least two waves of measurement as described throughout this thesis. In this PhD, long-term collaboration refers to 1 to 2 months of collaboration.

1.1.2 Activity Awareness

Awareness is an umbrella term describing the up-to-date knowledge that people have about the situation of a specific environment. It is a complex concept that is vital in various

environments such as learning, training, air traffic control, medical, and military and can be described based on the context. In Human Computer Interaction (HCI) and Computer Supported Collaborative Learning (CSCL), awareness can be defined as "an understanding of the activities of others, which provides a context for your own activity" (Dourish & Bellotti, 1992).

One type of awareness is activity awareness, which is a widely adopted concept in studying collaboration. Carroll et al. (2006) define activity awareness as an active process in which different kinds of information are continuously shared, tested, and updated to guide group behaviour. Activity awareness is significant concept in collaborative learning in order to enable students to coordinate tasks effectively (Dourish & Bellotti, 1992). Activity awareness requires awareness of synchronous and asynchronous interactions over long periods of time (Convertino et al., 2004).

Another type of awareness that is commonly reported in collaborative environments is situation awareness. Endsley (1995) suggests three levels of situation awareness: the perception of elements in the environment; the comprehension of their meaning; and the projection of their status into near future. This concept of awareness is widely used in training, air traffic control, and military. However, in the learning context, situation awareness subsumes the concept of activity awareness (Carroll et al., 2003).

Other types of awareness have also been reported in collaborative environments, such as knowledge awareness and workspace awareness. The concept of knowledge awareness is used to enhance collaborations in collaborative learning environments by providing information for each learner about up-to-the-minute activities of other learners in a shared knowledge space (Ogata & Yano, 2000). This information helps to make the learner aware of someone with the same problem or knowledge, or with a different view about the problem or knowledge, or with potential to help in solving the problem. The concept of workspace awareness is used to support collaboration activities in a shared digital workspace by providing information about where people work, what they do, and what they will do next (Gutwin & Greenberg, 2004).

In this thesis, activity awareness in the context of collaborative learning groups is defined as the knowledge of what each member did, is doing, and is planning to do over the duration of the project. Convertino et al. (2004) state that many breakdowns in longitudinal collaboration happen because of a lack of activity awareness. To the best of my knowledge, there is a

limitation in existing studies looking at activity awareness, they were conducted in artificial settings, i.e. designed tasks and scenarios (e.g. Convertino et al., 2004), and therefore they were not representative of real learning projects. Therefore, the research reported in this thesis addresses this gap by studying activity awareness in real collaborative groups who are working in naturalistic settings i.e. in the wild. Naturalistic settings means that students work on real learning projects and decide how they collaborate and which applications and tools they will use in their collaboration without any external intervention.

1.1.3 Persuasive Technologies

Nowadays, technologies are integrated into our daily lives, as we use them in almost every activity at home, work, education, health, communication, entertainment, and in many other areas. Technologies play a significant role in education and learning and different kinds of technologies have been used to support collaborative learning including general-purpose applications (e.g. email, discussion forums (Phielix et al., 2010), blogs and user groups (Anderson & Lin, 2009)); and CSCL tools (e.g. Blackboard and Wimba Live Classroom (Carrington et al., 2010)). Most of these technologies are used to communicate (e.g. email), share documents and materials (e.g. Dropbox and email), track the work of a group (e.g. Blackboard), or distribute and allocate tasks, i.e. to support sharing of data and/or the functional activities of the group.

In recent years, innovative technologies such as persuasive technologies have also been used in learning and many other areas. Fogg (2003) defines persuasive technology as "any interactive computing system designed to change people's attitudes or behaviours or both, without using coercion or deception".

Within the area of learning, examples of persuasive technology have included SISATSpace (Firpo et al., 2009), the HANDS project (Mintz & Aagaard, 2012), Persuasive Learning and Technologies (PLOTs) (Behringer & Øhrstrøm, 2013), and persuasive technology to support self-directed learning of adults in organisations (Janssen, 2012). SISATSpace (Firpo et al., 2009) is a WordPress MU based system and it was designed to increase the sense of community among a group of students. They applied a number of persuasive features including social facilitation, social comparison, social learning, cooperation, competition, recognition, credibility, trustworthiness, expertise, and similarity. The HANDS project (Mintz & Aagaard, 2012) was designed for children with autism in special schools to

improve their social skills. In the HANDS projects, they employed the persuasive design elements of reduction, tunneling, tailoring, personalisation, self-monitoring, credibility, praise and rewards. Behringer and Øhrstrøm (2013) used Persuasive Learning and Technologies (PLOTs) in four real-world case studies covering different teaching and learning situations; these are: adult learning in industry, informal learning at a museum, literature studies, and language learning. In each case they used different persuasive features, for instance, they used tailoring and simulation in adult learning in industry and reduction, conditioning, and suggestion in language learning. Janssen (2012) suggested two prototypes to support self-directed learning; the first one was based on social comparison and the other one was based on social learning.

However, there has been no attempt to investigate and consider the use of persuasive technologies to support collaborative learning specifically. Therefore, my focus is to explore the potential of using a persuasive technology for this purpose.

Several models have been created to support the design of persuasive technologies, such as Fogg's design model (Fogg, 2009a) and the Persuasive Systems Design model (PSD) (Oinas-kukkonen & Harjumaa, 2009). Fogg (2009a) suggests an eight-step design process to follow in order to create a robust persuasive technology. The steps involve choosing a target behaviour, an audience, and a common technology channel, finding what prevents that behaviour, finding relevant examples, reproducing successful ones, testing and iterating quickly, and finally expanding on success.

The PSD model was proposed by Oinas-kukkonen and Harjumaa (2009) and it consists of two parts: the persuasion context and system characteristics. The persuasion context includes: defining the intent of persuasion, describing the event, and finally determining the strategies that will be used in the persuasion. Regarding system characteristics, the model focuses on the persuasive techniques that will be implemented in the persuasive technology and these fall into four categories: primary task support, dialogue support, system credibility support and social support.

1.2 Problem Definition

Collaborative learning environments have been investigated widely over the last 20 years, and many technologies have been developed to help students during their collaboration. Many of these technologies are used to support the actual collaborative activities (e.g.

Blackboard (Carrington et al., 2010)). They focus on enabling students to communicate, share materials, and collaborate; or they produce notifications when someone completes a task or adds new inputs. These technologies tend to be heavyweight and comprehensive. In general, limited attention has been paid to promoting activity awareness in the collaborative learning literature. The work that does exist has focused on enhancing activity awareness by capturing and sharing details of the activity (e.g. Ganoe et al., 2003; Carroll et al., 2003). In contrast, there are no technologies that focus on the learners and their attitudes to collaboration without considering the functional aspects of the group's work. Moreover, no studies have explored collaborative learning in long-term learning projects in naturalistic settings and or evaluated students' activity awareness over the course of such projects.

In this PhD, I hypothesise that persuasive technologies can offer a novel way of promoting activity awareness by changing learners' attitudes and behaviours and persuading them to be more aware of fellow group members' activities. Therefore, this research has investigated an alternative approach to accomplish the outcome of enhancing activity awareness – by using persuasive technology to change the attitudes and behaviours of the learners. Figure 1.1 describes areas covered in this research.

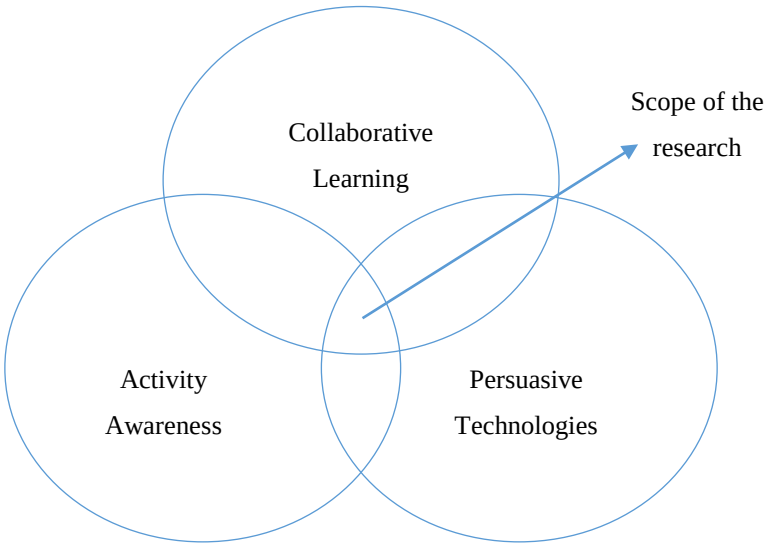


Figure 1.1: Research scope

The scope of this research is focused on persuasive technologies to promote activity awareness in collaborative learning groups. In the context of this thesis, collaborative learning groups are small groups of students who are working on learning projects for several

weeks and who practice both co-located and remote collaboration in naturalistic settings. In higher education, it is common for the syllabus of subjects such as computer science to incorporate collaborative group projects that run over several weeks. The empirical work undertaken here has been with students who are working on real group projects as part of their academic study.

1.3 Research Aim, Questions, and Objectives

The overall aim of this research was to investigate a new approach to supporting students who are working on long-term collaborative projects by promoting their activity awareness, through the use of persuasive technology. Five research questions addressed this aim:

RQ1: How do students collaborate in long-term collaborative learning groups? This has four sub-questions:

> ***RQ1.1:*** What collaboration styles and activities are identified in long-term collaborative learning groups?
>
> ***RQ1.2:*** What awareness behaviours and awareness types are exhibited in long-term collaborative learning groups?
>
> ***RQ1.3:*** What applications and tools do groups use during meetings and for collaboration outside of meetings?
>
> ***RQ1.4:*** What problems do students encounter during their collaboration?

RQ2: How can activity awareness be measured in long-term collaborative learning groups?

RQ3: What activity awareness do group members have in long-term collaborative learning groups?

RQ4: How can a persuasive social actor for activity awareness in long-term collaborative learning groups be designed and evaluated? It has three sub-questions:

> ***RQ4.1:*** How can a persuasive social actor for activity awareness in long-term collaborative learning groups be designed?
>
> ***RQ4.2:*** How can the success of the persuasive social actor be evaluated from the users' point of view?

RQ4.3: How can the success of the persuasive social actor be evaluated from expert reviews?

RQ5: Can a persuasive technology support students' activity awareness in long-term collaborative learning projects?

The research questions were addressed through the following main research objectives:

O1: To identify how students collaborate in long-term collaborative learning groups, which includes the following sub-objectives:

O1.1: To identify collaboration styles and activities.

O1.2: To identify awareness types and behaviours.

O1.3: To identify applications and tools used during meetings and for collaboration outside of meetings.

O1.4: To identify problems that students encounter while they are collaborating.

O2: To develop a method to measure the level of students' activity awareness in learning groups.

O3: To investigate activity awareness in long-term collaborative learning groups.

O4: To design and evaluate a persuasive social actor based on the Persuasive Systems Design model in order to promote activity awareness in long-term collaborative learning groups.

O5: To investigate the potential of using persuasive technologies to support students' activity awareness in their long-term collaborative learning projects.

The research questions and objectives are addressed in chapters 3 to 7 of this thesis as presented in Table 1.1:

Table 1.1: Research questions and objectives in each chapter

Research question	*RQ1*	*RQ2*	*RQ3*	*RQ4*	*RQ5*
Objective	*O1*	*O2*	*O3*	*O4*	*O5*
Chapter	3 & 4	4, 5 & 7	4, 5 & 7	6 & 7	7

1.4 Approaches and Methods Used in This Doctoral Research

This research is divided into two parts: exploratory research and persuasive technologies research. The exploratory research includes three studies to explore collaboration and activity awareness in collaborative learning groups. Then, research on persuasive technologies was conducted based on the behaviour change support system (BCSS) framework suggested by Oinas-Kukkonen (2010) which is described later in this section.

At the beginning of this PhD, the focus was on collaborative learning in general. A small pilot study was conducted to understand how students collaborate and to find out what problems students encounter during their collaboration (Chapter 3). Interviews were used for data collection and conducted with seven participants who had worked on a collaborative learning project. A general inductive analysis was applied to derive themes from the collected data. In an inductive analysis, a detailed reading of raw data is used to develop themes, concepts, or a model (Thomas, 2006). All interview transcripts were read several times to identify themes (see Figure 1.2). Although data were limited, there were some interesting findings. Results showed that some problems in collaboration arose due to a lack of awareness; for example, group members duplicated work or they did not reply to messages or emails from other members. This study started to answer part of the first research question RQ1 and the first objective O1.

Based on the results from the pilot study, an observational study was conducted to investigate activity awareness in depth, as well as to explore collaboration activities and awareness behaviours in learning groups (Chapter 4). The study also measured activity awareness in groups. Three data collection methods were used: questionnaires, interviews, and observations. Data were collected over a 6-week period. This study employed a mixed qualitative and quantitative approach. Qualitative data sources included transcripts of interviews with students and field notes of observations of group meetings. Quantitative data included group report grades and students' responses to a Likert-scale questionnaire about their awareness and satisfaction with their learning experience as well as their learning preferences. A general inductive analysis was applied to derive themes from the collected qualitative data (see Figure 1.2). Results showed that activity awareness varied over time for these groups and students were not always fully aware of each others' activity. This study helped to answer part of the first 3 research questions: RQ1, RQ2, and RQ3, along with their mapped objectives: O1, O2, and O3.

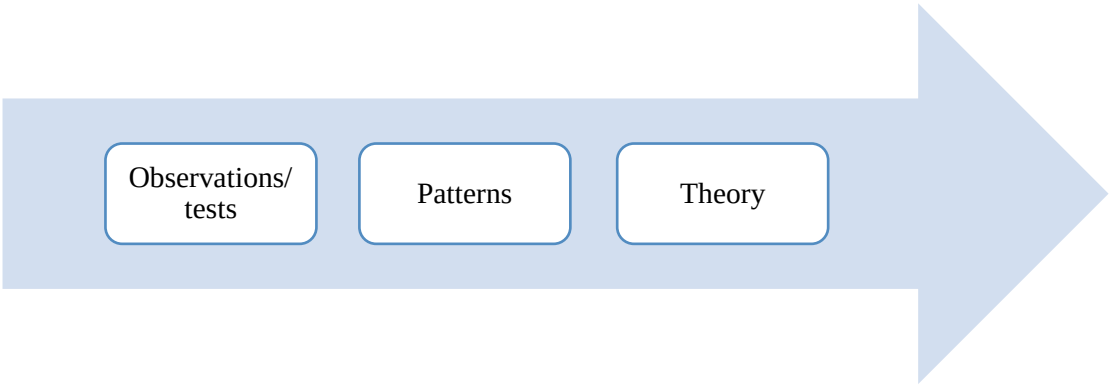


Figure 1.2: Inductive approach

A third study was then conducted and studied a similar collaborative learning situation (Chapter 5); this time the aim was to validate the application of the method for measuring activity awareness, which had been proposed in the second study. Data were collected through questionnaires and interviews over a 6-week period. There was no observation this time as the focus was only on validating the method of measuring activity awareness. This study also employed a mixed qualitative and quantitative approach. Qualitative data sources included transcripts of interviews with students; and quantitative data included group report grades and students' responses to a Likert-scale questionnaire about their awareness and satisfaction with their learning experience. Participants were students involved in a collaborative learning project. Results again showed that students were not always fully aware of their colleagues' activity awareness. The method for evaluating activity awareness was also refined as part of this study and a set of rules was created to ensure that the method was rigorous and reliable. This study was used to answer part of the second and third research questions: RQ2 and RQ3, along with their mapped objectives: O2, and O3.

Distilling the results of these three studies framed the remainder of the PhD. Results showed that students' activity awareness was variable over the duration of their projects. Various technologies have been used to support collaborative learning in other research, and some of these studies have focused on promoting activity awareness. However, none of these studies have focused on promoting activity awareness by changing students' behaviours without considering the functional aspects of the group's work. Therefore, I decided to investigate the use of persuasive technology to promote students' activity awareness, as the main concept of persuasive technology is changing users' behaviours and/or attitudes without coercion or deception.

Oinas-Kukkonen (2010) defines a behaviour change support system (BCSS) as "an information system designed to form, alter or reinforce attitudes, behaviours or an act of complying without using deception, coercion or inducements". He suggests a five-step process model for conducting research on behaviour change support systems (BCSS):

1. *Select the theoretical basis for research.*
2. *Analyse the intent through the O/C Matrix (Outcome/Change).*
3. *Analyse the BCSS through the PSD model (Persuasive Systems Design).*
4. *Measure the behaviour change.*
5. *Explain the change through the theories, the O/C Matrix, and the PSD Model.*

This model was followed in the later stages of this doctoral research to conduct research on persuasive technologies for activity awareness in learning groups. The first step of the model is to choose supportive theories for the research. This is followed by analysing the intent of change using the O/C Matrix, which suggests three potential outcomes: the formation, alteration or reinforcement of three change types: attitudes, behaviours, or complying. The third step is to analyse the BCSS using the PSD model, which includes analysing the persuasion context and the software system characteristics. The final steps are to measure the behaviour change and explain the change based on the chosen theories, the O/C Matrix, and the PSD model. Each step is described in detail later on in Chapters 6 and 7.

Thus, a novel approach was investigated to promote activity awareness in collaborative learning groups by using persuasive technology to change learners' behaviours. Accordingly, a persuasive social actor was designed and developed for this purpose in the form of an iPhone app (Chapter 6). Finally, an empirical study was conducted to test this social actor app (Chapter 7). In this study, a deductive analysis was applied to test the hypothesis that using a persuasive social actor will promote learners' activity awareness (see Figure 1.3).

A repeated-measures design was employed: all participants were provided with the social actor app and comparisons were made between participants' attitudes and behaviours at baseline and after using the app. Self-reported measures were taken to measure perceived persuasiveness and behavior change. Ethics considerations dictated that students participating in the study were not advantaged or disadvantaged relative to each other. This imposed the constraint that it was not possible to run a comparative study in which some participants used the app while others did not.

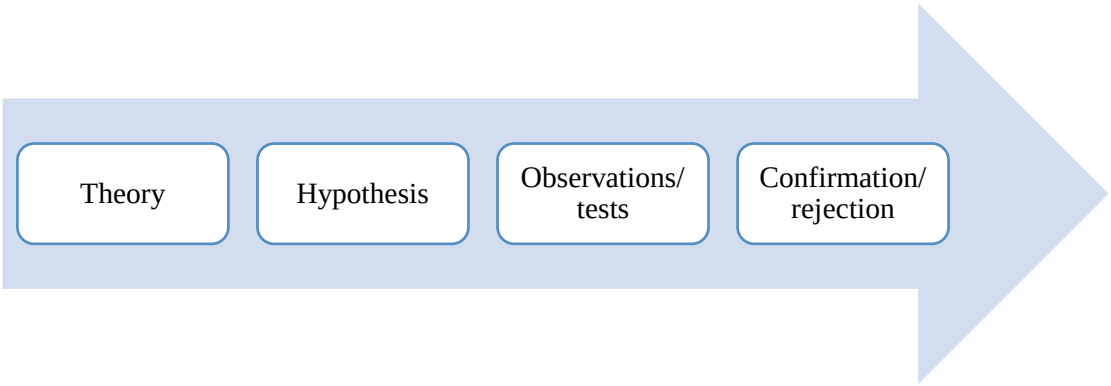


Figure 1.3: Deductive approach

Two data collection methods were used: questionnaires and interviews to collect mixed qualitative and quantitative data. Qualitative data sources included transcripts of interviews with students and open-ended questions from the questionnaires. Quantitative data included students' responses to Likert-scale questionnaires. Results showed that persuasive technologies could influence students' attitudes and behaviours and promote their activity awareness.

For all studies, the participants were a convenience sample and ethical approval was granted from the School of Mathematics, Computer Science, and Engineering of City, University of London to conduct the studies.

1.5 Contributions

This research makes four main contributions to the field of HCI and persuasive technologies. Table 1.2 summarises contributions, research questions and objectives according to the chapter where they are addressed. The contributions are:

1. The main contribution is presenting a novel approach to enhance or maintain activity awareness in collaborative learning groups by changing learners' attitudes and behaviours using a persuasive social actor. (Chapters 6 & 7)
2. The research proposes a new method to study activity awareness, by conducting interviews at different intervals across the duration of the project, and provides a structured framework to evaluate the level of activity awareness. (Chapters 4, 5, & 7)
3. The research gives insights into designing and evaluating a persuasive social actor using the Persuasive Systems Design (PSD) model. (Chapters 6 & 7)

4. The research contributes to the existing research on collaborative learning, specifically long-term collaborative groups who worked in naturalistic settings and the collaboration activities and behaviours that support awareness. (Chapters 3 & 4)

Table 1.2: Research questions, objectives and contributions in each chapter

Research question	*RQ1*	*RQ2*	*RQ3*	*RQ4*	*RQ5*
Objective	*O1*	*O2*	*O3*	*O4*	*O5*
Contribution	4	2 & 4	2	1	1, 2, & 3
Chapter	3 & 4	4, 5 & 7	4, 5 & 7	6 & 7	7

1.6 Published Papers

Two papers have been published and peer reviewed based on the research undertaken in this thesis. These papers are in Appendix F.1 and F.2:

Al Ashaikh, R., Wilson, S, & Jones, S. (2016). A Persuasive Social Actor for Activity Awareness in Learning Groups. *In: BCS Learning and Development Ltd. Proceedings of British HCI 2016 - Fusion, Bournemouth, UK.*

Al Ashaikh, R., Wilson, S., & Jones, S. (2014). Exploring Awareness Behaviours and Collaboration Activities in Learning Groups. *In: BCS Learning and Development Ltd. Proceedings of HCI 2014, Southport, UK.* 376–377.

1.7 Thesis Structure

This chapter has provided the motivation for investigating the use of a social actor in promoting activity awareness in collaborative learning groups and has given some background in the areas of collaborative learning, activity awareness, and persuasive technologies. These underpinning concepts are expanded in Chapter 2. It has also presented the aim, research questions and objectives; and has highlighted the main contributions to the field of HCI. The remainder of this thesis is structured as follows:

Chapter 2: Literature Review. This chapter presents an overview of the literature on collaborative learning, awareness, and technologies. It gives a deep understanding of the published research related to the topic.

Chapter 3: Exploring Collaborative Learning Groups – pilot study. This chapter presents a detailed report of the pilot study. It includes the motivation for conducting the study, and methods used in data collection and analysis. It also discusses results and highlights the limitations of the study. It helps in answering three sub-question of the first research question *RQ1*: *RQ1.1, RQ1.3* and *RQ1.4,* and to meet sub-objectives of the first objective *O1*: *O1.1, O1.3* and *O1.4.*

Chapter 4: Exploring Awareness Behaviours and Collaboration Activities in Learning Groups. This chapter presents an exploratory study in detail including motivation, methodology, results, and discussion. It helps in answering the first three research questions *RQ1* (particularly *RQ1.1, RQ1.2* and *RQ1.3*), *RQ2,* and *RQ3,* and to meet the first three objectives *O1* (particularly *O1.1, O1.2* and *O1.3*), *O2,* and *O3.*

Chapter 5: Evaluating Activity Awareness in Learning Groups. This chapter presents a follow-up study to evaluate activity awareness. It includes motivation, methodology, results, and discussion. It helps in answering the second and third research questions *RQ2,* and *RQ3,* and to meet objectives *O2,* and *O3.*

Chapter 6: The Design of the Social Actor. This chapter presents the design and development of the social actor. It helps in answering one sub-question of the fourth research question *RQ4*: *RQ4.1,* and to meet objective O4.

Chapter 7: A Persuasive Social Actor for Activity Awareness in Learning Groups. This chapter presents an empirical study in detail including motivation, methodology, results, and discussion. It helps in answering four research questions *RQ2, RQ3, RQ4* (*RQ4.2* and *RQ4.3*) and *RQ5,* and to meet objectives *O2, O3, O4* and *O5.*

Chapter 8: Discussion and Conclusion. This chapter provides a further discussion on the thesis and draws a conclusion.

Chapter 2: Literature Review

This PhD is primarily located within the discipline of HCI but draws on others, such as: learning, collaborative learning, learning styles and theories, awareness, CSCW/CSCL, technologies used in collaborative learning and awareness, and persuasive technologies. In this chapter, these topics are reviewed. First, learning is introduced briefly, and then it talks about a specific type of learning, which is collaborative learning, and presents learning theories that are related to collaborative learning, the significance of collaborative learning over other types of learning, advantages and potential disadvantages of collaborative learning, and then reviews some learning styles. Then, a detailed report on awareness is provided, and some key awareness types that associated with collaborative learning are described. Finally, technologies that used in collaborative learning and awareness were reviewed, and then a detailed summary of persuasive technologies with some examples of their use is presented.

As this PhD research was focused mainly on three topics: collaborative learning, activity awareness, and persuasive technologies, the literature review reflects these topics with a broader view. In learning section, a number of learning theories related to collaborative learning were reviewed, but not all general theories of learning were reviewed as they were not relevant to the research and not useful to the purpose of the thesis. In awareness section, awareness types that related to collaboration and collaborative learning were reviewed as they found useful to the purpose of the thesis. Awareness types such as context-awareness, health awareness, and drug awareness were not reviewed as they were unrelated to collaboration and out of the scope of this thesis. In technologies section, a number of existing technologies for collaborative learning or for awareness were reviewed to enrich the literature on technologies and to define the gap. Persuasive technologies were reviewed to understand what they are and how to design and use them, in order to help me in developing the social actor for activity awareness.

2.1 Learning

Many students continue to higher education after finishing high school to carry on their learning journeys, with the hope of getting better careers in the future. For instance, there were over two and a quarter million students in higher education in the UK for the year 2014/2015, which is 3.48% of the population (Higher Education Statistics Agency, 2015), and around 1 million and a half students in higher education in Saudi Arabia for the same year, which is around 4.7% of the population (Observatory on Education, 2015). Given these large numbers of students in higher education, there is significant interest in different methods that might enhance their learning experience and learning outcomes. Unsurprisingly many research and conferences are dedicated to the latest research and practice in education (e.g. Teaching and Learning, E-learning, and Technology-Enhanced Learning, Association for Learning Technology (ALT)).

2.1.1 What is Learning?

While learning is not the primary focus of this research, some of the most influential definitions of learning are summarised here. Knowles (1973) defines learning as "the process of gaining knowledge and expertise." From the view of psychology, learning can be defined as "a process of change that occurs as a result of an individual's experience" (Mazur, 1998). Most of the psychological scientists used this definition for learning where the keyword is the change (Mazur, 1998). Gagne (1985) defines learning as "a change in human disposition or capability that persists over a period of time and is not simply ascribable to processes of growth". Moreover, Ambrose et al. (2010) define learning as "a process that leads to change, which occurs as a result of experience and increases the potential of improved performance and future learning". Smith (1992) expands the definition of learning to refer to "the acquisition and mastery of what is already known about something, the extension and clarification of meaning of one's experience, or an organised, intentional process of testing ideas relevant to problems". From another view, the Oxford dictionary defines learning as "the acquisition of knowledge or skills through study, experience, or being taught". These definitions either rely on "change" or "knowledge acquisition" as keywords for defining learning.

Some scientists argue that learning is not only a process, but it is also a product. It is a process where learning takes place; and it is a product in terms of the outcome of the learning

experience (Mazur, 1998). For example, Smith (1992) states that learning can be a product, a process, or a function. On the other hand, some researchers (e.g. Ambrose, et al., 2010) argue that learning is only a process, not a product, and because this process happens in the mind, the only way to know that it has occurred is from students' products or performances.

2.1.2 Collaborative Learning

Collaborative learning has been reported to be an effective approach to supporting the learning process (Dillenbourg, 1999; Anderson & Lin, 2009). First, collaboration in general is defined and compared it to cooperation, and then collaborative learning is described. One influential definition of collaboration is presented by Roschelle and Teasley (1995): they define collaboration as "a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem". Adding to that definition, Lipponen (2002) states that collaboration can be defined as any activity performed by pairs or groups and can be described as "a process of participating in knowledge communities".

Engeström (1992) categorised the level of interaction in any collaborative work situation into three levels: coordination, cooperation, and reflective communication. The coordination level describes the role and actions of each member. In the cooperation level, members attempt to solve a common problem by conceptualising it. In reflective communication, members concentrate on reconceptualising their own interactions. The cooperation level defined by Engeström (1992) matches the definition of collaboration given by Roschelle and Teasley (1995). Likewise, Lipponen (2002) states that collaboration can be described as "a special form of interaction". In some literature, cooperation and collaboration are treated the same, but Roschelle and Teasley (1995) differentiate between them: in cooperation, each member is responsible for completing a specific task, while in collaboration, members work together to solve a problem.

Collaborative learning is described as the situation in which a small group of students work together as a team to complete an academic problem-solving task designed to support their learning (Alavi, 1994). Moreover, Gokhale (1995) defines collaborative learning as "an instruction method in which students at various performance levels work together in small groups toward a common goal" and Dillenbourg (1999) describes collaborative learning as the situation in which a group of learners work together to complete a common task. Tiessen

and Ward (1999) define collaboration in learning as "the process of creating new knowledge and involves communication through a shared artifact for the sake of creating a new understanding that the participants could not have achieved on their own". This definition indicates that collaborative learning has more potential to facilitate knowledge construction than individual learning.

These definitions of collaborative learning share the same concept in which there should be at least two learners and they work together to complete some work. However, acquiring new knowledge or sharing new understanding is not clearly acknowledged in some definitions.

In collaborative learning, students are responsible for their learning and for each other's learning, and the success of one student facilitates the success of the other students (Gokhale, 1995). Some literature has suggested different ways to construct a successful and effective collaborative learning situation. For example, Crook (1998) asserts that successful collaborations occur through three social interaction features: closeness and understanding among participants; full access to external resources (e.g. computers); and histories of joint activity between participants (i.e. friendship status). Similarly, Dillenbourg (2002) reports that the effectiveness of collaborative learning depends on several factors, such as the group structure, the task characteristics, and the communication media. The group structure involves group size, age, gender, and heterogeneity.

Some researchers have assumed that collaborative learning usually includes some collaborative activities within an educational environment, for instance, studying a course material (Dillenbourg, 1999). "Collaborative activities enhance learning by allowing individuals to exercise, verify, solidify, and improve their mental models through discussions and information sharing during the problem-solving process" (Alavi, 1994).

2.1.2.1 Learning Theories and Approaches

Many theories have been created to support and explain learning. These come from behaviourist, cognitive, and constructivist viewpoints. In higher education, students should take a significant responsibility for their learning. Many learning theories were used and discussed in higher education or adult learning such as experiential learning and self-directed learning. Experiential learning is based on the constructivist theory, in which learners learn from experience. Kolb presented a learning model which is focused on the nature of experiential learning to define learning styles, as reviewed in the next section (2.1.3).

Knowles (1984) coins the term andragogy for adult learning. Initially, he defined andragogy as the 'art and science of helping adults learn' (Knowles, 1984). Then after decades of work, he redefined andragogy to have five principles:

- *"As a person matures he or she becomes more self-directed.*
- *Adults have accumulated experiences that can be a rich resource for learning.*
- *Adults become ready to learn when they experience a need to know something.*
- *Adults tend to be less subject-centred than children; they are increasingly problem-centred*
- *For adults the most potent motivators are internal."*

Dillenbourg's (1999) theory of collaborative learning involves four items: the situation, interactions, processes and effects. He claims that the key for understanding collaborative learning is in the relations among these four items. Accordingly, the situation generates interactions types; and these interactions activate process and mechanisms, which then produce effects as a result. The collaborative situation usually affected by two scales: group size and time span. The group size could be pairs, a small group of 3-5, or a larger group (e.g. society); and the time span could be an hour, day, week, month, or even years (Dillenbourg, 1999). A long-term collaborative learning project is any group project designed for learning purposes that lasts for several weeks or months, in which group of students work together to solve a given problem or task. Hence, the situation of this collaborative learning is affected by time span, which is several weeks or months.

There are different learning theories and approaches that can support collaboration such as constructivist theory, project-based learning and the active learning method. Dillenbourg et al. (1996) suggested three different learning theories that could be used to develop collaborative learning systems: socio-constructivist theory, socio-cultural theory, and shared cognition theory.

Socio-constructivist theory focuses on the development of individual cognition through social interactions. The development of a learner cognitive happens through interacting with others and participating in particular social interactions. As a result, it allows the individual to construct new cognitive levels. The socio-cultural approach concentrates on the relationship between social interaction and individual cognitive change. In the shared cognition theory, the environment is an essential part of the cognitive activity and it involves both social and physical contexts and it takes into account the social communities of the collaborators.

Another learning approach is that of project-based learning, which is a student-centred pedagogical approach and it becomes popular and preferable in higher education. Project-based learning and collaborative learning are very interrelated and imperative to each other for an effective work in university courses. The facilitation of group working structures is considered as an important element in the implementation of project-based learning (Lou & MacGregor, 2004).

In active learning, students are involved in the learning process, while in traditional lectures they are likely to be passive learners (Hakimzadeh et al., 2011). Active learning is "any instructional method that engages students in the learning process" (Prince, 2004). Furthermore, active learning methods enhance students learning and retention (Hakimzadeh et al., 2011).

Bagley and Chou (2007) state that collaborative and cooperative learning environments are effective teaching strategies as they support learning through social interactions. Moreover, they confirmed that collaboration is an important pedagogy to use in teaching computer science and in performing java programming.

From a social constructivist perspective, Salomon (1993) confirms that collaboration between students is likely to encourage participation, and enhance the mutual development of knowledge.

2.1.2.2 Significance of Collaborative Learning

First, literature that highlights the significance of collaborative learning are reviewd, and then literature on making comparisons between individual learning and collaborative learning is presented. According to Anderson and Lin (2009), collaborative learning is an effective method to enhance the learning experience. Several studies have reported on the effectiveness and benefits of collaborative learning. Some supporters of collaborative learning have stated that collaborative learning increases the interest in exchanging ideas within small groups as well as encouraging critical thinking. In collaborative learning, students have the chance to be engaged in discussion and be responsible for their own learning (Gokhale, 1995).

Lou and MacGregor (2004) conducted an exploratory study to investigate how between-groups collaboration could improve the knowledge co-construction and performance on project-based learning tasks undertaken by collaborative learning groups. The findings were based on two case studies; the first one focused on between-group mentoring and the second

one on between-group project reviews. Both approaches were highly accepted by the students and had a positive influence on their collaborative learning skills, the acquired knowledge shown in their online dialogue, and the project performance of all students.

Gokhale (1995) investigated the effectiveness of individual learning as compared to collaborative learning in enhancing drill-and-practice skills and critical thinking skills. The findings illustrated that students who worked collaboratively achieved better scores in the critical thinking test than students who worked on their own, while both groups got equal scores on the drill-and-practice test. Johnson and Johnson (1986) showed that collaborative groups reach higher levels of thinking and retain information longer than individual students.

Dillenbourg (1999) compared between individual learning and collaborative learning in terms of their mechanisms and the activities needed to trigger these mechanisms. Individual learning activates some learning mechanisms such as induction, deduction, and compilation. These mechanisms can be activated by performing some individual activities such as reading, building, and predicting. Likewise, collaborative learning activates certain learning mechanisms such as knowledge elicitation, internalisation, and reduced cognitive load, which can be activated by performing activities that require two learners or more, such as explanation, disagreement and mutual regulation. These mechanisms and activities could occur more often in collaborative learning than in individual learning situations. However, there is no guarantee that these mechanisms will be activated in collaborative learning and the challenge is how to develop techniques to promote these interactions (Dillenbourg, 1999).

Magney (1996) conducted a study on the use of cooperative learning with faculty members in the College of Technical Careers at Southern Illinois-Carbondale (SIUC) and a sample of the membership of the American Technical Education Association (ATEA). Some instructors reported that students in groups achieve higher grades, learn more and learn more quickly than students working individually. Results showed that working in a group enhanced student learning of the course content and promoted the development of student skills in group processes and participation in courses.

2.1.2.3 Potential Disadvantages of Collaborative Learning

The disadvantages of collaborative learning are relatively minor as compared to its advantages. Some researchers have highlighted possible disadvantages of collaborative learning. Bower and Richards (2006) conducted a survey covering several aspects of teaching

and student learning. The participants were undergraduate computing students. In the survey, students identified potential benefits of collaborative learning, such as minimising frustration when they are stuck, having better understanding, and seeing different viewpoints. However, some disadvantages of working in groups were also recognised, including: distractions and conflicts that could occur between members, and it being less time efficient. Students also stated that they cannot choose their own pace, or focus on concept formation/difficult problems if they are working in groups.

From the lecturers' perspective, they are concerned about plagiarism or freeloading from inactive members in a group and about the challenge of identifying individual efforts. It also takes a lot of effort to design assignments that promote interaction and collaboration and it becomes more difficult to manage if a group gets into trouble. Also, it is hard to know the contribution of each student accurately and to be fair when allocating the marks (Bower & Richards, 2006).

In the study conducted by Magney (1996), instructors highlighted some problems of collaborative learning, which included time management and coverage of material, marking policies, and free-riding by group members. Moreover, in long-term collaborative learning, students might fail in their collaboration if they are not aware of their group's activities (Convertino et al., 2004).

2.1.3 Learning Styles

A learning style can be described as the way that an individual perceives and processes information (Grant, 2003). Geisert and Dunn (1991) define learning styles as: "one's learning style is composed of consistent patterns of how an individual begins to concentrate on, process, internalise, and remember new and different information. To identify a person's learning style, one must examine each individual's multi-dimensional characteristics to determine what is most likely to trigger and maintain each person's concentration and cause the person to respond to his natural processing style and retain the information in long-term memory."

There are more than 70 learning styles theories and models (Dureva & Tuparov, 2008). Some of the most popular models are Kolb's Learning Styles Inventory, Felder-Silverman Learning Styles Model, Gardner's Multiple Intelligence Inventory, and Reid. For example, Felder-

Silverman model consists of four scales: Active – Reflective; Sensing – Intuitive; Visual – Verbal; and Sequential – Global (Dureva & Tuparov, 2008).

Brown et al. (2007) implemented a "Visual – Verbal" learning styles scale for the user model in an existing AEH (Adaptive educational hypermedia) system, however, it suffered from several problems. So they had to use "Sequential – Global" learning styles as the user model in AEH system because there are several studies that showed positive results when this model was used with students.

In conclusion, differentiation between learning styles, learning style scales, and learning style models is highlighted as following:

- Learning styles are the basic components defining the individual's way of receiving and processing information, e.g. visual, auditory, and kinesthetic.
- Learning style scales are the range of different styles from the same dimension, e.g. Visual – Verbal; Sequential – Global.
- Learning style theories or models are the frameworks in which different learning styles and scales are used, e.g. Kolb's Learning Styles Inventory, Felder-Silverman Learning Styles Model.

Ivanova and Ivanova (2009) argued that the new generation of students, known as Net-Generation or Net-Gen, are different from previous generations in terms of their attitudes towards learning, and thus research into learning styles now becomes significant. They reviewed the current research into Net-Gens' learning style and indicated some key steps and strategies that are needed to prepare universities to educate the Net-Generation. One of the suggested strategies is "Enabling First-Person Learning, Interaction and Collaboration". Therefore, collaboration in learning could be used as a new learning style for forthcoming generations.

Several factors determine the kind of collaborative style in learning environments, such as the characteristics of learners (age, gender, group size), their relationship, and the nature of the task or the context (Dillenbourg & Self, 1995).

Zander et al. (2009) conducted a test where students were asked to decide which learning style was suitable for them in learning mathematics and programming. The Felder-Silverman learning styles were used. Overall students preferred the reflective style in learning mathematics and the active style in learning programming. They also assumed that learning

mathematics has a strong verbal style, while learning programming is mainly visual. Therefore, learning style might be affected by the subject or content.

Krichen (2009) states that "learning styles play a crucial role in the effectiveness and satisfaction of the learning experience". He highlighted the importance of learning styles in online learning environments and discussed different learning style models, as follows:

- The Canfield Learning Style Inventory, which presents an operational perspective to learning styles, explains scales that support interaction characteristics.
- Kolb's learning model is focused on the nature of experiential learning to define learning styles. Kolb cycle consists of four aspects of learning through which individuals should navigate to achieve the best learning: concrete experiential, reflective observation, abstract conceptualisation and active experimentation.
- Dunn and Dunn's model includes both the cognitive and pragmatic elements of identifying learning styles. It incorporates 21 aspects of learning subdivided into five categories, which include environment aspects, emotional aspects, sociological aspects, physiological aspects and psychological aspects of the learning context.

Some researchers discovered that reflective global learners did better in online courses than active sequential learners and this was unexpected results from Kolb's and Felder's perspectives. This might be an indication of the complexity of the relationship between learning styles, and learner satisfaction and learning outcomes (Krichen, 2009).

Stash et al. (2004) introduced a tool to allow authors to use different learning styles in their adaptive educational hypermedia applications. This tool is an interface between classical learning styles and instructional strategies and the modern field of adaptive educational hypermedia. There are some learning systems that use learning styles, such as iWeaver and MANIC.

Bruhn and Burton (2003) illustrated the use of studio teaching in Java programming. Students learn by three learning styles: auditory, visual, and kinetic. They practiced the programming concepts in the classroom on the computer as the instructor presents them. This method can help students to better understand Java programming concepts during classroom presentations. The studio teaching has some disadvantages; such as it is costly to provide labs with computers and time needed to present the material to the students as well as more time for students to practice programming concepts on the computer in class.

2.2 Awareness

Awareness is a complex concept that is critical in various environments such as learning, training, air control, medical, and military. In general, awareness requires the up-to-date knowledge about the situation of a specific environment. In this section, awareness is described and some of the key types of awareness that usually involved in collaborative learning context are reviewed.

2.2.1 Awareness Definition and Characteristics

Awareness is a very broad concept and can be described based on the context. In the context of HCI and CSCL, awareness can be defined as the understanding of the activities of others, which then provides a context for one's own activity (Dourish & Bellotti, 1992).

Gutwin and Greenberg (2004) outline four basic characteristics of awareness: first, awareness is knowledge about the situation of a specific environment; second, it should be updated as environments change over time; third, people interact with the environment to maintain their awareness; and finally, maintaining awareness is a secondary goal where the main goal is to complete some tasks in the environment.

A good level of awareness can support people to make their communication simpler, have opportunities to help each other, be able to coordinate tasks, and have an access to shared resources (Nacenta et al., 2007). Hornecker et al. (2008) suggested that awareness could be considered as both a product and process.

The awareness concept is considered and used in many areas. Different terminologies were used in conjunction with the word "awareness", such as situation awareness, activity awareness, and knowledge awareness. The meaning of each awareness concept depends on the context and the goal of awareness.

2.2.2 Awareness Types

In collaborative learning environments, awareness is a useful concept in promoting collaboration opportunities and improving the effectiveness of collaborative learning (Paletta & Herrero, 2011). Moreover, awareness is a crucial aspect of any collaborative work, and working for several weeks on different tasks requires a good level of awareness.

Some awareness types are overlapped or similar and can be treated the same in some cases. For instance, situation awareness includes activity awareness in learning context. Several types of awareness were reported in the literature, such as activity awareness, knowledge awareness, workspace awareness, group awareness and situation awareness.

2.2.2.1 Activity Awareness

Activity awareness is a requirement for effective communication, planning, coordination, decision-making, and actions during long-term collaboration and it also involves collaborators' ability to perceive and maintain "the big picture" of the ongoing collaboration (Convertino et al., 2004).

Carroll et al. (2006) define activity awareness as an active process in which different kinds of information are continuously shared, tested, and updated to guide group behaviours. Activity awareness requires awareness of synchronous and asynchronous interactions over long periods of time (Convertino et al., 2004). Brons et al (2010) define activity awareness as "the knowledge of what one's collaborators are doing and expectations of what they are going to do directed at specific goals and objectives that promotes the coordination and integration of interdependent activities".

Activity awareness affects group activity that takes place over an extended period of time. In order to maintain awareness of the whole activity, group members must develop and maintain common understanding of shared plans, goals, roles, and norms; monitor the resources over time; and stay aware of the actual status of the execution of the group activity and its relationship with the previous aspects (Convertino et al., 2004).

My definition of activity awareness in the context of collaborative learning includes the knowledge of what other group members did, are doing, and are planning to do throughout the project.

Carroll et al. (2006) described a framework for understanding activity awareness for long-term collaborative work that includes four aspects: common ground, communities of practice, social capital, and human development. They confirmed that collaborators should be aware of each other in all four aspects to work and learn in an effective way. Convertino et al. (2004) state that many breakdowns in longitudinal collaboration happen because of a lack of activity awareness and they suggested a method to evaluate activity awareness and collaborative activities in a controlled setting. This method has three major properties:

1. The use of reliable tasks and collaborative situations
2. The use of a confederate
3. The use of several collaborative sessions over time

They conducted an experimental study in the laboratory where participants grouped in pairs and worked on a long-term project over several experimental sessions for 4 weeks. Each pair consisted of a student and a confederate, and they were asked to complete some tasks in each session, however, in the time interval between the collaborative sessions, the participants did not have to actually do the work; instead, they received all their work for each session when they arrived. Then participant's activity awareness was assessed by two graduate HCI researchers based on the following coding scheme:

1. Participants were evaluated 'fully aware' when they had spontaneously noticed the inconsistencies.
2. They were evaluated 'partially aware' if they noticed the inconsistencies after being prompted by the confederate or the experimenter.
3. They were considered 'unaware' in all remaining cases.

This method is used as a basis of my evaluation of activity awareness in the research. An explanation of how this method used is described in chapter 4 (section 4.4.5).

2.2.2.2 Situation Awareness

Endsley (1995) define situation awareness (SA) as ''the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future''. SA has three levels of awareness. The first level is the perception of elements in the environment; the second level is comprehension of their meaning; and the third level is the projection of their status into near future (Endsley, 1995).

Situation awareness is usually employed in environments where teams need to solve complex tasks in a distributed way, such as air traffic control (Bosse et al., 2013). However, the concept of situation awareness could be useful in the context of collaborative learning.

SA could be measured using different measurement techniques, for instance, real-time probe techniques. Salmon et al. (2009) conducted a comparison study to compare between two different approaches to measuring SA: SAGAT (a freeze probe recall approach) and SART (a

post-trial subjective rating approach). Participants were working on military planning task. Salmon et al. (2009) advised that choosing a suitable SA measure would be determined by the task characteristics. For instance, they suggested that SAGAT is the most appropriate approach for measuring SA in tasks with a stable environment and pre-defined elements.

2.2.2.3 Workspace Awareness

Gutwin and Greenberg (2004) define workspace awareness (WA) as "the up-to-the-moment understanding of another person's interaction with the shared workspace". WA provides information about where people work, what they do, and what they will do next. This information will help to support collaboration activities. Gutwin and Greenberg (2004) identified three mechanisms to gather information about WA: intentional communication, consequential communication, and feedthrough.

Intentional communication can be used to gather information produced by conversations and gestures. Consequential communication is "the mechanism of seeing and hearing other people active in the workspace". It is used to gather information created by people's bodies in the workspace including postures and hands movements. Feedthrough is "the mechanism of determining a person's interactions through the sights and sounds of artifacts". It used to gather information that produced from workspace artifacts (Dix et al., 1993).

Gutwin and Greenberg (2004) identified five collaboration activities used in workspace awareness; these are: management of coupling, simplification of verbal communication, coordination, anticipation, and assistance.

2.2.2.4 Knowledge Awareness

Ogata and Yano (2000) proposed knowledge awareness concept to enhance collaborations in collaborative learning environments. Knowledge Awareness (KA) can be defined as "awareness of the use of knowledge". KA provides information for each learner about up-to-the-minute activities from other learners in a shared knowledge space in order to encourage collaboration. This information comes in a shape of messages to make the learner aware of someone: with the same problem or knowledge; with a different view about the problem or knowledge; or with potentials to help in solving the problem. KA message could be "someone is looking at the same knowledge that you are looking at", for instance.

Knowledge Awareness Filtering System (KAFS) has been developed in an open-ended collaborative learning environment called Sharlok (Ogata & Yano, 2000). It consists of an agent-based program named KA-Agent, which provides information and messages to the learner. KAFS helped in eliminating unnecessary KA messages, that might disturb learning process, and also recommending suitable KA messages for each learner based on their priorities.

2.2.2.5 Group Awareness

Group awareness is vital for collaboration as it enables peers to understand their colleagues' intentions and therefore coordinate their own tasks within the group's activities (Bodemer & Dehler, 2011). Group awareness is "the understanding of others' presence, locations, and current activities in the shared workspace" (Nacenta et al., 2007). In CSCL environments, group awareness includes the knowledge and perception of behavioural, cognitive, and social context information on a group or its members (Bodemer & Dehler, 2011). Bodemer and Dehler (2011) identify three types of group awareness: behavioural awareness informs about learners' activities in the CSCL environment, cognitive awareness informs about the knowledge of group members, and social awareness informs about the functioning of the group as perceived by the collaborators. Bodemer and Dehler (2011) state that there are two ways of constructing group awareness: naturally as a by-product of the collaboration or by means of a specific awareness tool. In synchronous communication, as in face-to-face situation, behavioural awareness information can be gathered more easily than in synchronous communication.

To conclude, awareness is the knowledge about the situation of a specific environment; and we can define it precisely based on the context (e.g. learning, air control, etc.); and also based on the type of awareness (e.g. situation awareness, activity awareness, etc.) bearing in mind that some of these types if they are used within the same context they might be referring to the same thing. For example, in collaborative learning context, situation awareness subsumes activity awareness. Also, group awareness in CSCL is similar to workspace awareness.

2.3 Technologies

Various kinds of technologies have been used in collaborative learning and awareness including CSCL, general-purpose applications, tangible user interfaces, tabletops, tablets and a mixture of these. In this part, first some tools and technologies used to support collaborative learning and awareness are reviewed, and then a detailed report on persuasive technologies is given.

2.3.1 Computer-Supported Collaborative Learning

Computer-Supported Collaborative Learning (CSCL) becomes an emerging paradigm of educational technology (Koschmann, 1996). Different collaborative learning environments and groupware have been created to support learners in many domains for diverse purposes. Groupware can be described as any software that expected to be used by groups rather than individuals (Koschmann, 1994).

Crook (1994) categorised the collaborative interactions with the presence of computers into four forms: interactions with the computers; interactions at the computers; interactions in relation to computer applications; and interactions around computers. Each interaction form indicates to which extent computers are involved in the collaborative activity. So, interactions with the computer mean the computer used as a tutor. While interaction at the computers occurs when a group of learners collaborate and work at shared space, presented by computers, to complete some tasks. Interactions in relation to computer applications correspond to the computer-based activities that involve teacher-student and student-student relations. Finally, interactions around computers appear in online courses over networks or in group activities in computer labs.

Another aspect that can support learning is the blended learning, where traditional face-to-face teaching and online systems are combined, and it is likely to enhance the quality of learning, as well as making communication among participants more convenient and flexible and increasing student satisfaction (Carrington et al., 2010).

2.3.1.1 CSCW/CSCL Environment

Computer-Supported Collaborative Work (CSCW) and Computer-Supported Collaborative Learning (CSCL) have almost identical concepts and methods; however, CSCL is exclusive

to learning and it could be considered as a special type of CSCW. In CSCW, computers can be used to assist, enhance, and redefine interactions among members of the work group (Koschmann, 1994). CSCL is focused on enhancing interaction and facilitating sharing and distributing of knowledge and expertise among group members in learning context (Lipponen, 2002).

Researchers have highlighted some cognitive and social advantages for groups in CSCL environments compared with face-to-face groups. Phielix et al. (2010) summarised the cognitive and social aspects of collaboration in CSCL based on previous literature. In terms of the cognitive aspects, students reach higher levels of learning, take better decisions, submit more comprehensive reports, participate more evenly, and get involved in more complicated discussions than students who are working face-to-face. For the social aspects, students working in CSCL environments reach higher levels of satisfaction than face-to-face groups.

However, there are also some conflicting results. Regarding the cognitive aspects of collaboration, sometimes students have more confusing discussions, with less productivity, and additional time needed in order to reach an agreement and to make a decision, more than students who are working in face-to-face (Phielix et al., 2010).

Moreover, it has been found that the levels participation was low and associated with higher conflicts levels. Furthermore, groups suffered from low levels of cohesiveness and satisfaction. In conclusion, students do not reach their full potential all the time, when they are working in CSCL environments (Phielix et al., 2010).

Phielix et al. (2010) argue that two significant factors are considered as the main reasons that can explain the difference between the potential of groups working in CSCL environments and their performance, which are: the design of CSCL environment, and both cognitive and social behaviours of the group members.

Dewiyanti et al. (2007) conducted an exploratory study to investigate distance learners' experiences with collaborative learning in asynchronous CSCL environments. Participants were working in groups of 4 to 11 members on collaborative courses. Assessments towards students' experiences were taken during and after the course. Also, students' satisfaction with collaborative learning was assessed after the course. Results showed that distance students were quite satisfied, and have positive experiences with the collaborative learning.

2.3.1.2 Awareness in CSCW/CSCL

In Computer Supported Cooperative Work (CSCW), awareness used to increase cooperation and collaboration in distributed environments. In Computer Supported Collaborative Learning (CSCL), awareness is useful in promoting collaboration opportunities and improving the effectiveness of collaborative learning (Paletta & Herrero, 2011). It is found that distributed learning groups are faced several difficulties during the process of knowledge construction (Romero, 2012). These difficulties appear as a result of lacking the face-to-face interactions. Therefore, researchers attempt to develp tools to enhance awareness in CSCL to mitigate the consequences of these problems.

For instance, Romero (2012) designed group awareness widgets called EuroCAT, which aims to enhance the group awareness of CSCL activities in a virtual campus. This tool has been developed to help in reducing the impact of not having the contextual cues that available in face-to-face situations.

Phielix et al. (2010) conducted a study to investigate the group performance in a CSCL environment while they were using a peer feedback tool and a reflection tool. Participants were students working with or without the tools, in pairs and groups of 3 or 4 on a collaborative writing task. Results illustrated that awareness increases the social performance of a CSCL group. In addition, results showed that groups who used the tools were performed better, their group satisfaction levels were higher, and their conflicts levels were lower.

2.3.2 Technologies for Collaborative Learning

A variety of existing applications has been used to investigate their roles and potentials to support collaborative learning. In this section, tools such as emails, blogs, whiteboard, blackboards, and audio/video chat are reviewed while they were using in collaborative learning systems.

General-purpose applications, such as email, discussion forums, and video conferencing, have proved to be helpful in supporting collaborative learning (Phielix et al., 2010). In addition, Anderson and Lin (2009) investigated the possibility of using blogs and user groups as collaborative tools to build inclusive collaborative learning communities outside the classroom for computer sciences students. The results presented that blogs are effective tools for collaboration.

Aiken et al. (2005) developed and implemented a prototype for an intelligent collaborative learning environment. This environment has two software components: an Intelligent Collaborative Support System (ICSS) and a shared activity space: the Tulka Whiteboard. By combining these two systems, the ICSS and the Whiteboard, students were able to collaborate on a specific educational task as well as to get feedbacks on this collaboration while they are working together.

Bagley and Chou (2007) conducted a study to identify the best time for collaboration in problem solving using Java programming. The study showed that when a problem becomes more complex, the need for collaboration becomes more important. From the results, the most important time for collaboration in the problem-solving process is at brainstorming and formulating the problem, and designing individual components. In addition, conceptual knowledge and procedural learning were higher for groups (Bagley & Chou, 2007).

Carrington et al. (2010) conducted an observational study using two online collaboration technologies: Blackboard and Wimba Live Classroom during teaching Software Engineering courses. Blackboard is used for creating announcements, making course materials accessible, and updating information about software tools in the course. Furthermore, Blackboard enables text chatting and recording, while Wimba Live Classroom offers audio chatting, application sharing, lectures recording and the whiteboard facility. They evaluated online collaboration software informally within the Software Engineering course with both internal and external students. The findings indicated an improvement in the quantity and the quality of communication between instructor and students for distance learning. Furthermore, an overall enhancement for flexibility and convenience of the communication was observed. Students showed a high satisfaction with the course and the collaboration technologies assisted students to achieve their aims from the course. Wimba gave several direct advantages for external students, however, it still needs a more effective technique to view and search recordings. So far, the benefits for internal students were limited, in which they were only able to join chatting sessions and view lecture recordings and chats.

Additionally, blended spaces, which blend digital and physical spaces, have been used in creating collaborative environments for working. For example, Broughton et al. (2009) have proposed a design of distributed work environments for hands-on collaboration in which users feel that they are co-located. They have developed a functional Blended Interaction Space prototype for a small, distributed work group. This blended space imitates the co-located features of natural face-to-face communication and shared digital interaction for

distributed work groups. Results of using this prototype showed that it enabled a strong user experience of being co-located.

Benyon and Mival (2012) investigate the design, development, implementation and the use of real world functional multi-touch enabled interactive collaborative environments (ICEs). These environments are blended spaces and intended to create new ways of interactions and enable new user experiences. The ICE is an interactive meeting room with videoconferencing suites; this room has an interactive table, interactive whiteboard walls, and multi-touch wall screens, and all devices are connecting by wireless internet and cloud-based services such as Dropbox. They state that the concept of the ICE is to consider discrete objects (screens, laptops, mobile devices) as portals to function and content in order to enable and facilitate real time, synchronous, local, and remote collaboration.

Groupware is usually created for specific purposes to support either collaborative learning or collaborative work. Some of the developed groupware are reviewed. Single Display Groupware (SDG) is a groupware presented by Stewart et al. (1999). It helps to enhance collaborative work among people who are physically close to each other. Also, they compared between this model and other forms of traditional remote collaboration. The requirements of SDG in computer technology have been described, and the costs and benefits that may come from the use of SDG systems have been highlighted. A prototype SDG system was created and examined its usability working with 60 elementary school children. Their study showed that SDG technology is likely to promote new interaction forms, and it can decrease some of the drawbacks that exist with the current technology. However, it is also noted that some of the new interaction problems may arise as a result of employing this technology. They concluded that in order to have a better understanding of the general impact that SDG technology, more long-term naturalistic studies are required. Moreover, such studies will help design a better SDG application.

Collaborative learning groupware used in schools to help students in their learning activities. For instance, Sugimoto et al. (2002) introduced a teaching aid project to assist group learning at elementary schools. The system objective was to improve the learning outcome for students who have used a textbook to study environmental problems. Students were asked to construct a town in a physical space and to evaluate the construction using computer simulations. Designing the system was an outcome of a collaborative effort between teachers and their students in the elementary schools. Generally, the system evaluations took place in classrooms located in the elementary schools. In light of the feedback obtained from teachers

and students, a number of changes were made to the design of the software in order to enhance the engagement in group learning. Overall, the study has provided a description of the process of designing the system, then evaluating it, then collaboratively redesigning it by teachers and students. They highlighted some lessons learned from the designing process, which can be used to design any interactive system.

Franco et al. (2003) demonstrated through a project that integrates interactive technologies, computer graphics and collaborative learning jointly would enhance both instructors and learners' knowledge. As a result of this project, traditional and digital literacy skills improved as well as collaborative and cooperative work.

Some collaborative learning technologies are developed to help students in higher education. For example, Co-web is a collaborative learning environment used in the introductory English classes at Georgia Institute of technology, and it supports learning activities at low cost (Rick et al., 2002).

One of the current collaborative learning environment examples called JavaWIDE (Java Wiki Integrated Development Environment). JavaWIDE is a web-based development environment built for collaboration (Jenkins et al., 2012). It was created in 2007 initially to eliminate the need for installing an IDE, as well as using the collaborative features of a wiki and then it has been improved to include lots of frequently used features, such as code completion and syntax highlighting. In addition, it allows the automatic posting of all source code and executable programs, integration with social networking sites, and a shared codebase which allows everyone to see, use and modify code on the system. JavaWIDE has been used in different environments, such as in the high school or colleges, all with different needs but with the same goal to include active learning and collaboration in the introductory programming experience. The students' responses to the active learning and collaboration were mostly positive. They enjoyed working together and sharing codes easily. They also enjoyed receiving help, not only from their teachers but also from their classmates (Jenkins et al., 2012).

Shared interactive surfaces with multi-touch feature (i.e. tabletops) have become significantly common, as they have potentials to assist collaborative interactions in co-located groups when they use them for different activities, such as playing games and planning trips Hornecker et al. (2008). Tabletops are promising to offer new ways to enhance collaborative learning and increase its effectiveness (Martínez et al., 2011).

It is crucial to have a better understanding of how tabletop environments can be designed. So people will be able to capture information related to collaboration processes, and then it can be offered in a certain form that is beneficial for learners, their teachers and facilitators. Martínez et al. (2011) suggested a set of design guidelines for a tabletop learning system. Moreover, they demonstrated how these guidelines have been used to design *Collaid* (Collaborative Learning Aid) environment.

Likewise, tablets can be used to support collaborative learning. Rick (2012) investigated the potential of using tablets in collaborative learning. He introduced the proportion tablet application to explore whether the tablet can be a supportive tool in co-located collaborative learning and investigate how children communicate to collaborate. Some differences between tabletops and tablets are outlined, which are: tablets are commercially more successful because they are smaller and cheaper than tabletops; but tabletops provide a large display surface. As a result, tablets are more likely to have an impact on everyday learning activities. The designed application used to support collaborative learning for two co-located students. They have to work together to solve a proportion problem and carry on to the next problem. Rick (2012) performs two cycles of user testing to improve the interface and detect any usability issues. He raised some questions regarding the tablet-based collaboration.

A number of collaborative learning environments have used tangible user interfaces to support collaborative learning. This section presented some examples of collaborative learning using TUI. Tangible user interfaces (TUI) requires designing both digital and physical elements, and their interrelations within a hybrid environment. In addition, it needs to design new types of interaction that can be characterised as full body, haptic, and spatial (Hornecker & Buur, 2006). In TUI systems, users often use several physical objects as tools for manipulation. These objects (aka physical icon or phicon) often have a specific meaning in the application, and therefore many tangible systems are domain specific (Rekimoto, 2008).

Resnick et al. (1998) introduced early examples of tangible interfaces that developed for learning. They presented digital manipulatives, computationally enhanced toys in where children are able to explore scientific concepts in a playful way. One of the most famous TUIs is LEGO programmable bricks, in which children can use these programmable bricks to create micro-worlds and to explore computation and scientific thinking (McNerney, 2004). Another example of TUI is the Augmented Chemistry (AC), which is a TUI application that

used in organic chemistry education. This application was used by students and they found it acceptable in terms of ease of use and learning (Fjeld et al., 2007).

Horn and Jacob (2007) described a new technique for implementing educational programming languages using tangible interface technology. Students can create programs in offline settings (on their desks or on the floor). They use a portable scanning station to compile their codes. They introduced two tangible languages for middle school and late elementary school. The languages are: Quetzal and Tern. Quetzal is a language for controlling LEGO Mindstorms™ robots. Tern is a language for controlling virtual robots on a computer screen or real robots such as iRobot Create™ (Horn et al., 2009). These tangible languages are symbolic representations of algorithms. Both languages can include loops, branches, and parameter values. In Quetzal, plastic tiles in different shapes are used to represent their data type while in Tern, wooden blocks like jigsaw puzzle pieces are used. Authors conducted an initial evaluation to detect any usability problems and get an overall view for how students would react to physical programming. All children were easily able to construct chains and read the series of actions aloud when asked. After first instruction, children were able to build programs without direct help from adults. The system also encouraged the children to collaborate (Horn & Jacob, 2007).

Horn et al. (2009) compared between the use of TUI and GUI in a science museum exhibit. In TUI, learners used Tern as a tangible programming language for creating programs to control a robot called iRobot Create™. Programs created with Tern consist of chains of wooden blocks look like jigsaw puzzle pieces. These blocks represent actions for the robot to perform (e.g. TURN LEFT); or control-flow structures (e.g. REPEAT loop). In GUI, they replaced the wooden blocks with visual jigsaw puzzle pieces with same functions and used a single standard two-button computer mouse. The results of user tests showed that TUI offers many considerable advantages over the traditional GUI in the context of informal science education. TUI is more engaging in collaboration interaction as well as at encouraging children to actively exploring and learning (Horn et al., 2009).

Moreover, Vaucelle et al. (2005) presented a TUI to support collaborative learning called *Moving Pictures: Looking Out/Looking In*. It is a tangible and multi-user system that encourages young users to create, explore, manipulate and share video content with others. The Moving Pictures system consists of an interactive tabletop with embedded RFID readers, a computer, a screen, a set of two cameras, and a collection of RFID tokens. Blue tokens used for video clips and yellow tokens used for sound effects. There are three modes in this

system: Shooting, VideoJockey and Storyboard. Shooting mode is for recording scenes. VideoJockey mode is for playing the clips. Storyboard mode is to produce a collection of scenes by placing the tokens on a Storyboard tool and playing them sequentially. Observations from user tests showed that children enjoyed using this system. They have understood how to make a movie using series of traditional shots represented by the physical tokens. The interface allowed children to collaborate as well as to work individually. The TUI of the system facilitated the group work and encouraged participation.

Some systems integrated both tabletops and TUI, for example, Patten et al. (2001) presented the *Sensetable*, which is an electromagnetic tabletop display surface that tracks the positions and orientations of multiple wireless objects with high accuracy and low latency. The system offers two improvements over existing tracking systems. First, the *Sensetable* system tracks objects quickly and precisely. Second, the tracked objects' state can be modified by attaching physical dials or modifiers and the system can detect these changes in real-time. Authors implemented the system prototype by connecting two sensing tablets to form the sensing surface. They used a number of sensing pucks to represent objects. Each puck has a socket to attach the dial or modifier. They also developed two applications to examine this system: chemistry and system dynamics simulation. Chemistry application used to teach students about chemical reactions. They use pucks as atoms or molecules and by placing modifiers on the top of the pucks; they can change their electrical charge. System dynamics simulation application can be used in business and social sciences fields. Users were tested the interface during the development process. They enjoyed being able to use both hands to alter two different parameters at the same time and see real-time changes (Patten et al., 2001).

2.3.3 Technologies for Awareness

Some technologies are dedicated to enhancing awareness in groups either in learning context or in other situations. Different technologies are used for this purpose including general-purpose applications (e.g. emails), ambient tools, TUIs, and large displays. For example, Brush and Borning (2003) introduced 'Today' messages to replace status updates in group meetings. 'Today' messages are brief status emails sent by group members to each other on daily basis. These messages increased group awareness with very low cost.

Etter and Röcker (2007) implemented a music-based awareness system called 'Social Radio'. The system built to enable small intimate groups to stay in touch by using tangible artifacts.

The purpose of this system is to share personal music with a small group of family members or friends. The interface helped the users to control the communication settings and provide awareness information for each individual.

Alavi and Dillenbourg (2012) developed an ambient awareness tool, called *Lantern*. It was designed to assist learning process in recitation sections, like in the case when students work together in small groups on exercise support by teachers help. An interactive lamp is provided in all groups to show the group work status, which can be about what exercise are they working on, whether if they have asked for support or not, and if so, at what time and on which exercise. By providing all this information, *Lantern* is aimed to assist the interaction between teachers and groups, as well as to promote collaboration between students. They examined *Lantern's* effect on groups and individuals' performance in recitation sections. They suggested that *Lantern* could increase the efficiency of teacher-teams' interaction and improve the structure of inter-team communications; also it can support the intra-team collaboration. Moreover, due to the simple design of Lantern and being in the classroom environment, distracting the focus of students from their main task will be avoided and will disappear quickly when not used.

Public displays usually used in work environments to promote awareness as they present information for large groups who are loosely connected with limited knowledge of each other's activities or interests. However, these public displays have some drawbacks in terms of content relevance and privacy concerns. Huang and Mynatt (2003) introduced the use of "Semi-Public Displays" to overcome these issues of using public displays and still gain benefits from their features. Semi-Public Displays are designed for small and co-located groups (usually they have shared interests). Semi-Public Displays provide visible information about the group activity, and therefore, increase awareness and enhance collaboration.

The interaction techniques used in tabletop groupware systems could have an effect on group collaboration. However, limited knowledge about these effects makes the choice of appropriate techniques difficult when developing a tabletop groupware (Nacenta et al., 2007).

Nacenta et al., (2007) conducted an exploratory study to investigate the impacts of using different interaction techniques on coordination and awareness in two different tasks: a game and a storyboarding. The interaction techniques are: drag-and-drop, pantograph, radar views, tele-pointers and laser beam. The results showed that the choice of interaction technique significantly impacted the measures of coordination and performance, as well as preference;

yet, each task had different effects than the other. They concluded that the choice of tabletop interaction technique is an important issue to be considered, and it offers an insight into how tabletop systems can efficiently enhance group work.

Hornecker et al. (2008) conducted an empirical study to analyse different features of awareness when using tabletop surfaces by comparing two types of inputs: multi-touch and multiple mice. They proposed a set of indicators for positive awareness, negative awareness and awareness work and used it in the analysis phase; these indicators are based on CSCW and HCI literature. Their findings demonstrated higher levels of awareness in the multi-touch situation with more interfering actions than in multiple mice situation. In addition, the interactions in the multi-touch situation were smoother and that interference was resolved fast. They suggested that it is necessary to find techniques to moderate the interference rather than trying to avoid it. Implementing an appropriate interaction technique is a design challenge (Hornecker et al., 2008).

2.3.4 Persuasive Technologies

This section reviews the concept of persuasive technologies, the key design models, and some examples of them. Then, literature for the design for persuasive technologies is reviewed in Chapter 6. Fogg (2003) defines persuasive technology as “any interactive computing system designed to change people's attitudes or behaviours or both (without using coercion or deception)”. He coins the term "captology", an acronym for "computers as persuasive technologies".

Fogg (2003) also suggests two levels of persuasion: macro and micro. In macrosuasion, persuasion is the main purpose of the product, while in microsuasion, persuasion is used to help in completing a different main goal. For instances, a persuasive simulator called Baby Think It Over, is designed to persuade teenage girls to avoid becoming pregnant, so this is a macrosuasion intent, while on the other hand email programs, for example, have microsuasion intent to persuade as they could integrate smaller persuasive elements to complete a different overall goal.

Researches define different persuasive techniques, and sometimes they refer to techniques by strategies, principles or qualities. Fogg (2003) defines seven persuading strategies that can be used to influence behaviour change. These are: reinforcement, simplification, self-

monitoring, suggestion, surveillance, personalisation, and tunneling. While Oinas-kukkonen and Harjumaa (2009) define 28 persuasive techniques as described later (section 2.3.4.3).

2.3.4.1 The Functional Triad

Fogg (2003) presents a framework for captology called the "Functional triad" which identifies the role of computers as tools, media, or social actors.

The first corner of the functional triad is the role of computers as tools. The goal of computing products when acting as tools is making activities easier or more efficient to do or doing things that would be almost impossible without technology.

The second corner of the functional triad is the role of computers as media. There are two categories of computers as media: symbolic and sensory. Symbolic media when symbols are used to convey information (e.g. text, graphics, charts, and icons). Sensory media when sensory information is provided (i.e. audio, video, and even smell and touch sensations). Virtual reality and simulations are examples of the role of computers as media.

The third corner of the functional triad is the role that computers as social actors or living entities. When people use an interactive technology, they often respond to it as though it were a living being. It is worth to mention that a persuasive technology could function as two roles or even as the three roles. Figure 2.1 illustrates the functional triad in detail.

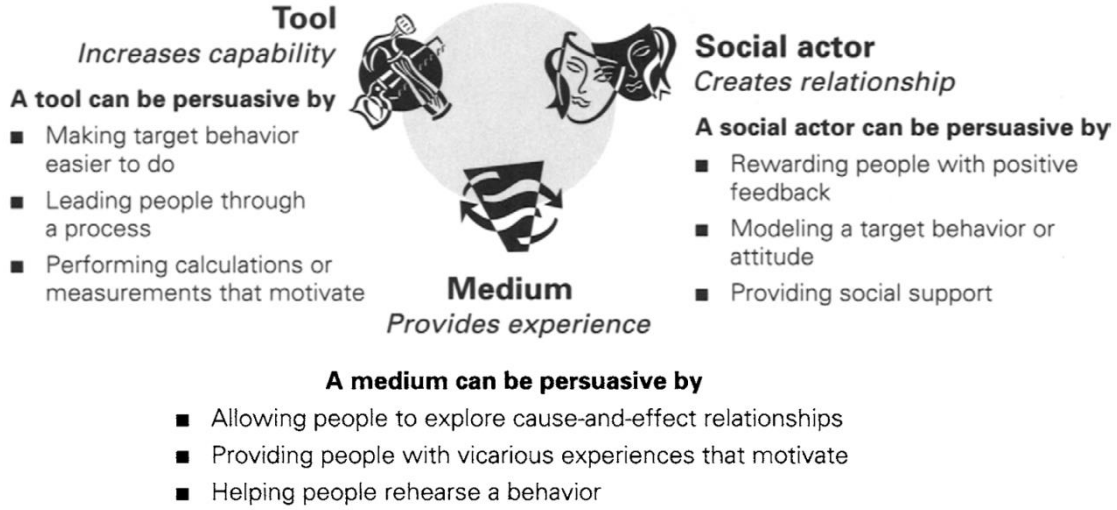


Figure 2.1: The functional triad (Fogg, 2003)

2.3.4.2 Fogg Behaviour Model (FBM)

Fogg (2009b) suggests a new model for understanding human behaviour called Fogg Behaviour Model (FBM). This model has three factors: motivation, ability, and triggers. Each factor has subcomponents. The FBM claims that in order for a person to perform a target behaviour, he or she should be appropriately motivated, has the ability to perform the behaviour, and be triggered to perform the behaviour. These three factors should occur at the same time; otherwise the behaviour will not perform. The FBM is useful in analysing and designing persuasive technologies.

Motivation has three subcomponents: pleasure/pain, hope/fear, and social acceptance/Rejection. The first motivator in the FBM is a dimension that has two sides: pleasure and pain. Pleasure and pain are primitive response and powerful motivators. People usually respond to what is happening instantly. Designers can look at how pleasure and pain can be embodied to enhance levels of motivation. The second motivator in the FBM is a dimension that has two sides: hope and fear. This dimension is regarded anticipation of an outcome; hope is the anticipation of something good happening, while fear is the anticipation of something bad, usually the anticipation of loss. The third motivator in the FBM is a social dimension that has two sides: social acceptance and social rejection. It controls much of our social behaviours.

The second factor in the FBM is ability. It also referred to simplicity and it has six parts, these are: time, money, physical effort, brain cycles (i.e. deep thinking), social deviance (i.e. against the norm), and non-routine. If a target behaviour requires any of these parts and people do not have this part, then the target behaviour is not simple. For example, if the target behaviour is to complete a long online survey and it needs time, but users have no time available, then this behaviour is not simple. The same is true if people have limited financial resources and the target behaviour costs money (e.g. buying a new car), then the behaviour is not simple.

The third factor in the FBM is triggers. There are three types of triggers: sparks, facilitators, and signals. A spark is a trigger that motivates behaviour. When users lack motivation to perform a target behavior, a spark trigger should be designed to appear concurrently with a motivational element. A facilitator trigger makes behaviour easier and it is suitable when users have high motivation but lack ability. A signal trigger indicates or reminds to perform behaviour and it works as a reminder. It is appropriate when users have both the ability and

the motivation to perform the target behaviour. Triggers can be embodied in text, video, graphics, and more. Figure 2.2 illustrates the FBM with all its subcomponents.

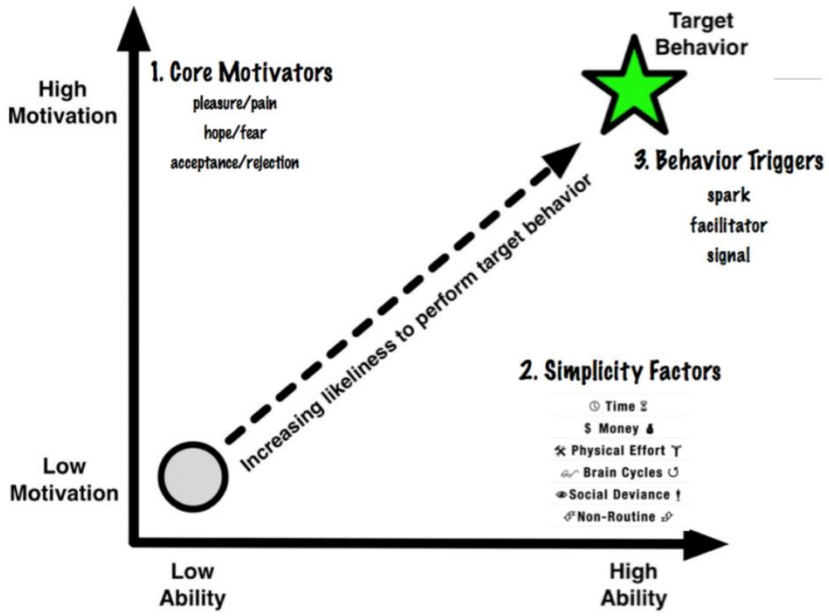


Figure 2.2: Fogg Behaviour Model (Fogg, 2009b)

2.3.4.3 The Persuasive Systems Design Model (PSD)

Oinas-kukkonen and Harjumaa (2009) suggest a model for designing persuasive technologies called PSD (Persuasive Systems Design) model. The PSD model consisted of 2 parts: the persuasion context and the software system characteristics. The persuasion context includes three parts: the intent, the event, and the strategies. Each of these parts has subcomponents. The intent involves deciding the persuader and the change type; the event focuses on the context of the use, user, and technology; while the strategies are about the message and the route to deliver this message. The software system characteristics have four categories of persuasive techniques: primary task support, dialogue support, system credibility support and social support. Each of these categories includes seven persuasive techniques, giving a total of 28 persuasive techniques. A detailed review on the PSD model is given in Chapter 6 (in section 6.1.2).

2.3.4.4 Persuasive Technologies in Use

Persuasive technologies have been used in different areas such as health, wellbeing, e-commerce, and learning (Fogg, 2003). In this section, some examples of persuasive technologies are reviewed. Most of these examples are published in the proceedings of the annual PERSUASIVE Conference; the first PERSUASIVE conference was in 2006. These examples are included as they have *persuasive technology* as one of their keywords.

Within the area of learning, examples of persuasive technology have included Behringer et al., (2013) who investigated how to use persuasive technology for learning in a business context. They present two case studies of academic business computing and language learning. They describe how they designed persuasive tools to help business students in their learning and the design principles they applied for each case study. They concluded that persuasive technologies are beneficial for encouraging learning and that it is not practical to apply a common set of persuasive design principles to all learning contexts, i.e. each learning situation needs a specific set of persuasive designs.

Other examples of persuasive technologies in learning have included the HANDS project (Mintz & Aagaard, 2012), which is a persuasive technology designed for children with autism in special schools to improve their social skills. They have proposed some persuasive design principles that can be used in educational settings. They also recommended that credibility and Kairos should be considered in the design of persuasive mobile applications to be used in schools.

SISATSpace (Firpo et al., 2009) is another example of a persuasive technology designed to increase the sense of community among a group of students. They developed WordPress MU based system, SISATSpace. The results show that the system can change students' attitudes and behaviours in the community at SISAT (School of Information Systems and Technology) and it promoted the sense of community within its members.

Janssen (2012) investigates how persuasive technology could help to support the self-directed learning of adults in organisations. He tests two different prototypes principle to persuade people to reflect on their learning activities and stimulate social interaction. These prototypes have been used by 18 participants for 35 days. Results show that the social persuasive design principles have a positive impact on using a tool to support self-directed learning. The study did not provide clear evidence that persuasive technology can support self-directed learning;

however, it gives insights on the link between them that could be used as a base for further research.

Persuasive technologies are also used in health and wellbeing context. For example, Beun (2013) investigated the use of persuasive technology in the field of self-help insomnia treatment. He designed a virtual mobile coach that functions as a first intervention for insomnia treatment in a stepped care context. He suggested three general persuasive strategies from cognitive behaviour therapy and communication theory, these are: alignment, adaptation, and motivational support. The first two strategies aim at tailoring the intervention, while the last one aims at the coach's communicative activities to remove motivational barriers. Alignment involves continuous monitoring and feedback; adaptation involves personalisation and being able to adjust user's needs, abilities, preferences, knowledge, and location; Motivational support refers to verbal and/or nonverbal communication.

Another example of persuasive technologies in health wellbeing context is a mobile application to reduce user's exposure to cell phone radiofrequency (RF) emissions, as these emissions might be carcinogenic to humans. Burigat and Chittaro (2014) present the design of this application that utilises persuasive principles to encourage the use of earphones during cell phone calls in order to reduce direct exposure of the brain to RF electromagnetic emissions of cell phones. They offer different notifications and visualisations to inform users about their behaviour of using earphone. They also investigate understandability, emotional impact, and perceived usefulness of the offered solutions and then draw a design implications based on the results.

Persuasive technologies have been used also in energy conservation. For instance, Al Mahmud et al. (2007) investigate the design and evaluation of the iParrot, a persuasive social agent that encourages family members to conserve energy in their home. iParrot offers feedback, advice, praise, and provides incentives. They evaluate iParrot in two conditions regarding its friendliness. Results show that if the agent is friendlier, people will respond to the advice for energy conservation. Additionally, participants were able to perceive the friendliness level for both conditions clearly. It is noticeable that iParrot is a persuasive social actor.

Another example of using persuasive technologies to change behaviours related to energy usage is a computer game called PowerHouse designed by Bang et al. (2006). This game aims to influence behaviours related to energy use and promote an energy-aware lifestyle

among teenagers. They use a set of target activities in the home using several persuasive techniques. They discuss the overall game design and its advantages and disadvantages in relation to the methods they have employed in the game. In the PowerHouse, a player manages a simulated domestic environment with seven characters and the game informs implicitly and explicitly about various energy-efficient actions. Almost all activities in the game need electrical energy such as taking a shower, washing clothes, cooking, and watching television. Therefore, the goal is to direct the characters to perform the suitable energy-efficient actions. Whenever the player performs correct actions, he/she gets virtual money and better game control. As the PowerHouse used simulation, it is a persuasive technology in a form of media.

BrightDark (Alharbi & Chatterjee, 2015) is another example of a persuasive technology designed to encourage households to reduce their electricity consumption. BrightDark is a smartphone app that offers customised motivation and awareness solution for households to reduce their electricity consumption based on their concern whether it is cost or environmental concern. The motivational solution embodied by using e-fotonovela, which is art-based research, and text messages. Results show that the customised e-fotonovela and text messages were efficient in motivating and promoting households' awareness towards electricity conservation.

Another use of persuasive technologies is fitness and mobility context. For instance, Wunsch et al. (2015) investigate three persuasive strategies and their potential to encourage biking as a low-energy transportation mode. The strategies were designed to facilitate more frequent biking using triggering messages that employ social influence, to increase biker's self-efficacy for city biking through a virtual bike tutorial, and to help non-routine bikers overcome initial barriers towards biking through an arranged bike ride. Each of these strategies integrated several persuasive principles. The potential of these strategies was examined by 44 participants, who self-reported their trips over a period of four weeks, and questionnaires and interviews were conducted. Results show a significant increase in bike share, an increase of perceived self-efficacy for non-routine bikers, and participants have a positive experience of city biking. The explored strategies provide implications on the design and implementation of persuasive technologies in the field of mobility.

Persuasive technologies can offer solutions to motivate people to promote their physical activities. For example, Hirose and Kitamura (2015) developed a virtual cycling system, which consisted of a bicycle, a computer and a display. Although several virtual cycling

systems have been developed, however the alternatives of the cycling routes are usually limited. So, they developed the virtual cycling system with Google Street View to provide almost unlimited route choices to the users. They evaluated through an experiment how the system promotes physical activity by measuring the average pedaling speed of the users. Results show there was a significant difference between the scores of using the system with Google Street View and the one without it.

Persuasive technologies have been used to encourage drivers towards eco-friendly driving. For instance, Atzl et al. (2015) present an in-car Android-based smartphone app called Bet4EcoDrive, which aims to encourage drivers to change their driving behaviour for an economical driving style. The app suggests a bet that the driver can achieve, for example, the driver can bet to stay within a specific RPM (revolutions per minute) range to prevent driving at high RPM and then to decrease fuel consumption. The app provides live feedback of the actual status while driving by displaying different visualisations. An exploratory study with five participants was conducted in-situ to verify the feasibility of their approach. The results show that participants were encouraged to reduce average RPM values while driving in order to win the bet.

The use of persuasive technologies has also been investigated in safety context. For instance, Chittaro and Zangrando (2010) use persuasive virtual reality simulations to change peoples' attitudes towards smoke in evacuating buildings. They investigate different ways of providing negative feedback to promote awareness of personal fire safety issues. They test two techniques with different emotional intensity and different levels of increased anxiety. The first technique is simulating the effects of smoke on the user through a visualisation that should not stimulate strong emotions, while the second one is replicating the anxiety of an emergency situation. Results show that the second technique is better in increasing users' anxiety towards smoke and changing their attitudes.

Salam et al. (2010) have designed and developed a persuasive prototype called a Persuasive Multimedia Learning Environment (PMLE) for children who have dental anxiety. The PMLE is an interactive educational courseware which also can be used by parents, dentists, or teachers to motivate the children to overcome dental anxiety and gain confidence when visiting a dentist. This prototype was tested with primary school children age between seven and nine years old by assessing their dental anxiety level before and after using the PMLE. Results show positive effects in decreasing children dental anxiety and might let the children behave in a good manner for their dental visit in the future.

2.4 Summary

Two aspects of the literature were particularly relevant for this PhD research. Firstly, the literature reveals a number of tools have been developed to enhance awareness, which have focused on enabling collaborators to share their progress (e.g. whiteboard (Aiken et al., 2005); blackboard and Wimba Live Classroom (Carrington et al., 2010); and peer feedback tool and reflection tool (Phielix et al., 2010)). However, no attempt has been made to enhance activity awareness by encouraging collaborators to practice behaviours that enhance awareness instead of developing tools that enable them to share their progress. This gap was one of my main drivers to pursue my PhD.

Secondly, the work of Convertino et al. (2004) had important implications for initiating the approach to measuring activity awareness adopted in this PhD, by using the suggested rankings for activity awareness. Moreover, the definition of awareness includes the knowledge about the situation of a specific environment (Gutwin & Greenberg, 2004) and this definition influenced the data collection method for measuring activity awareness, where participants were asked about the knowledge they have about their colleagues' activities, i.e. what each member knows about the situation of their group project.

In summary, this literature review covers several areas related to the research including learning, collaboration, collaborative learning, and technologies. It gives a deep understanding of collaborative learning and highlights the significance of it as well as the supportive learning theories and methods. It also offers an overview of awareness and its role in enhancing the collaboration along with some reported awareness types. Moreover, it shows different existing technologies that support collaborative learning and awareness and their advantages and limitations, as well as the concept of persuasive technologies and how they were used in learning context.

Chapter 3: Exploring Collaborative Learning Groups – Pilot Study

This chapter presents a detailed report of a pilot study undertaken to explore collaborative learning groups. It covers the background and motivation for conducting the study, and methods used in data collection and analysis. It also discusses results and highlights the limitations of the study.

In collaborative learning, normally students are responsible for their own learning (Gokhale, 1995). One collaborative learning situation is when small group of students work collaboratively to complete a group project that runs over several weeks. Usually these groups practice both co-located and remote collaboration. To support such groups, it is important to understand how students collaborate, what learning styles they have and what problems they encounter during their collaboration.

A learning style can be described as the way that an individual perceives and processes information (Grant, 2003). Some researchers have highlighted the importance of learning styles in learning environments and have discussed different learning style models (e.g. Krichen (2009) states "learning styles play a crucial role in the effectiveness and satisfaction of the learning experience").

There are many models of learning styles that are concerned with individual learners (e.g. Kolb's Learning Styles Inventory and Felder-Silverman Learning Styles Model) but those to support collaboration are very limited. A collaboration style can be defined as the way that people collaborate with each other to complete a common goal.

Limited work has focused on identifying collaboration styles in collaborative learning groups. One study that investigated collaboration styles was conducted by Cockburn and Greenberg (1996) who identified four collaboration styles in children: parallel activity, sequential activity, independent activity, and domination. These collaboration styles were identified in a study where children worked in pairs and used a collaborative tool called "Turbo-Turtle microworld system" to learn some Physics laws. Collaboration style in this context can be described as how children attempt to manage the microworld within their pairs.

In the parallel activity style, pairs continuously discussed their actions and managed their collaboration at the same time; in the sequential activity style, pairs set a sequence of

activities and then this sequence was carried out in order with no overlapping of actions; in the independent activity style, pairs almost ignored the fact that they were working together and struggled against the actions of each other; and in the domination style, one person dominated the interaction. These styles were investigated in another situation as described in the next section.

Another recent study on collaboration styles was conducted by Shaer et al. (2011). They identified four collaboration styles when pairs were working together on G-nome Surfer 2.0, a tabletop interface for promoting inquiry-based learning of genomics. The collaboration styles were: turn-takers, driver-navigator, driver-passenger and independent. In the turn-taker style, both users make and accept suggestions and observations. In the driver-navigator style, both users are engaged. The navigator contributes with suggestions and observations. In the driver-passenger style, the driver is fully engaged; the passenger is not focused on the task. In the independent style, users are engaged in their own activity with minimal verbal communication. These collaboration styles were used and investigated in other studies (e.g. Schneider et al., 2012).

3.1 Motivation

This research is focused on adult learners who are collaborating on a long-term real group project. As a first step, a pilot study was conducted to explore collaboration in adults when they are working on a long-term real learning group project and also to identify any issues that appear in such collaborations. The study also investigated the potential of applying an existing collaboration styles model to help understand collaboration or introducing a new classification based on the collected data.

The collaboration styles identified by Cockburn and Greenberg (1996) were chosen for this purpose as there had been no previous attempt to investigate if these collaboration styles are applicable in other collaborative learning situations. Four collaboration styles were identified: these are parallel activity, sequential activity, independent work, and domination. Their study was with children who were working in pairs for 30 minutes using a collaborative software to explore Newtonian physics. Whereas this study investigated if these collaboration styles are applicable in adult students who were working in groups of 5 or 6 members, and on a long-term project, over weeks or months.

Although many literature were tried to explore how students collaborate as individuals but there was a limited focus on collaboration styles.

3.2 Research Aim and Research Questions

A small pilot study was undertaken to understand collaboration in groups working on a long-term learning project in order to work towards answering the first main research question *RQ1* as stated in Chapter 1. The study aimed to investigate how students collaborate and what problems they encounter during their collaboration in group projects. This study helped in answering the main research question *RQ1*, which is:

RQ1: How do students collaborate in long-term collaborative learning groups? More specifically, this study focused on three sub-questions *RQ1.1, RQ1.3,* and *RQ*1.4, which are:

> ***RQ1.1:*** What collaboration styles and activities are identified in long-term collaborative learning groups?
>
> ***RQ1.3:*** What applications and tools do groups use during meetings and for collaboration outside of meetings?
>
> ***RQ1.4:*** What problems do students encounter during their collaboration?

3.3 Method

This section describes the participants, data collection, data analysis, and the materials used in this study. The study was conducted with 2nd year undergraduate students taking a computing degree who were enrolled on the "Team Project" module, in which students worked on a real collaborative project over two semesters for 22 weeks in total. Ethical approval was granted from the School of Informatics[2] of City University London to conduct this study. The project involved the design and implementation of a software product. There were 3 deliverables, and for each deliverable, there were several tasks to be completed.

[2] Now it is called the School of Mathematics, Computer Science, and Engineering

3.3.1 Participants

The participants were a convenience sample of undergraduate students in their 2nd year who were enrolled on the "Team Project" module. Groups were formed by the module leaders and each group consisted of 5 or 6 students from different Computing programmes. Seven students participated in this study and they were from different groups. They were 6 males and 1 female. Students were registered on one of these undergraduate programmes: Business Computing, Computer Science, Information Systems, or Software Engineering. Participants were recruited by inviting them to participate by email. Incentives of 5 pounds Amazon vouchers were given to each participant after the interview.

3.3.2 Data Collection

Semi-structured interviews were used for data collection and took place in premises at City University London. Each interview lasted for about 20 to 25 minutes. Interview questions consisted of three sections: the first section was regarding general information about the participants and their groups; the second section was about their collaborations in the group; and the last section was more about participant's preferences and attitudes towards working in their groups. For each collaboration style, a question was asked about whether this style was exhibited in the group or not. For parallel and sequential work, participants were asked whether they distribute tasks in a parallel or sequential way. Regarding independent work, participants were asked whether they have worked independently without telling their team what they were doing. For domination, participants were asked if they have insisted that their solution or their opinion should be selected or should be applied for a specific task. Interview questions can be found in Appendix A.1.

3.3.3 Data Analysis

The data analysis approach was partly inductive and partly deductive. Firstly, a general inductive analysis was applied to derive themes from the collected data. Then, a deductive approach was applied to code for collaboration styles based on the collaboration styles model identified by Cockburn and Greenberg (1996).

In an inductive analysis, a detailed reading of raw data is used to develop themes, concepts, or a model (Thomas, 2006). All interview transcripts were read several times to identify codes and themes.

Two cycles were undertaken for coding: the first cycle was to code data; and then the second cycle was to refine the codes. In the first cycle, a bottom-up approach (i.e. inductive approach) was applied for coding the data, and then a top-down approach (i.e. deductive approach) was applied to code for collaboration styles.

3.3.4 The Coding Scheme

Only codes for collaboration styles were influenced by the previous work of Cockburn and Greenberg (1996), while the rest of the codes were emerged from data. Four main themes and 27 sub-themes were identified in the data. Each sub-theme included at least two codes (e.g. submission problems) and a maximum of 18 codes (e.g. problem with members). The main themes were: meeting, applications and tools, collaboration, and preferences. The meeting theme included 4 sub-themes:

1. number of members
2. meeting rate
3. meeting structure
4. participants' roles

The applications and tools theme included 4 sub-themes:

5. applications used
6. tools used
7. positive comments on applications
8. negative comments on applications

The collaboration theme included 13 sub-themes:

9. collaboration activities
10. task assigning
11. collaboration styles

12. finding solutions
13. positive aspects of group or work
14. negative aspects of group or work
15. problem with members
16. communication problems
17. problems with tasks
18. submission problems
19. group work description
20. satisfaction
21. collaboration success

The preferences theme included 6 sub-themes:

22. choosing members
23. manner of processing
24. orientation to change
25. deciding
26. working and learning preferences
27. learning styles

The detailed coding scheme can be found in Appendix A.2, including themes, sub-themes, and their codes with description of each code along with an example from the collected data. These codes were used in analysing data and reporting findings.

3.4 Results

In this section, results are presented based on the identified themes. Meeting and applications and tools themes were intended to collect factual data about the meeting and the used applications and tools. While collaboration theme was intended to collect data about collaboration including: collaboration styles and activities, problems that students encountered, and their satisfaction. The final theme, preferences, was intended to collect data about participants' preferences in learning and working in groups.

3.4.1 Meeting

This theme provided a summary description of the group that the participants belonged to and their meetings. The number of members in each group varied, but usually there were either 5 or 6 members. In some cases, members dropped out and the total number of members became 4. Groups had different frequencies of meetings ranging from frequent meetings to infrequent. In addition, groups had different meeting structures, for instance, some groups took attendance while others did not.

As part of the project requirements, several roles should have been assigned to group members. Normally, each participant should have had two roles. Results showed that each participant agreed to be in charge of one role or more. Participants' roles were: project manager, programmer, designer, tester, and system analyst. Table 3.1 shows all roles for each participant ordered by the most frequent roles.

Table 3.1: Participants' roles in their groups

Role	Participant							Number of participants
	P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***	
Programmer	•	•	•	•	•	•		6
Project manager	•		•			•	•	4
Designer			•	•	•			3
System analyst			•	•				2
Tester				•				1

3.4.2 Applications and Tools

This theme included a summary of applications and tools that participants chose to use during their group project. This theme aimed to recognise the kind of applications that group members liked to use in their collaborations. It was clear that each group used different kinds of applications and software to manage their project. Each group used at least two of the following applications: email, Facebook, WhatsApp, and Dropbox. Groups usually used these applications to communicate, discuss, store or exchange documents. All groups used laptops in their meetings. Table 3.2 reports the applications used and their functions and how many participants used them in their projects ordered by the most common ones.

Table 3.2: Applications used by participants and their functions

Application	Number of participants used the application	Function							
		Formal communication	Informal communication	Discussion	Sharing documents	Storage	Take attendance	Write meeting minutes	Documentation
Email	5	•	•		•				
Facebook	5		•	•					
Dropbox	5				•	•			
WhatsApp	4		•	•					
Excel	4						•	•	
Word	4							•	•
Phone calls	3		•						
Video chat	2		•	•					
Trello	1		•	•	•	•			
Moodle	1				•				
SMS	1		•						
PowerPoint	1							•	

Some participants provided positive or negative comments on the applications they used. P1 gave a positive comment on using Trello and Facebook, and a negative comment on Moodle. P7 found Facebook was effective while Dropbox was hindering him.

3.4.3 Collaboration

This theme included everything related to the collaboration including: collaboration activities, task assigning, collaboration styles, ways for finding solutions, positive and negative aspects of the group or work, problems students encountered, group work description, satisfaction towards working in groups, and collaboration success. Each of these components is described here.

A collaboration activity can be defined as any activity that "enhances learning by allowing individuals to exercise, verify, solidify, and improve their mental models through discussions and information sharing during the problem-solving process" (Alavi, 1994).

The collaboration activities sub-theme involved all collaboration activities including: discussion, awareness, helping each other, clarifying, revision, and persuading. Starting with discussion, where group members usually discussed their tasks, roles, skills, and progress, all participants discussed their tasks with group members. Three participants reported that they

discussed their roles: P1, P3, and P4. Also, three participants mentioned that they discussed their skills with members of their group: P3, P4, and P6. Two participants reported that they discussed their progress: P1 and P7. Only one participant stated that he had discussions with other groups. Table 3.3 presents discussion types identified in the groups.

Table 3.3: Discussion types identified in the groups

Discussion	Participant							Number of participants
	P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***	
Discussion about tasks	•	•	•	•	•	•	•	7
Discussion about roles	•		•		•			3
Discussion about skills			•	•		•		3
Discussion about progress	•						•	2
Discussion with other groups	•							1

Moreover, some awareness behaviours were identified in the data. In awareness, members usually gave an overview of their work and were updated with details about each other's work and progress. Four participants reported some awareness behaviours: P4, P5, P6, and P7. For instance, P5 stated: "*when we attend the meeting we need to kind of give an overview of what we exactly done and maybe show them this is what we done*".

Other collaboration activities were identified in the groups: students helping each other, clarifying uncertain points, revising each other work, and persuading some members to complete their tasks. These collaboration activities are presented in Table 3.4.

Tasks were assigned to members based on their skills, by volunteering, or by the project manager of the group. Table 3.5 presents how tasks were assigned to group members.

Table 3.4: Collaboration activities identified in the groups

Collaboration activity	Participant							Number of participants
	P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***	
Helping each other	•				•		•	3
Clarifying	•		•	•				3
Revising				•	•			2
Persuading	•							1

Table 3.5: How tasks were assigned to group members

Task assigning	Participant						
	P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***
Task assigning based on skills			•	•	•	•	
Task assigning by volunteering	•			•			•
Task assigning by project manager		•	•				•

Regarding the collaboration styles, Cockburn and Greenberg (1996) studied collaboration styles in one learning situation that had not drawn to other learning situations. Cockburn and Greenberg's collaboration styles were identified in the data. However, it was found that a single group could have more than one collaboration style. There were two potential reasons for having more than one collaboration style: first, in contrast with the study of Cockburn and Greenberg (1996) which had groups of pairs, each group has either 5 or 6 members, in which some members would collaborate in a specific style while others might collaborate in a different style; second, the group project ran for several weeks, which is a long period of time and the mode of collaboration might change unlike the duration of 30 minutes of collaboration as in the study of Cockburn and Greenberg (1996).

Five participants reported 2 collaboration styles: P1, P2, P4, P5, and P6. P7 reported 3 collaboration styles, while P3 reported only one collaboration style. Table 3.6 presents collaboration styles and the number of participants for each style as well as the number of collaboration styles identified for each group.

Table 3.6: Collaboration styles identified in groups

Collaboration style	Participant							Number of participants
	P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***	
Sequential work			•	•	•	•	•	5
Independent work		•		•	•	•	•	5
Parallel work	•	•						2
Domination	•						•	2
Number of Collaboration styles	**2**	**2**	**1**	**2**	**2**	**2**	**3**	

An example of each collaboration style is presented here from the collected data. P2 reported that they worked in parallel as he stated: "*I would say it is much more parallel*", while P3 reported that they worked sequentially as he stated: "*it was sequential in this case, because it was a step-by-step*". For the independent style, P6 reported that: "*Everyone was given or had to work independently*". In the domination case, P1 answered this question "*Have you*

insisted that your solution or your opinion should be selected or should be applied for a specific task?", and he said: "*I think I did do that quite a number of times*".

Participants used different techniques to complete their tasks and find best solutions. Usually they used resources and conducted research for this purpose. Table 3.7 summarises the most common techniques that participants used to find solutions for their tasks.

Table 3.7: Most common ways to find solutions for tasks

Finding solutions	Participant							Number of participants
	P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***	
Use resources	•		•		•	•	•	5
Conduct research			•		•	•		3
Iterative process	•	•		•				3
Give opinions			•		•			2
Talk to consultant	•				•			2

Positive aspects reported about the group or their work included: work done on time, getting good marks, learning experience, feeling responsibility, motivating members, being a democratic group, remaining calm, having a better understanding, showing up on time, being an enthusiastic member, having focused members, working was fun, trying their best, and having a good experience.

Four participants reported that they got good marks in their first two deliverables for the project: P3, P4, P5, and P7, and three participants threw light on their learning experiences: P1, P5, and P6. Three participants stated that work was done on time: P3, P6, and P7. Two participants stated that their group was a democratic group: P4 and P6. Also, two participants suggested ideas that could help the group to bond: P1 suggested game playing while P6 suggested having social activities.

Some participants stated negative comments about their group including: had a weak group or bad group, working was stressful, had lots of arguments, working in their group was unfair, they were not an actual team, group project was hassle, group struggled a lot, and had a bad experience. Two participants mentioned that working in their group was stressful: P3 and P6. Each of the other negative comments appeared once only.

Each group faced a number of problems and difficulties. Problems can be categorised as the following: problems related to members, communication problems, problems with tasks and submission problems. Participants reported problems they faced with their group members or

in their communications. The most common problems with members and communication problems are presented in Tables 3.8 and 3.9.

Table 3.8: Most common problems with members

Problem with members	Participant							Number of participants
	P1	*P2*	*P3*	*P4*	*P5*	*P6*	*P7*	
Some working members		•	•	•	•	•		5
Member dropped out	•				•	•		3
Lack of motivation	•					•		2
Low contribution	•			•				2

Table 3.9: Most common communication problems

Communication Problem	Participant							Number of participants
	P1	*P2*	*P3*	*P4*	*P5*	*P6*	*P7*	
No reply		•	•	•		•		4
Late reply	•		•	•		•		4
Unchecked accounts	•		•			•		3

With regard to problems with tasks and submission problems, there was no common problem among participants; each problem appeared only with one participant (e.g. start from scratch and late submission).

Participants were asked to describe their group work. P5 and P7 gave positive descriptions, for instance P5 said: "*I'll say very professional*". P3 and P4 gave neutral descriptions, for instance P3 said: "*good and bad*". On the other hand, P1, P2, and P6 described their group work in a negative way, for instance, P6 said: "*stressful*".

Participants were also asked about their satisfaction with working in their groups. Most of them were satisfied. Participant P7 was strongly satisfied with working in his group. Participants P3, P4, P5, and P6 were satisfied with working in their groups, while participants P1 and P2 showed a neutral attitude. Table 3.10 presents participants' satisfaction with working in their groups.

Table 3.10: Participants' satisfaction with working in their groups

Satisfaction	Participant							Number of participants
	P1	*P2*	*P3*	*P4*	*P5*	*P6*	*P7*	
Strongly satisfied							•	1
Satisfied			•	•	•	•		4
Neutral attitude	•	•						2

Regarding collaboration success, three participants thought that they collaborated successfully in their groups: P3, P4, and P7. Participant P5 believed that his group had a good collaboration. On the other hand, P1 and P6 reported that they had half good collaboration, while P2 reported that there was no actual collaboration in his group. Table 3.11 illustrates collaboration success in the groups.

Table 3.11: Collaboration success in the groups

Collaboration success	Participant							Number of participants
	P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***	
Successful collaboration			•	•			•	3
Good collaboration					•			1
Half good collaboration	•					•		2
No collaboration		•						1

3.4.4 Preferences

The final theme reflects participants' preferences including whether they would like to work again with the same members or some of them, their problem-solving style, and their learning and working styles.

In general, participants had various preferences with regard to working and learning. Most participants preferred to choose some members of their groups to work with them again: P2, P3, P4, P5, and P6, while participants P1 and P7 preferred to choose the same members.

Some preferences were based on existing model of problem-solving style called VIEW and it has 3 dimensions, which are: manner of processing, orientation to change, and deciding (Treffinger & Selby, 2004). In the manner of processing dimension, participants P2, P3, and P4 preferred to work with someone, participants P5 and P6 preferred to work individually, while participants P1 and P7 did not mind either option. For the orientation to change dimension, participants P1, P2, and P3 preferred to explore new options, while P5, P6, and P7 preferred to stick to prepared plans, and P4 was fine with both options. Regarding the deciding dimension, all participants thought they are logical persons in work, and P3 believed that sometimes he could be an emotional person.

On the other hand, participants P1, P4, and P5 preferred to work with friends, while the rest preferred to work with professionals. Table 3.12 presents all preferences sub-themes and codes and their frequencies.

Table 3.12: Preferences

Sub-Theme	Code	Participant						
		P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***
Choosing members	Choose same members	•						•
	Choose some members		•	•	•	•	•	
Manner of processing	Working individually	•				•	•	•
	Working with someone	•	•	•	•			•
Orientation to change	Prepared plan				•	•	•	•
	Explore new options	•	•	•	•			
Deciding	Logical person	•	•	•	•	•	•	•
	Emotional person			•				
Working and learning preferences	Working with friends	•			•	•		
	Working with professionals		•	•			•	•
	Look at diagrams			•	•	•		
	Read notes						•	•
	Attend a lecture			•		•		•
	Read a book				•		•	
Learning styles	Visual person			•		•		
	Auditory person							•

3.5 Discussion

This study tackled the issue of collaboration from several angles and a response for the research question and its sub-questions is given from the coding.

RQ1: **How do students collaborate in long-term collaborative learning groups?**

This research question has four sub-questions. This study helped in answering three of them based on the results. The research sub-questions were *RQ1.1, RQ1.3,* and *RQ*1.4. Answer to each of them is presented in this section.

RQ1.1: **What collaboration styles and activities are identified in long-term collaborative learning groups?**

Some collaboration activities were identified in the groups: discussion, helping each other, clarifying uncertain points, work revision, and persuading some members to complete their tasks. Group members usually discussed their tasks, roles, skills, and progress. They usually assigned tasks to members based on their skills, by volunteering, or by the project manager of the group. In four groups, tasks were assigned to members based on their skills: P3, P4, P5, and P6; three of them got good marks (see Table 3.13).

Table 3.13: Relation between task assigning by skills and grades

Code	Participant			
	P3	***P4***	***P5***	***P6***
Task assigning based on skills	•	•	•	•
Get good marks	•	•	•	

Four groups showed some awareness in their collaborations: P4, P5, P6, and P7; three of them reported that they collaborated successfully or at least had a good collaboration versus one group collaborated in a less successful way. Table 3.14 presents collaboration success and grades for participants who showed some awareness behaviours in their groups. Also, the three groups who collaborated successfully or had a good collaboration reported that they got good marks in their first deliverable.

Table 3.14: Relation among awareness, collaboration, and grades

Code	Participant			
	P4	***P5***	***P6***	***P7***
Awareness	•	•	•	•
Successful collaboration	•			•
Good collaboration		•		
Half good collaboration			•	
Get good marks	•	•		•

Awareness code included situations when members gave an overview of their work and were updated with each other's work and progress. For instance, P4 stated: "*we up to date with each other's work, so I knew, or how much this guy done for this part of the programming or that part of the diagram, I would know*."

Six groups had more than one collaboration activity including discussions: P1, P3, P4, P5, P6, and P7; four of them mentioned that they got good marks and collaborated successfully or at least had a good collaboration. Table 3.15 presents the relation among collaboration activities, collaboration success, and grades.

Participants who collaborated successfully or at least had a good collaboration reported that they got good marks in the first 2 deliverables, while participants, who did not get good marks in their first two deliverables stated negative comments and descriptions for their group work.

Table 3.15: Relation among collaboration activities, collaboration success, and grades

Sub-Theme	Code	Participant						
		P1	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***
Collaboration activities	Help each other	•				•		•
	Clarifying	•		•	•			
	Revision				•	•		
	Persuading	•						
	Discussion (all)	•	•	•	•	•	•	•
	Awareness				•	•	•	•
Collaboration success	Successful collaboration			•	•			•
	Good collaboration					•		
	Half good collaboration	•					•	
	No collaboration		•					
Good features of group members	Get good marks			•	•	•		•

Regarding collaboration styles, Cockburn and Greenberg's collaboration styles can be identified in the data: parallel work, sequential work, independent work, and domination; but a single group can have more than one collaboration style. As the project was undertaken over an extended period of time, different collaboration styles identified within the same group. An attempt was made to find common collaboration styles among groups in order to discover if there is any pattern in the collaboration styles.

Parallel work collaboration style was identified in 2 participants: P1 and P2. P1 reported 2 collaboration styles: parallel work and domination, while P2 reported 2 collaboration styles: parallel work and independent work. There was no other common collaboration style between them. Table 3.16 illustrates collaboration styles for P1 and P2.

Table 3.16: Parallel work compared to other styles for P1 and P2

Collaboration style	***P1***	***P2***
Parallel work	•	•
Sequential work		
Independent work		•
Domination	•	

Sequential work collaboration style was identified in 5 participants: P3, P4, P5, P6, and P7. Table 3.17 illustrates collaboration styles for participants P3 to P7. Four groups of them (P4 to P7) had another common collaboration style, which is: independent work. However, P7 had one more style, which is domination. In conclusion, participants P4, P5, and P6 have the same collaboration styles, which are: sequential work and independent work. P3 reported one

collaboration style only, which is sequential work, while P7 reported 3 collaboration styles, which are: sequential work, independent work, and domination.

Table 3.17: Sequential work compared to other styles for P3, P4, P5, P6, & P7

Collaboration style	*P3*	*P4*	*P5*	*P6*	*P7*
Parallel work					
Sequential work	•	•	•	•	•
Independent work		•	•	•	•
Domination					•

So, three groups had the same collaboration styles: P4, P5, and P6. In addition, P4 and P5 have different collaboration activities while P6 did not report any collaboration activities other than discussions. P4 and P5 have a good level of collaboration and got good marks in the first 2 deliverables.

Table 3.18 presents collaboration styles for participants P2, P4, P5, P6 and P7 as they shared the independent work style. As mentioned above, P4, P5, P6 had the same collaboration styles, while P2 had a parallel work style besides the independent work style.

Table 3.18: Independent work compared to other styles for P2, P4, P5, P6, & P7

Collaboration style	*P2*	*P4*	*P5*	*P6*	*P7*
Parallel work	•				
Sequential work		•	•	•	•
Independent work	•	•	•	•	•
Domination					•

P1 and P7 were the only participants that showed domination style in their collaborations and there was no other common style between them. Table 3.19 illustrates collaboration styles for participants P1 and P7.

Table 3.19: Domination compared to other styles for P1& P7

Collaboration style	*P1*	*P7*
Parallel work	•	
Sequential work		•
Independent work		•
Domination	•	•

RQ1.3: **What applications and tools do groups use during meetings and for collaboration outside of meetings?**

Groups usually used general-purpose applications to communicate, discuss, store or share documents. Each group used at least two of the following applications: email, Facebook, WhatsApp, and Dropbox. This indicated that groups preferred to use common general-purpose applications rather than using specific tools for group collaborations.

RQ1.4: **What problems do students encounter during their collaboration?**

Each group faced a number of problems and difficulties. Problems can be categorised as the following: problems related to members, communication problems, problems with tasks and submission problems.

P1, P2 and P3 reported some cases of a lack of awareness. For example, P2 said: "*because literally person who is designing IP has no attention to the design when I was going making my one*", and P3 said: "*none of us was actually notice that the work was in Dropbox, that he already completed the work on his bit*".

3.5.1 Awareness

Although, no question was asked about awareness, however, a number of findings were emerged from data and were related directly to awareness or problems that occurred either as causes or consequences of lacking awareness. Awareness codes included situations where group members were aware of each other's work and progress. For instance, P5 stated: "*when we attend the meeting we need to kind of give an overview of what we exactly done and maybe show them this is what we done*".

Codes considered as potential causes for a lack of awareness were: bad communication, no reply, late reply, no answer, unchecked accounts, no awareness, no discussion, and no full communication. The code "bad communication" indicated that there was a bad communication between the group members as stated by P6 "*we had a really bad communication going on*". The code "no reply" reflected a case when one or more group members did not reply on messages, as reported by P2 "*and any time I post any code to them, no one will reply*". The code "late reply" indicated a case when one or more group members did not reply immediately on messages. For instance, P4 stated "*just a few members who*

wouldn't reply immediately or within the same day" and P1 stated "*I thought like there would be 4 to 5 days before I actually get responses*". The code "no answer" indicated a case when one or more group members did not answer phone. For instance, P1 stated "*why did you give people your phone number when you can't answer it*". The code "unchecked accounts" reflected a case when a member did not check his/her accounts on email, Facebook, or another tool. For example, P6 said "*the one who never had WhatsApp will never go on his WhatsApp*". The code "no awareness" indicated a case when group members were not aware of each other's work and progress. For instance, P2 stated "*literally person who is designing IP has no attention to the design when I was going making my one*". The code "no discussion" reflected that there was no discussion about the tasks between group members, as stated by P2: "*As a general rule of thumb, persons sorts of did what they did and don't really discuss it*". The code "no full communication" indicated there was no full communication with one or more members. For example, P3 said about 2 members in his group "*there was like a wall or something that's blocking, so we couldn't get that full communications of them*".

Codes considered as potential consequences of a lack of awareness were: start from scratch, mismatch work, and duplicated work. The code "start from scratch" indicated a case when a participant started from scratch and did the work again, as reported by P2 "*I throw all the work and just starting again from scratch*". The code "mismatch work" reflected a case when there was mismatch work, as reported by P1 "*when we submitted the lecturer said none of these diagrams match*". The code "duplicated work" represented a case when there was duplicated work, as reported by P2 "*there wasn't really risk for anyone to duplicating work*".

Awareness emerged as a key issue that shaped my focus because there were a number of problems that appeared as a cause or result of the lack of awareness, which could affect the overall collaboration and learning experience. Also, previous studies have reported on the significance role of the awareness in collaborative learning (e.g. Gutwin et al., 2004; Convertino et al., 2004; Paletta & Herrero, 2011), which encouraged me to take this direction for my research. Moreover, no attempt was made to explore types of awareness or awareness behaviours in this study as the focus was not on awareness, but this encouraged me to investigate awareness in depth in the next study.

3.5 Limitations

This study had a limited number of participants with only 7 participants taking part in the study. Moreover, participants were from different groups and only one member of each group participated and was interviewed, so there are some chances of bias. Also, interviews were the only data collection method in which participants reported what they think, but it should not be the whole picture of the group work. However, it gives an overview of the problems that group members encounter while they were working collaboratively together on their group project.

3.6 Summary

At the beginning of conducting this study, I started with no focus on awareness; the focus was on exploring collaboration styles in collaborative learning groups; but then interesting findings came across. These findings were related to awareness and problems that occurred either as reasons or consequences of lacking awareness.

Moreover, some lessons learned from this study including how to code qualitative data, and it also gave insights on problems that collaborative learning groups encountered. The findings suggested conducting an exploratory study to collect more objective and real-time data in order to understand how students collaborate in long-term projects and investigate activity awareness in depth as reported in the next chapter.

Chapter 4: Understanding Activity Awareness and Collaborative Behaviours in Learning Groups

The previous chapter (Chapter 3) helped in answering the first research question *RQ1*. However, there was a need for more objective, real-time data to answer this question in depth. Therefore, an exploratory study was conducted to overcome this limitation. This study helped to answer three of the main research questions *RQ1, RQ2,* and *RQ3* by investigating how students collaborate, what awareness they have, and how to measure activity awareness in long-term collaborative learning groups.

Collaborative learning is one of the useful learning methods that shown to be effective in supporting learning (Smith & Macgregor, 1992). Collaborative learning is defined as the situation in which a small group of students work together as a team to complete an academic problem-solving task designed to support their learning (Alavi, 1994). It is significant to understand how students really collaborate in learning groups.

Awareness is one of the factors that can influence the success of collaborative groups. It is a useful concept in promoting collaboration opportunities and improving the effectiveness of collaborative learning (Paletta & Herrero, 2011). Results from the previous study showed that awareness arose in several places in the coding scheme where some codes were either reasons or consequences of lacking awareness. For instance, late or no reply to messages or emails from other members were usually reasons of lacking awareness, while starting the work from scratch or duplicating some work were appeared as consequences of lacking awareness.

There are different types of awareness such as activity awareness and situation awareness. Carroll et al. (2006) define activity awareness as an active process in which different kinds of information are continuously shared, tested, and updated to guide group behaviour. Endsley (1995) defined situation awareness as ‘‘the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future’’.

4.1 Motivation

Previous studies have reported on the significant role of awareness in enhancing collaboration in groups (Gutwin et al., 2004; Convertino et al., 2004); however, studies about understanding awareness in collaborative groups for longitudinal learning projects are limited. Convertino et al. (2004) state that many breakdowns in longitudinal collaboration happen because of a lack of activity awareness and they suggested a method to evaluate activity awareness and collaborative activities in a controlled setting.

As reported in Chapter 3, a small pilot study was conducted to explore collaboration in collaborative groups. However, the findings highlighted some problems such as students duplicated some work, sometimes they restarted the work from scratch, or they did not reply to messages or emails from other members. These problems appeared as a cause or result of the lack of awareness. This result was a motivation to investigate the issue of awareness by using different collection methods as there was a limitation in the previous study where only interviews were used. Also, along with participants' views, more objective, real-time data was needed.

This study focused mainly on awareness since the previous study was not tailored to awareness. It also gave insights on other aspects of collaboration in order to understand how students collaborate and which tools and applications they used to support their collaboration. Although the previous study focused on different aspects of collaboration, however, there was a limited number of participants. Investigating other aspects of collaboration would also help to discover their impacts on awareness.

4.2 Research Aim and Research Questions

The aim of this study was to understand awareness behaviours, awareness types and collaboration activities in learning groups who are working on long-term projects. Awareness behaviour can be described as any activity or action that can increase awareness or enhance other members' awareness. Awareness type is any form of awareness that is related to a specific kind of awareness such as activity awareness, skill awareness, and current-state awareness.

An exploratory study was undertaken to understand awareness in groups working on a longitudinal learning project. This study helped to tackle three main research questions *RQ1*, *RQ2*, and *RQ3:*

RQ1: How do students collaborate in long-term collaborative learning groups? and this study focused on three of its sub-questions *RQ1.1*, *RQ1.2*, and *RQ1.3*, which are:

> ***RQ1.1:*** What collaboration styles and activities are identified in long-term collaborative learning groups?
>
> ***RQ1.2:*** What awareness behaviours and awareness types are exhibited in long-term collaborative learning groups?
>
> ***RQ1.3:*** What applications and tools do groups use during meetings and for collaboration outside of meetings?

RQ2: How can activity awareness be measured in long-term collaborative learning groups?

RQ3: What activity awareness do group members have in long-term collaborative learning groups?

4.3 Method

A mixed methods approach was adopted in this study. Ethical approval was granted from the School of Informatics to conduct this study. Three main data collection methods were used; observations, short interviews and questionnaires.

What is the coursework? The coursework involved the design of an interactive device as part of an introductory module on interaction design i.e. real learning project. Interaction Design coursework is a group project. The coursework is a design project and there are 2 deliverables; the main deliverable is a group report of the design process and includes: data gathering, requirements, conceptual and detailed design, and evaluation. Moreover, all group members normally receive the same mark for this part of the assignment. The second deliverable is an individual reflection from each member on his/her experience in the project.

4.3.1 Participants

The participants were a convenience sample of MSc students who were working on the collaborative coursework. Group members had not worked together previously and had

different educational backgrounds, experiences, and skills. Five groups participated in the study with either 3 or 4 members in each group and a total of 17 participants (3 groups of 3 and 2 groups of 4). Each group determined its own working methods and selected various software applications to support their collaboration. For the purpose of this study, each group was given a code (A, B, C, D, and E), and each member of the group was given a unique code consisting of the group name and a number (e.g. A1, B2, C3, D1, etc..). Participants were recruited in the City University by inviting them to take part in this study in one of their classes, also an email was sent to them through Moodle to explain the study and encourage them to participate. Each participant received an incentive of 10 pounds Amazon voucher at the end of the study.

4.3.2 Data Collection

Three data collection methods were used; questionnaires, interviews, and observations. Data were collected over a 6-week period. Table 4.1 shows the timeline of the data collection.

Table 4.1: The timeline plan for data collection

Group	**Week**					
	Week 1 **(4/11 – 10/11)**	***Week 2*** **(11/11 – 17/11)**	***Week 3*** **(18/11 – 24/11)**	***Week 4*** **(25/11 – 1/12)**	***Week 5*** **(2/12 – 8/12)**	***Week 6*** **(9/12 – 15/12)**
A	Observation 1 Interview 1 Demographic Questionnaire		Observation 2 Interview 2			Self-assessment Questionnaire
B	Observation 1 Interview 1 Demographic Questionnaire		Observation 2 Interview 2	Observation 3		Self-assessment Questionnaire
C		Observation 1 Demographic Questionnaire		Interview 1	Interview 1 (cont.) Observation 2	Self-assessment Questionnaire
D		Observation 1 Demographic Questionnaire	Interview 1	Observation 2 Interview2		Self-assessment Questionnaire
E		Observation 1 Demographic Questionnaire	Interview 1		Observation 2 Interview 2	Interview 2 (cont.) Self-assessment Questionnaire

4.3.2.1 Questionnaires

Questionnaires were used to collect data about participants at the beginning and their self-assessment of the learning experience at the end of the study. Each participant was given 2 questionnaires.

First questionnaire: The first questionnaire was a "demographic questionnaire" and it was administered at the beginning of the study to collect factual data, such as demographic, background study, and skills. It consisted of 11 questions about age, gender, education background, studied MSc programme, roles, skills, applications used and learning preferences. This questionnaire helped to give an overview of participants and also to answer *RQ1.3*. The questionnaire is in Appendix B.1.

Second questionnaire: The second questionnaire was a "self-assessment questionnaire" and it was given at the end of the project. It used Likert-scale questions to assess students' awareness and satisfaction with their learning experience as well as their learning preferences. It consisted of 17 questions and was divided into two sections: questions 1 to 13 were about participants' experience in working as a group on their coursework, for instance: "I always knew what my group members were going to work on over the week"; while questions 14 to 17 were about their learning preferences, for instance: "I would prefer to work on group projects over other types of learning activities." This questionnaire helped to answer *RQ3*. The questionnaire is in Appendix B.3. Questions 1 to 5 and 8 to 14 were from the experimental study done by Convertino et al. (2004) and they were modified to suit this study. The original questionnaire can be found in Appendix B.5.

4.3.2.2 Interviews

Interviews were used to collect data about applications used, awareness types, changes in activity awareness, and collaboration styles; to help in answering research questions of this study. Each participant was interviewed individually twice for about 4 to 7 minutes, except for one group (group C), where each member was interviewed once only as they did not get back to the researcher. All interviews were audio-recorded and transcribed. The goal was to conduct the first interviews at the beginning of the project; however, plan did not work well as some groups were firstly interviewed in the third week or fourth week of the project. Groups A and B were interviewed at the beginning of the project after the first observations. The second interviews were conducted in the middle or near the end after the second

observations. The interview questions were semi-structured and mostly designed to probe awareness, collaboration, and applications they used. For example, one of the questions was "what have you done last week?" to explore activity awareness. All interview questions can be found in Appendix B.6.

4.3.2.3 Observations

Observations were used to collect data about awareness behaviours, awareness types, collaboration activities, and tools used, in order to answer the study research questions. Groups were observed twice for about 30 minutes during their regular meetings in the City University premises, except Group B where they were observed 3 times. The researcher did not intervene in their meetings. Their actual meetings usually lasted more than 30 minutes, but only the first 30 minutes of each meeting was observed, as the researcher set an observation block time of 30 minutes. The first observations were made at the beginning of the project, while the second observations were made in the middle or near the end of the project. All observations were recorded in audio form and field notes were taken as well. One observation was video recorded. Sample field notes can be found in Appendix B.9. Observation was a big difference from the pilot study in which only interviews were conducted.

There was a challenge in conducting observations with students. Sometimes it was very difficult to get access to them, as a group, as they worked on real projects and they had other learning commitments. The aim was to conduct three observations for each group in order to discover any patterns in collaboration activities and behaviours. A number of attempts were made to contact students to arrange for a third observation, bearing in mind ethical considerations and what was feasible, it was managed to conduct three observations with only one group, which was group B, and two observations with each of the other groups.

4.3.3 Data Analysis

This study employed a mixed qualitative and quantitative data. Qualitative data sources included transcripts of interviews with students and field notes of group meetings' observations. Quantitative data included group report grades and students' responses to a Likert-scale questionnaire. Data from all data collection method were analysed.

4.3.3.1 Questionnaire Analysis

For the demographic questionnaire, answers were analysed for each group by counting frequencies of each answer. For the self-assessment questionnaire, averages (i.e. means) and standard deviations were calculated for each question for each group.

4.3.3.2 Interview Analysis

Interviews were audio-recorded and transcribed, and then they were coded and analysed. NVivo, which is a tool for qualitative data analysis, was used in coding data from interviews. Mixed approaches were used to code and analyse the interviews transcripts.

All interview transcripts were read several times to identify themes. Two cycles were made for coding: the first cycle was to code data; and then the second cycle was to refine the codes. In the first cycle, a top-down approach was applied by using the coding scheme derived from the first study (Chapter 3, see Appendix A.2 for the coding scheme), and then a bottom-up approach was applied to create new codes and themes. More detail about the coding scheme is presented later in section 4.3.3.4.

The coded data in the interviews were: meeting structure, tasks assigning, applications used, positive and negative comments on applications, awareness behaviours, awareness types, collaboration activities and styles, and problems (see Table 4.2). Interviews were also used to measure activity awareness as described later in section 4.4.5.

4.3.3.3 Observation Analysis

All observed meetings were audio-recorded and field notes were taken during observations. Also, field notes were enriched by transcribing recordings of observations. All field notes were coded using Nvivo. As in the interviews' analysis, all field notes were read several

times and two cycles for coding were made. The coded data in the observations were: meeting activities, meeting structure, tasks assigning, tools used, awareness behaviours, awareness types, and collaboration activities (see Table 4.2).

4.3.3.4 The Coding Scheme

A general inductive analysis was applied to derive themes from the collected data. In an inductive analysis, a detailed reading of raw data used to develop themes, concepts, or a model (Thomas, 2006).

A coding scheme was created to include all the codes that identified in the interviews and the field notes. There were 4 main themes, with 12 sub-themes; and a total of 55 codes identified in the data. Table 4.2 presents the coding scheme and the source of the coded data. Description of each code can be found in Appendix B.8.

Table 4.2: The coding scheme

Themes	Sub-themes	Codes	Coded data	
			Interviews	*Observations*
Meeting	1. Activities	Drawing		•
		Working		•
		Writing		•
	2. Meeting structure	Book a room		•
		Initial plan	•	•
		Write notes	•	•
	3. Tasks assigning	Task assigning by availability	•	
		Task assigning by experience	•	•
		Task assigning by skills	•	
		Task assigning by volunteering	•	•
		No criteria	•	
Applications and Tools	4. Applications used	Use email	•	
		Use Facebook	•	
		Use Google drive	•	
		Use Google Hangouts	•	
		Use SMS	•	
		Use WhatsApp	•	
	5. Tools used	Use iPad		•
		Use iPhone		•
		Use laptop		•
	6. Positive comments on applications	Positive comment on Google drive	•	
		Positive comment on Google Hangouts	•	
		Positive comment on WhatsApp	•	
	7. Negative comments on applications	Negative comment on Google drive	•	
		Negative comment on Google Hangouts	•	

Themes	Sub-themes	Codes	Coded data	
			Interviews	*Observations*
Awareness	8. Awareness behaviours	Ask direct question		•
		Ask external person		•
		Ask for clarification		•
		Catch up		•
		Checking	•	•
		Offer clarification		•
		Update absent group member		•
		Work review	•	•
	9. Awareness types	Activity awareness	•	•
		Current state awareness	•	
		Next-step-awareness		•
		Skill awareness	•	•
		Time awareness		•
Collaboration	10. Collaboration activities	Agreement	•	•
		Disagreement	•	•
		Pair discussion		•
		Group discussion	•	•
		Editing	•	•
		Engage		•
		Help		•
		Review		•
		Suggesting	•	•
	11. Reported collaboration styles	Parallel	•	
		Sequential	•	
		Mix of both	•	
	12. Problems	Different thinking	•	
		Communication problem	•	
		Coursework understanding	•	
		Redo work	•	
		Language	•	

During the coding process, a number of codes were refined. Code refinement included renaming codes to be more descriptive; adding more information to the code; or combining two similar or overlapped codes to become one code. For instance, code “to ask” was renamed and became “ask an external person”, code “update” improved and became “update an absent group member”, code “discussion by 2” renamed and became “pair discussion”, and codes “look at drive” and “look at notes” combined together and became “checking”.

4.3.3.5 Reliability Check for the Coding

A reliability check is a process to assess the reliability of the qualitative research coding. Usually qualitative data analysis can be interpreted differently. It is not like quantitative data analysis where you have definite answers based on numbers or quantities. For example, if two coders were asked to code the same interview transcript, they could generate two different set of codes based on their research questions, what they are looking for in the data, and also what terms they used to describe something. Reliability check used to ensure that qualitative analysis is valid and persistent (Riffe et al., 2005).

In order to assess the reliability of the coding at least two different researchers must code the same body of content. Mouter and Noordegraaf (2012) summarise five main steps for intercoder reliability test:

1- *"Determine the scope of the intercoder reliability check":* by defining and selecting the most relevant categories/themes to the study objectives that need to be checked.
2- *"Draft the protocol":* by training the coders to use the coding and be familiar with the definitions.
3- *"Determine the sample that is tested":* it is suggested that using 10% of the data is sufficient (Lombard et al., 2004).
4- *"Execute the test, select the reliability coefficient and calculate the coefficient":* the intercoder reliability check consists of coding and comparing the findings of the coders. Reliability coefficients can be used to measure the agreement between the coders.
5- *"Assess the results and draw conclusions":* by determining if the agreement of the test is acceptable for the chosen coefficient. There is no consensus on "what acceptable agreement is". Some scientists determine that a coefficient of 0.90 or greater is acceptable to all situations, and 0.80 or greater is acceptable in most cases and below that, there is a high disagreement. On the other hand, Riffe et al., (2005) state that a coefficient of 0.667 would be appropriate for some research.

The Jaccard index was used for intercoder reliability check to calculate agreement between two coders. The Jaccard index equation is as follows:

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|}$$

Where A is the number of codes identified by the first coder, and B is the number of codes identified by the second coder, where Jaccard index is their intersection over their union.

The reliability check process followed the steps above. Two rounds were carried out to reach an acceptable agreement. One theme of the coding scheme was chosen as the scope for this process, which is "awareness behaviours" because it is the core of the findings and the rest of this research will depend on this part. Data are the field notes on group meetings' observations.

A document that includes codes, their definitions, and examples were given to the second coder before starting the reliability check process. Then, a printed document that includes a sample of data from field notes was given to the second coder.

In both rounds, 20% of the data were coded by the researcher and a second coder. Literature suggest that using 10% of the data in the reliability check process is sufficient (Lombard et al., 2004). In the first round, an agreement of 60% was reached between the coders which was not sufficient and the need to run a second round was a must. The total number of codes in the sample was 40 codes and the intersection between coders was 24 codes, and the agreement was calculated as 24/40 = 0.6. Based on the feedback of the second coder, codes and their definitions were refined and modified. In addition, one of the codes (informing) was overlapping with some codes (work review and offer clarification), so this code was removed and the data were re-coded based on the new coding scheme and codes' definitions.

In the second round, the same process was followed as in the first round but with different data set. An agreement of 85% was reached between the coders. The total number of codes in the sample was 40 codes and the intersection between coders was 34 codes, and the agreement was calculated as 34/40 = 0.85.

4.4 Results

In this section, an overall description of each group is highlighted first. Then, the result of each data collection is presented. Finally, a separate section for studying activity awareness is given.

4.4.1 Description of Groups

Group A consisted of 3 members. They used email, Google drive, and Google Hangouts to collaborate. They used laptops and notes during meetings. A1 and A3 reported that they worked in a parallel way while A2 reported that they worked sequentially. Parallel work means that members are working at the same time on different tasks, while in sequential work, members perform tasks in order and their tasks depend on each other's tasks with no overlapping of actions. Group A got 75 in the group report, which is the main deliverable of the module coursework.

Group B consisted of 3 members. They used email and SMS. They used laptops and notes during meetings. Group members reported that they worked mostly in a parallel way. They got 67 in the group report.

Group C consisted of 3 members. They used email and SMS to collaborate. They used laptops and notes during meetings. Group members reported that they worked mostly in a parallel way. Group C had less frequent meetings than the others. They distributed tasks from the first meeting. They got 55 in the group report.

Group D consisted of 4 members. They used email and WhatsApp to collaborate. They used iPads and notes during meetings. Group members reported that they worked mostly in a parallel way. Group D met regularly, twice a week. Group D in the first observation did an organised work review where each member talked about her work for 2-3 minutes with no interruption. They got 65 in the group report.

Group E consisted of 4 members. They used Google drive, and Google Hangouts to collaborate. They used laptops and notes during meetings. Group members reported that they worked mostly in a parallel way. They got 73 in the group report.

In general, all group were worked in parallel most of the time, but at some points they worked between parallel and sequential ways. Group A and E used the same applications and tools to collaborate. Group A usually booked rooms for their

meetings, as they booked a room in both observations. Group B booked a room once in their second observation. Other groups met in different locations at the City University such as the Library, and the HCID common room.

4.4.2 Questionnaire Results

Two questionnaires were collected: one at the beginning of the study (demographic questionnaire) and the other one at end of the study (self-assessment questionnaire). The result of each questionnaire is presented here.

4.4.2.1 Demographic Questionnaire

All 17 participants completed the questionnaire. Most participants were in the age range between 18 and 39. Table 4.3 presents the number of participants in each age group. Two groups were all female and three groups were mixed. Table 4.4 shows the number of males and females in each group.

Table 4.3: Number of participants in each age group

Group	Age group			
	18-29	**30-39**	**40-49**	**+50**
A	1	2	0	0
B	1	2	0	0
C	1	1	0	1
D	3	1	0	0
E	2	1	1	0
Total	**8**	**7**	**1**	**1**

Table 4.4: Number of males and females in each group

Group	Gender	
	Male	**Female**
A	2	1
B	1	2
C	0	3
D	0	4
E	2	2
Total	**5**	**12**

They had different educational backgrounds, experiences, skills, and learning preferences. Participants were studying on different MSc programmes and they were a mixture of full-time and part-time students. In terms of programme and study mode, there were 3 homogenous groups (A, B, & E) and 2 heterogeneous groups (C & D). Tables 4.5 and 4.6 illustrate the distribution of the participants as full-time or part-time students in each group, and the distribution of the participants and their MSc programmes.

Table 4.5: Distribution of participants as full-time or part-time students

Group	Study mode	
	Full-time	Part-time
A	0	3
B	3	0
C	1	2
D	4	0
E	4	0
Total	**12**	**5**

Table 4.6: Distribution of participants across MSc programmes

Group	MSc programme		
	HCS	BSAD	E-Publishing
A	3	0	0
B	0	3	0
C	3	0	0
D	2	0	2
E	4	0	0
Total	**12**	**3**	**2**

Participants reported that there was no specific role for each member in the group. Applications they used will be presented in the interview results. Full answers to the first questionnaire can be found in Appendix B.2.

4.4.2.2 Self-assessment Questionnaire

This questionnaire was administered in the last week of the project, either in the City University premises or by email. All participants completed the questionnaire except one member from group B (participant B2 did not get back to the researcher).

For each group, averages of questions 1 to 13 were calculated to find the overall average of the self-assessment of the experience of working as a group. Before

calculating the average per group, the scale of the first question was converted because it was a negative statement, so if a participant gave 1, then the score converted to 7, if he/she gave 2, then the score converted to 6, if he/she gave 3, the score converted to 5, and if he/she gave 4, the score remains the same because it is neutral. The first question was: "I found it difficult to tell what work my group members had done during the last week". Standard deviations (SD) were also calculated for each question for all groups to find out whether group members had similar opinion or experience for each question or not. So if SD is equal to zero that means group members gave same rating for the question, while higher SD means group members chose different values. Table 4.7 presents an example of averages and standard deviations calculated for group A. Full answers to this questionnaire can be found in Appendix B.4.

Table 4.7: Averages and standard deviations for questions 1 to 13 for group A (7-point Likert-scale)

Question	Participant			Avg.	SD
	A1	***A2***	***A3***		
1. I found it difficult to tell what work my group members had done during the last week.	2	1	2	1.67	0.58
2. It was easy to find what my group members had done using the collaborative tool (e.g. Google Drive or email).	5	7	2	4.67	2.52
3. I could tell what my group members were doing while we were collaborating remotely.	2	7	5	4.67	2.52
4. I always knew what my group members were going to work on over the week.	6	5	3	4.67	1.53
5. It was always clear what my group members were going to do.	6	5	5	5.33	0.58
6. I found the tools we used to share documents were effective.	6	7	1	4.67	3.21
7. I could tell what the current state of our project was at any given time.	6	7	6	6.33	0.58
8. I became more aware of my group members' plans over time.	4	6	1	3.67	2.52
9. My group members and I planned adequately.	5	4	3	4	1
10. My group members and I communicated well with each other.	4	6	n/a	5	1.41
11. My group members collaborated with me to complete the project.	6	6	2	4.67	2.31
12. My group members contributed equally to this project.	6	4	2	4	2
13. I enjoyed collaborating with group members.	6	5	2	4.33	2.08
Average/ participant	**5.23**	**5.85**	**3.17**	**4.75**	

Averages were calculated for questions 1 to 13 for each participant to find the overall self-assessment for each member in the group (Q1 also was converted before

calculating the average). In addition, the overall average for each group was calculated as well. Table 4.8 shows the average for each participant and overall average for each group.

Table 4.8: The average of self-assessment questionnaire for participants and their groups

Participant	Average	Group Average
A1	5.23	4.75
A2	5.85	
A3	3.17	
B1	5.85	6
B2	n/a	
B3	6.15	
C1	6.31	5.77
C2	5.23	
C3	5.77	
D1	6.54	5.96
D2	6.46	
D3	5.08	
D4	5.77	
E1	5.38	4.67
E2	4.69	
E3	4.31	
E4	4.31	

Groups A and E gave lower overall satisfaction towards working as a group. The results showed that participants felt they were aware of their colleagues' activity (all averages are above 4, where 4 is neutral). Groups B, C, and D enjoyed collaborating with their group members more than groups A and E, as they ranked this statement: "I enjoyed collaborating with group members". Further discussion on the results of this questionnaire was made in the discussion section.

Table 4.9 presents learning and working preferences for group A. All participants in group A gave neutral ratings for working on group projects over other types of learning activities, and having a prepared plan for work or exploring new options. Regarding work with someone or individually, A1 and A2 preferred to work individually, while A3 gave a neutral answer. For working with professionals or friends, A2 and A3 preferred to work with professionals, While A1 gave a neutral answer. Answers for all participants can be found in Appendix B.4

Table 4.9: Answers for preferences' questions 14 to 17 for group A (7-point Likert-scale)

Question	Participant		
	A1	***A2***	***A3***
14. I would prefer to work on group projects over other types of learning activities.	4	4	4
15. I would prefer to: *Have a prepared plan/ Explore new options*	4	4	4
16. I would prefer to work: *With someone/ Individually*	6	5	4
17. I would prefer to work with: *Professionals* / Friends	4	2	3

4.4.3 Interview Results

Results from the interviews are presented by themes, and then analysis of activity awareness questions is given separately (in section 4.4.5).

4.4.3.1 Meeting

Two sub-themes were identified in meeting theme from the interviews data: meeting structure and task assigning.

Meeting structure: Meetings frequencies were varied among groups. Some students reported that they created an initial plan to complete their project and they were taking notes during their meetings.

Task assigning: Tasks were assigned to members based on their skills or experience, by volunteering, or by availability. Five participants supposed that there were no specific criteria to choose tasks: C1, C3, E1, E2, and E3; however, two of them chose some tasks based on their previous experiences or by volunteering (C1 and C3). Group A chose their tasks by availability or volunteering. Group B chose their tasks in different ways: by availability, experience, skills, or some times by volunteering. Participant C2 stated that tasks were assigned based on skills. Group D had different opinions on how tasks were assigned: D1 said that tasks assigned by her as she was the project manager, D2 thought it was more based on skills, D3 stated it was based on experience, while D4 said it was by volunteering. Most participants in group E supposed that were no criteria for assigning their tasks, however, E4 thought it was by volunteering.

4.4.3.2 Applications and Tools

Three sub-themes were identified in applications and tools theme from the interviews data: applications used, positive comments on applications, and negative comments on applications.

Applications Used: It was clear that each group used different kinds of applications to manage their project. Group A used email to communicate; Google drive to share documents; and Google Hangouts for online meetings. Group B used email to share documents; and SMS to communicate. Group C used email to share documents; and SMS to communicate. Group D used email to share documents; and WhatsApp to communicate. Group E used Google drive to share documents; Google Hangouts for online meetings; and Facebook messenger to communicate at the beginning only. Table 4.10 summarises the applications and their uses in each group.

Table 4.10: Application used and their purposes for each group

Group	**Application used for**		
	Sharing documents	***Communication***	***Online meeting***
A	Google drive	Email	Google Hangouts
B	Email	SMS	n/a
C	Email	SMS	n/a
D	Email	WhatsApp	n/a
E	Google drive	Facebook (limited time)	Google Hangouts

Positive comments on applications: E1 gave a positive comment on Google drive as he said: "*that's also a good thing about Google drive because you always see who created what and who was editing a document and at what time*". Also positive comments on Google Hangouts were given by A1 and E1. For instance, A1 stated: "*I mean the great advantage of Hangouts is I can be at home and like we decide it will take an hour because usually it takes between an hour- an hour and half but it starts when the Hangouts starts and finishes when the Hangouts finishes*". D3 provided a positive comment on WhatsApp: "*we already share the phone numbers we already contact on WhatsApp because it's a really easy to contact*".

Negative comments on applications: A1 and E2 gave a negative comment on Google drive (e.g. A1 stated: "*one of the problem we had with it, I'll show to you is that it is become slightly unmanageable now*"). Also, negative comments on Google Hangouts

were given by A1, E1, and E2. For instance, E2 said: "*we had a big argument on the Hangouts which was a big problem. I think the problem is partly from the Hangouts*".

4.4.3.3 Awareness

Two sub-themes were found in awareness theme from the interviews data: awareness behaviours and awareness types. A description of each code is given later in section 4.4.4.3.

Awareness behaviours: Most of the awareness behaviours were from the field notes; however, two awareness behaviours were identified in the interviews: checking and work review. Checking behaviour appeared twice in the interview data with participants A1 and D1. For instance, when D1 was asked about what she has done in the project, she answered "*can I look in my calendar?*". Work review appeared 3 times in the interview data; all of them in the second interview for Group B (B1, B2, and B3). For instance, B2 stated "*and just make review in the meeting*".

Awareness Types: Several awareness types were evident in the interviews. Awareness types identified in the interviews were: activity awareness, skill awareness, and current state awareness. All groups had activity awareness as they had been asked about their colleagues' activities. For example, when A2 was asked about what A3 did, she answered: "*A3 did a couple of interviews as well, and he also started working on the personas for the task*". All groups had current-state awareness as they had been asked about the current state of their project. For instance, B1 stated: "*We finish the data gathering, and we are trying to analyse the data in order to list the requirements to do the second phase*". In addition, some evidence from the interviews was found about skill awareness. Groups A, D, and E showed some awareness of each other skills. For instance, D1 said about D3 "*she's the best artist in the group*".

4.4.3.4 Collaboration

Three sub-themes were found in collaboration theme from the interview data: collaboration activities, collaboration styles, and problems.

Collaboration activities: Five collaboration activities were identified in the interviews: agreement, disagreement, group discussion, editing, and suggesting.

Agreement appeared twice in A1 and E3 interviews; for instance, E3 said: "*we agreed with some requirements that we needed to bring*", disagreement appeared also twice in the first and second interviews for E4; for instance, he said: "*so we have some disagreement about the brief*".

Twelve participants mentioned group discussion in their interviews: A1, A2, B1, B2, B3, C3, D2, D3, D4, E1, E3 and E4. Four participants talked about editing in their interviews: B1, B3, C1, and D4. Three participants from group D mentioned suggesting in their interviews: D1, D2, and D3.

Collaboration Styles: The reported collaboration styles were parallel work, sequential work, and a mix of both. Parallel work means that members are working at the same time on different tasks, while in sequential work, members perform tasks in order and their tasks depend on each other's tasks with no overlapping of actions.

Some participants reported conflicting responses in their collaboration style, such as in group A, where A1 and A3 reported that they worked in parallel in the first meeting, while A2 said they worked in a sequential way. Group B worked in parallel and mixed of both styles; group C, D, and E worked in parallel at the first then worked in parallel and mixed of both later. Table 4.11 presents participants and their reported collaboration styles in both interviews (except group C as they interviewed once only).

Table 4.11: Reported collaboration styles in the first and second interviews for all groups

Participant	In the first interview	In the second interview
A1	Parallel	Parallel
A2	Sequential	Mix of both
A3	Parallel	Mix of both
B1	Parallel	Parallel
B2	Parallel	Mix of both
B3	Mix of both	Mix of both
C1	Parallel	n/a
C2	Parallel	n/a
C3	Parallel	n/a
D1	Parallel	Parallel
D2	Parallel	Parallel
D3	Parallel	Parallel
D4	n/a	Mix of both
E1	Parallel	Parallel
E2	Parallel	Mix of both
E3	Parallel	Parallel
E4	Parallel	Mix of both

Problems: Participants highlighted 5 problems they faced in their projects: group members have different thinking, communication problems, problems in coursework understanding, need to redo work, and language barriers. The frequency of the reported problems was low (max. 4 times). Most of the problems were related to understanding the given task, which might result in doing the work again. One problem was related to language barriers, as the participants were international students.

At the end of the semester, participants were asked about their grades for the group report part. Table 4.12 presents the grades for each group.

Table 4.12: Groups' grades for the group report part

Group	Grade
A	75
B	67
C	55
D	65
E	73

4.4.4 Observation Results

In this section, results from the observations are presented by the themes of the coding scheme.

4.4.4.1 Meeting

Meeting Activities: During meetings, different activities were performed in order to complete tasks such as writing, drawing, and working. The writing activity involves writing requirements, personas, scenarios, or the final report. The drawing activity includes drawing storyboards pictures, or the device prototype. The working activity is any activity done in the meeting to complete a task and it could be one of the followings: counting; calculating; analysing; creating categories or craftworks.

Meeting structure: Some groups booked a room for their meeting. Some groups had initial plans. Some participants were writing notes during their meetings to record what is going on.

Tasks assigning. There was only one case of task assignment in the field notes in Group C; where C2 volunteered to complete some tasks.

4.4.4.2 Applications and Tools

Tools Used: Groups used different tools during their meetings, such as laptops, iPads, and iPhones. In both meetings, group A and E used laptops, while group D used iPads. At least in one meeting, group B and C used laptops.

4.4.4.3 Awareness

Awareness Behaviours: Eight awareness behaviours were identified in the field notes of the first and the second observations: ask for clarification, ask direct question, ask external person, catch up, checking, offer clarification, update absent group member, and work review. A total of 190 instances of awareness behaviours were identified in all groups in all observations. Figure 4.1 illustrates awareness behaviours across all groups.

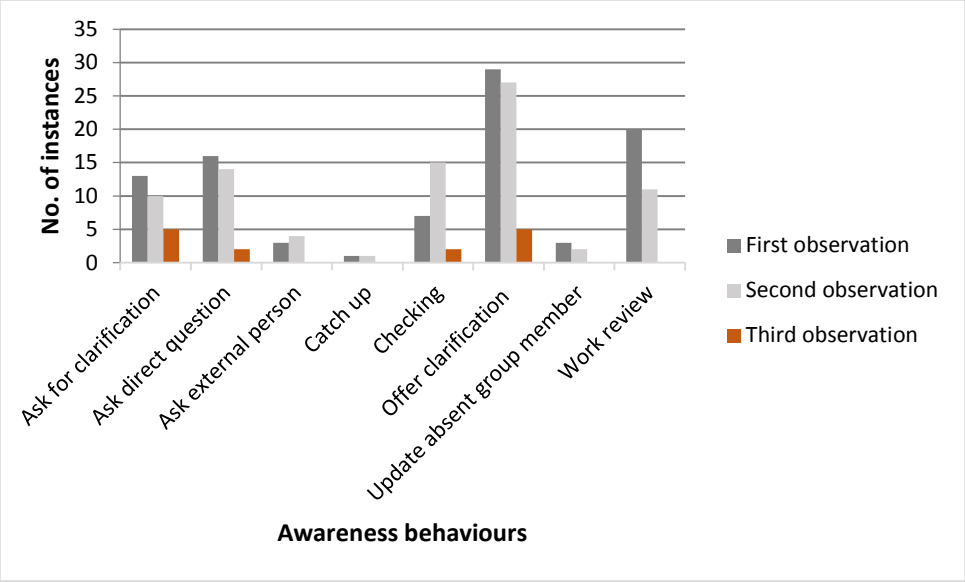


Figure 4.1: Awareness behaviours across all groups

In this section each code for awareness behaviour is described and examples from the data for each code are presented. The code "ask direct question" indicated that a participant asked a direct question to gain knowledge or to become aware of what

other members are doing in the meeting. For instance, E3 asked E1 "*what are you doing?*", and A1 asked "*what criteria are we taking for this?*" The code "ask external person" indicated that a participant was aware of what the group needs to ask their module leader, for example, A3 said "*that's what we need to ask in the surgery*". The code "ask for clarification" indicated that a participant asked other members to clarify their work or ensure that he/she was aware of what they did correctly. For instance, A1 asked A2 a question to clarify her work. The code "catch up" indicated that a participant asked for a minute or two to catch up with the group. As an example, E2 asked for a minute to catch up and read (Catharine) persona. The code "checking" was used when a participant checked notes, lecture slides, coursework description, or resources. For example, A1 checked the Interaction Design book looking for framework. The code "offer clarification" indicated that a participant clarified his/her work or any difficult part to other group members. For instance, A2 read from the screen and clarified each point. The code "update absent group member" indicated that a participant updated other member if he/she missed any part of the meeting. For example, A2 updated A1 about what they chatted before he came. The code "work review" indicated that a participant reviewed what he/she did before the meeting. For instance, D2 reviewed her work on interview.

For group A, awareness behaviours were identified either in the first or second observation, or both. A total of 51 instances of awareness behaviours were identified in group A: 19 in the first interview and 32 in the second one. Figure 4.2 presents "awareness behaviour" codes in the first and the second observations for group A. Work review was more frequent in the first observation. The number of awareness behaviours' instances was higher in the second observation.

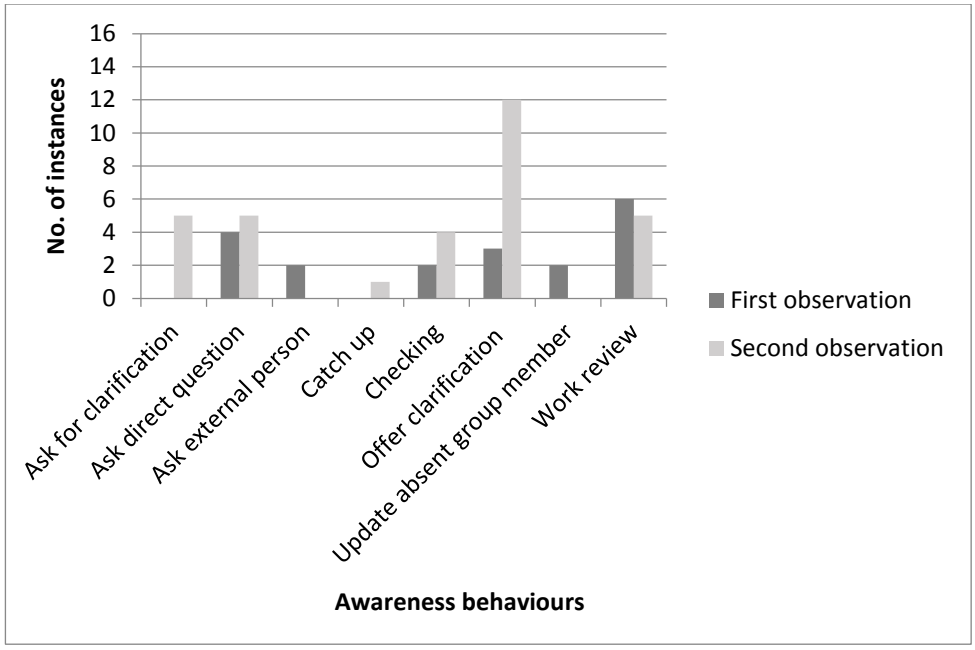


Figure 4.2: Awareness behaviours codes identified in group A

Figure 4.3 presents percentages of awareness behaviours occurrence in each observation for group A. In the first observation, work review was the most frequent behaviour while offer clarification was the most frequent behaviour in the second observation.

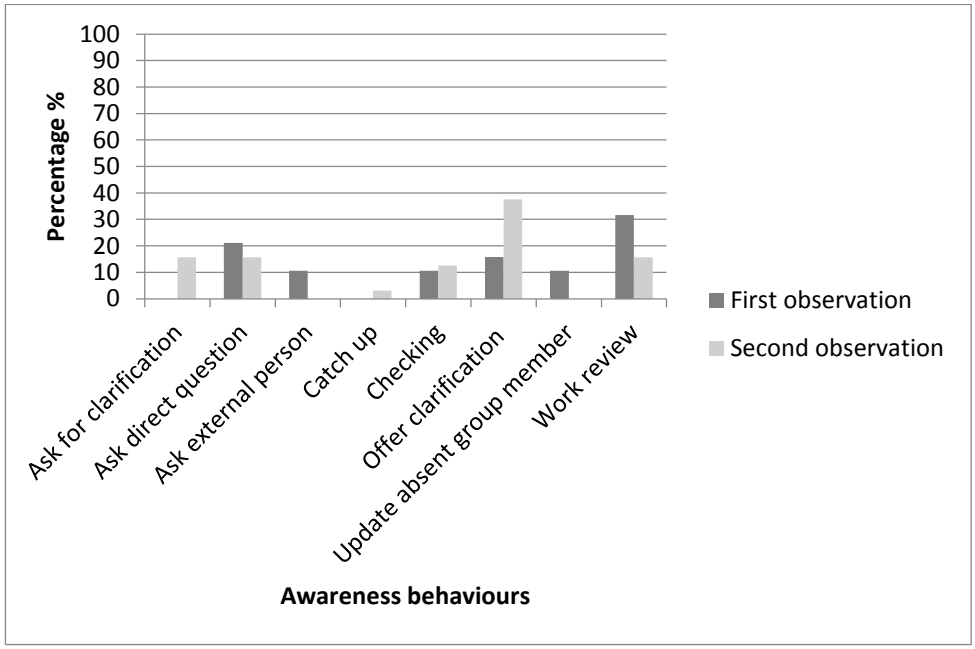


Figure 4.3: Percentages of awareness behaviours codes for group A

For group B, the awareness behaviours were: ask for clarification, ask direct question, ask external person, checking, offer clarification, and work review. A total of 67 instances of awareness behaviours were identified in group B: 32 in the first interview, 21 in the second, and 14 in the last one. Figure 4.4 illustrates "awareness behaviour" codes in the first, the second, and the third observations for group B. Work review was more frequent in the second observation than the first one, however, no work review identified in the third observation. The number of awareness behaviour codes was higher in the second observation.

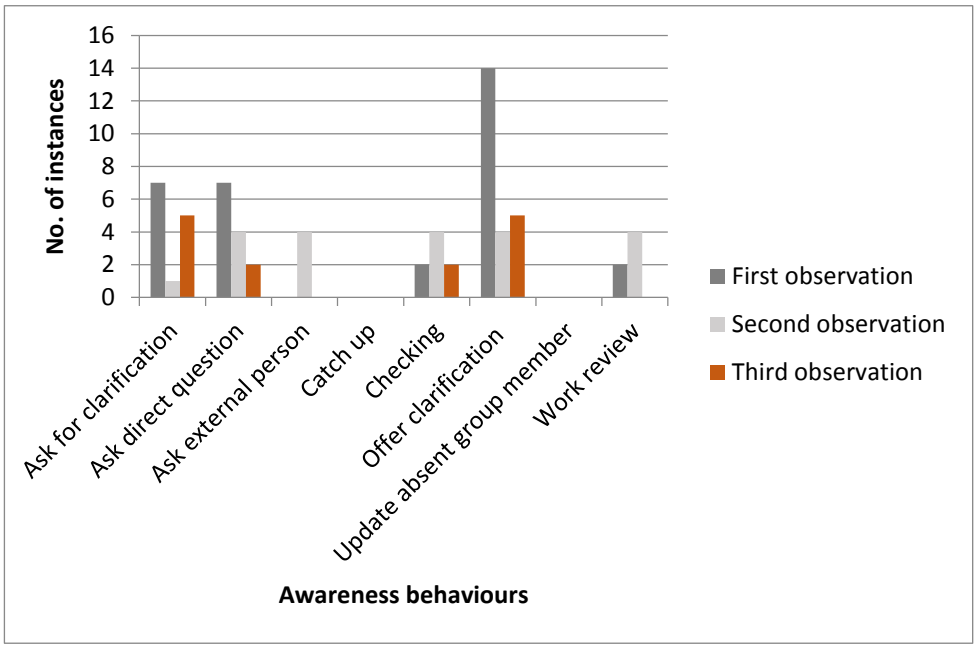


Figure 4.4: Awareness behaviours codes identified in group B

Figure 4.5 presents percentages of awareness behaviours occurrence in each observation for group B. Offer clarification was the most frequent behaviour in the first observation. Behaviours occurred equally except for ask for clarification in the second observation, while ask for clarification and offer clarification were equally the most frequent behaviours in the third observation.

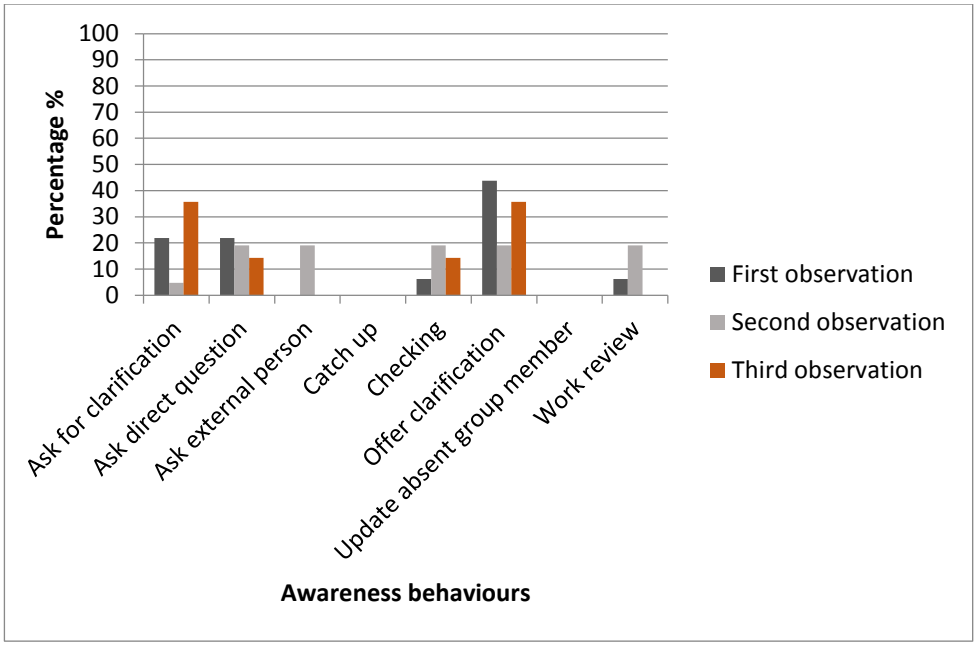


Figure 4.5: Percentages of awareness behaviours codes for group B

For group C, the awareness behaviours were: ask for clarification, ask direct question, ask external person, checking, offer clarification, and update absent group member. A total of 20 instances of awareness behaviours were identified in group C: 11 in the first interview and 9 in the second one. Figure 4.6 shows "awareness behaviour" codes in the first and the second observations for group C. No work review was identified in the observations. The number of awareness behaviour codes was higher in the first observation.

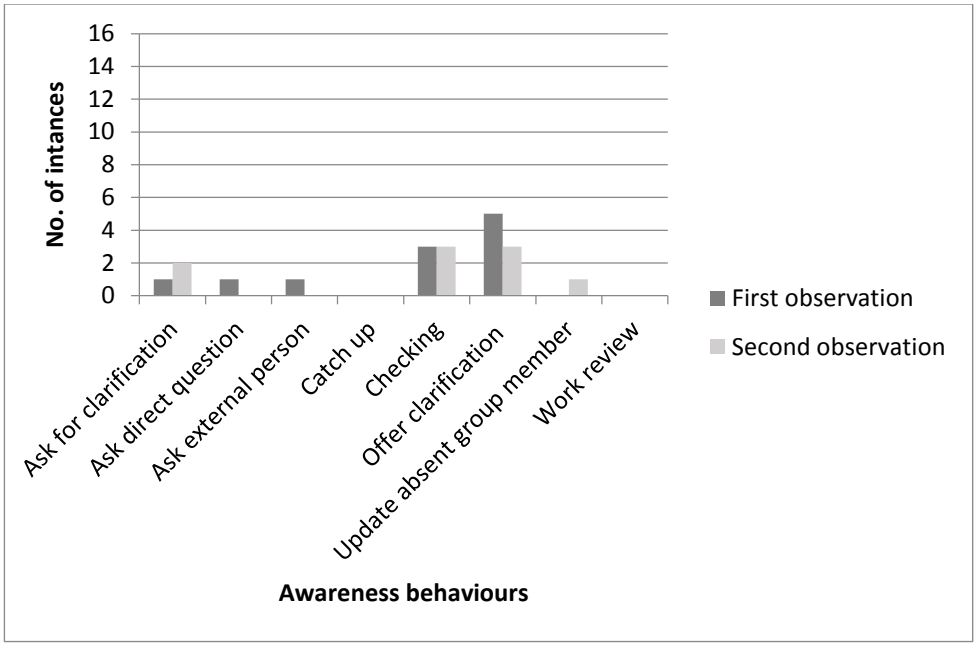


Figure 4.6: Awareness behaviours codes identified in group C

Figure 4.7 presents percentages of awareness behaviours occurrence in each observation for group C. In the first observation, offer clarification was the most frequent behaviour while checking and offer clarification were equally the most frequent behaviours in the second observation.

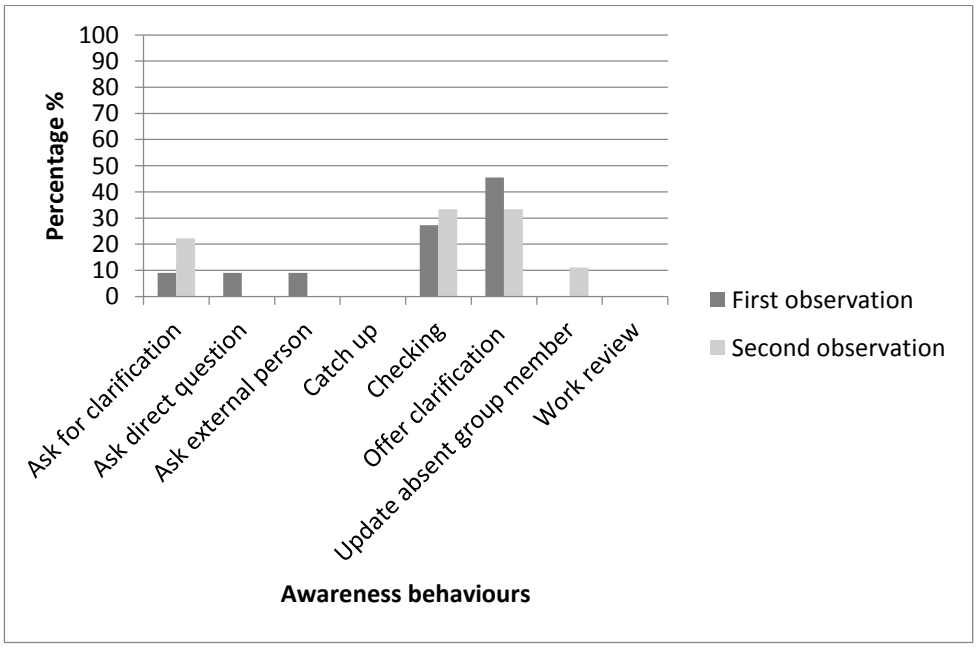


Figure 4.7: Percentages of awareness behaviours codes for group C

For group D, the awareness behaviours were: ask for clarification, ask direct question, checking, offer clarification, update absent group member, and work review. A total of 21 instances of awareness behaviours were identified in group D: 10 in the first interview and 11 in the second one. Figure 4.8 presents "awareness behaviour" codes in the first and the second observations for group D. Work review was more frequent in the first observation. Checking appeared only in the second observation. The number of awareness behaviour codes was higher in the second observation.

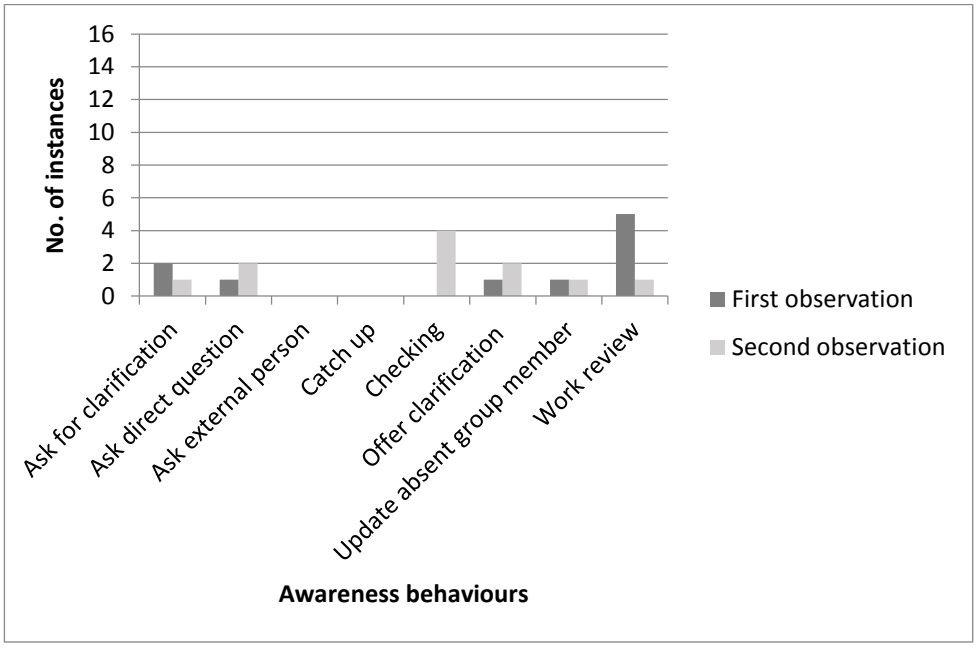


Figure 4.8: Awareness behaviours codes identified in group D

Figure 4.9 presents percentages of awareness behaviours occurrence in each observation for group D. In the first observation, work review was the most frequent behaviour while checking was the most frequent behaviour in the second observation.

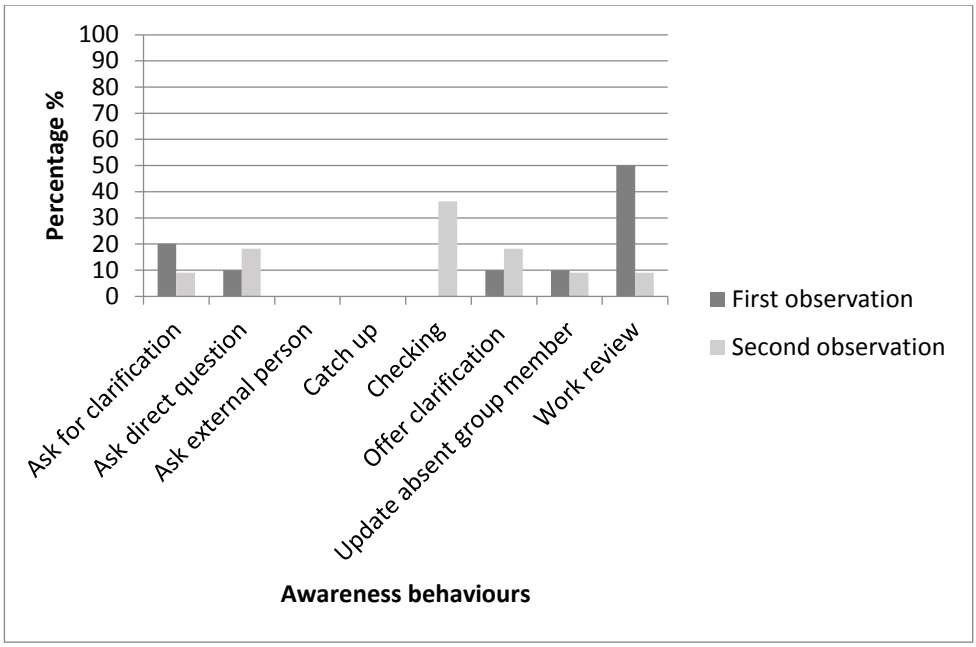


Figure 4.9: Percentages of awareness behaviours codes for group D

For group E, the awareness behaviours were: ask for clarification, ask direct question, catch up, offer clarification, and work review. A total of 31 instances of awareness behaviours were identified in group E: 20 in the first interview and 11 in the second one.

Figure 4.10 shows "awareness behaviour" codes in the first and the second observations for group E. Work review was more frequent in the first observation. The number of awareness behaviour codes was higher at the first observation.

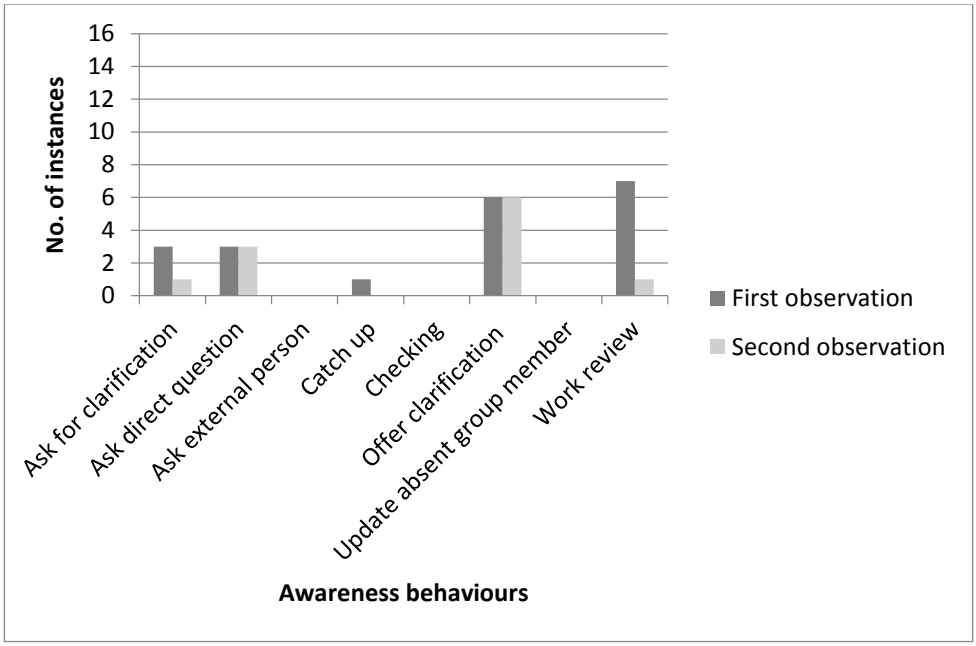


Figure 4.10: Awareness behaviours codes identified in group E

Figure 4.11 presents percentages of awareness behaviours occurrence in each observation for group E. In the first observation, work review was the most frequent behaviour while offer clarification was the most frequent behaviour in the second observation.

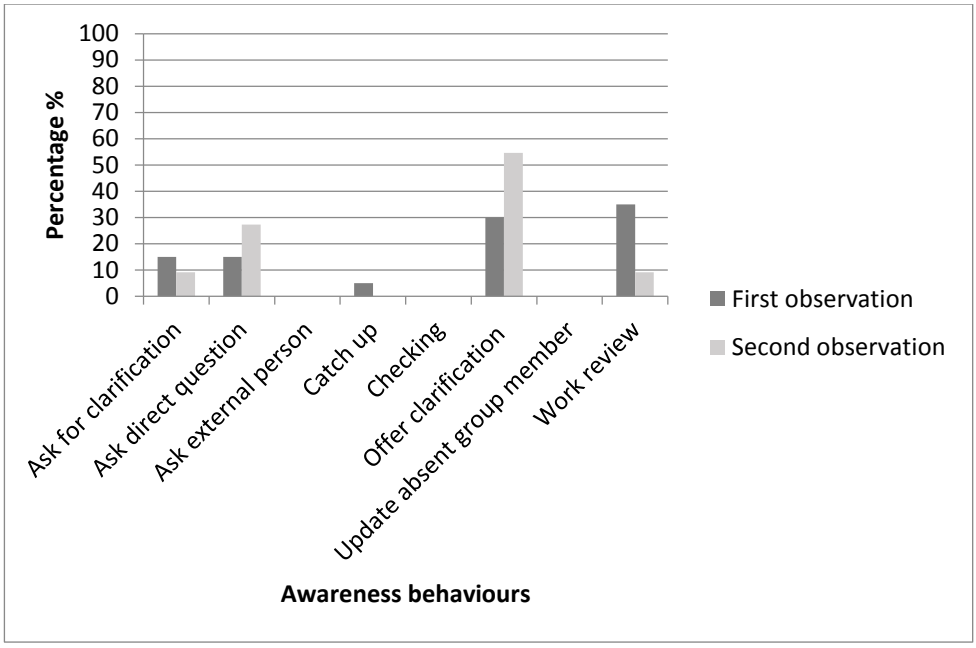


Figure 4.11: Percentages of awareness behaviours codes for group E

Awareness behaviours were identified in the collaborative groups. There were several ways of constructing awareness, such as reviewing the work, for instance: "*D2: Reviews her work on interview*"; asking direct questions, and checking recourses or notes. Offer clarification was frequent in the field notes. One example of offer clarification is: "*A2: Reads from the screen and clarifies each point*". Several activities were remarked to promote awareness including preparing questions need to ask, updating other members if they miss any part of the meeting, checking any uncertain point, asking for a minute to catch up to be in the same level of understanding with other members.

Awareness Types: Four awareness types were identified in the field notes including activity awareness, skill awareness, next-step awareness, and time-awareness. Activity awareness was identified once in the second observation of group A. Skill awareness was identified once in the first observation of group D. Next-step-awareness was identified in the second observation of group A, and the first observations of groups C and D. Time awareness was identified in the third observation of group B, and the first observations of groups C and D. No awareness types were identified in the field notes for group E. In general, activity awareness and skill awareness were more evident in the interviews data.

In this section, a description of each code for awareness type is presented along with examples from the data. The code “activity awareness” indicated that a participant was aware of other member’s activities. For example, A2 said “*I think you updated last night*” to A3 about interview file. The code “current state awareness” indicated that a participant was aware of the current state of their project. Current state awareness was evident in the interviews data only. The code “next-step-awareness” indicated that a participant was aware of the next step of their project. For example, D1 said: "*I think storyboards might be our next step*". The code “skill awareness” indicated that a participant was aware of other member’s skills. For instance, D1 said: “*D3 I'm looking at you, because I know this is your portrait*” when she talked about drawing the storyboards. The code “time awareness” indicated that a participant was aware of the time and deadlines. For example, C1 was aware of time of submission.

4.4.4.4 Collaboration

Collaboration Activities: Nine collaboration activities were highlighted in the field notes of the first and the second observations: agreement, disagreement, pair discussion, group discussion, editing, engage, help, review, and suggesting. For group A, the collaboration activities were: agreement, pair discussion, group discussion, editing, help, review, and suggesting. Figure 4.12 presents “collaboration activities” codes in the first and the second observations for group A. Group discussion were higher in the first observation.

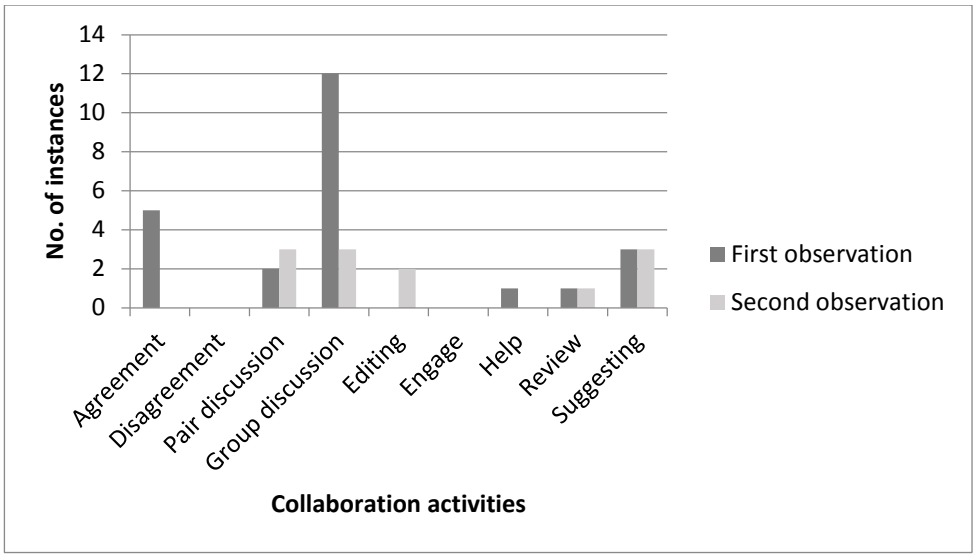


Figure 4.12: Collaboration activities codes identified in group A

Figure 4.13 presents percentages of collaboration activities in each observation for group A. In the first observation, group discussion was the most frequent activity while discussion by two, group discussion and suggesting were equally the most frequent activities in the second observation with 25% each.

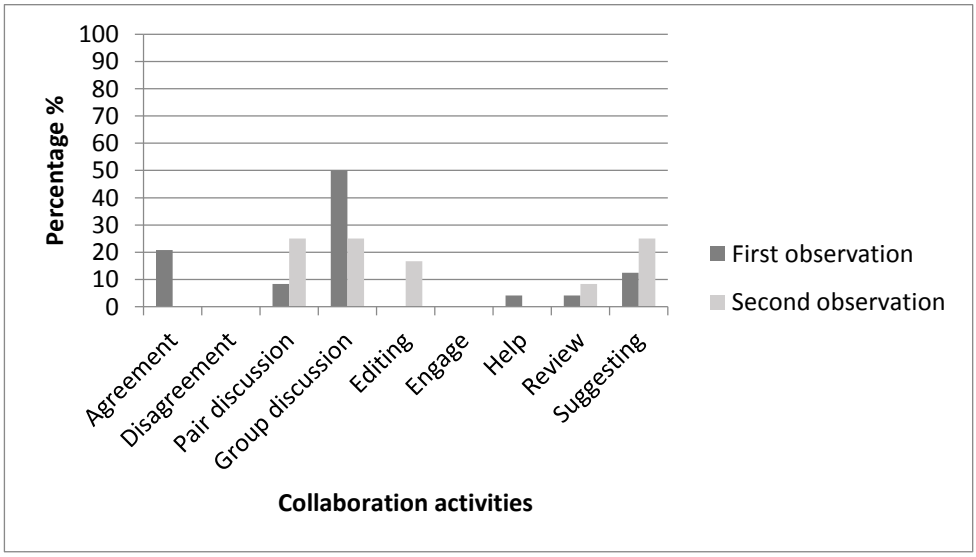


Figure 4.13: Percentages of collaboration activities codes for group A

For group B, all the nine collaboration activities were exhibited at least in one of the three observations. Figure 4.14 illustrates "collaboration activities" codes in the first

and the second observations for group B. The number of collaboration activities codes was higher in the second observation.

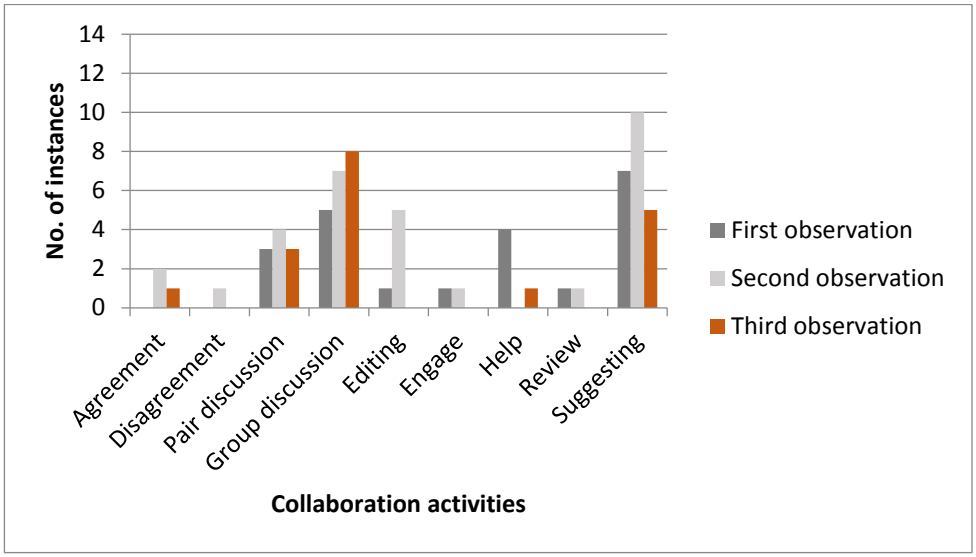


Figure 4.14: Collaboration activities codes identified in group B

Figure 4.15 shows percentages of collaboration activities in each observation for group B. Suggesting was the most frequent activity in the first and second observations, while group discussion was the most frequent activity in the third observation.

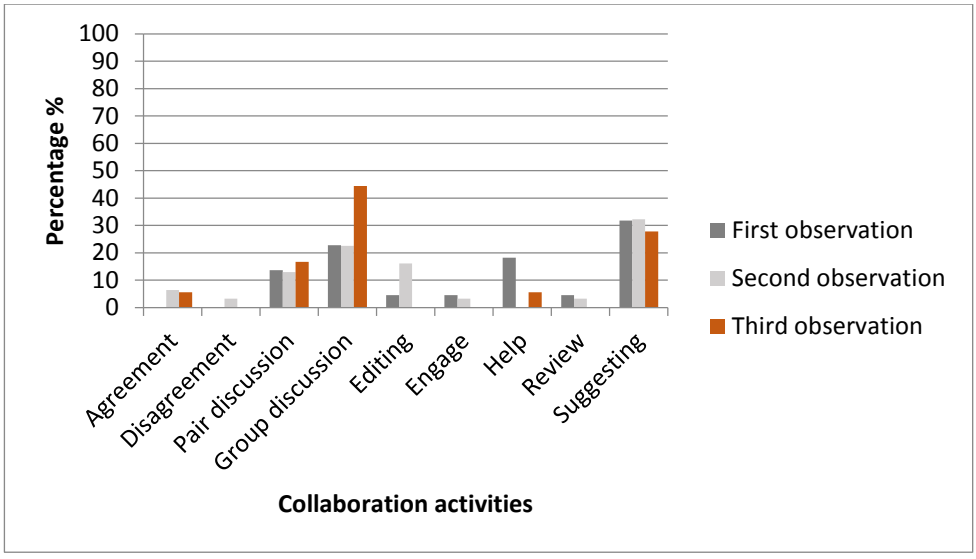


Figure 4.15: Percentages of collaboration activities codes for group B

For group C, the collaboration activities were: agreement, pair discussion, group discussion, editing, help, review, and suggesting. Figure 4.16 presents "collaboration activities" codes in the first and the second observations for group C. Group discussion and suggesting were almost the same in both observations.

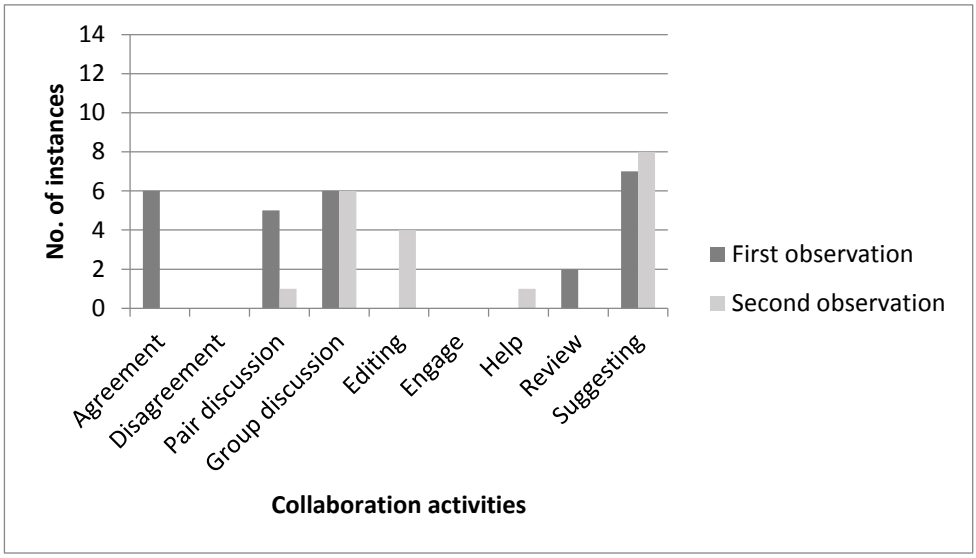


Figure 4.16: Collaboration activities codes identified in group C

Figure 4.17 illustrates percentages of collaboration activities in each observation for group C., while group discussion was the most frequent activity in the third observation. Suggesting was the most frequent activity in the first and second observations.

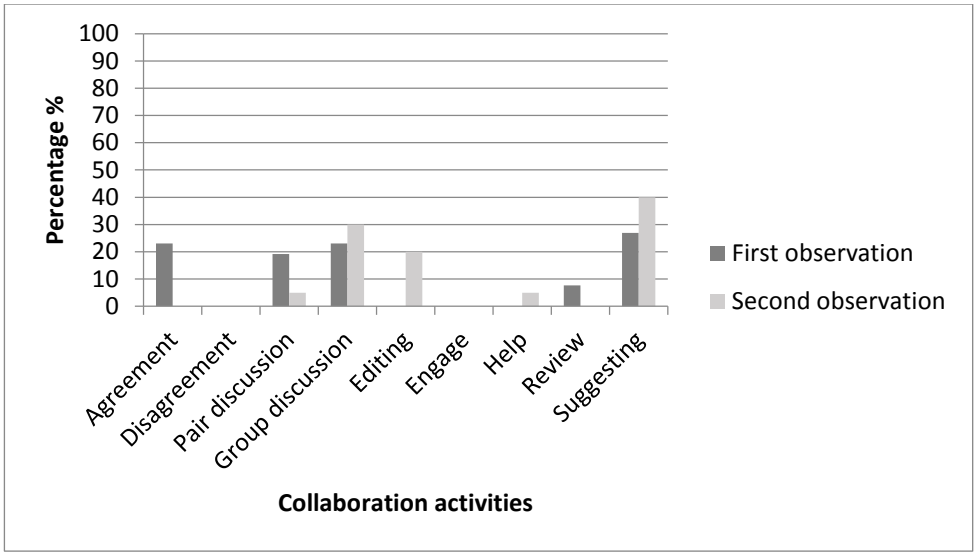


Figure 4.17: Percentages of collaboration activities codes for group C

For group D, the collaboration activities were: agreement, pair discussion, group discussion, engage, review, and suggesting. Figure 4.18 illustrates "collaboration activities" codes in the first and the second observations for group D. Suggesting was higher in the second observation.

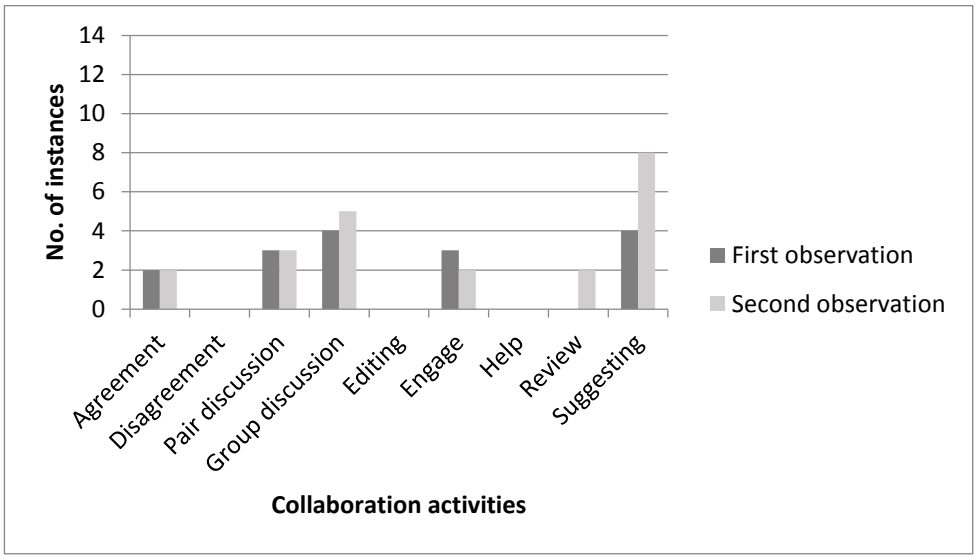


Figure 4.18: Collaboration activities codes identified in group D

Figure 4.19 presents percentages of collaboration activities in each observation for group D. In the first observation, suggesting was the most frequent activity, while

group discussion and suggesting were equally the most frequent activities in the second observation.

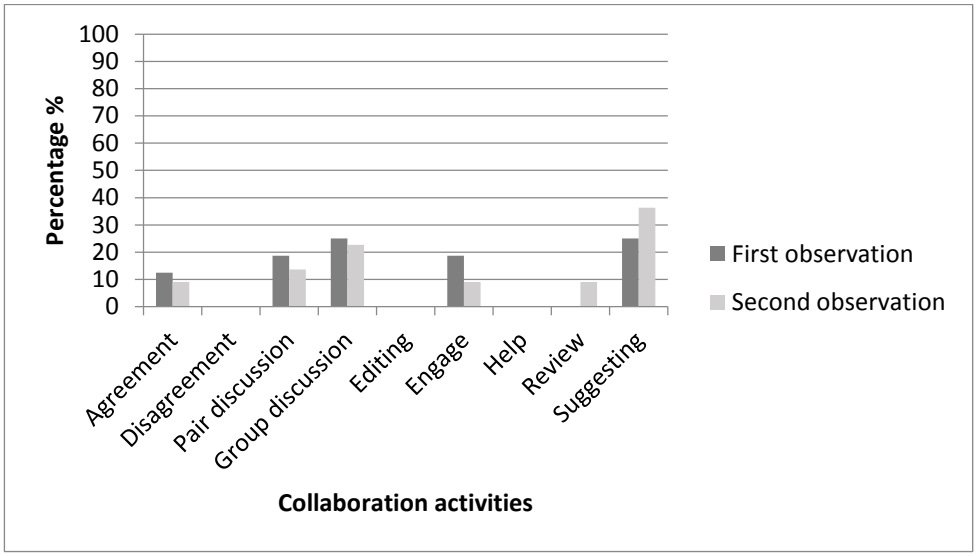


Figure 4.19: Percentages of collaboration activities codes for group D

For group E, the collaboration activities were: agreement, disagreement, pair discussion, group discussion, engage, review, and suggesting. Figure 4.20 shows "collaboration activities" codes in the first and second observations for group E. Pair discussion was higher in the second observation. Group discussion and suggesting were almost the same in both observations.

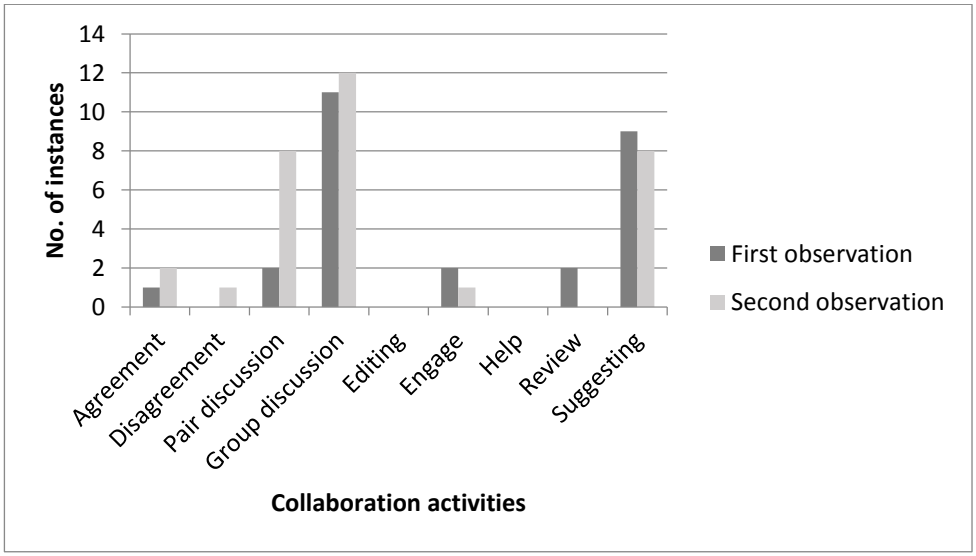


Figure 4.20: Collaboration activities codes identified in group E

Figure 4.21 shows percentages of collaboration activities in each observation for group E. Group discussion was the most frequent activity in the first and second observations.

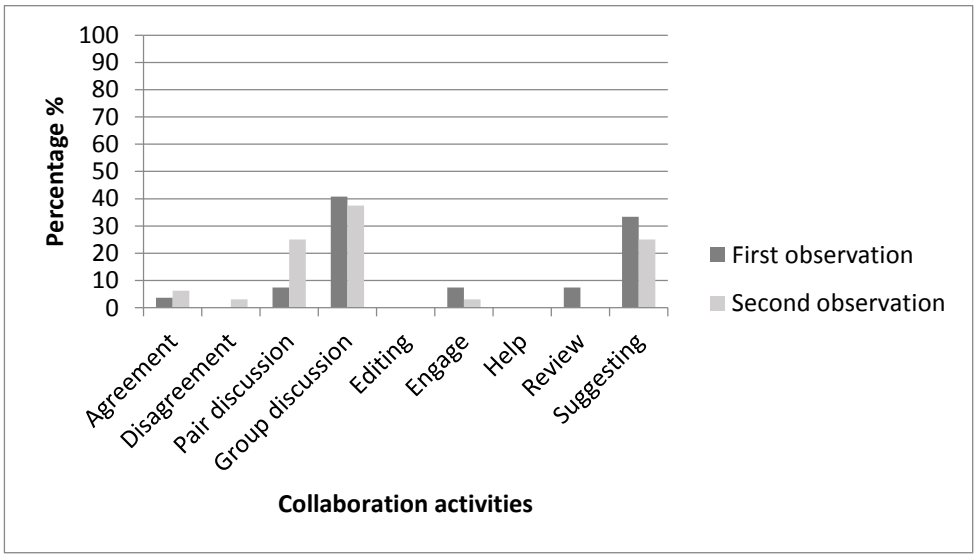


Figure 4.21: Percentages of collaboration activities codes for group E

In each group, a number of collaboration activities were identified such as discussion, editing, helping other members to complete a task, and reviewing other's work. Group members usually discussed their tasks, deadlines, and progress. Discussion about any point could be done by all group members or by two members of the group. Discussions include suggesting, agreement, and disagreement. Some participants tried to engage other members in making decisions or giving their opinions.

4.4.5 Activity Awareness Analysis

In this section, a description of the methodology of how to measure activity awareness of groups is presented.

In both interviews, students were asked about what they did in the last week of the project time, and were also asked about what each member in their groups did. Then, after transcribing all the interviews, comparisons grids were created which include the answers to the interview question about what participants did and what their colleagues did in the first and second interviews. The "accuracy" of participants' activity awareness was explored by comparing their answers to interview questions

about the activity of their colleagues against the reality of what those colleagues had been doing.

Convertino et al. (2004) categorised activity awareness into three levels: fully aware, partially aware, and unaware. In this study, the same levels were used but operationalised in a different way. Participants were ranked as fully aware if they reported what their colleagues did exactly. Participants were ranked as partially aware if they reported some of what their colleagues did. Participants were ranked as unaware if they did not report what their colleagues did correctly or if they did not know what their colleagues did.

Colour coding was used to differentiate between different levels of activity awareness. Cells in grey illustrates what participants reported about themselves; cells in green show that participants were fully aware of their colleagues' activity; cells in blue show that participants were partially aware of their colleagues' activity; cells in red show that participants were unaware of their colleagues activity; and cells in yellow show that information about activity were missing.

Tables 4.13 and 4.14 present the comparison grids for group A in the first and second interviews. In Table 4.13, for example, A1 was fully aware of A2's activity, so the cell is coloured in green, and he was partially aware of A3's activity, so the cell is coloured in blue. Then, the total number of each awareness level was calculated. For example, in Table 4.13, which represents the colour-coding table for first interview of group A, the total number of "fully aware" was 5, and the total number of "partially aware" was 1, while in Table 4.14, which represents the colour-coding table for second interview of group A, the total number of "fully aware" was 2, the total number of "partially aware" was 3, and the total number of "unaware" was 1. The same procedure was followed for all participants. All activity awareness tables are attached in Appendix B.7.

Table 4.13: Activity awareness comparison grid of the first interview for group A

(Grey: What participant did, Green: Fully aware, Blue: Partially aware, Red: Unaware)

Participant	What he/she reported about		
	A1	**A2**	**A3**
A1	I did observation last week. There is a separate research done by everyone, read different books and just kind of summarising them, just like literature.	She has contributed a few things using Google documents, she is also extends what she is doing. She is doing a Google research.	I'm not sure what he did, like I know from here [he opens the goggle docs] that he did enter his previous observations, but he didn't …… he just extend his observations
A2	We worked out the plan together of kind of, timings and when we are free to do stuff and then he went and put that into a schedule document and he did lots of research on interviews and observations as well and he went and did the interviews and he kind of organise docs for the Google drive. Oh sorry I mean not interviews, observation activities, whenever I said interviews I mean observation activities,	I have to look at the Google drive, cause I did do some, figure, Google search for where they were doing for high street stuff, and figure out research on observation and where are goals go lines with observation activities	He did lots of the observation activities
A3	A1 did observe, when observing as well, but also uploaded a lot of background information and organised or collated the data correctly on the drive	She searches for, she went to the Google and come and get a list of the most searched words for certain words and the associated words with that search term and to list of them for locations that we visited to observe so far	I went out to Stoke Newington high street/church street and just to observing, and do some reading on
Summary	A2 is fully aware of A1 activity A3 is fully aware of A1 activity	A1 is fully aware of A2 activity A3 is fully aware of A2 activity	A1 is partially aware of A3 activity A2 is fully aware of A3 activity
	2 FA	2 FA	1 FA, 1 PA

Table 4.14: Activity awareness comparison grid of the second interview for group A

(Grey: What participant did, Green: Fully aware, Blue: Partially aware, Red: Unaware)

Participant	What he/she reported about		
	A1	**A2**	**A3**
A1	and I did one….. (he means interview) and me and A3 transcribed it	A2 did 2 interviews	Did 2 interviews as well, and me and A3 transcribed it
A2	A1 did an interview and we talked about interviews on Google Hangouts	I summarised all of the research so did some interviews, and worked out and analysed those, looked at online for more research about the high street that we are looking at, did some Google in terms of search analysis and find what we needed	A3 did a couple of interviews as well, and he also started working on the personas for the task
A3	Last week, [oh god thoroughly quite slow week], I don't know	A2 did summary of the data, create the summary sheet and yes, create summary sheet of the data and analyse all the data	I read a lot on sort of how to analyse data and I tried to start creating personas and I found it quite difficult cause I think we did 5 demographics, so the way we're doing the interview, I don't think we should done that
Summary	A2 is fully aware of A1 activity A3 is not aware of A1 activity	A1 is partially aware of A2 activity A3 is partially aware of A2 activity A1 did not mention the summary A3 did not mention the interviews	A1 is partially aware of A3 activity A2 is fully aware of A3 activity A1 did not mention the personas A3 did not mention that he did 2 interviews
	1 FA, 1 UA	2 PA	1 FA, 1 PA

After comparing the activity awareness in the first interviews and the second interviews, another comparison was made between the total numbers of awareness level in the first interview and in the second interview for groups A, B, D, and E. Also, activity awareness for group C is presented but for one interview as they were interviewed once only. Tables 4.15 to 4.19 show activity awareness levels for each group, then these comparisons are illustrated in Figures 4.1 to 4.4 for groups A, B, D, and E.

For group D, some participants did not mention what they did and what other members did clearly, instead they mentioned their skills, but they did not rank as unaware due to missing information. The total number should be 12 because they are 4 members.

Table 4.15: Activity awareness level in the first and second interviews for group A

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	5	1	0
In the second interview	2	3	1

Table 4.16: Activity awareness level in the first and second interviews for group B

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	4	2	0
In the second interview	3	1	2

Table 4.17: Activity awareness level in the first interview for group C

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	6	0	0

Table 4.18: Activity awareness level in the first and second interviews for group D

Activity awareness level	Fully aware	Partially aware	Unaware	N/A
In the first interview	5	4	0	3
In the second interview	7	5	0	0

Table 4.19: Activity awareness level in the first and second interviews for group E

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	7	5	0
In the second interview	6	6	0

In Figure 4.22, “fully aware” of activity awareness was higher in the first interview, “partially aware” was higher in the second interview, and “unaware” was appeared in the second interview only.

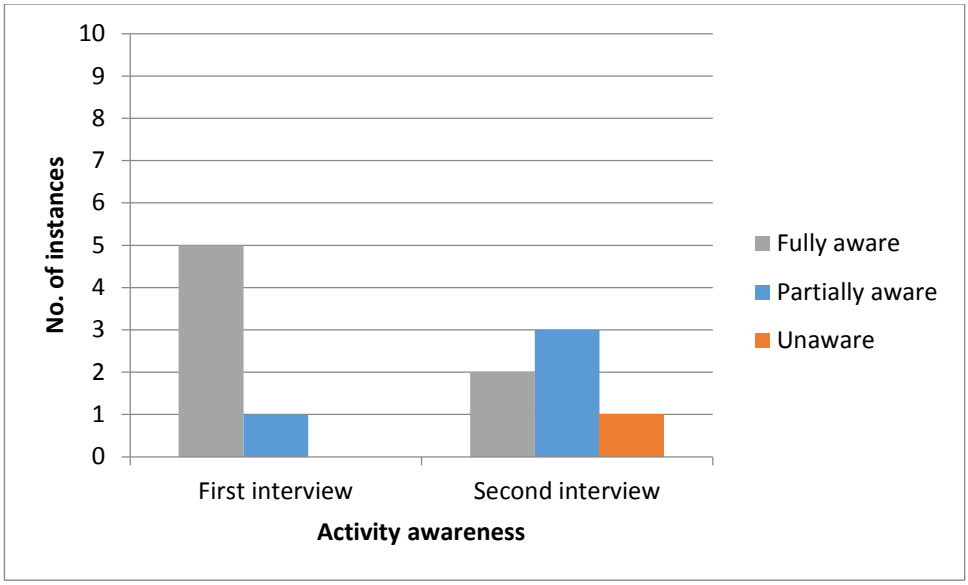


Figure 4.22: Activity awareness level for group A

In Figure 4.23, "fully aware" and "partially aware" of activity awareness were higher in the first interview, and "unaware" was appeared in the second interview only.

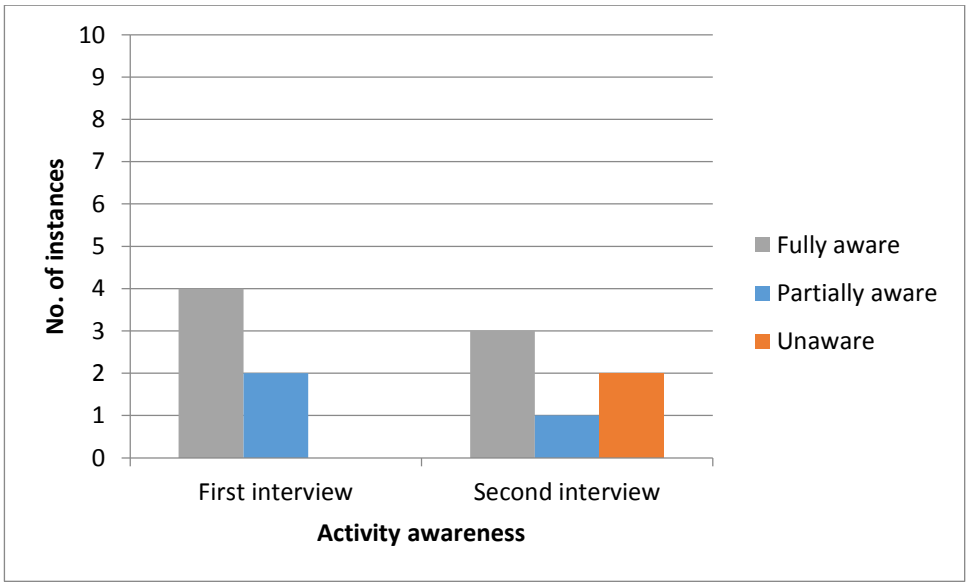


Figure 4.23: Activity awareness level for group B

In Figure 4.24, "fully aware" and "partially aware" of activity awareness was higher in the second interview, however, there were missing information in the first interview.

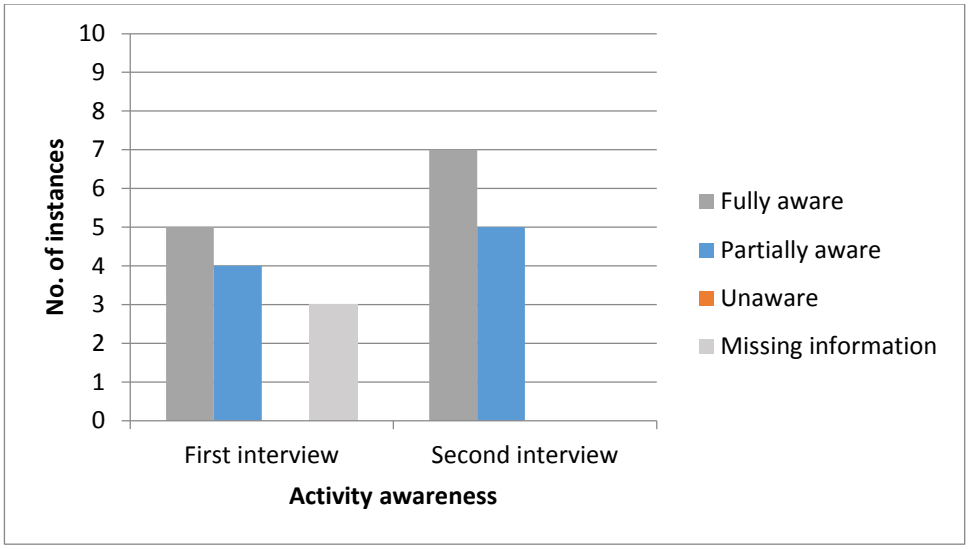


Figure 4.24: Activity awareness level for group D

In Figure 4.25, "fully aware" of activity awareness was higher in the first interview, "partially aware" was higher in the second interview, and "fully aware" and "partially aware" were equal in the second interview.

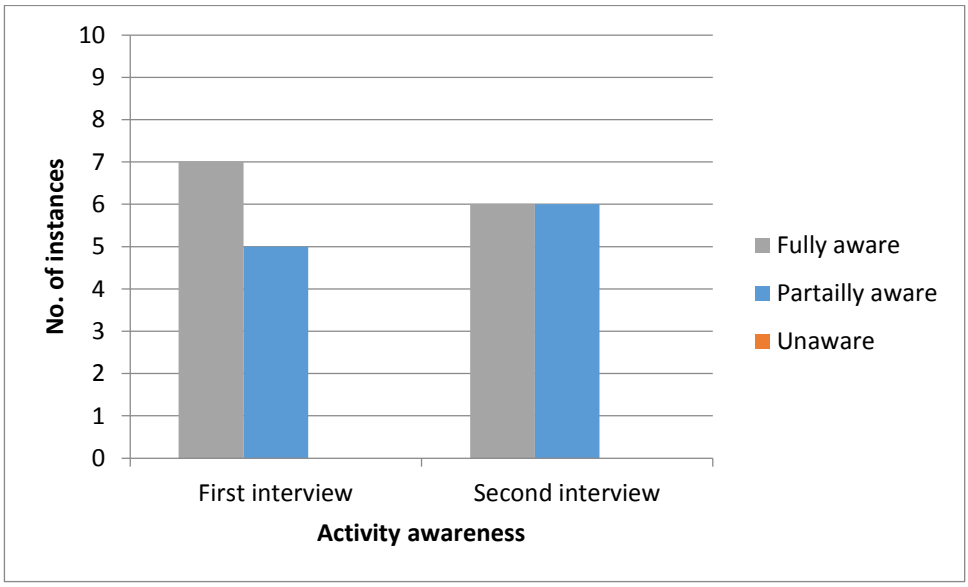


Figure 4.25: Activity awareness level for group E

It appeared that "fully aware" of activity awareness in the first interviews were higher than in the second interviews for all groups. In general, activity awareness at the beginning of the project was higher than in the middle or near the end.

Also, for each participant, a comparison was made between his/her activity awareness in the first and second interviews, in order to identify changes in their activity awareness. Table 4.20 presents the results of this comparison for each participant. It shows that the activity awareness of 5 participants decreased, the activity awareness of 5 participants did not change, and the activity awareness of 2 participants increased. There were missing information for D3 and D4.

Table 4.20: Changes in activity awareness of each participant

Participant	Change in activity awareness
A1	Decreased
A2	No change
A3	Decreased
B1	Decreased
B2	Decreased
B3	Increased
D1	No change
D2	No change
D3	n/a
D4	n/a
E1	Increased
E2	No change
E3	No change
E4	Decreased

The implication of awareness varying over time is that it could minimise chances of collaboration, affect communication, and decrease opportunities to help each other or coordinate tasks effectively (Nacenta et al., 2007; Paletta & Herrero, 2011). Therefore, this could lead to a breakdown in collaboration. From this it was concluded that full awareness is desirable most of the time. But on the other hand, students have other learning commitments and things to do, and there are chances of having information overload, and also making effort to find out what others are doing specially with long-term projects when people are not working on the project all the time. Apparently, there will be trade-offs between being fully aware throughout the project and having enough awareness at some points. However, students should maintain a good level of activity awareness in their collaborative learning projects as it influences their collaboration success. Maintaining activity awareness could be achieved by minimising breakdowns in activity awareness and increasing the instances of being fully aware.

4.5 Discussion

The discussion section presents answer for the main research questions as well as a detailed interpretation of the results. Table 4.21 summarises the data collection methods and which research questions they tried to answer.

Table 4.21: Data collection methods used to answer each research questions

Data collection methods	Research questions				
	RQ1.1	***RQ1.2***	***RQ1.3***	***RQ2***	***RQ3***
Demographic questionnaires			•		
Self-assessment questionnaires				•	
Interviews	•	•	•	•	•
Observations	•	•	•	•	•

In this section, an attempt to answer three main research questions, *RQ1*, *RQ2*, and *RQ3*, from the collected data is presented. Starting with the first research question:

RQ1: How do students collaborate in long-term collaborative learning groups?

This research question has four research sub-questions. This study helped to tackle three of them *RQ1.1*, *RQ1.2*, and *RQ1.3*. Each of these sub-questions is answered here.

RQ1.1: What collaboration styles and activities are identified in long-term collaborative learning groups?

This research sub-question was answered through the coding of interviews and observations. In each group, nine collaboration activities were recognised: agreement, disagreement, pairs discussion, group discussion, editing, engage, help, review, and suggesting. In each group meeting, at least five collaboration activities were evident. The most frequent collaboration activities were group discussion and suggesting. Also, students usually worked in different collaboration styles as the project was long-term, and they worked mostly in a parallel way to complete their tasks.

RQ1.2: **What awareness behaviours and awareness types are exhibited in long-term collaborative learning groups?**

The coding of interviews and observations were used to answer this research sub-question. The identified awareness behaviours were: ask for clarification, ask direct question, ask external person, catch up, checking, offer clarification, update absent group member, and work review. The identified awareness types were: activity awareness, current state awareness, next-step awareness, skill awareness, and time awareness. In addition, there were several ways of constructing awareness, such as reviewing the work, asking direct questions, and checking recourses or notes. Several awareness behaviours were noticed including preparing questions need to ask, updating other members if they miss any part of the meeting, checking any uncertain point, asking for a minute to catch up to be in the same level of understanding with other members.

RQ1.3: **What applications and tools do groups use during meetings and for collaboration outside of meetings?**

The results of the demographic questionnaire, interviews, and observations were used to answer this research sub-question. Demographic questionnaire and interviews were used to recognise applications, while observations were used to identify tools. Groups were used different existing applications during their collaborations such as Email, WhatsApp, Google drive and Hangouts. Email and Google drive were mostly used to share documents. Groups were used their laptops and iPads during the meetings, and sometimes they used their phones.

RQ2: **How can activity awareness be measured in long-term collaborative learning groups?**

A method was proposed to measure activity awareness (section 4.4.5). First, two interviews were conducted with each participant. In both interviews, students were asked about what they did in the last week of the project time, and were also asked about what each member in their groups did. Then, after transcribing all the interviews, comparisons grids were created which include the answers to the interview question about what participants did and what their colleagues did in the

first and second interviews. Then, comparisons were made between what each member self-reported against what their colleagues reported about them. Participants were ranked as fully aware if they reported what their colleagues did exactly. Participants were ranked as partially aware if they reported some of what their colleagues did. Participants were ranked as unaware if they did not report what their colleagues did correctly or if they did not know what their colleagues did.

RQ3: **What activity awareness do group members have in long-term collaborative learning groups?**

This research question was answered through the results of self-assessment questionnaires, interviews, and observations. Self-assessment questionnaires were used to assess students' awareness; interviews were used to evaluate their activity awareness; and observations were used to identify awareness types and highlight any issue with awareness. Different kinds of awareness were evident including activity awareness of completed work, current-state awareness, next-step awareness, skills awareness, and time awareness.

Interviews were used in measuring activity awareness, while observations were used in comparing awareness behaviours in the first and second observations. The activity awareness and work review were higher at the beginning of the collaborative project than at the middle or the end.

In this section, a further discussion on the results is given. Although it is unable to compare two different measurements, but comparing the self-assessment (7-point scale) to the activity awareness level of the interviews could give some indications of how people actually being aware of each other and how they assess their awareness. The results from the self-assessment questionnaire showed that participants felt they were aware of their colleagues' activity, and the results from interviews also confirmed that participants almost aware of their colleagues' activities.

Table 4.22 presents groups with their grades for the group report and the overall satisfaction of their experiences. Groups with lower self-assessment score (A and E) got higher grades (+70) than the other groups. In addition, groups B, C, and D enjoyed collaborating with their group members more than groups A and E.

Table 4.22: Groups' grades and their self-assessment averages

Group	Grade	Average
A	75	4.75
B	67	6.00
C	55	5.77
D	65	5.96
E	73	4.67

Results showed that activity awareness was higher at the beginning of the collaborative project than at the middle or the end. In addition, work reviews appeared more frequently at the beginning than near the end. So, there was a relation between the activity awareness and work review.

Awareness types were evident mostly in the interviews, while awareness behaviours were evident mostly in the observations. Different awareness types were identified, these are: activity awareness, current state awareness, next-step-awareness, skill awareness, and time awareness. The identified awareness behaviours were: ask for clarification, ask direct question, ask an external person, ask for time to catch up with the group, checking resources and notes, offer clarification, update absent group member, and work review.

There were different ways to construct self-awareness and to construct other members' awareness. Self-awareness could be built by different behaviours such as asking for clarification, asking direct question to other group members, or checking resources. Participants could enhance others' awareness by telling what they did, do or planning to do; or by reviewing their work during meetings. Therefore, awareness-promoting behaviours could be divided into two types: perceiving information (by asking and checking) and providing information (by offer clarification, updating and work reviewing).

The recognised collaboration activities were: agreement, disagreement, pair discussion, group discussion, editing, engage, help, review, and suggesting. At least 5 collaboration activities were identified in each meeting for each group.

Moreover, groups used different existing applications during their collaborations such as Email, WhatsApp, Google drive and Hangouts. Email and Google drive were mostly used to share documents. Two groups used Google Hangouts to make online meetings alongside with the collocated ones; and they also used Google drive to share

documents; but the other 3 groups used email for sharing documents and they were satisfied with the face-to-face meetings. Groups used their laptops and iPads during the meetings, and sometimes they used their phones. It seemed that participants preferred to use general-purpose applications to collaborate rather than trying to use any specific collaborative learning environment. This is a good indication of the possibility of using pervasive technology to support activity awareness. Figure 4.26 presents a summary of how students collaborate in long-term collaborative learning project based on the collected data.

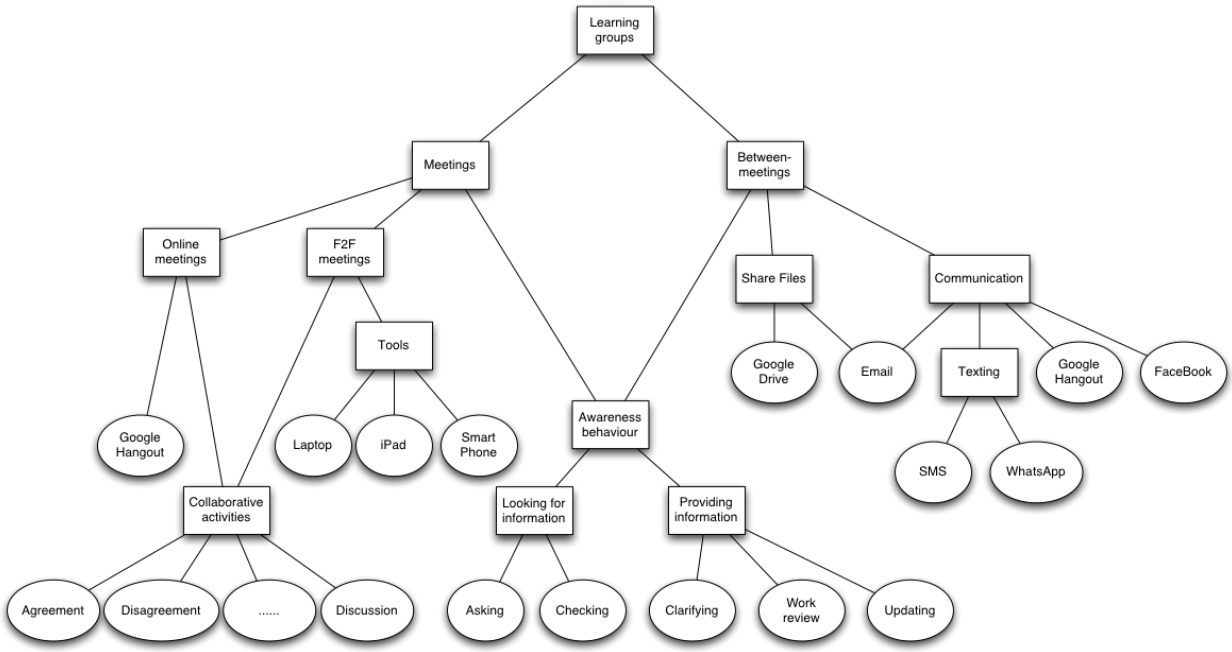


Figure 4.26: Summary of collaboration in long-term learning projects

It was found that the method of evaluating activity awareness was promising. However, there were a number of problems with the collected data, such as when participants reported skills rather than activities of their group members, when they did not report activities in a clear way, or when they reported future activities not completed ones. This finding motivated me to conduct the next study in order to address limitations and collect more accurate data and also to improve the method of evaluating activity awareness.

Awareness behaviours were evident. However, it was found that awareness behaviours decreased over time in three groups (B, C, & E), and also the level of

activity awareness; therefore, this finding encouraged me to find out how technology could help to promote activity awareness over long periods of time.

4.6 Limitations

This study had a limited number of participants, with only 5 groups participating. This limitation appeared because the participants were a convenience sample; they had to participate as a group and all members were required to agree to participate so this made recruiting participants a hard process. Also, participants had to be committed until the end of the study, which might have made them prefer not to participate. Moreover, there were some limitations in data about activity awareness as some participants reported skills rather than activities about their colleagues. One last limitation was that for group C, members could not be interviewed twice due to their time constraints.

4.7 Summary

This study presents a detailed report on how students actually were working during their co-located collaborations. It shows that most groups were more aware in their first interviews more than in their second interviews; which means their activity awareness decreased towards the end of the project. Another study was needed in order to use the method of evaluating activity awareness and improve it if needed, and also to get a greater insight of activity awareness and find out how activity awareness changes overtime.

Therefore, a further study was conducted to collect more data to further investigate and measure activity awareness in collaborative learning groups, and also to refine the method of evaluating activity awareness as reported in the next chapter (Chapter 5). The preliminary findings of this study are published in a paper in the British HCI Conference, 2014 (see Appendix F.1).

Chapter 5: Evaluating Activity Awareness in Learning Groups

This chapter reports a study for evaluating activity awareness in learning groups. In the previous chapter (Chapter 4), we found that most groups were fully aware in their first interviews more than in their second interviews; which means their activity awareness decreased towards the end of the project. However, the number of groups was limited; therefore, there was a need to conduct a further study in order to validate these results. This study helped to answer two of the main research questions *RQ2* and *RQ3* by investigating what activity awareness students have, and how to measure activity awareness in long-term collaborative learning groups.

5.1 Motivation

The previous study aimed to identify awareness types and behaviours that promote awareness as well as to highlight any change in activity awareness throughout the project. Also, activity awareness levels created by Convertino et al. (2004) were used to categorise awareness level but with a different explanation. Building on that study, another follow-up study was conducted to evaluate activity awareness and validate the findings from the previous study.

5.2 Research Aim and Research Questions

The aim of this study was to evaluate and measure activity awareness in learning groups and also to refine the method of evaluating activity awareness to make it more robust. The method described in Chapter 4 (section 4.4.5). The study helped in answering two main research questions *RQ2*, and *RQ3*, which are*:*

RQ2: How can activity awareness be measured in long-term collaborative learning groups?

RQ3: What activity awareness do group members have in long-term collaborative learning groups?

5.3 Method

In this section, an overview of the method used in the study design including details about participants, data collection methods and data analysis. Ethical approval was granted from the School of Informatics to conduct this study. The collaborative coursework was the same as the one in the previous study, which involved the design of an interactive device as part of an introductory module on interaction design. It is a group project and students should submit 2 deliverables; the main deliverable is a group report of the design process and includes: data gathering, requirements, conceptual and detailed design, and evaluation. The second deliverable is an individual reflection from each member on his/her experience in the project. Moreover, all group members normally receive the same mark for group report part of the assignment.

5.3.1 Participants

The participants were a convenience sample of Masters' students who were working on a collaborative learning coursework for 6 weeks.

Four groups participated in the study with 3 or 4 members in each group and a total of 15 participants (1 group of 3 and 3 groups of 4). Group members had not worked together previously and had different educational backgrounds, experiences, and skills. Each group determined its own working methods and selected various software applications for collaboration and communication.

Participants were recruited in the City University by inviting them to take part in this study in one of their classes, also an email was sent to them through Moodle to explain the study and encourage them to participate. Each participant received an incentive of 10 pounds Amazon voucher at the end of the study.

5.3.2 Data Collection

To investigate activity awareness in a longitudinal project, two main data collection methods were used; short interviews and questionnaires. Data were collected over a 5-week period. Table 5.1 shows the timeline of the collected data.

Table 5.1: The timeline plan for data collection

Group	Week				
	Week 3 **(17/11 – 23/11)**	***Week 4*** **(24/11 – 30/11)**	***Week 5*** **(1/12 – 7/12)**	***Week 6*** **(8/12 – 14/12)**	***Week 7*** **(15/12 – 21/12)**
A	Questionnaire 1 Interview 1	Interview 2	Interview 3		Questionnaire 2
B	Questionnaire 1 Interview 1	Interview 2	Interview 3		Questionnaire 2
C	Questionnaire 1 Interview 1	Interview 2	Interview 2 (cont.)	Interview 3	Questionnaire 2
D	Questionnaire 1	Interview 1	Interview 2	Interview 3	Questionnaire 2

5.3.2.1 Questionnaires

Questionnaires were used to collect data about participants and their self-assessment of the learning experience at the end of the study. Each participant was given 2 questionnaires, which were similar to the ones used in the previous study.

First questionnaire: The first questionnaire was a "demographic questionnaire" and it was administered at the beginning of the study to collect factual data, such as demographic, and background study. It consisted of 6 questions about age, gender, education background, studied MSc programme, mode of study, and used applications. The questionnaire is in Appendix C.1.

Second questionnaire: The second questionnaire was a "self-assessment questionnaire" and it was given at the end of the project, and it used Likert-scale questions to assess students' awareness and satisfaction with their learning experience. It consisted of 13 questions about participants' experience in working as a group on their coursework, for instance: "I always knew what my group members were going to work on over the week". Questions related to learning styles were deleted as the focus of the research has changed. Most of the questions were from the experimental study done by Convertino et al. (2004) and they were modified to suit this study. The questionnaire can be found in Appendix C.2.

5.3.2.2 Interviews

Interviews were used to collect data about activity awareness. Each participant was interviewed individually 3 times at different points during the project for about 4 to 7 minutes. The interview questions were semi-structured and mostly designed to explore activity awareness, collaboration, and applications they used. For example, one of the questions was "what have you done last week?" to explore activity awareness. The goal was to conduct the interviews on the same day for each group; however, this plan did not work well and it was out of the researcher control to conduct interviews on the same day as some participants were part timers and could not be interviewed on some days, or they were busy on the day that their colleagues were interviewed. The actual data collection for interviews is presented in the analysis section for each group. All interview questions can be found in Appendix C.5.

5.3.3 Data Analysis

This study employed a mixed qualitative and quantitative data. Qualitative data sources included transcripts of interviews with students. Quantitative data included group report grades and students' responses to a Likert-scale questionnaire.

For the demographic questionnaire, answers were analysed for each group by counting frequencies of each answer. For the self-assessment questionnaire, averages and standard deviations were calculated for each question for each group.

Interviews were audio-recorded and notes were taken. Two main questions were transcribed in details and about participants' activity and their mates' activities.

5.4 Results

In this section, an overall description of each group is highlighted first. Then, the result of each data collection is presented.

5.4.1 Description of Groups

Group A consisted of 3 members. They used email, Google drive, and texting to collaborate. Group A got 76 in the group report, which was the main deliverable of the module coursework. Group B consisted of 4 members. They used Wechat app and Dropbox for their collaboration. They got 70 in the group report. Group C consisted of 4 members. They used a number of tools for their collaboration including: email, Google drive, Dropbox, Facebook, Merely, and texting. They got 75 in the group report. Group D consisted of 4 members. They used Google drive, WhatsApp, and Facebook to collaborate. They got 80 in the group report. In general, all groups used at least two tools to support their collaboration and communication.

5.4.2 Questionnaire Results

Two questionnaires were collected: one at the beginning of the study (demographic questionnaire) and the other one at end of the study (self-assessment questionnaire). The results of each questionnaire are presented here.

5.4.2.1 Demographic Questionnaire

All 15 participants completed the questionnaire. Questions were about factual data about the participants. They were asked about their age, gender, education background, studied MSc programme, mode of study, and applications they used in their group project. Full answers to the first questionnaire can be found in Appendix C.3. Most participants were in the age range between 18 and 39. Table 5.2 presents the number of participants in each age group.

Table 5.2: Number of participants in each age group

Group	Age group			
	18-29	30-39	40-49	+50
A	2	1	0	0
B	2	2	0	0
C	0	2	2	0
D	3	1	0	0
Total	**7**	**6**	**2**	**0**

There were 7 females, and 8 males. One group was all female and three groups were mixed. Table 5.3 shows the number of males and females in each group and the total number of participants.

Table 5.3: Number of males and females in each group

Group	Gender	
	Male	Female
A	0	3
B	3	1
C	3	1
D	2	2
Total	**8**	**7**

They were a mixture of full-time and part-time students in each group, with a total of 8 full-time students and 7 part timers. Table 5.4 demonstrates the distribution of the participants as full-time or part-time students in each group.

Table 5.4: Distribution of participants as full-time or part-time students

Group	Study mode	
	Full-time	Part-time
A	1	2
B	3	1
C	1	3
D	3	1
Total	**8**	**7**

They had different educational backgrounds, and experiences. Participants were studying on different MSc programmes: 10 of them were from the Human-Centered Systems programme, 4 E-Business students, and 1 Health Informatics student. Table 5.5 shows the distribution of the participants and their MSc programmes in each group.

Table 5.5: Distribution of participants across MSc programmes

Group	MSc programme		
	HCS	**E-Business**	**Health Informatics**
A	3	0	0
B	0	4	0
C	4	0	0
D	3	0	1
Total	**10**	**4**	**1**

Each group used different kinds of applications to manage their collaboration as presented in Table 5.6.

Table 5.6: Applications used by each group

Group	Applications							
	Email	***Google drive***	***Dropbox***	***Facebook***	***Texting***	***Merely***	***WhatsApp***	***Wechat***
A	•	•			•			
B			•					•
C	•	•	•	•	•	•		
D		•		•			•	

5.4.2.2 Self-assessment Questionnaire

This questionnaire was administered at the end of the project, either in the City University premises or by email. All participants completed the questionnaire. Averages and standard deviations (SD) were calculated for each question for all groups. Table 5.7 presents average and standard deviation for each question for group A as an example. All answers can be found in Appendix C.4.

Table 5.7: Average and standard deviation for each question for group A (7-point Likert-scale)

Question	Participant			Avg.	SD
	A1	*A2*	*A3*		
1. I found it difficult to tell what work my group members had done during the last week.	1	2	6	3	2.65
2. It was easy to find what my group members had worked on.	7	7	7	7	0
3. I always knew what my group members were going to work on over the week.	7	5	7	6.33	1.15
4. It was always clear what my group members were going to do.	7	6	6	6.33	0.58
5. I found the tools we used to communicate were effective.	4	7	7	6	1.73
6. I could tell what the current state of our project was at any given time.	7	5	7	6.33	1.15
7. I became more aware of my group members' work plans over time.	2	6	7	5	2.65
8. My group members and I planned adequately	6	3	7	5.33	2.08
9. My group members and I communicated well with each other.	7	6	7	6.67	0.58
10. My group members collaborated with me to complete the project.	7	7	7	7	0
11. My group members contributed equally to this project.	7	5	5	5.67	1.15
12. I enjoyed collaborating with group members.	7	6	6	6.33	0.58
13. I would prefer to work on group projects over other types of learning activities (e.g. individual assignment).	5	2	3	3.33	1.53

Table 5.8 shows averages for each question for each group and the overall average of each question across all participants. It was found that all groups did not find it difficult to tell what their group members had done during the past week and it was easy to find what their group members had worked on. In addition, groups A, B and C usually knew what their group members were going to work on over the week and it

was clear for them, while group D had less knowledge towards what their group members were going to do and it was not so clear. Groups A, B and C could tell what the current state of their project was at any given time, but group D could not. Also, groups A, B, and C became more aware of their group members' work plans over time, while D did not agree on that.

Table 5.8: Overall averages for each question for all groups

Question	Averages				
	A	***B***	***C***	***D***	**Overall**
1. I found it difficult to tell what work my group members had done during the last week.	3	2.75	2	3.5	2.8
2. It was easy to find what my group members had worked on.	7	6.25	6	4.75	5.93
3. I always knew what my group members were going to work on over the week.	6.33	6.5	5.75	4.5	5.73
4. It was always clear what my group members were going to do.	6.33	6.25	5	4.5	5.47
5. I found the tools we used to communicate were effective.	6	7	6.25	3.5	5.67
6. I could tell what the current state of our project was at any given time.	6.33	6	5.25	3.25	5.13
7. I became more aware of my group members' work plans over time.	5	6.25	5.75	3.75	5.2
8. My group members and I planned adequately	5.33	5.75	5	3	4.73
9. My group members and I communicated well with each other.	6.67	5.5	6.25	2.75	5.2
10. My group members collaborated with me to complete the project.	7	6.25	6.5	4	5.87
11. My group members contributed equally to this project.	5.67	5.75	6.5	4	5.47
12. I enjoyed collaborating with group members.	6.33	6.25	7	3.25	5.67
13. I would prefer to work on group projects over other types of learning activities (e.g. individual assignment).	3.33	5	5.5	3.75	4.47

All groups found the tools they used to communicate were effective except group D. Groups A, B, and C agreed that their group members planned adequately and communicated well with each other, whereas group D disagreed on that. Regarding collaboration and contribution, groups A, B, and C agreed that their group members collaborated with them to complete the project and they equally contributed to the project, while group D had a neutral attitude towards their collaboration and contribution. Overall, groups A, B and C enjoyed collaborating with their group members, while group D relatively did not enjoy much. Regarding working preferences, groups B and C preferred to work on group projects, while groups A and D preferred to work other types of learning activities (e.g. individual assignment).

5.4.3 Activity Awareness Analysis

This was the main result of interviews. The proposed method for measuring activity awareness described in Chapter 4 (section 4.4.5) was used here. However, due to some limitations in the time of conducting some interviews, a set of rules were created for inclusion and exclusion of interview data in order to ensure that the process of measuring activity awareness is rigorous in order to obtain reliable data analysis. The rules were:

- The interviews should be on the same day or up to a maximum of two days, no more than 48 hours apart.
- If the difference was greater than 48 hours, then the interview was excluded
- If interviews with two participants were conducted on the same day but for different time-points (e.g. the first interview with participant X and the second interview with participant Y), then these interviews will be treated as if they were for the same time-point.

The timeline for conducting the interviews for each group is presented in Tables 5.9 to 5.12. Each table demonstrates when each interview was conducted; the grey cell indicates that the interview was included in the analysis process, while the red cell indicates that the interview was excluded from the analysis process, based on the rules described earlier.

For group A, all interviews were included. For group B, the first interview for participant B4 was excluded, and the second interview for B2 was excluded as well, as they were with more than two days' difference. For group C, all interviews were included; however, in the second interview the comparisons done between C1 and C2 together, and C3 and C4 together separately. Finally, for group D, the first interview for participant D1 was excluded and the second interview was treated as the first one, and for the first interviews of D2 and D3 were compared together, and D1, D3, and D4 were compared against each other.

Table 5.9: The timeline for interview collection for group A

P	Week 4							Week 5							Week 6							Week 7				
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5
A1			1							2							3									
A2			1							2									3							
A3			1							2									3							

Table 5.10: The timeline for interview collection for group B

P	Week 4							Week 5							Week 6							Week 7				
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5
B1			1							2							3									
B2					1										2				3							
B3					1							2							3							
B4								1				2							3							

Table 5.11: The timeline for interview collection for group C

P	Week 4							Week 5							Week 6							Week 7				
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5
C1					1							2												3		
C2					1							2												3		
C3					1										2									3		
C4					1											2									3	

Table 5.12: The timeline for interview collection for group D

P	Week 4							Week 5							Week 6							Week 7				
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5
D1					1							2													3	
D2								1											2						3	
D3										1							2							3		
D4												1							2					3		

To analyse activity awareness, this process was followed:

1. Transcribe interviews
2. Insert answers about activity into a comparison grid for each interview time for each group and follow the exclusion criteria
3. Colour self-reported cells in grey
4. Identify tasks in each cell
5. Compare answers based on the following rules:
    - If participant X mentioned all tasks as reported by participant Y, then participant X will be ranked as fully aware (FA) of the activity of participant Y

- If participant X mentioned some tasks correctly, then he/she will be ranked as partially aware (PA)
- If participant X said "I don't know or I can't remember", then he/she will be ranked as unaware (UA)
- If all members agreed that a specific member did something but he/she did not self-report it, then no enough information (NI) status will be given
- If members mentioned skills or how a member contributes rather than reporting what tasks he/she did, then also no enough information (NI) status will be given
- If participant X mentioned other tasks that participant Y did not self-report, then activity awareness of participant X will be evaluated based on what participant Y reported only.
- Synonyms are treated the same (e.g. prototype and wireframes are the same).

6. Colour "fully aware" cells in green
7. Colour "partially aware" cells in blue
8. Colour "unaware" cells in red
9. Colour cells with no enough information in yellow
10. Count, compare, and get results

Comparisons grids were created to include the answers to the interview question about what participants did and what their colleagues did in the first, second, and third interviews. Participants were ranked as fully aware if they reported what their colleagues did exactly. Participants were ranked as partially aware if they reported some of what their colleagues did. Participants were ranked as unaware if they did not know what their colleagues did. Colour coding was used to differentiate between different levels of activity awareness. Cells in grey illustrate what participants reported about themselves; cells in green show that participants were fully aware of their colleague's activity; cells in blue show that participants were partially aware of their colleague's activity; cells in red show that participants were unaware of their colleague's activity; and cells in yellow show that no enough information about activity to make a decision.

Tables 5.13, 5.14, and 5.15 present the comparison grids for group A in the first, second, and third interviews. In Table 5.13, for example, A1 was fully aware of A2 activity, so the cell is coloured in green, and she was partially aware of A3 activity, so the cell is coloured in blue. Then, the total number of each awareness level was calculated. In Table 5.13, which represents the comparison grid for first interview of group A, the total number of "fully aware" was 2, the total number of "partially aware" was 3, and the total number of "unaware" was 1, while in Table 5.14, which represents the comparison grid for the second interview of group A, respectively, the total number of "fully aware" was 6 for the second interview and no partially aware or unaware, and finally in Table 5.15, which represents the comparison grid for third interview of group A, the total number of "fully aware" was 3, the total number of "partially aware" was 3 as well. The same procedure was followed for all participants. All activity awareness analysis tables are attached in Appendix C.6.

Table 5.13: Activity awareness comparison grid of the first interview for group A

(Grey: What participant did, Green: Fully aware, Blue: Partially aware, Red: Unaware, Yellow: No enough information)

Participant	What he/she reported about		
	A1	**A2**	**A3**
A1	We kind of moving from conceptual design to detailed design like starting on it really just design the device but not the software for it - Any specific? Yes, design like how the device will look like - Prototype or..? No we haven't done prototype, well just paper prototype and started going into software design.	Like in the session we had? - In the session or during the week, even for individual work? Put some notes on Google drive that we agreed before she typed them, and at the session, she gave, well she was doing sketches and she gave input	She is done a lot of work during the week, put stuff on the drive and propose some reading before the session and give input on
A2	She has been more involved when it comes to the group, time together, she doesn't really be do anything outside when we meet up in person but she tries to do as much as she can. Last week we're doing paper prototype, so we met on Saturday, and set in the café sketching out what the actual product should look like, what the device should look like. Mainly that was A1 and myself, but we all discussed it and see what modifications needed to be made.	Last week we're doing paper prototype, so we met on Saturday, and set in the café sketching out what the actual product should look like, what the device should look like. Mainly that was A1 and myself, but we all discussed it and see what modifications needed to be made. - Yourself? Write up some notes from the interviews and observations and then share that on Google drive and maybe upload some photos or create the personas but we would all discussed it or write something down previously as a group.	Last week she, from the week before she took the … which is the storyboard created by A1, A1 was the main one drawing them and A3 took those and then actually frame them all, actually it is clear in one page for every single storyboard. She took everything away to scan, but I don't think I've received anything yet
A3	Not sure, she did conversation in meeting	Brainstorming, upload stuff on Google drive and observation	Write notations on storyboard And put them on Google drive
Summary	A2 is fully aware of A1 activity A3 is unaware of A1 activity	A1 is fully aware of A2 activity A3 is partially aware of A2 activity	A1 is partially aware of A3 activity A2 is partially aware of A3 activity
	1 FA, 1 UA	1 FA, 1 PA	2 PA

Table 5.14: Activity awareness comparison grid of the second interview for group A

(Grey: What participant did, Green: Fully aware, Blue: Partially aware, Red: Unaware, Yellow: No enough information)

Participant	What he/she reported about		
	A1	**A2**	**A3**
A1	Personally I draw some sketches and took part in discussion of design - Sketching for device? For paper prototype, well both device and the software	She did the same, so prototype and sketching with just talking about this and do it together	She took part in discussions and she took notes and then uploaded everything on drive
A2	A1 did one interview for user testing A1 and me were working together mainly to get the prototype drawing, going through scenario and storyboard, so make sure we including everything	We all did it together, so I haven't did anything apart from what we did together - So you just finish the prototype and write everything related to interviews and the storyboards? But I guess I was the main person drawing the paper prototype	She is gonna find at least one person to do with So we said we should at least have 5 people and not trying to get more than 5 people A3 was documenting all of that (interviews) And she turning them to requirements She also added annotations, storyboards after A1 is writing them up as well and she's writing them also looking at maybe other things should be including in our coursework, maybe reviewing what other people done, so we all trying to do something but it's difficult to have 3 people trying to draw a paper prototype
A3	So when we met, like all the 3 of us, A1 and A2 were working on the paper prototype Between meetings Not really	Paper prototype Between meetings Not really	I did annotations for the storyboard, because I actually ... last week, so I wrote them, put them on the computer, Wrote paper prototypes, start to structure the report, the body of the final report, Between meetings: I remember I did some scanning, so I scanned some stuff, I put it in the drive, I organise folders and move some information around (with content as well)
Summary	A2 is fully aware of A1 activity A3 is fully aware of A1 activity	A1 is fully aware of A2 activity A3 is fully aware of A2 activity	A1 is fully aware of A3 activity A2 is fully aware of A3 activity
	2 FA	2 FA	2 FA

Table 5.15: Activity awareness comparison grid of the third interview for group A

(Grey: What participant did, Green: Fully aware, Blue: Partially aware, Red: Unaware, Yellow: No enough information)

Participant	What he/she reported about		
	A1	**A2**	**A3**
A1	I interviewed 2 users I put notes for evaluation	Interviewed users and prepared form prototype	She interviewed some users and she put some notes for them And she put some stuff on the Google docs as well, like ,,, for writing reports and some findings from previous weeks
A2	Last week she did usability test. This week she didn't do anything	We have met up last Wednesday and we had a call earlier this week to discuss like what we need to do And in terms of actual work, I did usability test with a potential user of the device (I have only done one) I wrote up my findings of that and share that with the other two people	At some point I think she had some usability test (one each) she also output the structure for our report
A3	She did some annotations for the project and she is now supposed to do the prototyping part of the report (but not yet)	Let me think.. She also did her part of evaluation And now she started working on the report, on the first part	I did one evaluation and then I started writing requirements part for the report and also the evaluation part of the report
Summary	A2 is partially aware of A1 activity A3 is partially aware of A1 activity	A1 is partially aware of A2 activity A3 is fully aware of A2 activity	A1 is fully aware of A3 activity A2 is fully aware of A3 activity
	2 PA	1 FA, 1 PA	2 FA

All comparison grids are in Appendix C.6. After comparing the activity awareness in the interviews, another comparison was made between the total numbers of awareness level in the first, second, and third interviews for each group. Tables 5.16 to 5.19 show activity awareness levels for each group, and then these comparisons are illustrated in Figures 5.1 to 5.4 for all groups.

Table 5.16: Activity awareness level in each interview for group A

Activity awareness level	Fully aware	Partially aware	Unaware	No enough information	Excluded instances
In the first interview	2	3	1	0	0
In the second interview	6	0	0	0	0
In the third interview	3	3	0	0	0

Table 5.17: Activity awareness level in each interview for group B

Activity awareness level	Fully aware	Partially aware	Unaware	No enough information	Excluded instances
In the first interview	3	3	0	0	6
In the second interview	3	0	0	3	9
In the third interview	3	5	0	4	0

Table 5.18: Activity awareness level in each interview for group C

Activity awareness level	Fully aware	Partially aware	Unaware	No enough information	Excluded instances
In the first interview	2	10	0	0	0
In the second interview	4	0	0	0	8
In the third interview	7	5	0	0	0

Table 5.19: Activity awareness level in each interview for group D

Activity awareness level	Fully aware	Partially aware	Unaware	No enough information	Excluded instances
In the first interview	1	5	1	1	5
In the second interview	1	5	0	0	6
In the third interview	7	5	0	0	0

In Figure 5.1, “fully aware” of activity awareness was higher in the second interview, where all members were fully aware, “partially aware” was the same in the first and third interview, and “unaware” was appeared in the first interview only.

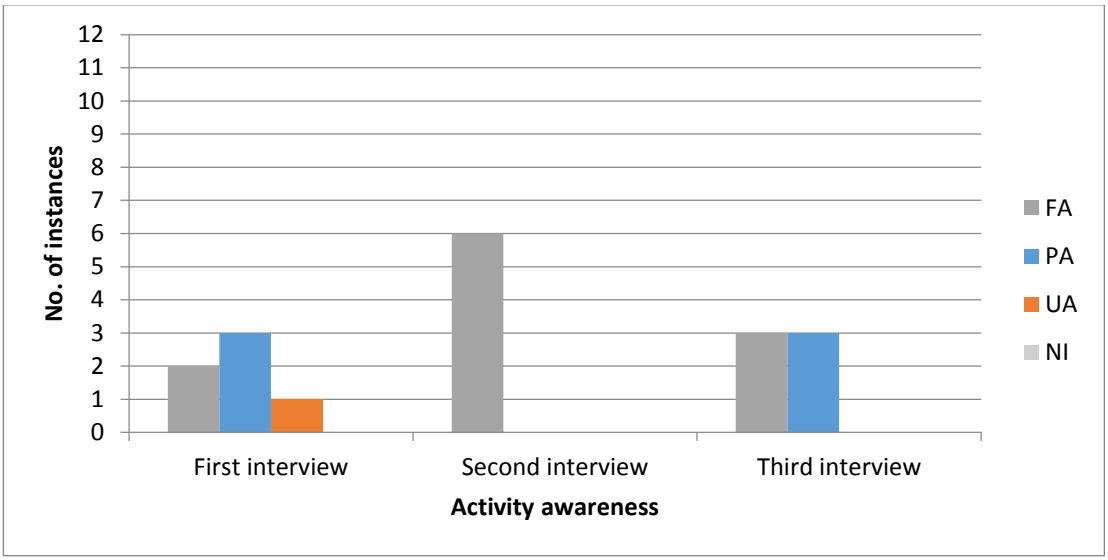


Figure 5.1: Activity awareness level for group A

In Figure 5.2, “fully aware” of activity awareness was almost the same in all interviews, and “partially aware” appeared in the first and third interview. A lot of incomplete information was found in the three interviews, where participants did not report enough information to make the comparison. Also, in the first interview 6 instances were excluded and in the second interviews 9 instances were excluded as they did not meet the inclusion criteria.

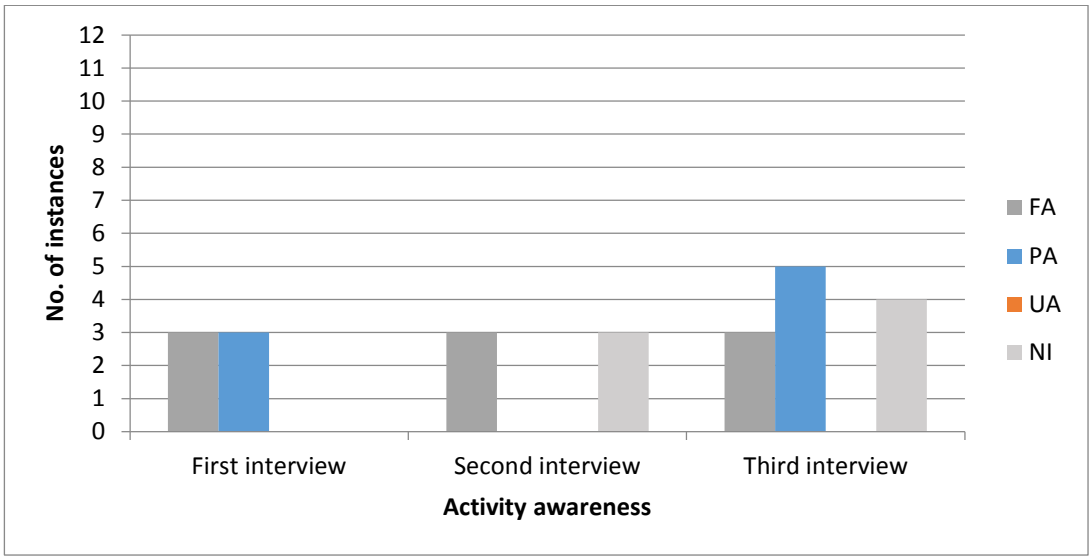


Figure 5.2: Activity awareness level for group B

In Figure 5.3, “fully aware” of activity awareness increased in the second and third interviews, while “partially aware” was higher in the first interview. In the second interview 8 instances were excluded.

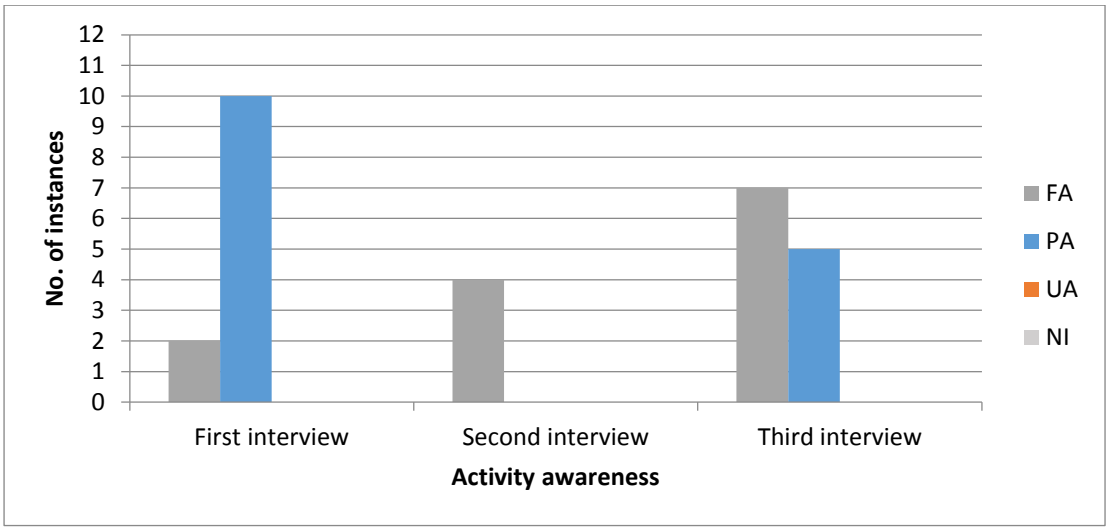


Figure 5.3: Activity awareness level for group C

In Figure 5.4, “fully aware” of activity awareness was higher in the third interview, “partially aware” was the same for all the interviews. However, numbers of comparison instances were different in each interview as in the first interview 5 instances were excluded and in the second interviews 6 instances were excluded.

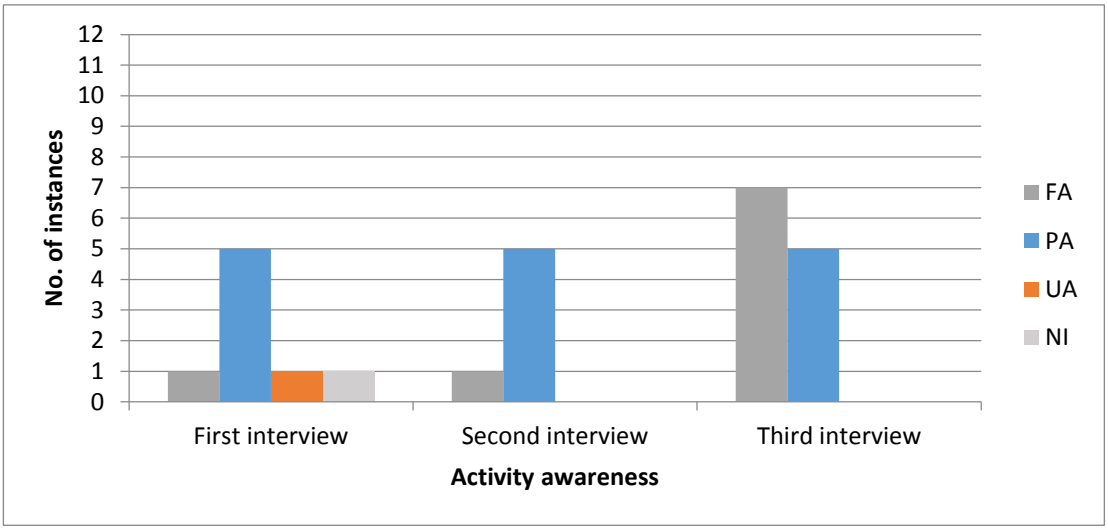


Figure 5.4: Activity awareness level for group D

At the end, participants were asked about their grades for the group report part. Table 5.20 presents the grades for each group.

Table 5.20: Groups’ grades for the group report part

Group	Grade
A	76
B	70
C	75
D	80

5.5 Discussion

This section starts by answering research questions *RQ2* and *RQ3* from the collected data. Then, a detailed reflection of the result is presented.

RQ2: **How can activity awareness be measured in long-term collaborative learning groups?**

The proposed method for measuring activity awareness described in Chapter 4 (section 4.4.5) was followed here. However, this study suffered from limitations in the time of conducting some interviews, i.e. when there was more than two days' gap between interviews for the same group. The proposed method depends on the results of comparing answers from members of the same group, so if there is a big gap between interviews, then chances of reporting mismatch activities is higher and the comparison is no longer reliable. Therefore, a set of rules was created for inclusion and exclusion of interview data to ensure that evaluating activity awareness is reliable. Lesson learned was to collect data from all members of the group on the same day or maximum within 2 days, since the activity of the group members may change and then the activity awareness analysis might not be reliable anymore if there is a big difference in data collection timeline. Difference of 2 days was chosen because participants were asked about what they did in the previous week and what each member in their group did, so taking into account that students were not working every day on the project and most probably no much work done in 2 days.

RQ3: **What activity awareness do group members have in long-term collaborative learning groups?**

Based on the results of the interviews, it was found that activity awareness was varied and changed over time; it could increase, decrease, or remain at the same level for a while. However, there was incomplete information about some participants' activities as they did not report their activities in a clear way, and also some interviews were excluded due to timing issue, i.e. when they were conducted in more than two days' apart.

Although there were some full awareness cases at various points of the project, however, there is a room to enhance activity awareness and persuasive technology has an opportunity to support activity awareness as described in chapters 6 and 7.

In this section, a further discussion of the results is given. The results from the self-assessment questionnaire showed that most participants felt they were aware of their colleagues' activity, and the results from interviews also confirmed that participants were almost aware of their colleagues' activities. Although Group D got 80, which is the highest grade in the groups, they always gave low ratings for their self-assessment experience in working in groups.

To get some sense of activity awareness percentage in all groups, each level of activity awareness was substituted with a value, so fully aware was substituted with 2, partially aware with 1, and unaware with 0, while the no enough information was excluded from the calculations, then percentages were calculated based on the total number. Figure 5.5 illustrates the overall percentages of activity awareness in the groups. Calculations in details can be found in the Appendix C.7.

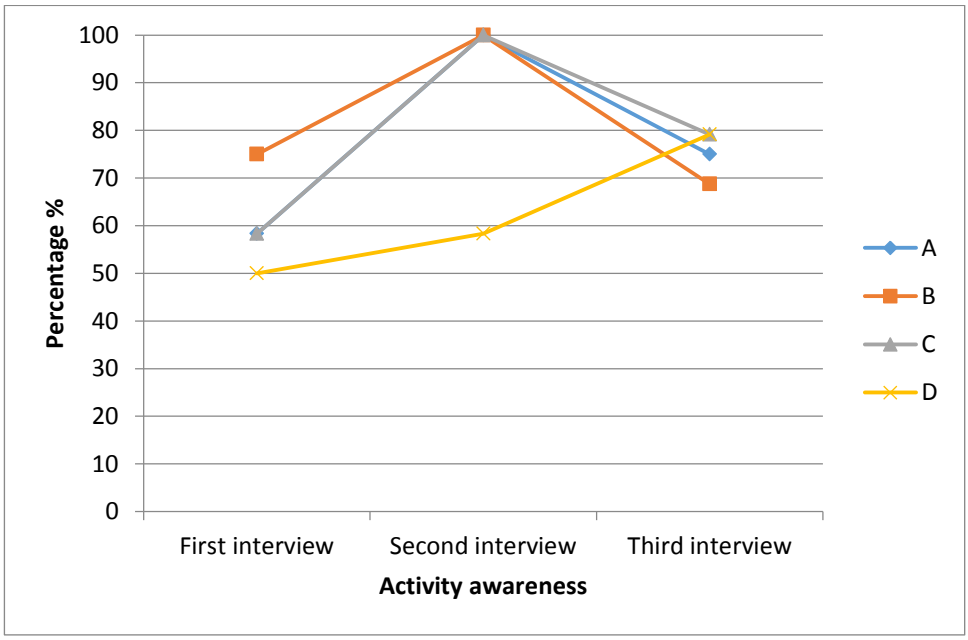


Figure 5.5: Activity awareness percentages for all groups

Figure 5.6 illustrates activity awareness percentages for each member in group A, and Figure 5.7 demonstrates activity awareness percentages across all interviews. It shows that activity awareness increased in the second interview and decreased by the third interview.

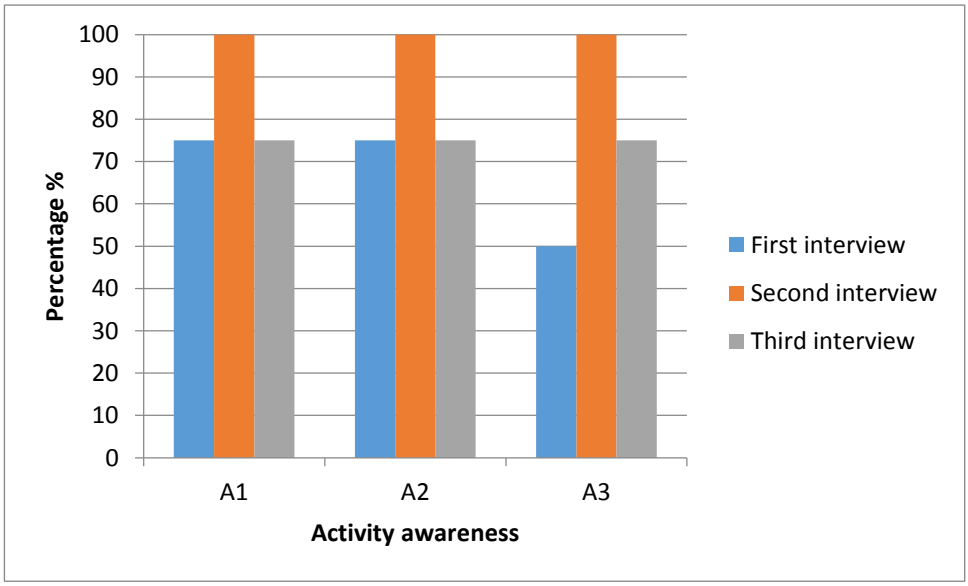


Figure 5.6: Activity awareness percentages for group A for each member

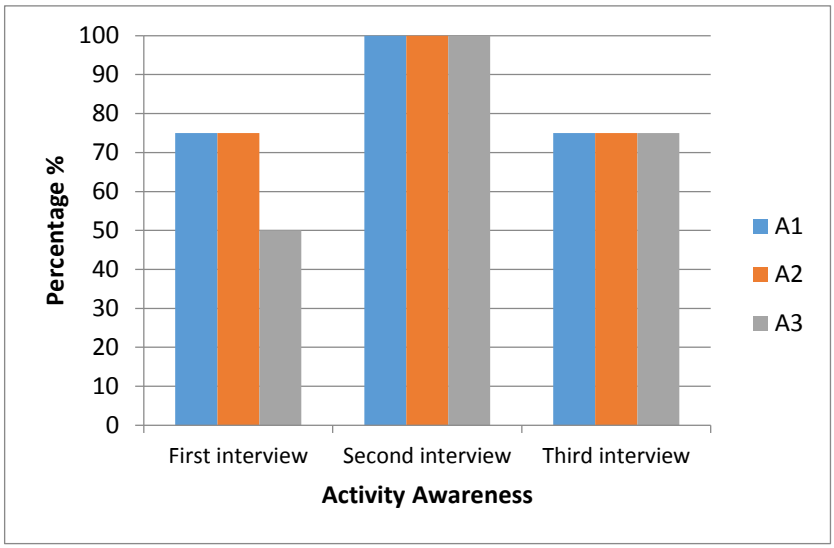


Figure 5.7: Activity awareness percentage for group A for each interview

Figure 5.8 illustrates activity awareness percentages for each member in group B, and Figure 5.9 demonstrates activity awareness percentages across all interviews. It shows that activity awareness was different for each member.

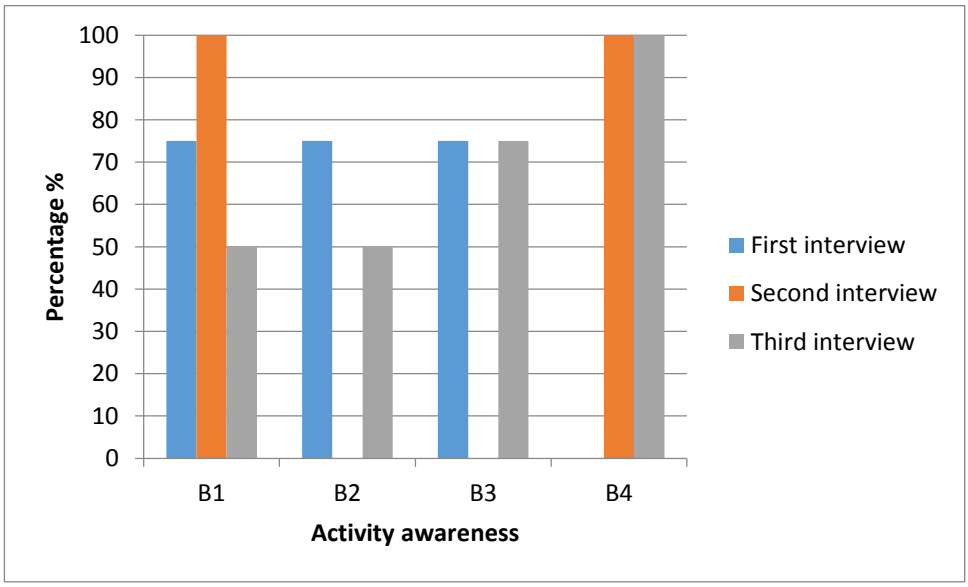


Figure 5.8: Activity awareness percentages for group B for each member

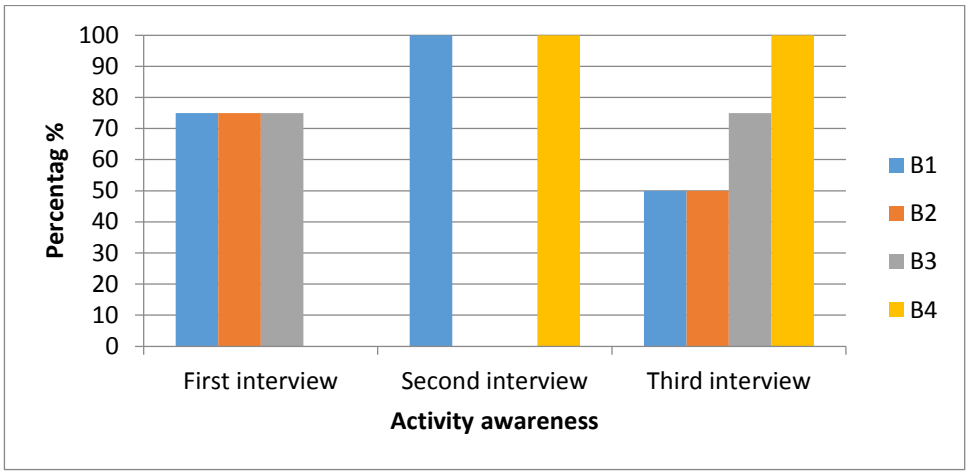


Figure 5.9: Activity awareness percentage for group B for each interview

Figure 5.10 illustrates activity awareness percentages for each member in group C, and Figure 5.11 demonstrates activity awareness percentages across all interviews. It shows that activity awareness increased in the second interview and decreased by the third interview.

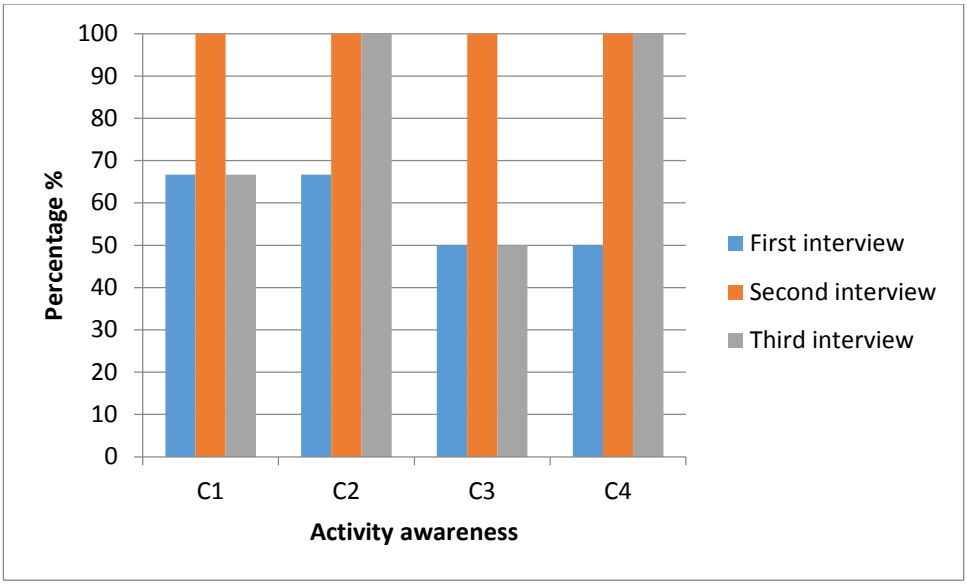


Figure 5.10: Activity awareness percentages for group C for each member

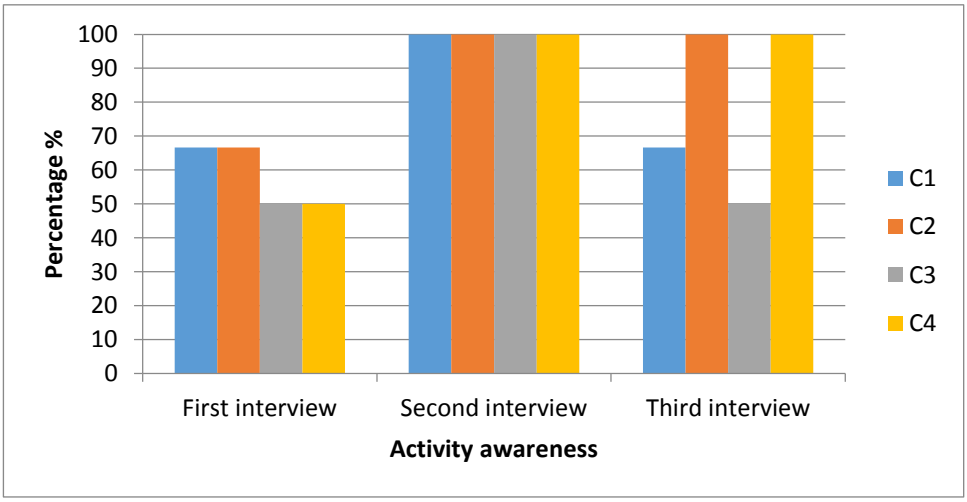


Figure 5.11: Activity awareness percentage for group C for each interview

Figure 5.12 illustrates activity awareness percentages for each member in group D, and Figure 5.13 demonstrates activity awareness percentages across all interviews. It shows that activity awareness was different for each member.

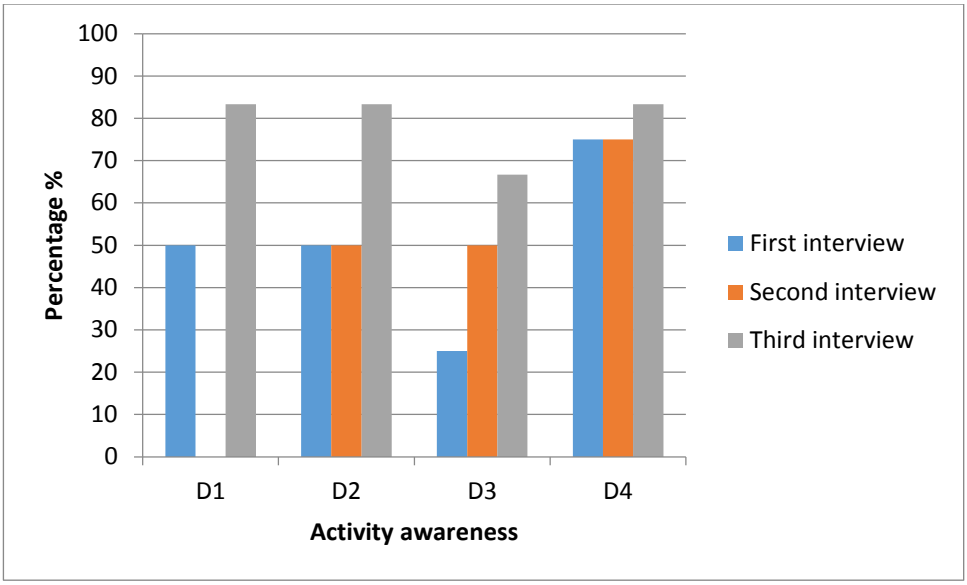


Figure 5.12: Activity awareness percentages for group D for each member

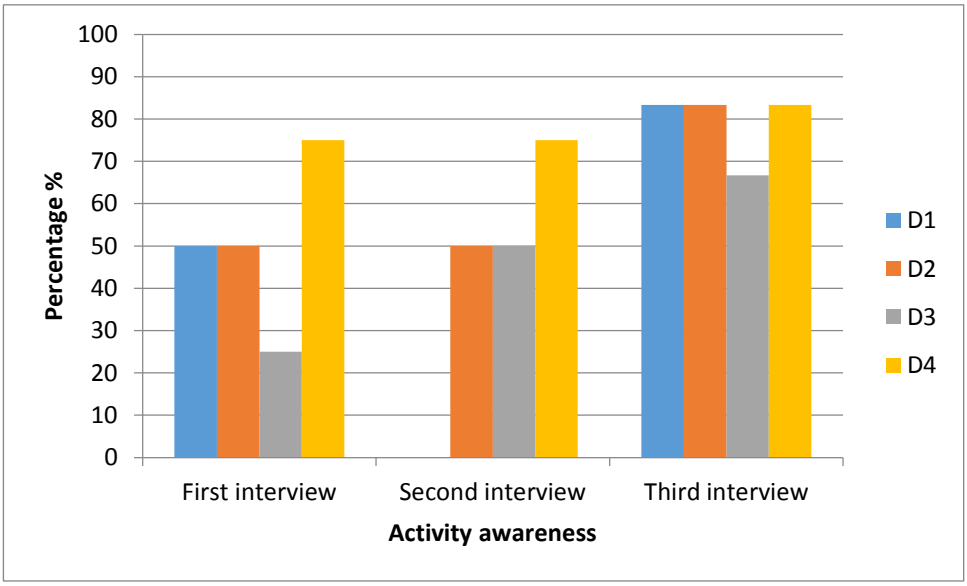


Figure 5.13: Activity awareness percentage for group D for each interview

As the project progressed, activity awareness changed over time. Although there was some missing information to evaluate activity awareness, however, there was change in activity awareness level in all groups. Some participants had similar patterns where their activity awareness increased in the middle and decreased by the end: A1, A2, A3, B1, C1, and C3. On the other hand, activity awareness for participants C2, C4,

D2, D3, and D4 increased towards the end. Table 5.21 presents changes in activity awareness for each participant.

Table 5.21: Changes in activity awareness of each participant

Participant	Changes in activity awareness
A1	*Increased then decreased*
A2	*Increased then decreased*
A3	*Increased then decreased*
B1	*n/a*
B2	*n/a*
B3	*n/a*
B4	*n/a*
C1	*From 1st to 3rd (no change)*
C2	*From 1st to 3rd (increased)*
C3	*From 1st to 3rd (no change)*
C4	*From 1st to 3rd (increased)*
D1	*n/a*
D2	*n/a*
D3	*n/a*
D4	*n/a*

5.6 Limitations

This study faced some limitations including the number of participants, where only 4 groups participated. This limitation could not be avoided as the sample was convenient sample and the number of the potential participants was small, however, this did not have an adverse impact on the findings. Also, for each group, it was hard to manage conducting interviews on the same day, or with 1 or two days' difference, to get reliable data about activity awareness. However, a set of rules was created for inclusion and exclusion criteria.

5.7 Summary

This study suggests a set of rules for evaluating activity awareness in a rigorous way. Although there were some full awareness cases at various points of the project, this does not mean that activity awareness did not need to be improved. Technology has an opportunity to improve and support activity awareness in long-term collaboration in different ways. It was hypothesised that persuasive technology could be used for that purpose and the next two chapters will illustrate that in details (chapters 6 and 7).

Chapter 6: The Design of the Social Actor

After determining that activity awareness varies over time, the aim was to support activity awareness in collaborative learning groups using a persuasive social actor. This chapter starts by reviewing some persuasion theories (section 6.1) and relevant work on the design of persuasive technology (section 6.2). Then, it presents the design and development of a lightweight persuasive technology takes the form of a digital social actor (section 6.3). It includes what persuasive techniques were used in the implementation of the social actor and how it works.

6.1 Persuasion Theories

This section reviews a number of persuasion theories that are related to user attitudes and behaviours including the Theory of Reasoned Action (Fishbein & Ajzen, 1975) and the Theory of Planned Behaviour (Ajzen, 1991), as well as theories related to computer science such as the Technology Acceptance Model (TAM) (Davis, 1989). Also, some theories are related directly to the change of attitudes and behaviours such as Self-Efficacy Theory (Bandura, 1977), Social cognitive theory (SCT) (Bandura, 1986), Cognitive dissonance theory (Festinger, 1957), and Elaboration likelihood model (ELM) (Petty & Cacioppo, 1986).

Self-efficacy theory (Bandura, 1977) suggests that an individual's belief in his/her ability to perform a behaviour determines their success in accomplishing it, i.e. it determines whether he/she will perform it. Expectations of self-efficacy are based on four major sources of information: performance accomplishments, vicarious experience, verbal persuasion, and emotional and physiological states. Performance accomplishments is based on personal experiences; vicarious experience is based on observing others perform activities - people convince themselves that if others can achieve it, they should be able to achieve it too; verbal persuasion is influencing people through the suggestion that they can perform a task or behaviour successfully even if they failed in the past; and emotional and physiological states can affect individual's perceived self-efficacy in handling threatening situations (e.g. depression can reduce people's confidence in their abilities whereas positive emotions can

improve confidence in their abilities). Self-efficacy theory is a core theory for some theories reviewed later.

Social cognitive theory (SCT) (Bandura, 1986) is based on self-efficacy and the perceived expected outcomes. Social cognitive theory posits that learning occurs in a social context with a dynamic and reciprocal interaction of the person (unique personal characteristics such as ability), environment (consequences from the organisational environment such as pay for performance), and the behaviour itself (previous successful or unsuccessful performances). Figure 6.1 illustrates the reciprocal interaction among the person, environment, and the behaviour.

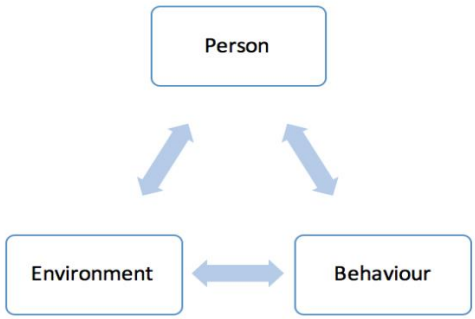


Figure 6.1: Triadic influence in social cognitive theory (Bandura, 1986)

Social cognitive theory involves concepts from both social learning theory and self-efficacy theory. From the social learning theory, five concepts are included: reciprocal determinism, behavioural capability, observational learning, reinforcements, and expectations.

The Theory of Reasoned Action (Fishbein & Ajzen, 1975) posits that behavioural intention is determined by the person's attitude toward the behaviour and/or subjective norms about the behaviour. Behavioural intention is the immediate antecedent to behaviour. Figure 6.2 illustrates the theory of reasoned action.

According to theory of reasoned action, if an individual thinks the suggested behaviour is favorable (i.e. he/she has a positive attitude towards the behaviour), and or if he/she believes other people want them to perform the behaviour (i.e. subjective norm), this generates the intention to perform the behaviour which more likely leads to them actually performing it.

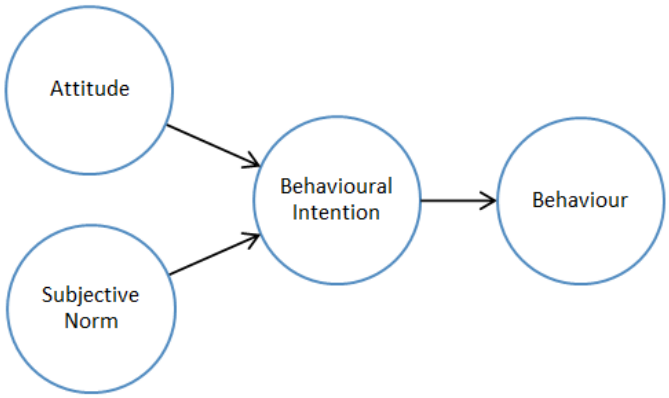


Figure 6.2: Theory of Reasoned Action (Fishbein & Ajzen, 1975)

The Theory of Planned Behaviour (Ajzen, 1991) is an expanded version of the theory of reasoned action, where perceived behavioural control can also determine the behavioural intention along with attitude and subjective norms and can also influence the behaviour. Perceived behavioural control is the perception of the ease with which the behaviour can be performed (i.e. perceived ease of use or self-efficacy). Figure 6.3 illustrates the theory of planned behaviour. The theory of planned behaviour is based on the theory of reasoned action and self-efficacy theory. Perceived behavioural control includes any external factor to perform a behaviour.

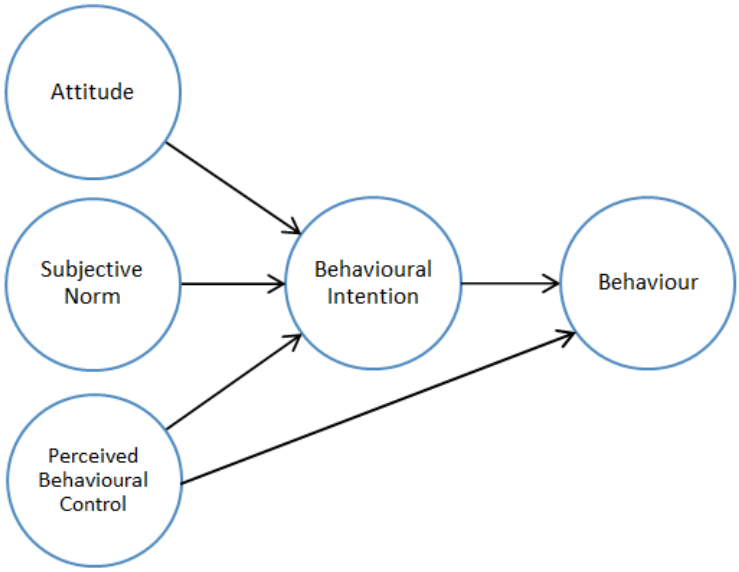


Figure 6.3: Theory of Planned Behaviour (Ajzen, 1991)

Cognitive dissonance theory (Festinger, 1957) posits that individuals seek consistency between their attitudes and behaviours; inconsistency between them generates dissonance which produces discomfort and as a result there will be a pressure to reduce or remove this dissonance. Usually people attempt to reduce dissonance by either changing one or more of their behaviours or beliefs involved in the dissonance; acquiring new information or beliefs that will reduce the dissonance; or changing their perception of the behaviour that caused the dissonance.

The Elaboration Likelihood Model (ELM) (Petty & Cacioppo, 1986) suggests two key routes for persuasion: central and peripheral routes. The central route results from a person's critical thinking and thoughtful consideration in processing the information presented, while the peripheral route results from some simple cues in the persuasion context without considering checking the accuracy of the information presented and is based on rules of thumb. The central route occurs when motivation and ability to assess information are relatively high, while the peripheral route occurs when motivation and/or ability are relatively low and attitudes are determined by positive or negative cues in the persuasion context. The central route is direct and the peripheral route is indirect. Moreover, change through the central route is more enduring, resistant and predictive of behaviour.

The Technology Acceptance Model (TAM) (Davis, 1989) is a theoretical model for information systems and it has two parts: perceived usefulness and perceived ease of use and they are determinants of user behaviour i.e. the user's acceptance of technology. Davis (1989) defines perceived usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance", and perceived ease of use as "the degree to which a person believes that using a particular system would be free of effort". Perceived ease of use is based on self-efficacy, while perceived usefulness is based on outcomes judgments. Also, perceived ease of use influences perceived usefulness.

6.2 Designing for a Persuasive Technology

The literature review (Chapter 2) defined persuasive technology and reviewed some design models and examples of the use of persuasive technologies. The concept of using persuasive technologies involves changing users' behaviours or attitudes without coercion or deception (Fogg, 2003). Therefore, researchers identified different ways to classify the type of change. In addition, they suggested some guidelines for designing a persuasive technology. In this section, some matrices for the change type and some design guidelines are reviewed here.

6.2.1 Type of Behaviour or Attitude Change

A number of researchers have developed matrices to classify types of behaviour change. Three common matrices are reviewed here: The Behaviour Grid for 35 types of behaviour change (Fogg, 2009c), The Behaviour Wizard for 15 types of behaviour change (Fogg & Hreha, 2010), and the Outcome/Change design matrix (Oinas-Kukkonen, 2012). These matrices were created by key people in the fields of persuasive technologies.

6.2.1.1 The Behaviour Grid

Fogg (2009c) presents an initial framework to classify behavior change called the Behavior Grid. Table 6.1 illustrates the Behaviour Grid and it shows 35 types of behavior change organised as two categorical dimensions: the type of behaviour change, and the time/duration for that change. The columns represent the type of behaviour change and there are five types of the change:

- perform new behaviour,
- perform existing behaviour,
- increase behavior,
- decrease behaviour, or
- stop behaviour

The rows represent the time/duration for the behaviour change and there are seven types of time/duration:

- one time behaviour,
- one time behaviour that leads to ongoing obligations/cost,
- behaviour for a period of time,
- behaviour that repeated on a predictable schedule,
- behaviour is on cue that happens irregularly,
- behaviour is performed at any moment, or
- behaviour is always performed

Table 6.1: The Behaviour Grid (Fogg, 2009c)

			What type of behaviour change?				
			A	**B**	**C**	**D**	**E**
			Perform new behaviour (unfamiliar behaviour)	**Perform existing behaviour** (familiar behaviour)	**Increase behaviour** (frequency, intensity, or duration)	**Decrease behaviour** (frequency, intensity, or duration)	**Stop behaviour** (cease ongoing behaviour)
On what schedule?	**1**	**One time behaviour**	A1	B1	C1	D1	E1
	2	**One time behaviour that leads to ongoing obligations/cost**	A2	B2	C2	D2	E2
	3	**Behaviour for a period of time** (X has a duration)	A3	B3	C3	D3	E3
	4	**Behaviour on a predictable schedule** (X gets repeated, periodicity)	A4	B4	C4	D4	E4
	5	**Behaviour is on cue** (X is cued irregularly; it's a change in habitual response)	A5	B5	C5	D5	E5
	6	**Behaviour is at will** (can perform X at any moment)	A6	B6	C6	D6	E6
	7	**Behaviour is always performed** (X means change in habit, in way of being)	A7	B7	C7	D7	E7

For instance, cell A1 represents performing new behaviour for one time. This was an early attempt to identify behaviour change, and further amendments took place later in another research described next, however, it is still can be beneficial for designers and researchers to think more clearly about behaviour change and persuasive technology.

6.2.1.2 The Behaviour Wizard

The second matrix reviewed here is the Behaviour Wizard identified by Fogg and Hreha (2010). They used the Behaviour Grid as a starting point to create the

Behaviour Wizard. They simplified the 35 types of behaviour change to be 15 types of behaviour change in order to be more practical and conceptually appealing. The goal of the Behaviour Wizard is to match types of target behaviors with solutions for achieving those target behaviors and also to identify patterns of behaviour change. Table 6.2 illustrates the Behaviour Wizard and it shows 15 types of behaviour change with five columns and three rows. The columns represent the type of change and the rows represent the duration for that change.

Table 6.2: The Behaviour Wizard (Fogg & Hreha, 2010)

	Green behaviour Do new behaviour, one that is unfamiliar	**Blue behaviour** Do familiar behaviour	**Purple behaviour** Increase behaviour intensity or duration	**Gray behaviour** Decrease behaviour intensity or duration	**Black behaviour** Stop doing a behaviour
Dot behaviour is done one-time	**GreenDot** Do new behaviour one time	**BlueDot** Do familiar behaviour one time	**PurpleDot** Increase behaviour one time	**GrayDot** Decrease behaviour one time	**BlackDot** Stop doing a behaviour one time
Span behaviour has specific duration, such as 40 days	**GreenSpan** Do new behaviour for a period of time	**BlueSpan** Do familiar behaviour for a period of time	**PurpleSpan** Increase behaviour for a period of time	**GraySpan** Decrease behaviour for a period of time	**BlackSpan** Stop a behaviour for a period of time
Path behaviour is done from now on, a permanent change	**GreenPath** Do new behaviour from now on	**BluePath** Do familiar behaviour from now on	**PurplePath** Increase behaviour from now on	**GrayPath** Decrease behaviour from now on	**BlackPath** Stop a behaviour from now on

The Behaviour Wizard is a consolidated version of the Behaviour Grid, where the columns in the Behaviour Grid and Behaviour Wizard are the same, but the rows are altered/different: the first two rows in the Behaviour Grid, i.e. rows 1 and 2, combined to be "dot behaviour" row in the Behaviour Wizard, which represent one time behaviour; rows 3, 4 and 5 became "span behaviour" row, which represent performing behaviour for some time or more than one time; and rows 6 and 7 became "path behaviour" row, which represent lasting behaviour.

6.2.1.3 The Outcome/Change Design Matrix

The last matrix is the O/C matrix, which identified by (Oinas-Kukkonen, 2012). The O/C matrix has 3 potential outcomes: the formation, alteration or reinforcement of 3 change types: attitudes, behaviours, or complying. Table 6.3 illustrates the O/C design matrix. This matrix is useful in design and research regarding persuasive technologies.

A forming outcome (F-Outcome) means the construction of a new behaviour or attitude that did not exist before. An altering outcome (A-Outcome) includes any change of an existing attitude or behaviour (i.e. increasing or decreasing), where the change can be related to frequency, intensity, or duration of the behaviour. A reinforcing outcome (R-Outcome) means the reinforcement of current attitudes or behaviors.

Table 6.3: Outcome/change design matrix (Oinas-Kukkonen, 2012)

	C-Change	***B-Change***	***A-Change***
F-Outcome	Forming an act of complying (F/C)	Forming a behaviour (F/B)	Forming an attitude (F/A)
A-Outcome	Altering an act of complying (A/C)	Altering a behaviour (A/B)	Altering an attitude (A/A)
R-Outcome	Reinforcing an act of complying (R/C)	Reinforcing a behaviour (R/B)	Reinforcing an attitude (R/A)

These matrices overlapped and mostly covered similar type of changes, for instance, in the O/C design matrix "forming a behaviour (F/B)" is similar to A column in the Behaviour Grid and the "green behaviour" in the Behaviour Wizard. An important difference is that O/C matrix looks at changes in both behaviours and attitudes, while the Behaviour Grid and Behaviour Wizard cover changes in behaviours only.

In general, the Behaviour Grid and Behaviour Wizard focus on the type and the time/duration of the behaviour change, while O/C design matrix focuses on the type of the outcome (i.e. forming, altering, or reinforcing) and the change type (i.e. act of complying, behaviour, or attitude).

6.2.2 Guidelines for Designing a Persuasive Technology

Researchers have suggested different frameworks for designing persuasive technologies. For example, Fogg (2009a) suggests an eight-step design process to follow in order to create a robust persuasive technology. The steps involve choosing a target behaviour, an audience, and a common technology channel, finding what prevents that behaviour, finding relevant examples, reproducing successful ones, testing and iterating quickly, and finally expanding on success.

Oinas-kukkonen and Harjumaa (2009) suggest a model for designing persuasive technologies called the PSD (Persuasive Systems Design) model. The PSD model consists of two parts: the persuasion context (Table 6.4) and the software system characteristics (Table 6.5). Analysing the persuasion context includes analysing the intent, the event, and the strategies. Analysing the intent involves deciding the persuader and the change type; the event focuses on the context of the use, user, and technology; while the strategies are about the message and the route to deliver this message. Table 6.4 presents the persuasion context in detail.

Table 6.4: The persuasion context (Oinas-kukkonen & Harjumaa, 2009)

Persuasion context	Includes
The intent	***Persuader:*** (Endogenous, exogenous, or autogenous)
	Change type: Attitude and/or behaviour change
The event	***Use context:*** The features arising from the problem domain
	User context: This context analysis in the large means analyzing a user's interests, needs, goals, motivations, abilities, pre-existing attitudes, commitment, consistency, compromises, life styles, persistence of change, cultural factors, deep-seated attitudes, social anchors, and perhaps even the whole personality. It is about understanding the user's goals, including current progress toward achieving them, and potentially past performances.
	Technology context: The strengths and weaknesses, as well as the risks and opportunities, of specific technological platforms, applications and features need to be thoroughly understood
The strategies	***Message:*** Refers to the form and/or content selected to deliver the intended transformation;
	Route: Considering the proper route (it can be direct, indirect, or both)

Oinas-kukkonen and Harjumaa (2009) identify four categories of persuasive techniques for system characteristics: primary task support, dialogue support, system credibility support and social support. Each of these categories includes seven persuasive techniques, giving a total of 28 persuasive techniques. For instance, reduction, which is defined as reducing a complex behaviour into simple tasks, is a persuasive technique for primary task support. Table 6.5 presents all the design techniques for each category along with their description. These techniques were considered in designing the social actor as described later (section 6.3.2).

Table 6.5: Software system characteristics (Oinas-kukkonen & Harjumaa, 2009)

Software system characteristic	Design principles	Description
Primary task support	Reduction	A system that reduces complex behavior into simple tasks helps users perform the target behavior, and it may increase the benefit/cost ratio of a behavior.
	Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.
	Tailoring	Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group.
	Personalisation	A system that offers personalised content or services has a greater capability for persuasion.
	Self-monitoring	A system that keeps track of one's own performance or status supports the user in achieving goals.
	Simulation	Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect.
	Rehearsal	A system providing means with which to rehearse a behavior can enable people to change their attitudes or behavior in the real world.
Computer-human dialogue support	Praise	By offering praise, a system can make users more open to persuasion.
	Rewards	Systems that reward target behaviors may have great persuasive powers.
	Reminders	If a system reminds users of their target behavior, the users will more likely achieve their goals.
	Suggestion	Systems offering fitting suggestions will have greater persuasive powers.
	Similarity	People are more readily persuaded through systems that remind them of themselves in some meaningful way.
	Liking	A system that is visually attractive for its users is likely to be more persuasive.
	Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.
Perceived system credibility	Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.
	Expertise	A system that is viewed as incorporating expertise will have increased powers of persuasion.
	Surface credibility	People make initial assessments of the system credibility based on a firsthand inspection.
	Real-world feel	A system that highlights people or organisation behind its content or services will have more credibility.
	Authority	A system that leverages roles of authority will have enhanced powers of persuasion.
	Third-party endorsements	Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility.
	Verifiability	Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.
Social influence	Social learning	A person will be more motivated to perform a target behavior if (s)he can use a system to observe others performing the behavior.
	Social comparison	System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others.
	Normative influence	A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior.
	Social facilitation	System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them.
	Cooperation	A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate.
	Competition	A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete.
	Recognition	By offering public recognition for an individual or group, a system can increase the likelihood that a person/group will adopt a target behavior.

6.2.3 What is a Social Actor?

A persuasive technology can be in a form of a tool, a medium, or a social actor, or even a mix of them. A social actor is a computing persuasive technology that gives different social cues to elicit social responses from users (Fogg, 2003). Possible social cues include physical cues (e.g. face and body), psychological cues (e.g. empathy and humour), language (e.g. spoken language), social dynamics (e.g. praise for good work), and social roles (e.g. guide). Social actors can persuade people to change their attitudes or behaviours by rewarding them with positive feedback, providing social support, or modelling target behaviours or attitudes (Fogg, 2003).

Table 6.6 shows the social cues identified by Fogg (2003) for social actors and examples of each social cue. Social cues are not an alternative to the PSD techniques; they are what give social actors their basic features.

Table 6.6: Social cues with examples (Fogg, 2003)

Cue	Examples
Physical	Face, eyes, body, movement
Psychological	Preferences, humor, personality, feelings, empathy, "I'm sorry"
Language	Interactive language use, spoken language, language recognition
Social dynamics	Turn taking, cooperation, praise for good work, answering questions, reciprocity
Social roles	Doctor, teammate, opponent, teacher, pet, guide

Social actors have been used as persuasive technologies for purposes such as encouraging people to stop smoking (Barbat & Cretulscu, 2003) and minimising electricity consumption (Ham et al., 2009).

6.3 The Process of Designing the Social Actor

In this section, a detailed description of designing the social actor is presented. This section answered the design part of the fourth research questions *RQ4.1*, which is:

RQ4.1: **How can a persuasive social actor for activity awareness in long-term collaborative learning groups be designed?**

A lightweight social actor was developed for activity awareness called "Mr. Mentor"[3]. The aim of the social actor was to promote activity awareness in collaborative learning groups by changing the attitudes and behaviours of students. Mr. Mentor is a digital character that interacts with users by asking questions, providing feedback, and making suggestions, using voice, text and facial expressions. The app meant to be lightweight so the design was not aimed to capture the state of the work. The main job of the social actor is reminding users to perform the target behaviours rather than capturing their behaviours.

This part of research is based on the BCSS framework (Oinas-Kukkonen, 2012), where a research on persuasive technologies is conducted. As mentioned in the introduction (Chapter 1), this model has five steps to carry out a research for persuasive technologies. Firstly, theoretical background is chosen (section 6.1). Then, the outcome/change design matrix is analysed (section 6.3.1). After that, the PSD model is analysed (section 6.3.2). Then, step 4, which is about measuring the change is described in Chapter 7 (section 7.4.1). Finally, an overall reflection on the results through the background theories, the O/C design matrix, and the PSD model is presented in Chapter 7 (section 7.4.8).

[3] The name "Mr. Mentor" denotes the fact that the social actor "mentors" the collaboration; it does not mentor people, or give advice or support about the activities of the project itself

6.3.1 Choosing the Target Behaviours and Attitudes

Analysing the O/C is the second step in conducting a research for the BCSS (Oinas-Kukkonen, 2012). Different options for a change type can be considered using the O/C design matrix. Table 6.7 presents potential examples of designing each outcome/change in a collaborative learning context.

Table 6.7: Potential examples of each outcome/change design in collaborative learning

	C-Change	***B-Change***	***A-Change***
F-Outcome	Forming an act of complying (F/C) Example: helping a group member to ask other group members about their progress	Forming a behaviour (F/B) Example: helping a group member to adopt collaborative behaviour by deciding to start communicating with their group members	Forming an attitude (F/A) Example: helping a group member to believe that being aware of activities of the group is significant to their success
A-Outcome	Altering an act of complying (A/C) Example: encouraging a group member who currently works individually to start working with a group	Altering a behaviour (A/B) Example: encouraging a group member that currently does not attend group meetings to start attending	Altering an attitude (A/A) Example: encouraging a group member that currently does not think that working in group is useful to start considering the benefits of collaborative learning
R-Outcome	Reinforcing an act of complying (R/C) Example: motivating a group member to ask other group members again about their progress	Reinforcing a behaviour (R/B) Example: motivating a group member to continue telling other group members about his/her progress	Reinforcing an attitude (R/A) Example: motivating a group member to continue considering that sharing what he/she did is significant to the group success

In this PhD research, the target behaviours were to encourage students to share their work with others in their collaborative learning group and, vice versa, to encourage students to look at the work done by others in the group. Table 6.8 presents the outcome/change design matrix for the target behaviours. A reflection on the change through the O/C design matrix is described in Chapter 7 (section 7.4.8).

Table 6.8: The O/C design matrix for the target behaviours

	C-Change	***B-Change***	***A-Change***
F-Outcome	Forming an act of complying (F/C) n/a	Forming a behaviour (F/B) n/a	Forming an attitude (F/A) 1- helping a group member to believe that that sharing his/her work with the group is important to the group success 2- helping a group member to believe that looking at the group work is important to the group success
A-Outcome	Altering an act of complying (A/C) n/a	Altering a behaviour (A/B) 1- encouraging a group member that currently does not share his/her work to start sharing his work with the group 2- encouraging a group member that currently does not look at the group work to start looking at the group work	Altering an attitude (A/A) 1- encouraging a group member that currently does not think that sharing his/her work with the group is important to start considering the importance of that 2- encouraging a group member that currently does not think that looking at the group work is important to start considering the importance of that
R-Outcome	Reinforcing an act of complying (R/C) n/a	Reinforcing a behaviour (R/B) 1- motivating a group member to continue sharing his/her work with the group 2- motivating a group member to continue looking at the group work	Reinforcing an attitude (R/A) 1- motivating a group member to continue considering that sharing his/her work with the group is significant to the group success 2- motivating a group member to continue considering that looking at the group work is significant to the group success

6.3.2 Using the PSD Model

Analysing the PSD model is the third step in conducting a research for the BCSS (Oinas-Kukkonen, 2010). The Mr. Mentor app was developed based on the Persuasive Systems Design (PSD) model by Oinas-kukkonen and Harjumaa (2009). This model was chosen because it is more comprehensive than the process suggested by (Fogg, 2009a). After we chose the behaviours and attitudes we aimed to target: sharing what a member did (i.e. providing information) and looking at other members' work (i.e. perceiving information), and the attitudes related to these target behaviours, then we analysed the system through the PSD model. The PSD model involves two parts: the persuasion context and system characteristics. Table 6.9 presents the persuasion context for Mr. Mentor in detail.

Table 6.9: Persuasion context of Mr. Mentor app

Persuasion context	Includes
The intent	Persuader: researcher (exogenous)
	Change type: attitude and behaviour change
The event	Use context: to promote activity awareness in collaborative learning groups
	User context: the users are students grouped in 3 and working on collaborative learning projects. Persuasion will promote their activity awareness which in turn will improve their collaboration and learning experience
	Technology context: Single lightweight app that works on iPhones and PCs
The strategies	Message: in a form of text, sound, and animation with facial expressions delivered by a virtual social actor. The content of the message includes questions, feedback, suggestions, reminders, rewards and praise
	Route: direct and indirect

The persuasive techniques of the PSD model were used in designing the Mr. Mentor app. Each of the 28 PSD techniques was considered for its potential suitability and practicality to be applied in this context. Some techniques were deemed inappropriate; for example, simulation is a technique that enables the user to observe the link between cause and effect and is more suitable for persuasive technology in the form of media. Likewise, PSD techniques such as third-party endorsements and expertise are useful for e-commerce situations, but were not relevant in this case. The analysis is in Appendix D.1.

Table 6.10 shows all the persuasive techniques from the PSD model that were applied in designing the iPhone and web versions of the app and how they were applied. The

iPhone version was shaped by 15 design techniques whereas, due to the constraints of web technology, only 11 were applied in the web version.

Table 6.10: Persuasive techniques in each app version and corresponding statement numbers

Categories of support	Applied persuasive techniques	#S	iPhone	Web
Primary task support	Reduction: simplifying the interaction with Mr. Mentor by using buttons for answers	*S1*	•	•
	Tunnelling: guiding users through a series of questions to complete the interaction with Mr. Mentor	*S2*	•	•
	Personalisation: offering a personalised service, which is selecting a preferred time for notifications	*S3*	•	
	Self-monitoring: providing a reward page, so users can see their total earned points	*S4*	•	
Dialogue support	Praise: offering praise when users share their work or look at the group's work	*S5*	•	•
	Rewards: rewarding users with virtual points whenever they share their work or look at the group's work	*S6*	•	
	Reminders: reminding users to share their work and to look at the group's work	*S7*	•	•
	Suggestion: offering appropriate suggestions when users did not perform the target behaviours	*S8*	•	•
	Liking: making the app visually attractive	*S9*	•	•
	Social role: adopting a social role for a mentor	*S10*	•	•
Perceived credibility support	Trustworthiness: providing true and reliable information about the app and the study	*S11*	•	•
	Surface credibility: no ads in the app	*S12*	•	•
	Real-world feel: displaying the researcher's info	*S13*	•	•
Social support	Cooperation: use of the app is to support collaboration	*S14*	•	•
	Competition: displaying the total earned points, to support competition between users	*S15*	•	

For each persuasive technique applied in the design of the app, also a statement was created to describe the feature designed for that technique. For example, the statement S1 "The app simplified the interaction with Mr. Mentor by using buttons for answers, and no need to write them" was created for the reduction technique. These statements were used later in evaluating the effectiveness of the approach through conducting an empirical study (see Chapter 7). The actual implementation for each persuasive technique is described later in section 6.3.5.

These particular characteristics were applied in the design as they seemed to be beneficial and supportive to the purpose of the technology. Other characteristics

might be useful but due to limitation in time and resources, they were not used. Moreover, some characteristics were not appropriate in this context.

6.3.3 Applied Social Cues for Mr. Mentor App

Mr. Mentor is a persuasive social actor and it has some social cues that provide its basic characteristics. The Table 6.10 shows the social cues applied in the Mr. Mentor app.

Table 6.11: The social cues in Mr. Mentor app

Cue	Cues in Mr. Mentor App
Physical	Face, body, movement, expressions
Psychological	Personalisation, self-monitoring
Language	Spoken language
Social dynamics	Praise, rewards, reminders, suggestion
Social roles	Mentor

There are seven points of overlap between the PSD techniques and the social cues identified by Fogg. These are: social role, praise, rewards, reminders, suggestion, personalisation and self-monitoring. Social role is a social cue and also a persuasive technique in the PSD model for dialogue support. Praise, rewards, reminders, and suggestion are cues for social dynamics, and also persuasive techniques in the PSD model for dialogue support. Personalisation and self-monitoring are psychological cues and also persuasive techniques in the PSD model for Primary task support. Some persuasive techniques in the PSD model are incorporating social cues identified by Fogg (2003).

6.3.4 Paper Prototype

A paper prototype was implemented to sketch the interactions with app based on the selected PSD techniques. The paper prototype was modified several times until the final version was achieved. Figure 6.4 illustrates the paper prototype for Mr. Mentor app (iPhone version). The wireframes were created mainly using *Balsamiq* tool then the prototype was completed by hand. The prototype was evaluated with one

researcher to check the flow of interactions with Mr. Mentor. A larger version of the prototype can be found in Appendix D.2.

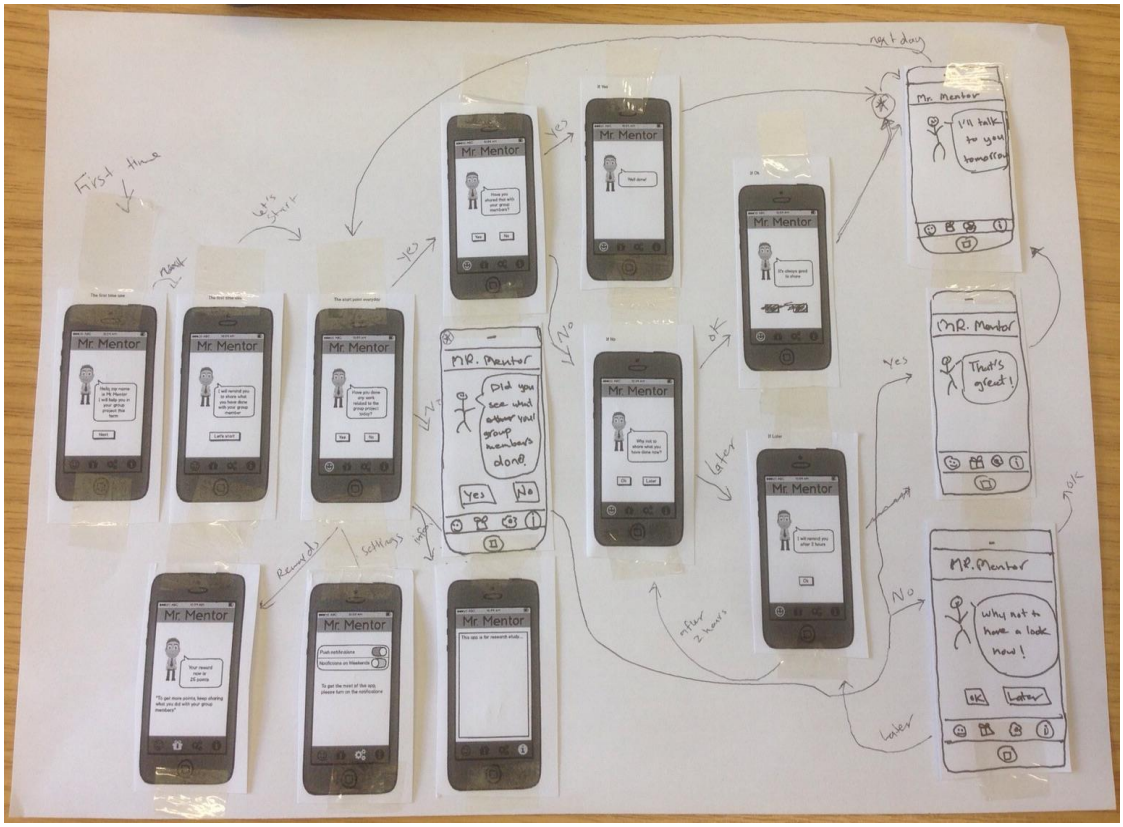


Figure 6.4: A paper prototype for Mr. Mentor app

6.3.5 Implementation

After creating the final prototype, two versions of Mr. Mentor were implemented: an iOS version that runs on iPhones and a web version that works on desktop and laptop computers. At the beginning only the iOS version was created, then a web version with slightly less functionality was developed later to enable more participants to use the social actor. In the iOS version, *Xcode* was used to code the app, while *HTML* was used for coding the web version. For the animation, a tool called *GoAnimate* was used to generate Mr. Mentor face, body, movement, sound, and visual effect.

There are 4 main tabs in the iPhone version: ‘Mr. Mentor’, ‘rewards’, ‘settings’, and ‘about me’. The Mr. Mentor tab is for interacting with Mr. Mentor; the rewards tab is used to display the total collected points; the settings tab is used to customise the time for notifications to talk to Mr. Mentor; and finally the about me tab displays information about the researcher (see Figure 6.5).

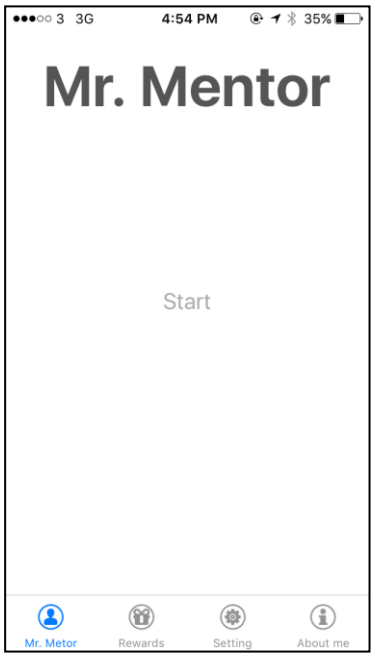


Figure 6.5: The starting screen of Mr. Mentor app (iPhone version)

6.3.5.1 Implementation of the PSD Techniques

In this section, an explanation for implementing each persuasive technique is presented. Reduction was implemented to simplify the interaction with Mr. Mentor by using buttons for answers as demonstrated in Figure 6.6

Figure 6.6: A screenshot for reduction implementation

Tunnelling was implemented by guiding users through a series of questions to complete the interaction with Mr. Mentor as illustrated in Figure 6.7.

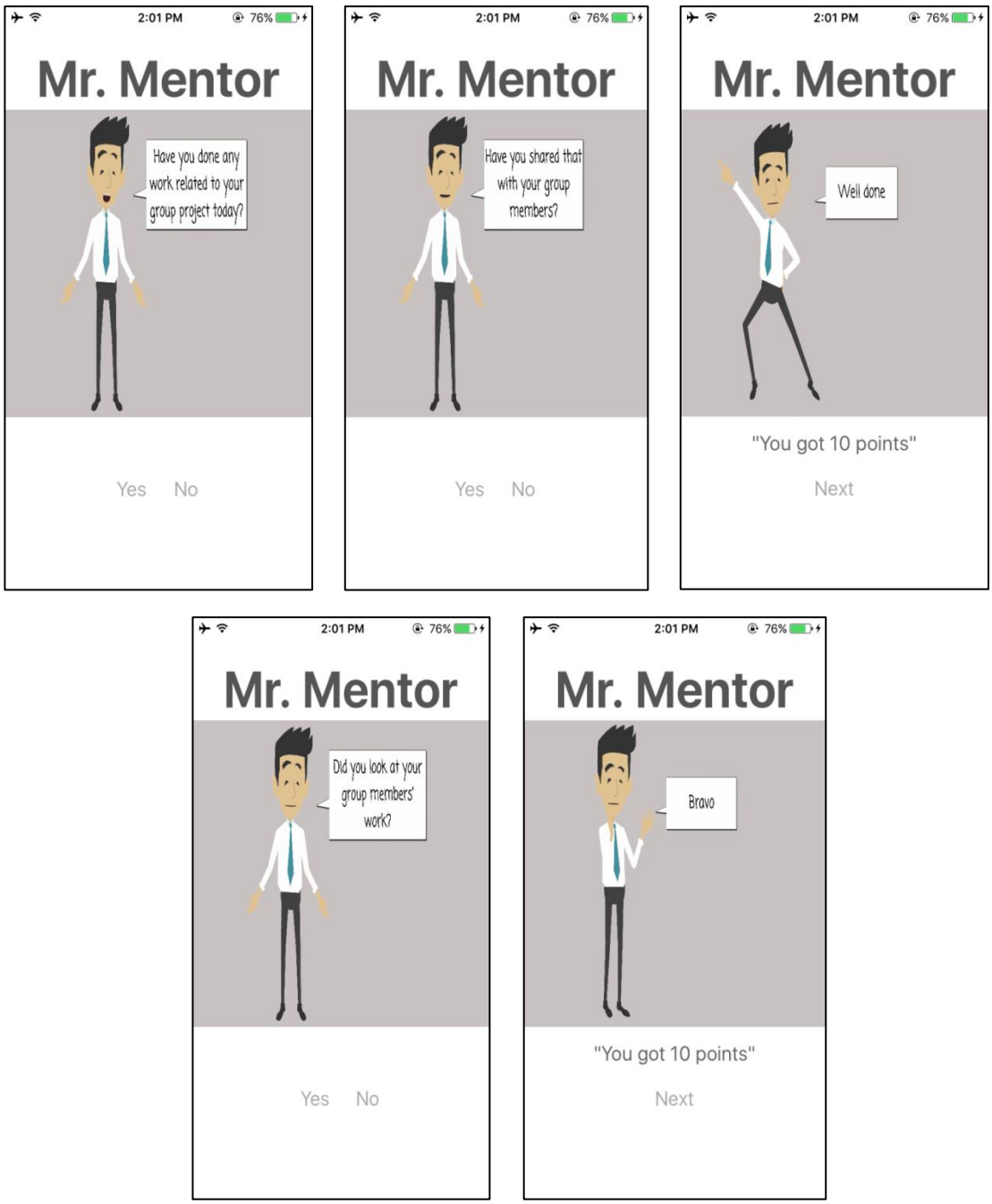


Figure 6.7: Screenshots for tunneling implementation

Personalisation was implemented by offering a personalised service, which was selecting a preferred time for notifications as shown in Figure 6.8.

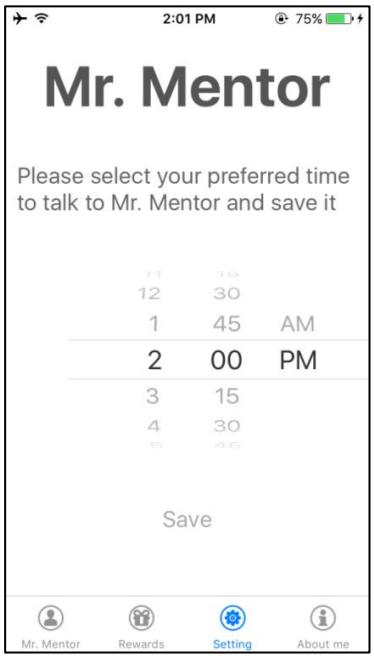


Figure 6.8: A screenshot for personalization implementation

Self-monitoring was implemented by providing a reward page, so that users could see their total earned points as demonstrated in Figure 6.9.

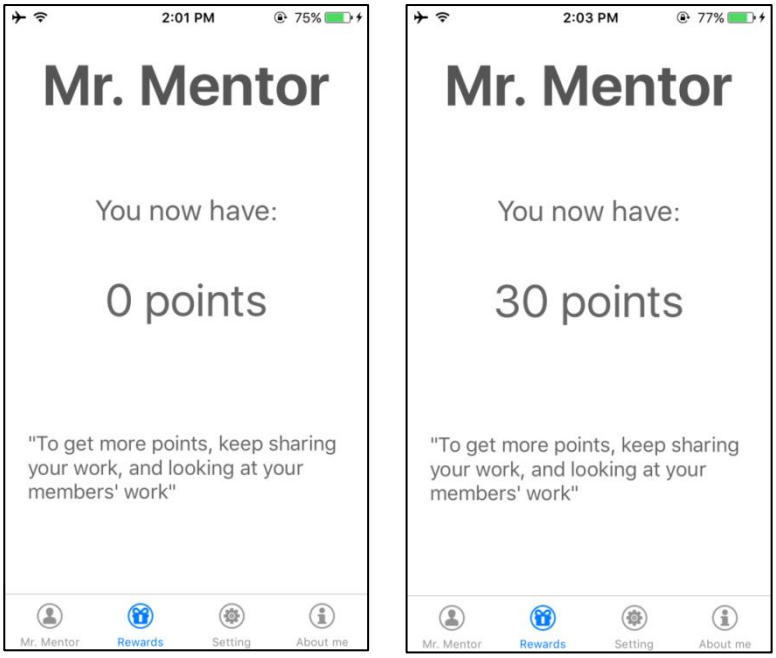


Figure 6.9: Screenshots for self-monitoring implementation

Praise was implemented by offering praise when users shared their work or looked at the group's work as illustrated in Figure 6.10.

Figure 6.10: A screenshot for praise implementation

Rewards was implemented by rewarding users with virtual points whenever they shared their work or looked at the group's work as shown in Figure 6.11.

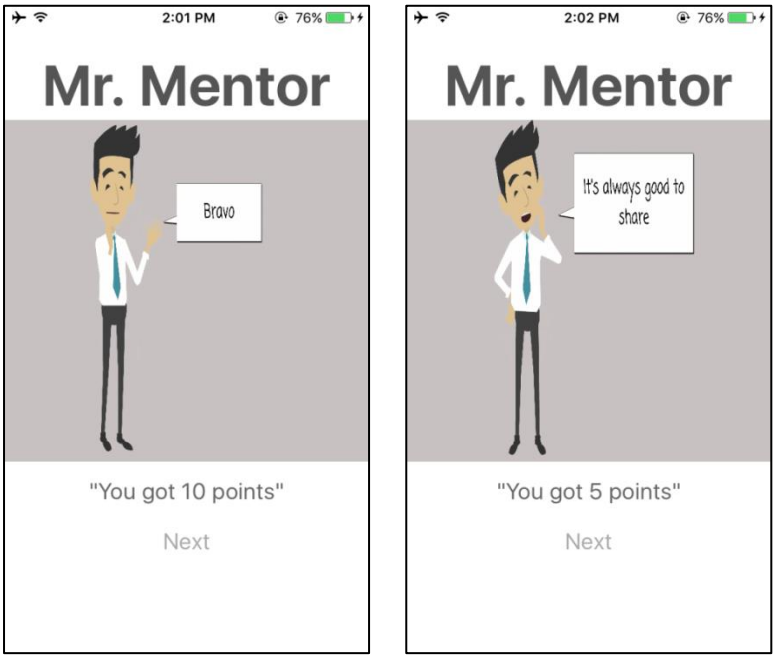


Figure 6.11: Screenshots for rewards implementation

Reminders was applied through reminding users to share their work and to look at the group's work as demonstrated in Figure 6.12.

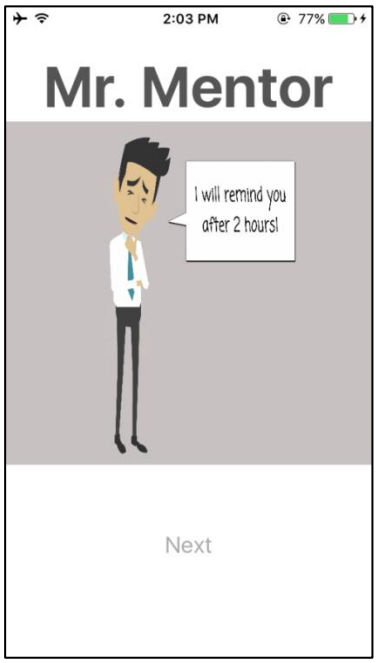


Figure 6.12: A screenshot for reminders implementation

Suggestion was applied through offering appropriate suggestions when users did not perform the target behaviours as illustrated in Figure 6.13.

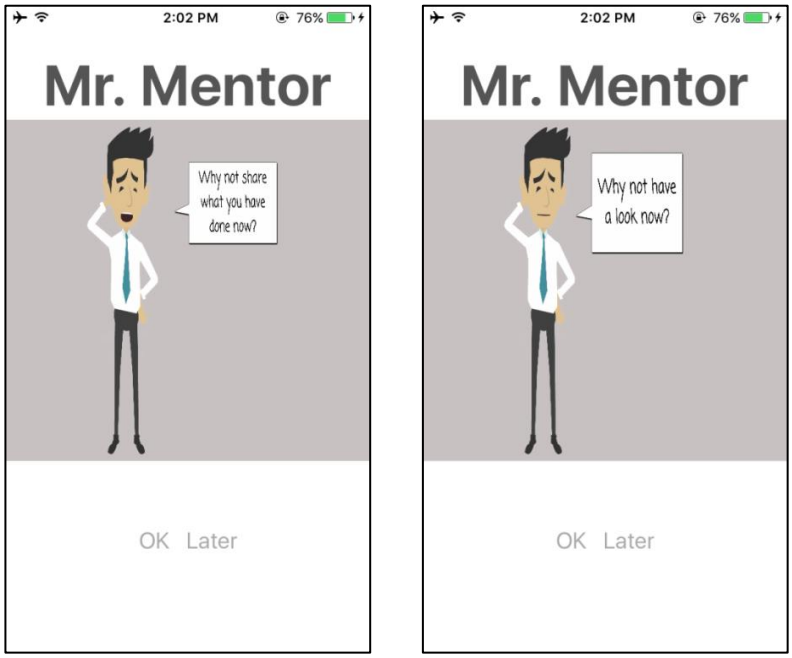


Figure 6.13: Screenshots describing suggestion

Liking was applied by making the app visually attractive as shown in Figure 6.14. Social role was implemented by adopting a social role for a mentor as illustrated in Figure 6.15.

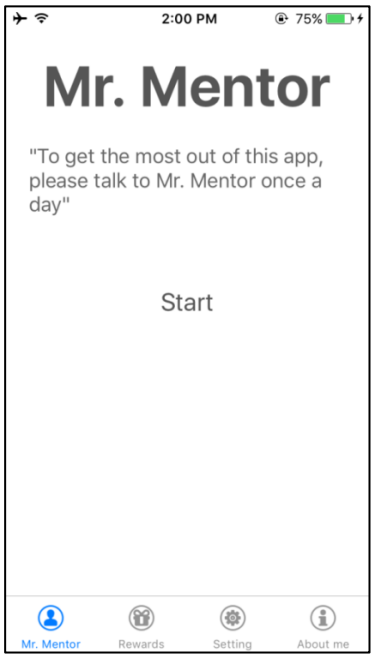


Figure 6.14: A screenshot for liking implementation

Figure 6.15: A screenshot for social role implementation

Trustworthiness was implemented through providing true and reliable information about the app and the study as demonstrated in Figure 6.16.

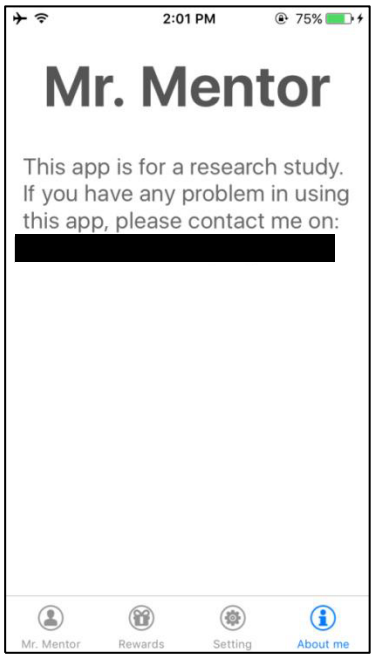


Figure 6.16: A screenshot for trustworthiness implementation

Surface credibility was applied by having no ads in the app while real-world feel was implemented by displaying the researcher's info as illustrated in Figure 6.17.

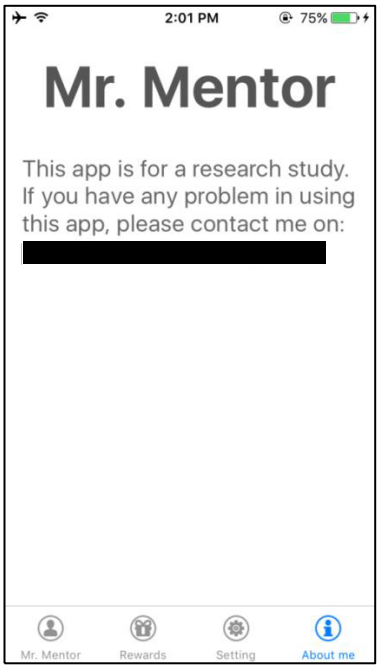


Figure 6.17: A screenshot for surface credibility implementation

Cooperation was partially implemented through showing means of cooperation by encouraging users to share their work and look at the work of their group (see Figure

6.13). Competition was partially implemented by displaying the total earned points to support competition between users (see Figure 6.9).

6.3.5.2 Implementation of the Social Cues

Regarding the social cues described in Table 6.11, seven cues were directly part of the applied persuasive techniques; these were personalisation, self-monitoring, praise, rewards, reminders, suggestion, and social role. The physical cues included Mr. Mentor's face, body, movement and facial expressions as illustrated in different Figures (see Figure 6.7). The spoken language was implemented, so whenever Mr. Mentor speaks, a speech balloon is created to include his speech.

6.3.6 How Does the Mr. Mentor App Work?

As described earlier, the target behaviours for Mr. Mentor were to encourage students to share their work with others in their collaborative learning group and, vice versa, to encourage students to look at the work done by others in the group. Therefore, Mr. Mentor asks two main things: whether the user shared his/her work and then whether he/she looked at the work of the group.

Mr. Mentor is a social agent runs continuously on the device (iPhone or desktop web browser). It interacts with users by asking them on a regular basis whether they have carried out behaviours that support activity awareness. For example, Mr. Mentor asks users if they have shared completed tasks with their group, praises them if they have done so, and also awards 10 virtual reward points (see Figure 6.18).

There are six different praise statements: well done, that's great, you are awesome, fantastic, bravo and cool; there are also different interactions with each praise including: clapping, jumping, and dancing. If the user has not shared their work, Mr. Mentor suggests that they should share what they have done now, and the user can then choose either 'Ok' or 'Later'. If the user chooses 'Ok', Mr. Mentor will be happy and award 5 points. On the other hand, if the user chooses 'Later', Mr. Mentor will be sad and suggest that he will remind the user again after 2 hours (see Figure 6.19). The user will be notified after 2 hours (see Figure 6.20). Similarly, Mr. Mentor asks users

whether they have looked at others' work, rewards them if they have done so and is sad if they have not done so.

Figure 6.18: An example of the praise that Mr. Mentor offers to the user saying: "You are awesome" (iPhone version)

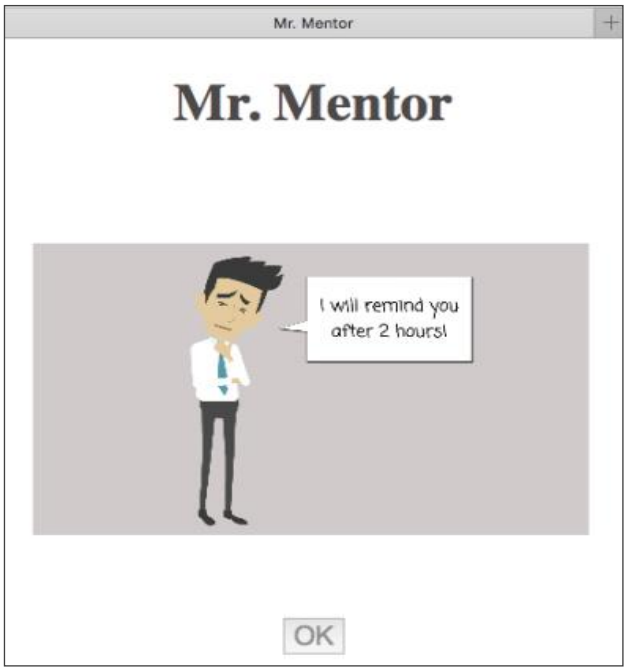


Figure 6.19: Mr. Mentor feels sad and suggests reminding the user after 2 hours (web version)

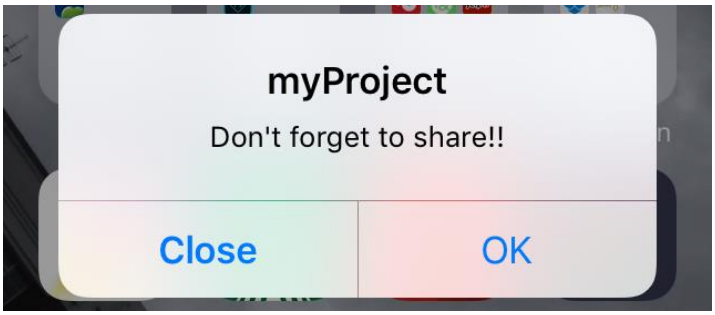
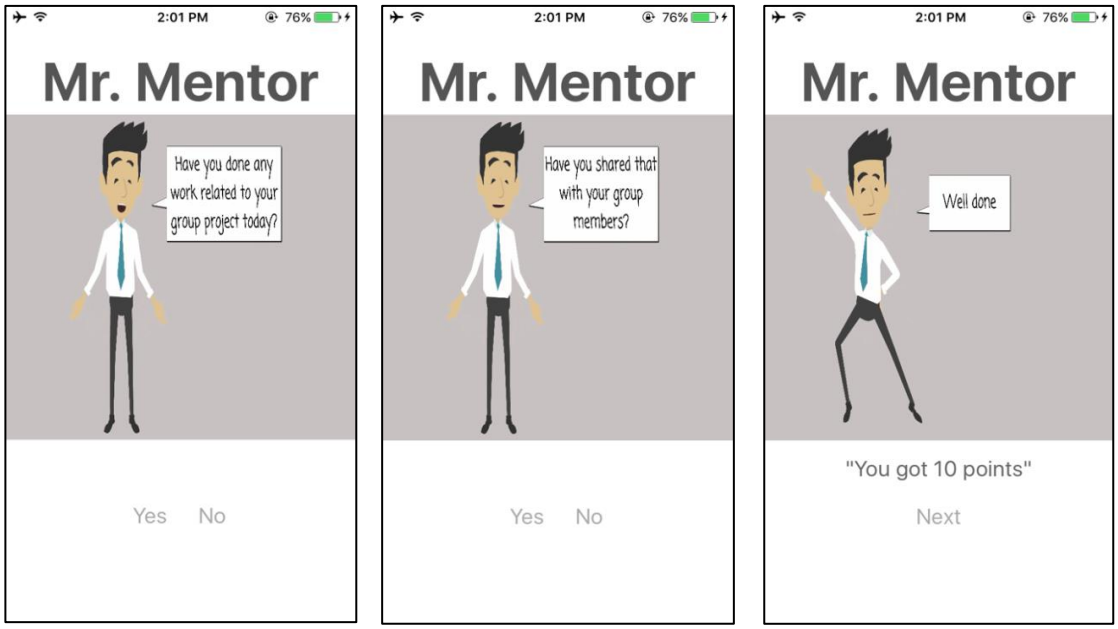


Figure 6.20: A screenshot for the notification after 2 hours (iPhone version)

Figure 6.21 describes an example of possible interaction with Mr. Mentor, first he asks if the user carried out any work related to the group project in the first screenshot (a) and if the user chooses "Yes", then the next screenshot (b) appears in which Mr. Mentor asks if the user have shared his work with the group, if the user chooses "Yes", then the last screenshot (c) appears with a praise and rewards for performing the target behaviour, which is sharing the work with the group.



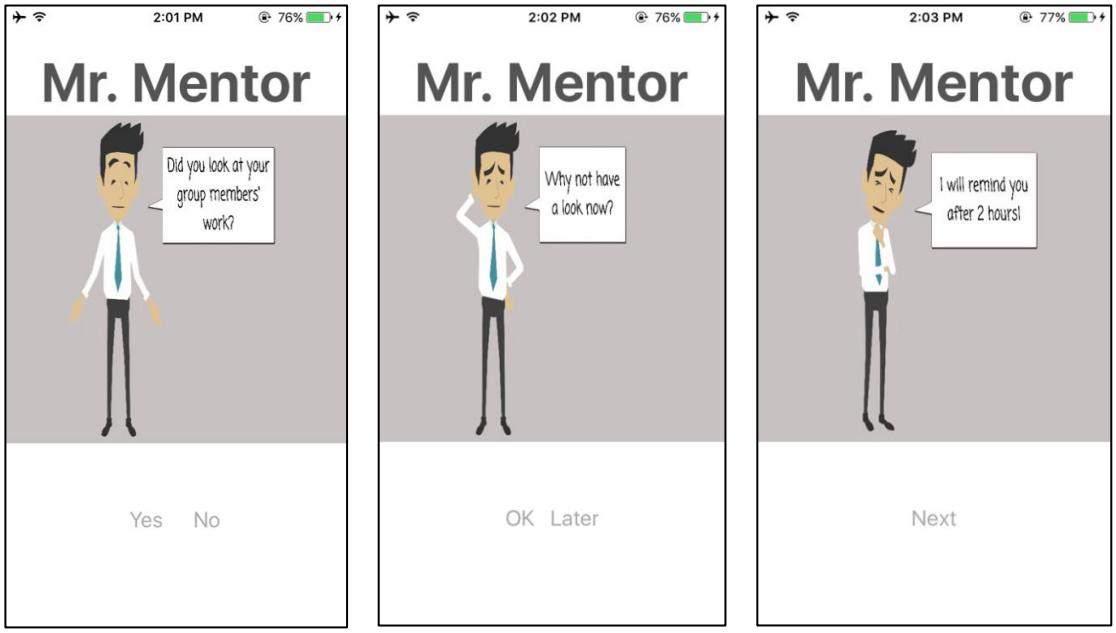
(a) Mr. Mentor asks the user if he/she carried out any work related to the group project

(b) if the user chooses yes, then Mr. Mentor asks if he shared that with the group

(c) if the user chooses yes, then Mr. Mentor praises and rewards him/her

Figure 6.21: An example of possible interaction with positive feedback (iPhone version)

In Figure 6.22, Mr. Mentor asks if the user has looked at his/her group members' work in the first screenshot (a) and if the user chooses "No", then screenshot (b) appears in which Mr. Mentor suggests to have a look now, and if the user chooses "Later", then the last screenshot (c) appears in which Mr. Mentor is sad and says he will remind him/her after 2 hours.



(a) Mr. Mentor asks the user if he/she looked at the group work

(b) if the user chooses no, then Mr. Mentor suggests to look now

(c) if the user chooses later, then Mr. Mentor is sad and says he will remind him/her after 2 hours

Figure 6.22: An example of possible interaction with suggestion and reminder (iPhone version)

All screenshots for the iPhone version can be found in Appendix D.3, and all screenshots for the web version are in Appendix D.4. Figure 6.11 illustrates the overall interactions with Mr. Mentor app (iPhone version) and how the app runs, also a larger version of this figure can be found in Appendix D.3.

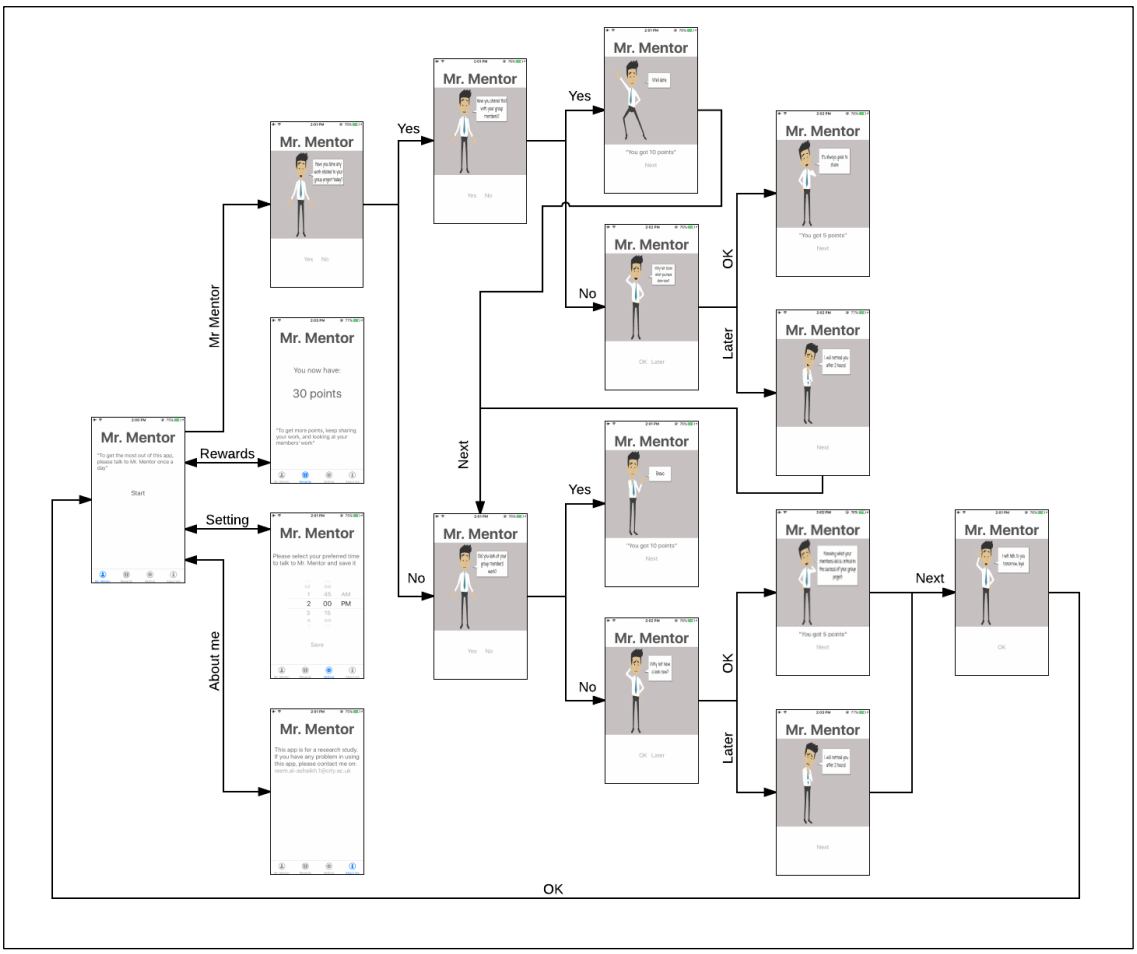


Figure 6.23: Screenshots of the interactions with Mr. Mentor app (iPhone version)

6.3.7 Key Design Decisions

There were different design options for the appearance of the social agent whether it should be cartoon-like vs human-like, or dynamic vs static. We did not take into account the gender of the social actor; it was chosen with no specific reason.

Parise et al. (1999) conducted a study with participants who played a social dilemma game with a human confederate through real-time videoconferencing or with one of three interface agents: a person-like interface agent, a dog-like interface agent, or a cartoon dog interface agent. Results showed that the human-like agent provoked greater cooperation, as they were playing with the human confederate. Dog owners also cooperated with dog-like interface agents. We chose the appearance of the social actor to be human-like in order to be more persuasive. When the social agent is more human-like, users make more social responses (Gong, 2008).

Tung and Deng (2007) conducted a study to explore the effect of employing emoticons as social cues in an e-learning environment for children. They used two versions of math problem-solving practice program; one provides feedback with dynamic emoticons and the other with static emoticons. Results show that children used the version with dynamic emoticon perceived a higher degree of social presence than those used the static emoticon version. They also found that the use of dynamic emoticons as social cues can increase children's motivation with learning. This suggests that incorporating dynamic social actor is more persuasive than the static one.

In social dynamics, when a user does not have the option to choose "no" in a dialogue box for registering in a website, for example, and only have "register now" or "maybe later", most people will choose "maybe later" option if they do not want to perform the task now, so by choosing this option, the user has made an implicit commitment to perform the task later, which is registration in this case, and in future the user become more compelled to perform that task if they asked again to do so (Fogg, 2003). This point was considered in designing the app when Mr. Mentor asked to share or look at group's work, there are two options either "OK" or "Later" to encourage users to perform these behaviours.

6.3.8 Testing

After implementing Mr. Mentor app, testing took place in order to ensure that the app ran efficiently. It was tested by two users and they were HCI researchers from the Centre for HCID at City, University of London. It was installed on their iPhones and they used it for two days to check that all of its features were working properly. Results showed that the Mr. Mentor app was working well apart from a minor problem in the rewards. The problem occurred when the collected points was reset after a while. This problem appeared because the app was installed locally on the iPhone device and not connected to the App Store, and due to time and resource limitations, this problem was not solved.

6.4 Summary

In summary, a number of persuasion theories were reviewed here along with relevant work on the design of persuasive technologies. The design process for the social actor app, Mr. Mentor, was described including the process of choosing target behaviours, applying the PSD model, identifying the social cues, presenting a paper prototype for the social actor app, implementation, and testing. Different design decisions were discussed as well. The next chapter reports an empirical study that was conducted with students to test and evaluate the persuasiveness of this social actor app.

Chapter 7: A Persuasive Social Actor for Activity Awareness in Learning Groups

This chapter reports an empirical study undertaken to test and evaluate the social actor app described in the previous chapter (Chapter 6). It starts with the motivation for conducting the study, along with the aim and research questions. Then, it describes the study design, and presents the results and discussion. Finally, it highlights the limitations of this study.

7.1 Motivation

One factor that has been reported as influencing the success of collaborative groups more generally is the awareness that members have of each others' activities - so-called activity awareness (Gutwin et al., 2004). However, the studies reported in Chapters 4 and 5, in which collaborative learning groups were working on long-term projects, showed that activity awareness varied over time. While some attempts have been made to develop software systems to enhance activity awareness in collaborative learning groups (e.g. (Ganoe et al., 2003; Carroll et al., 2003)) these typically do so by capturing and sharing details of the activity. An alternative approach is proposed here to accomplish the same outcome – enhancing activity awareness – by using persuasive technology to change the attitudes and behaviours of the learners.

7.2 Research Aim and Research Questions

The effectiveness of the social actor app was investigated in an empirical study. The aim of the study was to investigate the effect of using the social actor on collaborative learning groups working on learning projects over an extended period of time. This aim was achieved by evaluating Mr. Mentor in an authentic learning situation, a postgraduate course module, rather than by running a more controlled, but ultimately artificial, study. Approval for the study was obtained from the departmental ethics committee. This study contributed in answering four main research questions *RQ2*, *RQ3*, *RQ4*, and *RQ5*, which are:

RQ2: How can activity awareness be measured in long-term collaborative learning groups?

RQ3: What activity awareness do group members have in long-term collaborative learning groups?

RQ4: How can a persuasive social actor for activity awareness in long-term collaborative learning groups be designed and evaluated?

> ***RQ4.2:*** How can the success of the persuasive social actor be evaluated from the users' point of view?
>
> ***RQ4.3:*** How can the success of the persuasive social actor be evaluated from expert reviews?

RQ5: Can a persuasive technology support students' activity awareness in long-term collaborative learning projects?

7.3 Method and Study Design

Ethics considerations dictated that students participating in the study were not advantaged or disadvantaged relative to each other. This imposed the constraint that it was not possible to run a comparative study in which some participants could use the app while others could not to compare changes in activity awareness. Participation was voluntary.

The study was run during a postgraduate module on Interaction Design delivered as part of a Masters programme in HCI. All students taking the module were invited to participate. A repeated-measures design was employed: all participants were provided with the social actor app and comparisons were made between participants' attitudes towards collaboration and activity awareness and behaviours that support activity awareness at baseline and after using the app. Self-reported measures were taken to measure perceived persuasiveness and behavior change. Moreover, the social actor app was evaluated by users and experts using two different methods based on the PSD model.

7.3.1 Participants

Participants were a convenience sample of Masters students who were working on a compulsory collaborative coursework project for the Interaction Design module over a period of 6 weeks. Twenty-one of the 30 students taking the module were recruited to the study. None of the students had been involved in the design of the app described in Chapter 6 and they were not aware that it was intended to influence their activity awareness.

The coursework project involved the design of an interactive system as part of an introductory module on interaction design i.e. real learning project. Interaction Design coursework is a group project. The coursework is a design project and similar to the group project reported in study 2 and study 3 (Chapters 4 and 5) and there are 2 deliverables; the main deliverable is a group report of the design process and includes: data gathering, requirements, conceptual and detailed design, and evaluation. Moreover, all group members normally receive the same mark for this part of the assignment. The second deliverable is an individual reflection from each member on his/her experience in the project. The group project is worth 40% of the total grade for the module. Students worked in assigned groups of 3 members. However, not all the members of a given group participated in the study: Table 7.1 shows how many students participated from each group. Twelve participants were female and 9 were male, most of them were in the 18-29 age group, with different backgrounds and experiences. Of the 21 participants, 9 used the iPhone version of the app and 12 used the web version. Participants who possessed iPhones used the iPhone app; otherwise they used the web version. The app was either installed on the participants' iPhones at the outset of the project, or they were provided with a link to the web version.

Table 7.1: Number of participants from each group

Group	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Number of participants	*2*	*2*	*1*	*2*	*3*	*3*	*2*	*2*	*2*	*2*

Students decided the way they worked together, how to allocate tasks, when to meet, and which tools to use. They had the full powers for their working approach with no constraint from the module leader.

Participants were invited to participate in the study in their class and via Moodle. Students, who chose to participate, were asked to sign the consent form first. Then, they were asked to fill in the first questionnaire, then the app was installed into their iPhones or a link to the web app was sent to them via email. They were asked to use the app until the end of their project. At the end of the project, they were asked to fill in the second questionnaire. Also, during their project, each participant was interviewed twice in two different intervals. Details about data collection are in the next section.

7.3.2 Data Collection

Two data collection methods were used: questionnaires and interviews. Information about each of them is presented in this section.

7.3.2.1 Questionnaires

Questionnaires were used to collect factual data about demographics and to measure users' attitudes towards collaboration and activity awareness and behaviours that support activity awareness, their perception of whether Mr. Mentor had changed their behaviours at the end of the project and their views on the features of Mr. Mentor that arose from implementing the PSD techniques. Two questionnaires were given to each participant. One was given at the beginning of the study and the other one was given at the end of the project time.

First Questionnaire: The first was administered at the beginning of the project before using the app to collect factual data about demographics (e.g. age group, gender) and pre-test (baseline) data about students' attitudes collaboration and activity awareness and behaviours support activity awareness. Participants were asked to rate 12 statements using 7-point Likert scales; 8 statements for attitudes and 4 statements for behaviours. The questionnaire is in Appendix E.1.

Second Questionnaire: The second questionnaire was administered at the end of the project, after the students had submitted their work, to collect post-test data about students' attitudes and behaviours towards collaboration and activity awareness after using the app, using the same 12 statements with 7-point Likert scales. The second questionnaire additionally collected data about students' opinions of the "Mr. Mentor" app, using both open and closed questions. It examined to what extent participants perceived that the social actor had changed the target behaviours, using two 7-point Likert scales. The second questionnaire also contained statements regarding features introduced as a result of applying the persuasive techniques of the PSD model, and participants were asked to rate these statements using 7-point Likert scales. This data was used to examine whether the PSD techniques had been successfully implemented. Finally, the second questionnaire collected data about TAM as well to see weather students have perceived usefulness and ease of using the social actor app. This questionnaire can be found in Appendix E.2.

7.3.2.2 Interviews

Interviews were used to examine activity awareness. Two interviews were conducted with each participant, one in the fourth week and one in the last week of the coursework project. The interview questions were structured and mostly designed to probe awareness, collaboration, and the tools that students used to communicate and share information. Participants were not asked directly about awareness; they were asked what they had done on the project since last week and what each other member of their group had done to explore activity awareness. Interview questions can be found in Appendix E.3.

7.3.3 Data Analysis

This study employed a mixed qualitative and quantitative data. Qualitative data sources included transcripts of interviews with students and open-ended questions from the questionnaires. Quantitative data included students' responses to Likert-scale questionnaires.

7.3.3.1 Questionnaire Analysis

For the demographic questionnaire, answers were analysed for each learning group by counting frequencies of each answer. One-tailed Wilcoxon signed rank tests were used to test for differences between participants' responses in the pre-test and post-test questions about attitudes and behaviours that related to activity awareness. The Wilcoxon signed rank test is a non-parametric statistical test and can be used on repeated measures from the same sample. The one-tailed test was applied because it was hypothesised that changes might occur in one direction, i.e. the ratings for attitudes and behaviours would increase after using the social actor app.

For other ratings questions, answers were analysed and averages were calculated for all users in general and also for iPhone users and web users separately.

7.3.3.2 Interview Analysis

Interviews were audio-recorded and notes were taken. Two main questions were transcribed about participants' activity and their colleagues' activities, following the same method for measuring activity awareness described in Chapter 4 and 5 (section 4.4.5 and 5.4.3). The rest of questions were collected to distract students' attention that data were collected about their activities.

7.3.4 Expert Reviews

The PSD model can be used for designing and evaluating persuasive technologies (Oinas-kukkonen & Harjumaa, 2009). Expert reviews were conducted for evaluating the persuasive social actor using the PSD model.

Some researchers have conducted expert reviews based on the PSD model (Lehto & Oinas-kukkonen, 2009; Lehto & Oinas-kukkonen, 2010; Räisänen et al., 2010; Langrial et al., 2012). They suggested that at least two experts should be involved in the expert reviews process. They followed the PSD model, starting by analysing the persuasion context for the technology at hand, then rating to which extent each persuasive technique in the PSD model is supported usually from 0 to 3.

In this research, reviewers were asked to rate the existence of the applied persuasive techniques only, they were not asked to analyse the persuasion context because the aim of this evaluation was to find out whether the applied persuasive techniques were

successfully implemented or not, also because in these expert reviews (Lehto & Oinas-kukkonen, 2009; Lehto & Oinas-kukkonen, 2010; Räisänen et al., 2010; Langrial et al., 2012), they analysed the persuasion context to understand what this technology intended to do, whereas in this PhD research the researcher already analysed the persuasion context before developing the app and informed the reviewers about the persuasion context.

Two experts were involved in this process. Each reviewer was given an instruction sheet which describes what she should do exactly along with an evaluation sheet for each app version (see Appendix E.4). Each reviewer was asked to use the app and rate whether any given persuasive technique was supported in the app and if so how strongly it was supported, and then she had to fill in the evaluation sheet with her ratings and provide justification or comment for each rating. Ratings were from 0 to 3, where 0 is no support; 1 is low support; 2 is medium support; and 3 is high support. Reviewers were asked to rate only the implemented persuasive techniques in each version. Results of the expert reviews are presented later (in section 7.4.7).

7.4 Results

In this section, the results of measuring changes in attitudes and behaviours are described. Then, the result of perceived persuasiveness of the social actor, Mr. Mentor, is presented. After that, the result of measuring activity awareness is presented along with the result of the reliability check for the application of the method for measuring activity awareness. Next, users' opinions towards the social actor app are presented. Finally, user evaluation of the PSD persuasive techniques is described.

7.4.1 Measuring Changes in Attitudes and Behaviours

Measuring the behaviour change is the fourth step in the BCSS framework (Oinas-Kukkonen, 2010). This study suggested a method to identify changes in attitudes and behaviours. It was hard to depend on one measurement; therefore, it was proposed to use three measurements:

- Pre-tests and post-tests to identify changes in attitudes and behaviours
- Perceived persuasiveness using two statements 7-point Likert scale
- Perceived behaviour change using an open-ended question

Pre-tests and post-tests involve rating statements for attitudes and behaviours. Some statements were based on the statements suggested by Convertino et al. (2004) and some of them were created by the researcher. Perceived persuasiveness involves rating two statements of 7-point Likert scale, one statement for each target behaviour. Perceived behaviour change involves an open-ended question about whether students think that the social actor, Mr. Mentor, changed their awareness of their group's activities.

7.4.1.1 Changes in Attitudes

Petty and Cacioppo (1986) define attitudes as "general evaluations people hold in regard to themselves, other people, objects, and issues". Table 7.2 shows the 8 attitude statements with averages from the pre-tests and post-tests along with p-values

for the Wilcoxon signed rank test. The statements are ordered based on the p-values, and negative statements were reversed. The first two statements, SA1 and SA2, show significant differences in the pre- and post- test measures. After using the app during the coursework project, participants were more likely to say what they were planning to do in their group project even if no one asked them (SA1), with a p-value of 0.003 (<0.01). Also, the extent to which participants agreed that knowing what each member of a group is doing is essential in any group project changed after using the app (SA2) with a p-value of 0.011 (<0.05). Pre-test and post-test averages for all attitude statements are presented in Figure 7.1, showing that post-test averages were higher than pre-test averages across all statements.

Table 7.2: Attitude statements with averages in pre- and post-test questions and their corresponding p-values for Wilcoxon signed rank test

Statement	Pre. Avg.	Post. Avg.	p-value
SA1: I like to say what I'm planning to do in a group project even if no one asks me.	5.24	6.3	0.003**
SA2: I believe that knowing what each member is doing is essential in any group project.	6.38	6.76	0.011*
SA3: I think looking at other members' work enhances collaboration in a group project.	6.1	6.33	0.095
SA4: I believe that students should update their group members whenever they have completed a task.	5.48	5.95	0.102
SA5: I believe that each member should look at the work completed by his/her group members.	5.9	6.33	0.138
SA6: In a group project, only the final product matters. (Reversed)	5.1	5.33	0.271
SA7: I think that each member should know about others' progress in his/her group.	5.95	6.05	0.282
SA8: In any group project, each member is responsible for a specific task and doesn't need to know about the others. (Reversed)	6	6.05	0.466

** Significant at p<0.05; ** significant at p<0.01*

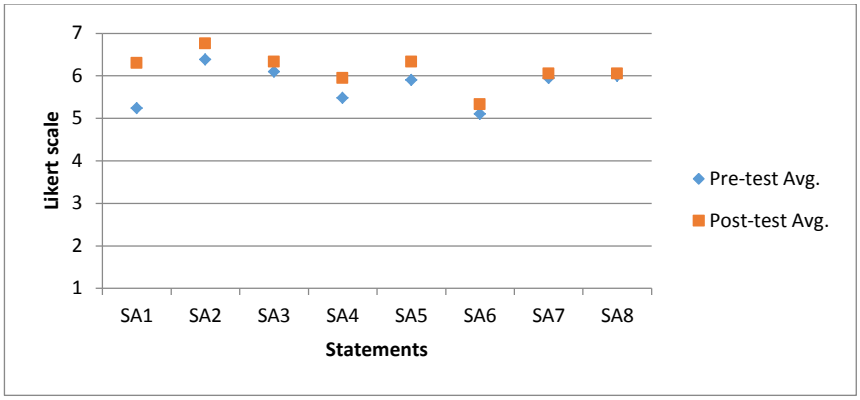


Figure 7.1: Pre-test and post-test averages for attitudes' statements

7.4.1.2 Changes in Behaviours

Table 7.3 presents the 4 behaviour statements with the pre-test and post-test averages and their p-values for Wilcoxon signed rank test. Participants were asked to rate the statements based on their previous experience of working in collaborative groups for the pre-test, and their experience of working in this collaborative group for the post-test. Results show that participants could tell what the current state of their project was at any given time more often after they used the app (SB1), where the p-value is 0.015 (<0.05). Also, they were more likely to inform group members about their progress (SB2), where the p-value is 0.042 (<0.05). Pre- and post-test averages for all behaviour statements are presented in Figure 7.2. This shows that behaviour changes are moving in the predicted direction, i.e. averages of users' responses increased, but the changes are limited as only a subset of statements were significantly different in the pre- and post-tests. All answers for pre- and post-tests can be found in Appendix E.5.

Table 7.3: Behaviour statements with averages in pre- and post-test questions and their corresponding p-values for Wilcoxon signed rank test

Statement	Pre. Avg.	Post. Avg.	p-value
SB1: In any group project, I could tell what the current state of the project was at any given time.	4.38	5.38	0.015*
SB2: In any group project, usually I tell my group members about my progress.	5.67	6.19	0.042*
SB3: In previous group project, usually I know what my group members are going to work on.	5.33	5.48	0.233
SB4: Based on my experience, it has been difficult to find out what my group members had worked on. (Reversed)	4.81	4.81	0.474

** Significant at $p<0.05$*

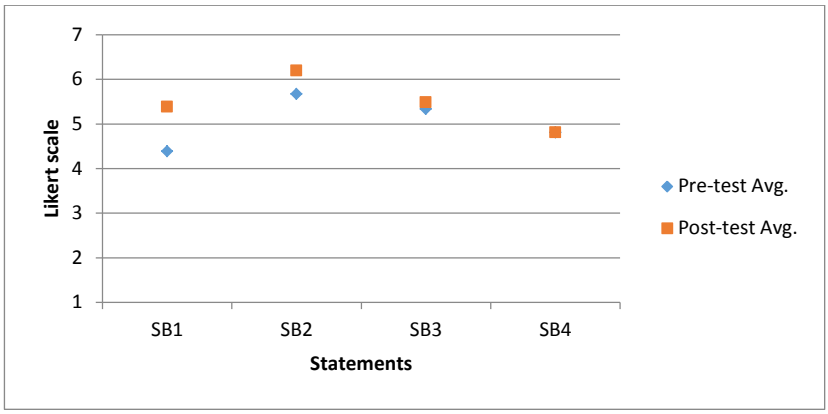


Figure 7.2: Pre-test and post-test averages for behaviours' statements

7.4.1.3 Perceived Persuasiveness

Two statements in the post-test questionnaire focused specifically on whether participants perceived that their behaviour had changed after they used Mr. Mentor. Table 7.4 presents these statements, A and B, and the averages across responses. Participants on average agreed that Mr. Mentor encouraged them to share their work with their groups, and also persuaded them to look at the work done by other members of their groups, with an average of 4.86 on the 7-point Likert scale for both target behaviours for all users. It was also noticed that iPhone users gave higher ratings for these statements than the web users.

Table 7.4: Statements A and B and their averages

Statement	Average		
	All users	iPhone users	Web users
A: Mr. Mentor encouraged me to share my work with the group.	4.86	5	4.75
B: Mr. Mentor persuaded me to look at the work done by my group.	4.86	5.22	4.58

It shows that participants slightly agreed that Mr. Mentor persuaded them to share their work with the group and to look at the work done by their group. In more detail, Figure 7.3 illustrates individual participants' responses for statements A and B.

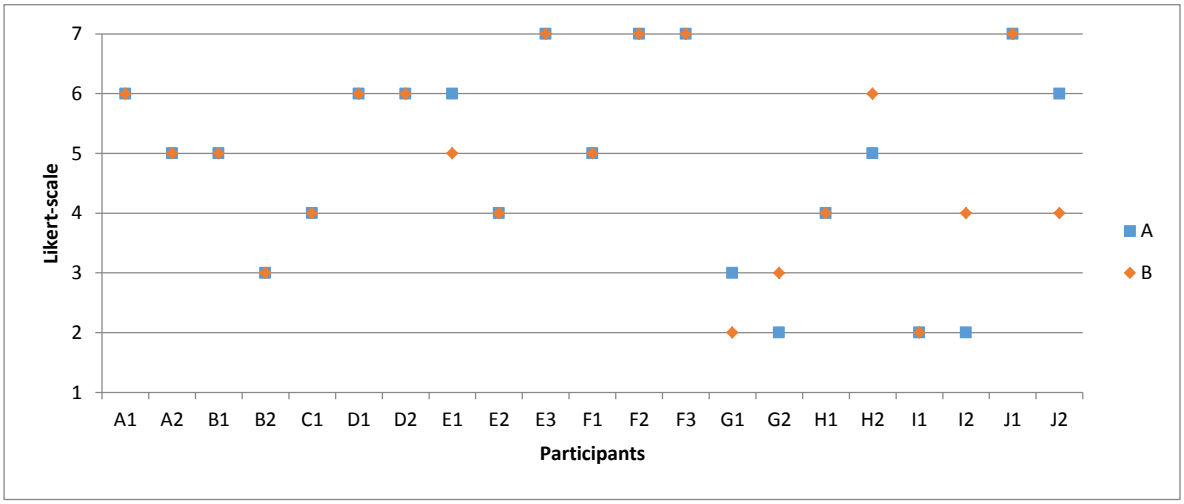


Figure 7.3: Participants' responses to statement A and B (1 = strongly disagree, 7 = strongly agree)

7.4.1.4 Perceived Behaviour Change

In one of the open-ended questions on the second questionnaire, participants were asked: "Did Mr. Mentor change your awareness of your group's activities?". In answer to this question, 10 participants confirmed some degree of change in their awareness of the group's work. For instances, participant E1 answered: "*Yes it did. It did raise some questions, which made me think about my group and our work*", F1 answered: "*It made me more likely to check with the others*", and J2 answered: "*Yes, it made me aware of what other people did for the coursework*". All answers can be

found in Appendix E.8 (Q4). This suggests that social actors can motivate students to increase their activity awareness.

7.4.2 Activity Awareness Analysis

An objective evaluation of activity awareness was obtained based on the participants' answers in the first and second interviews about what they and their colleagues in the group had done during the previous week of the project. The "accuracy" of participants' activity awareness was explored by comparing their answers to interview questions about the activity of their colleagues against the reality of what those colleagues had been doing. Therefore, comparisons were made between what each individual reported they had done and what the other members of their group reported they had done in the first and second interviews.

This is a novel approach to evaluate activity awareness. It has subjectivity in determining the level of awareness and therefore potential bias, however, inter-coder reliability checks were applied to mitigate this concern. In this research, low level of abstraction of the information that constructs awareness was considered in evaluating the level of awareness, i.e. if a participant reported all tasks that his/her colleagues performed without details then this participant is considered as fully aware. For example, if a participant stated that he conducted three interviews one with a single mother, and two with elder people; and his colleague reported that he conducted interviews, then his colleague is considered as fully aware of his activity since he knew what task he was working on.

All comparisons grids are in Appendix E.6. Tables 7.5 and 7.6 present the comparison grids for group A in the first and second interviews as an example.

Table 7.5: Activity awareness comparison grid of the first interview for group A

(Grey: What participant did, Green: Fully aware, Blue: Partially aware, Red: Unaware)

Participant	What he/she reported about	
	A1	**A2**
A1	I've build a persona, I've done a research on the geographic, the area of the county we are working with, we've done of mentored the group about the work I've done in the same field -Like literature review? Just past work I've done a literature review and kind of yeah	She's looked at user journeys, and got other examples on user journeys, it's all in a field that all mixed up together because our collaboration tool separate peoples' work, from what I remember from Facebook, done the user journey research, she's done some reading up as well, but physical output I think she, we don't get anything
A2	He does everything He does the persona, he send it to us, he is very practical and creative, He did the persona, - How many personas? he did one persona, and then the second persona we did it all of us Usually we create everything together	I did some research for the personas, and now, the last 3 days I'm doing the research for the user journeys and how we can/what layout we have to choose, if we have to make 1 or 3 user journeys because we have 2 personas, and we want a general user journey that we observed inside the customer service and how are we including the happy points, sad points, confusion points, how can we saw the emotional thing/perspective of the user in the user journey - You did interviews or observation? When we went to the centre, we all did observation, and then for interviews we split into 3, I was inside the centre grapping the customers "hello, we are doing this" and explain what we are doing, recruiter, then I was taking the customers and A1 was waiting with a recorder and asking the questions, and L was taking the notes
Summary	A2 is partially aware of A1 activity	A1 is partially aware of A2 activity
	1 PA	1 PA

Table 7.6: Activity awareness comparison grid of the second interview for group A

(Grey: What participant did, Green: Fully aware, Blue: Partially aware, Red: Unaware)

Participant	What he/she reported about	
	A1	**A2**
A1	I've done the design section of the report, I've done the wireframes in order to build a prototype so we can evaluate it, yes so this 2 pages of the report of the design section, the second section within the report, and the wireframes using balsamiq, and obviously taking part in the brainstorming and finding out and research reading a lot within the group, so individually we were rarely work individually	She's done the user journey, and conceptual design sketches, so most of the creative stuff because she has a really good idea
A2	A1 is doing the implementation of the system, the prototyping (balsamiq)	User journeys, storyboards, and a little bit of my individual reflection I start it, and references, I found some references for the report
Summary	A2 is partially aware of A1 activity	A1 is fully aware of A2 activity
	1 PA	1 FA

The comparisons were made in a rigorous way, using pairwise comparisons. Participants were ranked as fully aware if they reported what a colleague did correctly/exactly. Participants were ranked as partially aware if they reported some of what a colleague did. Participants were ranked as unaware if they did not know what their colleagues did.

Participant C1 was excluded from the activity awareness analysis because he was the only person in his group who participated in this study and therefore it was not possible to make any comparison.

Table 7.7 presents the number of instances of evaluating the activity awareness for each group: a total of 30 pairwise comparisons were made. For example, 2 participants were from group A, and the activity awareness for A1 was examined by his awareness of A2's activity (1 instance); and the activity awareness of A2 was examined by her awareness of A1's activity (1 instance). The total number of instances for group A is two. Whereas for group E, in which all members participated in the study, the activity awareness of E1 was examined by his awareness of E2's activity and E3's activity (2 instances) and the same for the rest of the group members, giving 6 instances. So groups with 2 participants resulted in 2 activity awareness instances; and groups with 3 participants had 6 activity awareness instances. However, for groups B and G, the third member of these groups was interviewed twice but did not use the app and their activity awareness of their colleagues was excluded. For example, for group B, the activity awareness of B1 was examined by her awareness of B2's activity and B3's activity (2 instances), and the activity awareness of B2 was examined by her awareness of B1's activity and B3's activity (2 instances), with a total of 4 instances of examinations. B3 and G3 are not included in Table 7.1. Tables 7.8 to 7.16 illustrate activity awareness in each group and Table 7.17 presents the activity awareness for all groups.

Table 7.7: Number of activity awareness instances

Group	***A***	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***
Number of instances	***2***	***4***	***0***	***2***	***6***	***6***	***4***	***2***	***2***	***2***

Table 7.8: Activity awareness level in the first and second interviews for group A

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	0	2	0
In the second interview	1	1	0

Table 7.9: Activity awareness level in the first and second interviews for group B

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	2	1	1
In the second interview	2	2	0

Table 7.10: Activity awareness level in the first and second interviews for group D

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	2	0	0
In the second interview	1	1	0

Table 7.11: Activity awareness level in the first and second interviews for group E

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	2	4	0
In the second interview	2	4	0

Table 7.12: Activity awareness level in the first and second interviews for group F

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	2	4	0
In the second interview	6	0	0

Table 7.13: Activity awareness level in the first and second interviews for group G

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	1	3	0
In the second interview	3	1	0

Table 7.14: Activity awareness level in the first and second interviews for group H

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	2	0	0
In the second interview	2	0	0

Table 7.15: Activity awareness level in the first and second interviews for group I

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	1	1	0
In the second interview	1	1	0

Table 7.16: Activity awareness level in the first and second interviews for group J

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	1	1	0
In the second interview	2	0	0

Table 7.17: Activity awareness level in the first and second interviews for all groups

Activity awareness level	Fully aware	Partially aware	Unaware
In the first interview	13	16	1
In the second interview	20	10	0

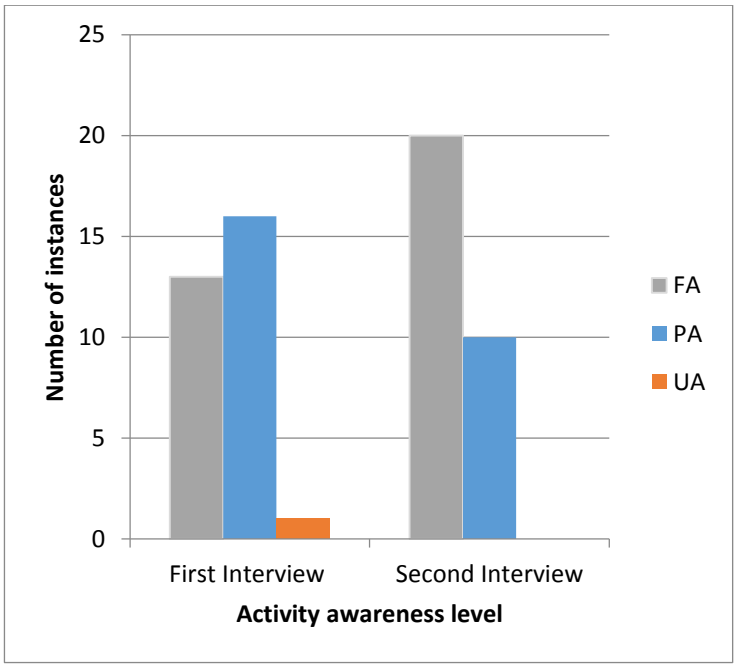


Figure 7.4: Activity awareness level for all participants

Figure 7.4 shows the breakdown of the 30 activity awareness instances for the first and second interviews. At the time of the first interview, just after halfway through the project, approximately less than half of the activity awareness instances were "fully aware" (13 out of 30), half were "partially aware" (16 out of 30), and one was “unaware”. Activity awareness was higher in the second interview, which was conducted in the last week of the coursework. The number of "fully aware" instances increased (20 out of 30), whereas the number of "partially aware" or "unaware"

instances decreased. In contrast with the study reported in chapter 4, activity awareness was not just maintained but actually increased in the later stages of the coursework projects. This suggests that using a persuasive social actor during collaborative group projects may be effective in promoting activity awareness within groups, although clearly other factors may also have influenced the outcome, such as individual differences in the students.

Moreover, for each participant, a comparison was made between his/her activity awareness in the first and second interviews, in order to identify changes in their activity awareness. Table 7.18 presents the results of this comparison for each participant. It shows that the activity awareness of 9 participants increased, the activity awareness of 8 participants did not change and the activity awareness of 3 participants decreased.

Table 7.18: Changes in activity awareness of each participant

Participant	Change in activity awareness
A1	Increased
A2	No change
B1	Decreased
B2	Increased
D1	Decreased
D2	No change
E1	Increased
E2	Decreased
E3	Increased
F1	Increased
F2	Increased
F3	Increased
G1	Increased
G2	No change
H1	No change
H2	No change
I1	No change
I2	No change
J1	Increased
J2	No change

7.4.3 Reliability Check

A reliability check was conducted with another researcher to ensure that the method of studying activity awareness was reliable and consistent. The second researcher was given an information sheet describing the method for evaluating activity awareness along with all comparisons grids for all groups for both interviews; the interview time was hidden for all interviews to ensure that interview time will not affect the researcher's decision. The information sheet and the comparisons grids can be found in Appendix E.7.

We, the researcher and the checker, reached an agreement of 80% from the first time; however, we discussed the disagreed cases to find out why. After discussion, the second researcher stated that he was not sure about some terminologies, and the main researcher revised 2 instances and changed them based on the discussion.

7.4.4 Users' Opinions towards the App

Participants were asked to rate some statements towards their opinions of using Mr. Mentor app on 7-point Likert scale. Table 7.20 shows the statements with averages for all users and averages for iPhone and web users.

Table 7.19: Participants opinions towards Mr. Mentor app

Statements	All	iPhone	web
Sometimes, I didn't complete the interaction with Mr. Mentor.	5.24	5.78	4.83
I felt bored using Mr. Mentor by the end of the project.	4.8	4.63	4.92
I did not like the sound of Mr. Mentor.	3.81	3.33	4.17
I interacted with Mr. Mentor as a real human.	3.05	3.89	2.42
I enjoyed using this app.	4.15	4.88	3.67
I understand the goal of this app.	5.24	5.56	5
I am satisfied with using this app to remind me to share my work and look at my group work.	4.43	4.89	4.08
I answered Mr. Mentor's questions honestly.	6.52	6.22	6.75
I used the app frequently.	4.38	4.78	4.08

Overall averages were calculated for students' opinions towards the app at the end of the study. It was found that participants sometimes they did not complete the interaction with Mr. Mentor. Some participants felt bored when using the app by the end of the project. Regarding Mr. Mentor sound, they found it fine. They did not think

that they interacted with Mr. Mentor as a real human. IPhone users enjoyed using the app more than the web users. Participants agreed that they understand the goal of the app. IPhone users were slightly satisfied with using this app to remind them to share their work and to look at the group work, while web users were almost had a neutral opinion. Participants reported that they mostly answered Mr. Mentor's questions honestly. IPhone users were used the app more frequently than the web users.

7.4.5 Open-ended Questions Results

Regarding open-ended questions, some participants found the app was annoying to some extent, for examples, when Mr. Mentor asked them the same questions, interrupted them in the middle of working on something else, or if they did not do any work related to the project. Table 7.21 shows participants who found the app was annoying and which app version they have used.

Table 7.20: Participants who found the app was annoying and the used app version

Participant	iPhone/web
A1	iPhone
B1	Web
B2	Web
G2	Web
J1	iPhone
J2	Web

Some students suggested that the app should have more customisation options such as the ability to choose the gender of the mentor, or to choose specific days to remind them. Table 7.22 displays participants who suggested having more customisation options and which app version they have used.

Table 7.21: Participants who suggested having more customisation options and the used app version

Participant	iPhone/web
A1	iPhone
A2	iPhone
B2	Web
E2	iPhone
G2	Web
J1	iPhone

Almost third of the participants agreed that Mr. Mentor should be more interactive and have more options for questions. Table 7.23 presents participants who suggested having more interactive options and which app version they have used.

Table 7.22: Participants who suggested having more interactive options and the used app version

Participant	iPhone/web
B1	Web
C1	iPhone
E1	Web
E3	Web
F2	iPhone
G2	Web
I1	Web

Two web uses, D2 and J2, thought it would be appreciated if they can practice an Android version of the app, as they really think it was helpful. Two participants suggested improving the interface: B1 (web user) and J1 (iPhone user). Ten out of the 12 web users referred to the fact that the web app has fewer features when they provide their opinions about the app.

Eleven participants provided positive comments on the app. These comments were about finding the app was useful, or it was a good reminder, or generally they liked the idea of the app (see Table 7.24).

Table 7.23: Positive comments on the app

Participant	iPhone/web	Comments
D1	iPhone	Nice way to get reminded
D2	Web	Sand app
E2	iPhone	Like the idea, Reminder is good
E3	Web	Enjoyable
F1	Web	Useful
F2	iPhone	easy to use
F3	Web	Idea is great
H1	iPhone	Cool and useful, Most useful functionality
H2	Web	Useful reminder
J1	iPhone	Positive feelings overall, Great idea
J2	Web	Good reminder

7.4.6 User Evaluation of the PSD Techniques

The persuasiveness of a system is more about system qualities or non-functional requirements (Oinas-kukkonen & Harjumaa, 2009), and the perceived persuasiveness is more about the users' satisfaction level with the system qualities (Alhammad & Gulliver, 2014). Averages across all participants were calculated for each of the statements on the questionnaire relating to the features introduced as a result of applying persuasive techniques from the PSD model (see Table 7.19).

Table 7.24: The corresponding statements for each applied persuasive technique

Categories of support	Applied persuasive techniques	Statements	#S	iPhone	Web
Primary task support	Reduction	The app simplified the interaction with Mr. Mentor by using buttons for answers, and no need to write them.	*S1*	•	•
	Tunnelling	The app led me through a series of questions to complete the interaction with Mr. Mentor.	*S2*	•	•
	Personalisation	The app offered a personalised service such as selecting a preferred time for notifications.	*S3*	•	
	Self-monitoring	The app provided a reward page, so I could see my total earned points.	*S4*	•	
Dialogue support	Praise	The app offered praise if I shared my work or looked at the group's work	*S5*	•	•
	Rewards	The app rewarded me whenever I shared my work or looked at the group's work.	*S6*	•	
	Reminders	The app reminded me to share my work and to look at the group's work.	*S7*	•	•
	Suggestion	The app offered appropriate suggestions.	*S8*	•	•
	Liking	The app was visually attractive.	*S9*	•	•
	Social role	The app adopted a social role for a mentor.	*S10*	•	•
Perceived credibility support	Trustworthiness	The app was trustworthy by providing true and reliable information about the app and study.	*S11*	•	•
	Surface credibility	The app was credible (i.e. no ads in the app).	*S12*	•	•
	Real-world feel	The app had a real-world feel by displaying researcher's name and her email.	*S13*	•	•
Social support	Cooperation	The app motivated users to cooperate.	*S14*	•	•
	Competition	The app supported competition between users by displaying the total earned points.	*S15*	•	

As shown in Figure 7.5, there was strong agreement with statements S1, S2, S5, S7 and S12, which means that participants thought the features related to reduction, tunnelling, praise, reminders, and surface credibility were successfully implemented in the app. In the web version, personalisation, self-monitoring, rewards, and competition (statements S3, S4, S6 and S15) were not explicitly implemented, however for rewards (statement S6) some web users thought it was applied because rewards sometimes seem similar to praise. On the other hand, participants did not think that competition (S15) was successfully implemented in either version of the app. For techniques that were applied in both versions, it was clear that the ratings from iPhone users were higher than the ratings from web users. This could be as a result of the number of persuasive techniques applied in the iPhone version, and also the characteristics of the iPhone as a small portable device. Results show strong evidence of the success of some of the persuasive features but a clear potential to improve the way in which other persuasive techniques were applied in the design of the social actor.

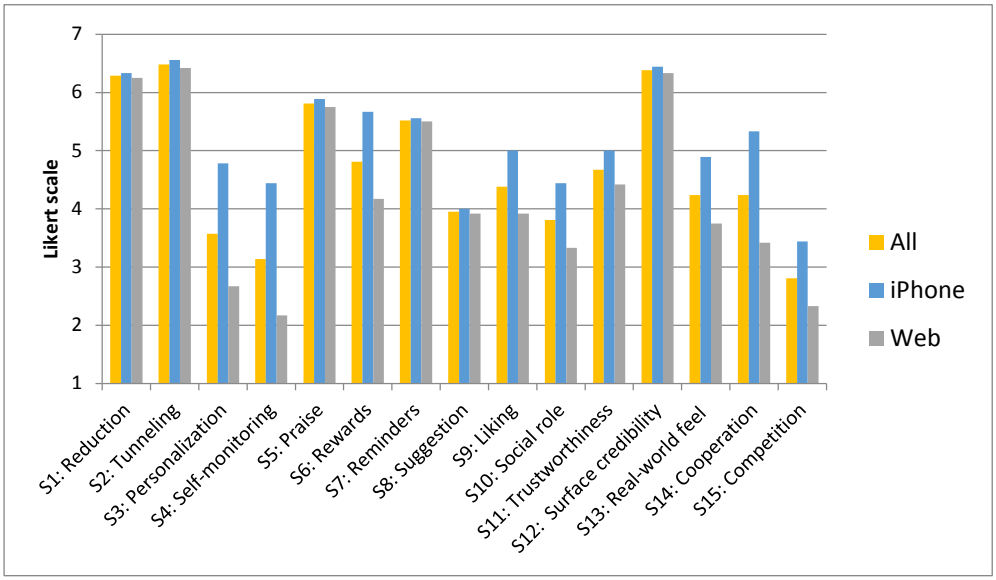


Figure 7.5: User evaluation of features resulting from persuasive techniques (1 = strongly disagree, 7 = strongly agree)

7.4.7 Expert Review Results

The results of the expert reviews are presented in Table 7.25 for each app version.

Table 7.25: Expert reviews for the iPhone app vs. web app

Support	Persuasive technique	iPhone app			Web app		
		R1	R2	Avg	R1	R2	Avg
Primary task support	Reduction	3	2	**2.5**	3	2	**2.5**
	Tunneling	2	3	**2.5**	2	3	**2.5**
	Personalisation	2	2	**2**	n/a	n/a	**n/a**
	Self-monitoring	1	1	**1**	n/a	n/a	**n/a**
Dialogue support	Praise	3	3	**3**	3	3	**3**
	Rewards	3	2	**2.5**	n/a	n/a	**n/a**
	Reminders	3	3	**3**	1	1	**1**
	Suggestion	2	2	**2**	3	2	**2.5**
	Liking	3	2	**2.5**	3	2	**2.5**
	Social role	3	3	**3**	3	3	**3**
Perceived system credibility	Trustworthiness	0	1	**0.5**	0	1	**0.5**
	Surface credibility	3	3	**3**	3	3	**3**
	Real-world feel	3	2	**2.5**	3	2	**2.5**
Social	Cooperation	0	1	**0.5**	0	1	**0.5**
	Competition	1	0	**0.5**	n/a	n/a	**n/a**

Reviewers (R1 and R2) found praise, social role and surface credibility were highly supported in both versions. Praise was highly supported as Mr. Mentor praises the user whenever he/she practiced a target behaviour. For instance, R1 commented on this technique by saying that "*Mr. Mentor praises you if you have completed and/or shared your work*". Social role was supported as the app adopted a social role of a mentor, as mentioned by R1: "the app has a virtual mentor persuading you to share work with group members and look at their work", and also R2 stated that "*the whole system is based on the social role of "Mr. Mentor" that interacts with the user while using the system*".

R1 stated that "*the app has a competent look and feel. Having the "about me" button on the homepage makes it more credible as you can contact a person regarding the app"*. Also, R2 stated that "*no ads in the application throughout. This increases its credibility*".

Reviewers rated between mid to high support for reduction, tunnelling, suggestion, liking and real-world feel for both versions. Reduction was supported, as R1 stated that "*Mr. Mentor is precise and to the point, asks users direct questions*" and R2 stated that "*the number of interactions is minimum between the system and user. The tasks required to do is considered simple*". Tunnelling was supported through a series of yes/no questions, and the app does guide users to take an action, however it could be a bit clearer, so that users know exactly how many steps there are and are able to go back one step or know how many steps they have to complete. Suggestion was supported as Mr. Mentor offers suggestions to users to share their work with group members and to look at members work when they answer no. Although liking is more about personal taste and opinion, but reviewers found liking was supported as they stated that the app is visually appealing, with a nice avatar talking to you, and the combinations of Mr. Mentor character, the sound, the speech balloons, and the music are attractive and likeable. Real-world feel was supported in the "about me" tab, where the user can contact a person via email regarding the app.

Reviewers found that reminders principle was highly supported only in the iPhone version, and was low supported in the web version as the reminders sometimes did not show when Mr. Mentor said it will.

Reviewers rated between low to no support for trustworthiness and cooperation for both versions. R1 stated that "*the app is not giving any information. It asks the user to enter or fill out the information*", so there was no support for trustworthiness, whereas R2 believed that there was low support for trustworthiness as Mr. Mentor did what he said (i.e. reminds the user and gives him points when he said that). For cooperation, R1 stated that "*the group members are not connected via the app, so there is no way to tell whether they are using the app for the group project or not*", while R2 stated that "*the system suggesting to share and to look at the work of the group members motivates users to cooperate*."

Four principles were reviewed exclusively for the iPhone version: personalisation, self-monitoring, rewards, and competition. Reviewers found that personalisation and rewards were relatively good.

Reviewers found that the support for self-monitoring was low. R1 commented on that by saying "*user is not able to fully track his performance, because he/she cannot set his/her goals with the app. It only reminds him to complete work, not see whether he achieved his target*", and R2 said that "*in the reward, because it reflects the user performance. But it is not applied in a proper way*".

For competition, reviewers rated between low to no support as R1 stated that "*the app has a point system, but the user is not able to share his/her points with his group members. They could maybe talk to each other about their points, but they cannot share or compare their points with their group members in order to compete*", while R2 stated that "*no competition is found*". All expert reviews anwers can be found in Appendix E.9.

7.4.8 Explaining the Change

Explaining the change through the theories, the O/C Matrix, and the PSD Model is the last step in the BCSS framework (Oinas-Kukkonen, 2010).

Explaining the change through the theories: Some persuasion theories were reviewed in Chapter 6 (section 6.1). In this section, a reflection on the change in attitudes and behaviours through the persuasion theories is discussed here as part of the last step in the BCSS framework.

First, self-efficacy theory (Bandura, 1977) can be considered which suggests that individual's belief in his/her ability to perform a behaviour determines their success in accomplishing it, i.e. determines that he/she will perform it. Self-efficacy theory (Bandura, 1977) involves the concept of the perceived ease of use which is part of TAM (Davis, 1989) and the theory of planned behaviour (Ajzen, 1991). From the results of TAM (described later on in this section), it was found that students perceived the ease of using Mr. Mentor app.

Moreover, expectations of self-efficacy are based on performance accomplishments, vicarious experience, verbal persuasion, and emotional and physiological states (Bandura, 1977). In this research, self-efficacy expectations are based on performance accomplishments and verbal persuasion. Performance accomplishments involve previous experiences of practicing the behaviour, and students reported about their previous experience as part of the pre-test questionnaire, which showed that they were familiar with the target behaviours. Verbal persuasion involves persuading people through suggestion, and the social actor encouraged students to perform the behaviour through suggestion at two points of interaction. Self-efficacy expectations could also be affected by vicarious experience and emotional and physiological states; however, it was not strongly evident in our research that students relied on observing their colleagues to perform the behaviours, although it could have happened indirectly but there was no data about that and emotional and physiological states were not captured. Self-efficacy theory is considered as part of the social cognitive theory (SCT) (Bandura, 1986), so part of the social cognitive theory is valid for this research.

According to the theory of reasoned action (Fishbein & Ajzen, 1975), if an individual thinks the suggested behaviour is favorable (i.e. he/she has a positive attitude towards the behaviour), and or if he/she believes other people want them to perform the

behaviour (i.e. subjective norm), this generates an intention to perform the behaviour which more likely leads the person to actually perform it. In this research, students had positive attitudes towards performing the behaviours as they reported in the pre-test questionnaire.

The theory of planned behaviour is based on the theory of reasoned action and self-efficacy theory, and it was found that both were valid in this research, therefore, the theory of planned behaviour is valid for this research as the students had positive attitudes towards performing the behaviours and they perceived the ease of using the Mr. Mentor app.

In cognitive dissonance theory (Festinger, 1957), individuals seek consistency between their attitudes and behaviours. In this research, results from pre-tests and post-tests questionnaires showed that there was no significant dissonance between attitudes and behaviours, and when they changed, students kept maintaining consistency between them.

Regarding the elaboration likelihood model (ELM) (Petty & Cacioppo, 1986), both routes were used in this research; the central route was used by asking students directly to perform the target behaviours, whereas the peripheral route was used through using social cues to either produce positive or negative cues in the persuasion context (e.g. when Mr. Mentor is happy if a user performs any of the target behaviours, or when he is sad if a user decides not to perform the behavior).

The technology acceptance model has 12 statements to rate perceived usefulness and the ease of use of a technology. Statements 1 to 6 are for perceived usefulness, and statements 7 to 12 are for perceived ease of use. Table 7.26 presents the averages of TAM statements for all users and for each app version. It was found that students agreed that it was easy to use the Mr. Mentor app, however, they did not perceive the usefulness of the Mr. Mentor app and this could be because the app is not meant to be a tool that support the functional work of the group.

Table 7.26: Averages of TAM statements for all users and for each app version

TAM statements	Average		
	All	**iPhone**	**Web**
1. The app enabled me to accomplish tasks more quickly.	2.86	3.44	2.42
2. Using the app improved my coursework performance.	3.19	3.67	2.83
3. Using the app increased my productivity.	3.76	3.89	3.67
4. Using the app enhanced my effectiveness on the coursework.	3.45	4	3.08
5. Using the app made it easier to do my coursework.	2.81	2.89	2.75
6. Overall, I found the app useful in my coursework.	3.19	3.33	3.08
7. Learning to operate the app was easy for me.	6.52	6.67	6.42
8. I found it easy to get the app to do what I want it to do.	4.43	4.56	4.33
9. My interaction with the app was clear and understandable.	5.9	6	5.83
10. I found the app to be flexible to interact with.	4.29	4.67	4
11. It was easy for me to become skillful at using the app.	5.24	6	4.67
12. Overall, I found the app easy to use.	6.1	6.44	5.83

Explaining the change through the O/C Matrix:

The target behaviours for Mr. Mentor were to encourage students to share their work with others in their collaborative learning group and, vice versa, to encourage students to look at the work done by others in the group.

For each target behaviour, there was a reinforcement of a behaviour (R/B) or increasing an existing behaviour (A/B), where the target behaviours already existed but they varied over time as indicated in the study reported in Chapter 4, so altering or reinforcing these behaviours was needed. Changes in attitudes were also considered in two ways: first, when Mr. Mentor informs users about the importance of performing these behaviours, and secondly as a reason for behaviour changes (from the Theory of Reasoned Action (Fishbein & Ajzen, 1975)). This change might be either forming an attitude (F/A), altering an attitude (A/A), or reinforcing an attitude (R/A). This because some students might do not have the attitude towards the behaviours that support activity awareness, so the attitude needs to be formed (F/A), also some students might have different attitude towards these behaviours, so the attitude needs to be altered (A/A), or even some students might have the attitude towards these behaviours but the attitude needs to be reinforced (R/A).

Explaining the change through the PSD Model: The PSD model involves two parts: the persuasion context and system characteristics. The social actor app was designed based on the PSD model. Results showed some changes in attitudes and behaviours that support activity awareness as described earlier (section 7.4.1 and 7.4.2).

In the persuasion context, changes were affected by direct route when the social actor, Mr. Mentor, asked users to perform the behaviours or indirectly through social cues of Mr. Mentor as described earlier. Regarding system characteristics, participants perceived the persuasiveness of some of the applied persuasive techniques including: reduction, tunnelling, praise, reminders, and surface credibility. Moreover, iPhone users also perceived the persuasiveness of rewards, personalisation, and self-monitoring.

7.5 Discussion

This study attempted to test the social actor app and to measure activity awareness. In this section, answers to research questions are given, and then a detailed discussion on the results is provided. The study helped in answering four research questions *RQ2*, *RQ3*, *RQ4*, and *RQ5*. Each of them is presented here.

RQ2: **How can activity awareness be measured in long-term collaborative learning groups?**

This study helped in answering part of this research question. Again, the proposed method for measuring activity awareness presented in Chapter 4 (section 4.4.5) was used in this study taking into account the rules for inclusion and exclusion of interview data suggested in Chapter 5 (section 5.4.3). In this study, a reliability check was conducted with another researcher to ensure that the application of the method for measuring activity awareness was reliable and consistent. The process described earlier (section 7.6). An agreement of 80% was reached from the first time, which means that the application of this method was reliable.

RQ3: **What activity awareness do group members have in long-term collaborative learning groups?**

This study also contributed to answer this research question. After using the social actor app, results showed that the number of "fully aware" instances increased, whereas the number of "partially aware" or "unaware" instances decreased. Moreover, for each participant, a comparison was made between his/her activity awareness in the first and second interviews, in order to identify changes in their activity awareness. It shows that, after using the social actor app, the activity awareness of 9 participants increased, the activity awareness of 8 participants did not change and the activity awareness of 3 participants decreased. The answer for this research question helped in answering the last research question *RQ5* as described later.

***RQ4:* How can a persuasive social actor for activity awareness in long-term collaborative learning groups be designed and evaluated?**

This research question has three sub-questions. In this study, two of these research questions were tackled *RQ4.2* and *RQ4.3*.

***RQ4.2:* How can the success of the persuasive social actor be evaluated from the users' point of view?**

For each implemented persuasive technique, a statement was created to describe how this technique was supported in the app. Then, at the end of the project, participants were asked to rate each statement on 7-point Likert scale whether they agree or disagree with it. Figure 7.6 illustrates user evaluations for the iPhone app. Results show that iPhone users found 11 out of 15 techniques were successfully implemented (reduction, tunneling, personalisation, praise, rewards, reminders, liking, trustworthiness, surface credibility, real-world feel, and cooperation), 3 techniques were acceptable (self-monitoring, suggestion, and social role) and one technique which is competition was not well implemented.

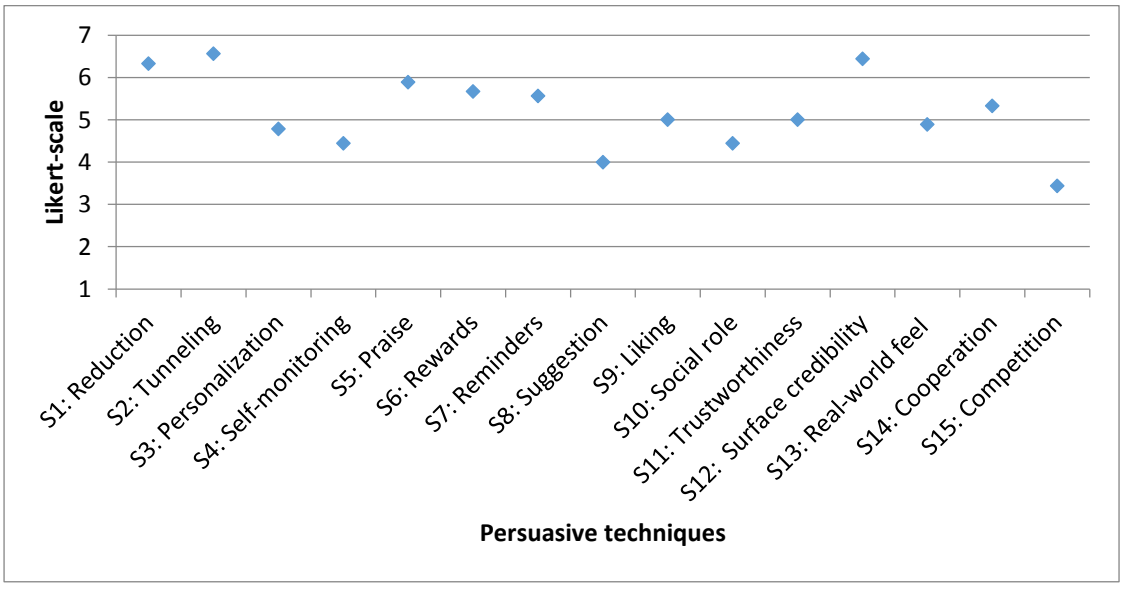


Figure 7.6: User evaluation of features resulting from persuasive techniques in the iPhone app (1 = strongly disagree, 7 = strongly agree)

Figure 7.7 illustrates user evaluation for the web app. Web users evaluated even the unimplemented techniques (personalisation, self-monitoring, rewards, and competition). However, they were excluded in the results. Results show that web users found 5 out of 11 techniques were successfully implemented (reduction, tunneling, praise, reminders, and surface credibility), 4 techniques were acceptable (suggestion, liking, trustworthiness, and real-world feel), and 2 techniques were not well implemented (social role and cooperation).

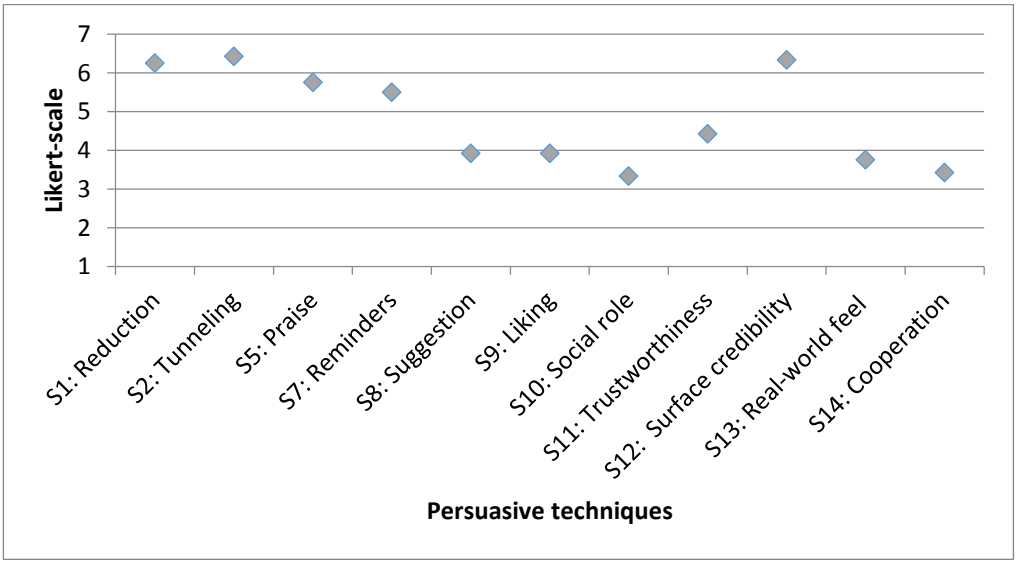


Figure 7.7: User evaluation of features resulting from persuasive techniques in the web app (1 = strongly disagree, 7 = strongly agree)

RQ4.3: How can the success of the persuasive social actor be evaluated from expert reviews?

It was proposed that the PSD model can be used for designing and evaluating persuasive technologies (Oinas-kukkonen & Harjumaa, 2009). I looked at different papers that use the PSD model for evaluation and find out how they have conducted expert reviews (Lehto & Oinas-kukkonen, 2009; Lehto & Oinas-kukkonen, 2010; Räisänen et al., 2010; Langrial et al., 2012). They suggested that at least two experts should be involved in the expert reviews process. They followed the PSD model, starting by analysing the persuasion context for the technology at hand, then rating to which extent each persuasive technique is supported usually from 0 to 3.

The PSD mode was followed in rating to which extent the applied persuasive technique is supported from 0 to 3. Two field experts were recruited to conduct expert

reviews. They were given an instruction sheet and evaluation sheet for each app version. They were asked to use the app for some time and familiarise themselves with it before they started the evaluation process. In the evaluation, experts were asked to rate each applied persuasive technique (from 0 to 3), whether it was supported or not and if so how strongly it was supported (where 0 is no support; 1 is low support; 2 is medium support; and 3 is high support). Then, reviewers had to fill in the evaluation sheet with their ratings and to provide justification for each rating.

Figure 7.8 illustrates expert reviews for iPhone version. It shows that 11 out of 15 persuasive techniques were between high and good support (reduction, tunneling, personalisation, praise, rewards, reminders, suggestion, liking, social role, surface credibility, and real-world feel), while 4 were not supported (self-monitoring, trustworthiness, cooperation, and competition).

Figure 7.9 illustrates expert reviews for web version. It shows that 8 out of 11 persuasive techniques were between high and good support (reduction, tunneling, praise, suggestion, liking, social role, surface credibility, and real-world feel), while 3 were not supported (reminders, trustworthiness, and cooperation).

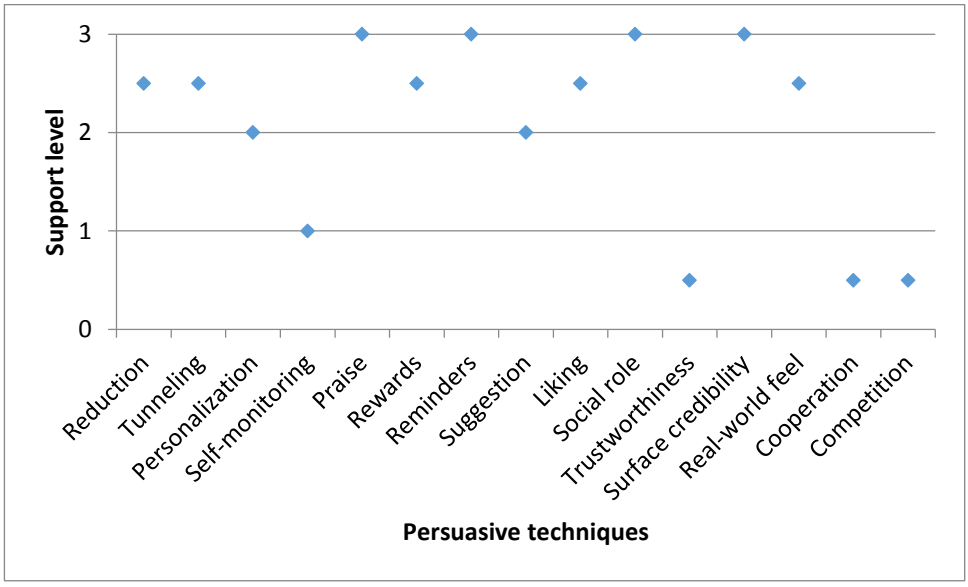


Figure 7.8: Expert reviews for iPhone version (0 no support, 3 high support)

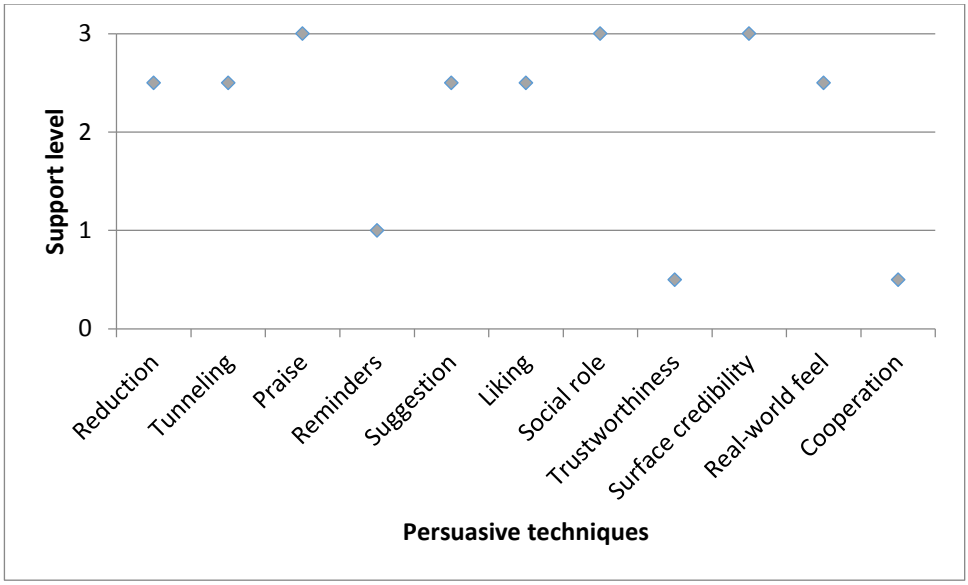


Figure 7.9: Expert reviews for web version (0 no support, 3 high support)

***RQ5:* Can a persuasive technology support students' activity awareness in long-term collaborative learning projects?**

This research question was tackled through pre- and post-test ratings of attitudes and behaviours about activity awareness; the results show that participants had a more positive attitude towards attitudes and behaviours that enhance activity awareness at the end of the project than they did at the beginning. Although these changes are limited, they were in the desired direction.

Participants' responses to statements A and B also addressed this research question, this time looking at self-reports of change. They were asked if they perceived any change in their behaviours at the end of their project using two statements of 7-point Likert scale. The ratings indicate that participants agreed to some extent that Mr. Mentor encouraged them to share their work with the group and to look at the work done by their group.

Also, when they were asked explicitly if they thought that Mr. Mentor changed their awareness of their group's activities, almost half of the participants (10 out of 21) confirmed that it did change to some degree their awareness of the group's work.

So, changes in attitudes and behaviours were measured using two different methods: objective (pre- and post-tests) and subjective (self-reporting) measures.

On the other hand, results of measuring activity awareness showed that the number of "fully aware" instances increased after using the social actor app, while results from previous studies (second and third studies, Chapters 4 &5) showed that the number of being "fully aware" decreased, which means that the social actor app influenced the activity awareness of the students.

From these results, it was confirmed that using a persuasive social actor during collaborative group projects is effective in promoting activity awareness within groups.

This empirical study was undertaken in the challenging context of real-world collaborative learning groups, using several complementary data collection techniques to tease apart the effect of the social actor app.

The study was undertaken to test and evaluate the social actor app (i.e. Mr. Mentor app). Different data were collected to measure the changes in attitudes and behaviours including pre- and post-tests and self-reporting data. The results show that post-tests averages were higher than the pre-test averages, which means that participants had a more positive attitude towards attitudes and behaviours that enhance activity awareness at the end of the project than they did at the beginning. Successful persuasion takes place when the target of change (e.g., attitudes, behaviours) is changed in the positive direction (Briñol & Petty, 2009). Although these changes are limited, they were in the desired direction. The result also showed that participants on average agreed that Mr. Mentor encouraged them to share their work, and also persuaded them to look at their group work. This indicates that social actors can motivate students and change their attitudes and behaviours to increase their activity awareness.

The study reported in Chapter 4 showed that activity awareness was higher at the beginning of collaborative learning group projects than near the end, i.e. that activity awareness decreased. However, in this empirical study, it was found that activity awareness increased towards the end of the project. All participants were at least partially aware of each others' activities and many were fully aware. This suggests that persuasive social actors have potential as a mechanism for promoting activity awareness in collaborative learning groups.

Evaluating the success of the implementation of the persuasive techniques through the 15 statements showed that we had been more successful in implementing some persuasive techniques than others. Improvements here may well lead to increased persuasiveness and hence further changes in attitudes and behaviours. Some participants felt bored when using the app by the end of the project. This may have been a consequence of the daily reminder that Mr. Mentor produced, and could be improved in the future by enabling users to customise reminder times: some participants reported that they did not work on the project everyday and they suggested that it could be beneficial if they could customise the times.

Also, some participants who used the web version of Mr. Mentor suggested that an Android version of the app should be developed. They highlighted the fact that the web app has less functionality than the iPhone version. Also, they felt using such app on PCs was not effective as they forgot to use it sometimes or it disrupted them when they were working on something else.

Some participants found the app was annoying to some extent, for example, when Mr. Mentor asked them the same questions, interrupted them in the middle of working on something else, or if they did not do any work related to the project on that day. Additionally, some students suggested that the app should have more customisation options such as choosing the gender of the mentor, or choosing specific days for reminders instead of daily reminders. Also, almost third of the participants agreed that Mr. Mentor should be more interactive and ask different questions. Two web users thought it would be appreciated if they can practice an Android version of the app, as they felt the app was really helpful. Two participants suggested improving the interface. Moreover, 10 out of 12 web users referred to the fact that the web app has less features when they provide their opinions about the app. Regarding changes in activity awareness, 10 participants confirmed some degree of change in their awareness of the group's work. For instance, participant E1 answered: "*Yes it did. It did raise some questions, which made me think about my group and our work*". Finally, 11 participants provided positive comments on the app, such as they liked the idea, found the reminders were useful, or it was easy to use the app. The overall responses of using the web version were low, whereas the overall responses of using iPhone version were higher.

Regarding expert reviews, Räisänen et al., (2010) stated that some persuasive techniques work better together and some do not work very well together. They said that excess use of reduction will make tunneling almost useless. We, researcher and reviewers, found that reduction and tunneling were finely implemented together.

Experts and users agreed on some persuasive techniques whether they were supported or not. They found that reduction, tunneling, praise, and surface credibility were successfully supported in both versions. They also agreed that competition was not supported.

There are many existing technologies to support collaborative learning groups for sharing documents and materials, communicating, tracking the group work, distributing and allocating tasks, to support the collaboration. However, there is no persuasive technology or social actor specifically designed to support collaborative learning groups in a lightweight way by changing their attitudes and behaviours to promote activity awareness and then to enhance group collaboration. Based on these results, it was concluded that persuasive technology can be used in collaborative learning as a supportive lightweight tool to enhance activity awareness of collaborative groups.

Learning technologists and researchers in collaborative learning can use the method for evaluating activity awareness in similar or other collaborative learning contexts. Previous literature has reported on the importance of activity awareness in collaboration (e.g. Gutwin et al., 2004; Convertino et al., 2004; Paletta & Herrero, 2011). Therefore, measuring activity awareness of the collaborators is valuable in order to know what awareness they have or if a technologist developed a tool to enhance awareness, for example, then he/she can measure activity awareness before and after to find out whether the tool is working or not, i.e. is there a change in activity awareness.

Designing and evaluating the social actor app can also be regarded as a case study of using the PSD model. Designers and researchers in persuasive technologies can look at this case study and see what works for designing social actors. Also, they could benefit from the method for user evaluation for persuasive technologies which was inspired by the PSD persuasive techniques. Moreover, this study suggests three measurements to measure the change in attitudes and behaviours, which could be used by other researchers in the field of behaviour change or persuasive technologies.

7.6 Limitations

The number of participants was limited and they used two different versions of the app, where one version had slightly less features. This empirical study was challenging, in terms of running a long-term study in naturalistic settings, recruiting participants, and collecting data on different intervals from the same participants, then analysing these data to get some sense of the actual effect of using social actors on activity awareness. Nonetheless, it gave insights into the real-world use of a persuasive technology that could not be obtained from a more contrived lab-based study.

Some options for study design were taken due to ethical considerations, for instance, it was not possible to conduct a comparative study between people who used the app and people who did not use it. All students should be able to use the app if they decided to participate in the study and it was not ethical to divide participants in two groups; one group is using the app and the other group is not.

7.7 Summary

This chapter reports the empirical study that was conducted to test and evaluate the persuasive social actor app for activity awareness. Participants were asked to use this app while working on a group project. Interviews were used to evaluate their activity awareness, while questionnaires were used to collect pre-test and post-test data about attitudes and behaviours, as well as their evaluation of the app. Also, expert reviews were conducted with two field experts. Results show that using a persuasive social actor during collaborative group projects may be effective in promoting activity awareness within groups, although clearly other factors may also have influenced the outcome, such as individual differences in the students. Regarding evaluation, users and experts found that some applied persuasive techniques were successfully supported. This empirical study is published in a paper in the British HCI Conference, 2016 (see Appendix F.2).

Chapter 8: Discussion and Conclusion

This chapter presents an overview of the research, summarises the studies that were conducted, gives answers to the main research questions, discusses contributions, discusses the limitations, and suggests future work.

8.1 Overview

The aim of this doctoral research was to investigate a new approach to supporting collaborative learning activities through the use of persuasive technology to promote activity awareness. This research was divided into two main parts: the first part explored collaboration and activity awareness in collaborative learning groups; and the second part investigated persuasive technologies to support activity awareness in collaborative learning groups based on the BCSS framework (Oinas-Kukkonen, 2010).

This doctoral research was undertaken in the context of collaborative learning groups and it is distinguished from previous work in two ways: data were collected from real collaborative learning groups who worked in naturalistic settings, and it investigated a novel approach to enhance activity awareness by changing students' attitudes and behaviours through the use of a persuasive social actor.

8.2 Summary of the Studies

Four studies were conducted: a pilot study to explore collaborative learning groups, an observational study to understand collaboration and activity awareness, a follow-up study to study activity awareness in more depth, and a final study where a persuasive social actor for activity awareness in collaborative learning groups was developed and a study was undertaken to investigate its impact in a collaborative learning situation. Each of these studies is summarised in this section.

8.2.1 Study 1: Exploring Collaborative Learning Groups – Pilot study

In the first study (Chapter 3), the aim was to explore collaboration in adult learners when they were working on a long-term collaborative learning group project, and to identify their collaboration styles and any issues that appeared in such collaborations.

This was a small study, where seven undergraduate students participated and interviews were used for data collection. I identified collaboration activities and styles, how the students assigned tasks, problems they encountered, and applications and tools they used to support their collaboration.

Although the data were limited, this study influenced the focus of this research to be on exploring activity awareness. Results showed that issues related to awareness appeared in several places; these issues were either reasons for or consequences of a lack of awareness. Reasons for a lack of awareness included no or late replies to messages or emails from other members of a group and unchecked accounts; consequences included the fact that people had to start the work from scratch or they duplicated work. Carroll et al. (2003) found that breakdowns in awareness occurred frequently in long-term collaborations, as discovered in this pilot study.

Other difficulties of working in groups have been reported in the literature and were summarised in Chapter 2. For example, in a study conducted by Bower and Richards (2006), some problems of working in groups were identified such as distractions and conflicts that could occur between members, or students cannot choose their own pace, or they cannot focus on concept formation or difficult problems. Working in groups is also less time efficient. Another potential problem of working in groups is the occurrence of free riders (Magney, 1996; Mcardle et al., 2005). In a study conducted by Magney (1996), instructors highlighted some problems of collaborative learning, which included time management and coverage of material, marking policies, and free-riding by group members. Some of these reported problems also appeared in the results of this study such as the occurrence of free riders.

From the results of this study, it was decided to focus on studying awareness, exploring it in depth, and finding how student's awareness in long-term collaborative learning groups could be promoted.

8.2.2 Study 2: Understanding Activity Awareness and Collaborative Behaviours in Learning Groups

Having decided to focus on awareness, in the second study (Chapter 4), the aim was to understand awareness behaviours, awareness types and collaboration activities in learning groups. The study also developed a method to collect and analyse data in order to measure activity awareness. The method was based on the work of Convertino et al. (2004). However, they measured activity awareness in controlled settings, whereas in this research another way was suggested to collect and analyse data about activity awareness in naturalistic settings using interviews. In essence, the same ratings for activity awareness were used but operationalised in a different way, as described later in the answer to the second research question *RQ2* (section 8.3.2).

Three data collection methods were used in this study: observations, interviews, and questionnaires. The data were collected over 6 weeks. Through coding of the data, eight awareness behaviours were identified: asking for clarification, asking direct questions to other group members, asking an external person, requesting some time to catch up and being on the same page with other members, offering clarification, updating other members if they missed any part of the meeting, checking resources or notes for any uncertain point, and reviewing the work. These awareness-promoting behaviours were either to construct self-awareness or to construct other members' awareness. Self-awareness could be developed through different behaviours such as asking for clarification, asking direct questions to other group members, asking an external person, requesting some time to catch up, or checking resources or notes. Participants could enhance others' awareness by offering clarification, updating absent members or by reviewing their work during meetings. Some of these behaviours were proactive (e.g. work reviewing) and some of them were responsive (e.g. offering clarification).

Therefore, awareness-promoting behaviours could be divided into two groups: perceiving information (by asking and checking) and providing information (by offer clarification, updating and work reviewing). Figure 8.1 illustrates awareness behaviours types based on the findings.

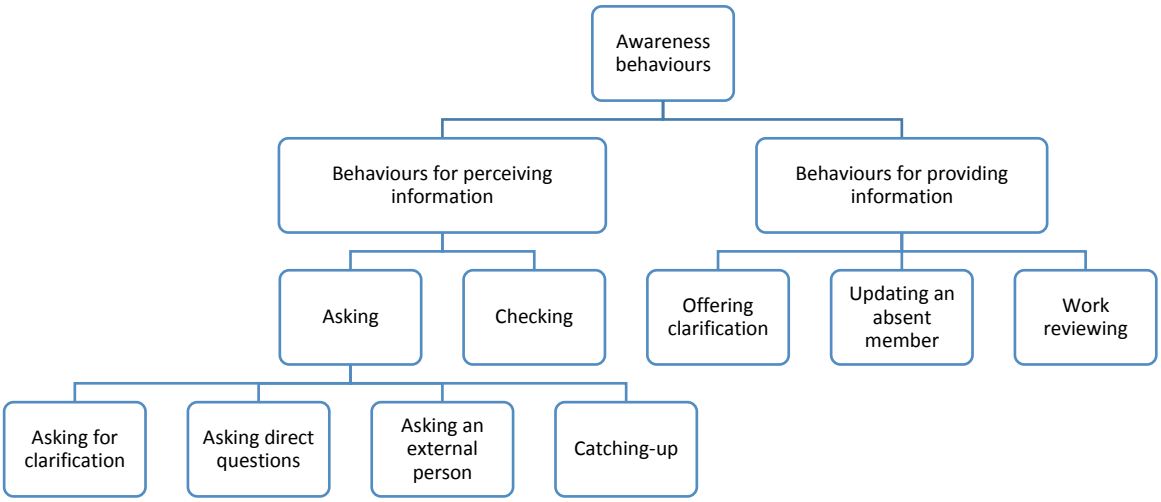


Figure 8.1: Awareness behaviours types

In addition, five awareness types were identified, these were: activity awareness, current state awareness, next-step awareness, skill awareness, and time awareness. Activity awareness is related to group activity that takes place over an extended period of time (Convertino et al., 2004) and I define activity awareness as the knowledge of what each member did, is doing, and is planning to do over the duration of the project. Some researchers have stated that awareness of the current state of the work is one aspect of activity awareness (e.g. Brons et al., 2010). Current state awareness is the knowledge of the up-to-moment progress of the group. Next-step awareness is the future part of activity awareness, which includes the knowledge of the upcoming tasks and what to do next. Therefore, it was concluded that activity awareness subsumes current state awareness and next-step awareness. In this PhD research, activity awareness of completed work particularly was investigated. Skill awareness is the knowledge of members' skills that could be utilised and applied in the collaborative project. Skill awareness is an important type of awareness in collaborating groups as it facilitates task allocation. Time awareness is the knowledge of deadlines and how to manage timing issues. Figure 8.2 illustrates the awareness types identified in the learning groups.

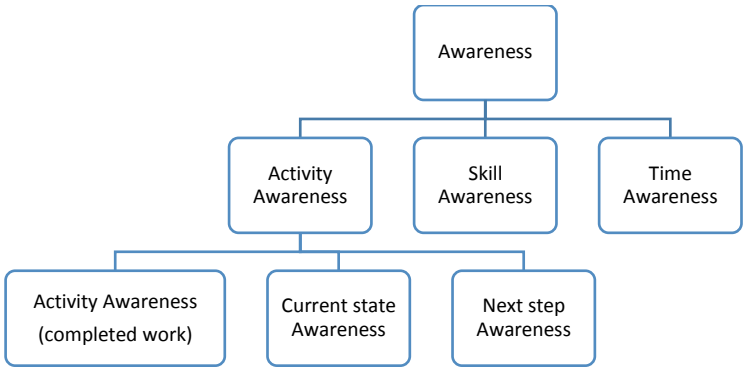


Figure 8.2: Awareness types identified in the learning groups

Results also showed that activity awareness of completed work was higher at the beginning of the collaborative project than at the middle or the end, which suggested that there was a breakdown in activity awareness. This is in line with the findings from the Carroll et al. (2003) study, as they found that awareness breakdowns frequently occurred in long-term collaborations.

Groups engaged in a number of collaboration activities including: agreement, disagreement, pair discussion, group discussion, editing, engaging, helping, reviewing, and suggesting. At least five collaboration activities were identified in each meeting for each group. Most of these activities appeared as part of discussion, which is known as the main activity in collaboration (Alavi, 1994).

Moreover, groups used different existing applications during their collaborations such as Email, WhatsApp, Google drive and Hangouts. It seemed that participants preferred to use general-purpose applications to collaborate rather than trying to use any specific potentially complicated collaborative learning environment. This finding suggested that using a lightweight application to support activity awareness would be an appropriate option.

8.2.3 Study 3: Evaluating Activity Awareness in Learning Groups

In the third study (Chapter 5), the aim was to collect more data to further investigate and measure activity awareness in collaborative learning groups as the previous study had a limited number of participants, and also to refine the method of evaluating

activity awareness. Two main data collection methods were used: short interviews and questionnaires. It was found that participants' activity awareness was not stable and changed over time; sometimes it increased, decreased, or remained at the same level for a while.

This study suffered from a limitation in collecting some of the interview data. This occurred when some participants from the same group were not available for interview on the same day or within two days. This made the comparison of their responses unreliable as the work of the group would have progressed. Results suggested a set of rules for inclusion and exclusion of interviews and a rigorous method to evaluate activity awareness.

Having identified the behaviours that promote awareness and found that people were not always fully aware of colleagues' activities, and based on the concept of persuasive technologies which involves changing users' behaviours and/or attitudes, it was hypothesised that a persuasive social actor could help students in promoting their activity awareness, as described in the next study.

8.2.4 Study 4: A Persuasive Social Actor for Activity Awareness in Learning Groups

A lightweight persuasive social actor called "Mr. Mentor" was developed for activity awareness (Chapter 6). The design of the social actor was based mainly on the Persuasive Systems Design model (PSD) as described in Chapter 6 (section 6.3.2). The aim of the social actor was to promote activity awareness in collaborative learning groups by changing the attitudes and behaviours of students. The target behaviours for Mr. Mentor were to encourage students to share their work with others in their collaborative learning group (i.e. providing information) and, vice versa, to encourage students to look at the work done by others in the group (i.e. perceiving information).

In the final study (Chapter 7), the persuasive social actor was tested and evaluated. The aim was to investigate the effect of using the social actor on collaborative learning groups working on learning projects over an extended period of time. Participants were asked to use the Mr. Mentor app while working on a group project. Interviews were used to evaluate their activity awareness, while questionnaires were

used to collect pre-test and post-test data about attitudes and behaviours, as well as their evaluation of the app.

Results showed that participants gave higher ratings for attitudes and behaviours that enhance activity awareness at the end of the project than they did at the beginning. This indicated that there were changes in attitudes and behaviours. Although these changes were limited, they were in the desired direction. Also, the pre-test averages for the attitude and behaviour statements were in general high (i.e. they were on the agreement side), which means that students already had these attitudes or engaged in these behaviours. It was also found that activity awareness increased or maintained towards the end of the project after using the social actor app. The social actor app was evaluated by users and experts. They agreed that a number of applied persuasive techniques were successfully supported.

8.3 Answers to Research Questions

This section revisits the main research questions of this thesis to answer them in detail. The answers have been arrived at through the synthesis of the results of the studies reported earlier. Starting with the first main research question:

8.3.1 RQ1: How do students collaborate in long-term collaborative learning groups?

Although there is already significant research into collaborative learning, this PhD started out by exploring how students collaborate in long-term collaborative learning projects in naturalistic settings, i.e. in the wild. This research question was answered through the results of the first and second studies. This question was not a main research question, but it was required as a precursor to investigate more about long-term collaborative learning groups in naturalistic settings. Three main dimensions were employed to describe students' collaboration, these were: collaboration activities and styles, awareness behaviours and types, and application and tools they used. Each of these is described here in detail.

Collaboration activities and styles: Alavi (1994) stated that "collaborative activities enhance learning by allowing individuals to exercise, verify, solidify, and improve their mental models through discussions and information sharing during the problem-

solving process". The main collaboration activity that has been reported was discussion (Alavi, 1994; Dillenbourg, 1999) and it was identified in both studies.

Dillenbourg (1999) stated that performing activities that require two learners or more would activate certain learning mechanisms such as knowledge elicitation, internalisation, and reduced cognitive load. Therefore, it was important to identify these activities in order to understand how students collaborate and then find out how these activities would be enhanced to support their collaboration.

The first study found that students practiced six main collaboration activities including discussion, awareness, helping each other, clarifying uncertain points, reviewing the work, and persuading some members to complete their tasks.

In the second study, more collaboration activities were identified as the sample was bigger and the collected data was more varied and richer. Again, the most common collaboration activity was discussion either as a group or in pairs. Other collaboration activities identified in the groups were: agreement, disagreement, editing some work, engaging members to participate in the discussions, helping each other, reviewing completed work, and suggesting ideas and solutions. Most of these activities appeared as part of discussion, such as agreement, disagreement, engaging members to add their inputs, and suggesting ideas and solutions. These collaboration activities varied in each meeting.

Group members usually discussed their tasks, deadlines, and progress. Moreover, they were responsible for allocating project tasks and each group used several methods for this. In the first study, students assigned tasks to members based on their skills, by volunteering, or by the project manager of the group. In the second study, tasks were assigned to members based on their skills or experience, by volunteering, or by availability. In conclusion, tasks mostly were assigned to members based on their skills or by volunteering.

Regarding collaboration styles, limited work has focused on identifying collaboration styles in collaborative learning groups. Cockburn and Greenberg (1996) identified four collaboration styles in children working in pairs: parallel activity, sequential activity, independent activity, and domination. More recent research on collaboration styles was conducted by Shaer et al. (2011) and they reported four collaboration styles

in students working in pairs: turn-takers, driver-navigator, driver-passenger and independent as described in Chapter 3 (section 3.1).

In this research, Cockburn and Greenberg's (1996) collaboration styles were used to examine the potential of finding these collaboration styles in different collaborative learning situation. Findings showed that a single group can have more than one collaboration style. As the learning group projects were undertaken over extended periods of time, different collaboration styles occurred within the same group. In the first study, where the participants were undergraduate students, sequential work and independent work were the most common collaboration styles, In the second study, where the participants were Masters' students, group members worked mostly in a parallel way to complete their tasks.

Awareness behaviours and types: The first study did not set out to investigate awareness behaviours as the aim was to explore collaboration styles, however, some awareness behaviours were identified in situations where members gave an overview of their work and were updated with information about each other's work and progress.

Then, in the second study, the intention was to undertake a broad exploration of awareness behaviours. Eight awareness behaviours were identified including: asking for clarification, asking direct questions, asking an external person, requesting some time to catch up and being on the same page with other members, offering clarification, updating other members if they missed any part of the meeting, checking resources or notes for any uncertain point, and reviewing the work.

Moreover, five awareness types were identified that were associated with collaborative groups including: activity awareness, current state awareness, next-step awareness, skill awareness, and time awareness. Some of these types were overlapping, for example, the definition of activity awareness subsumes both current state awareness and next-step awareness.

Activity awareness have been identified in some literature (e.g. Ganoe et al., 2003; Convertino et al., 2004). Next-step awareness is the knowledge of the upcoming tasks and what to do next and can be identified as the future part of activity awareness. Information about current state is part of situation awareness (Foster, 1998). To the best of my knowledge, skill awareness is not identified in any other study. Time

awareness which indicates the knowledge of the deadlines is identified as part of general awareness in collaboration (Carroll et al., 2003).

Applications and tools in use: In the projects studied for this doctoral research, students were not obligated to use any specific tool during their collaborations. They had the choice to use any tool they preferred. Groups used different existing general-purpose applications during their collaborations. They usually used them to communicate, discuss, store or share documents. In the first study, each group used at least two applications out of the following: email, Facebook, WhatsApp, and Dropbox. In the second study, groups mostly used email, WhatsApp, Google drive and Hangouts in their collaborations. They also used their laptops and iPads during the meetings, and sometimes their phones to search for something or to write notes.

This indicated that groups preferred to use a number of common general-purpose applications rather than using one specific tool for group collaborations. Although this could be because there was no single app they had common knowledge of or access to, it did suggest that they using an additional lightweight application to support their collaboration would be acceptable or even likely.

8.3.2 RQ2: How can activity awareness be measured in long-term collaborative learning groups?

This research question was answered through the approach developed during the second, third, and final studies. Convertino et al. (2004) categorised activity awareness into three levels: fully aware, partially aware, and unaware. In this research, the same levels for activity awareness were used but operationalised differently. These modifications were applied to suit the study settings; Convertino et al. (2004) studied activity awareness in a controlled study where users worked in pairs through a shared tool; whereas in this PhD research, activity awareness was investigated in naturalistic settings where users worked face-to-face and remotely. More information about the Convertino et al. (2004) study can be found in Chapter 2 (section 2.2.2.1).

After understanding how to rate activity awareness in controlled settings, a method was proposed to study activity awareness in naturalistic settings. First, it started with conducting interviews with students at two or three time-points across the duration of

a group project. It is important to mention that participants did not know that I was studying awareness. They were only asked about what they did and what each member of their group did in the past week. Then, after transcribing interviews, answers about activity were inserted into a comparison grid for each interview time for each group. Each comparison grid represented answers about activities for a specific group for a specific interview time. After identifying tasks in each cell, a proposed process was followed in which comparisons were made between what members reported they did against what their colleagues reported about them. If participant X mentioned all tasks as reported by participant Y, then participant X would be ranked as fully aware (FA) of the activity of participant Y; if participant X mentioned some tasks correctly, then he/she would be ranked as partially aware (PA); and if participant X said "I don't know or I can't remember", then he/she would be ranked as unaware (UA). However, sometimes participants reported skills or how a member contributed rather than reporting what he/she did, so no enough information (NI) status would be given. Also, sometimes participants mentioned what a member did using different terminologies; in this case, synonyms were treated the same (e.g. prototype and wireframes are the same). Finally, for each grid, the number of instances of each activity awareness level was counted to get the results. Colour coding was suggested to use in order to facilitate comparisons visually.

In the third study, rules were created regarding the inclusion and exclusion of interview data to ensure that data were reliable. The rules were:

- The interviews should be on the same day or up to a maximum of two days, no more than 48 hours apart.
- If the difference was greater than 48 hours, then the interview was excluded
- If interviews with two participants were conducted on the same day but for different time-points (e.g. the first interview with participant X and the second interview with participant Y), then these interviews will be treated as if they were for the same time-point.

In the final study, the application of this method was checked with another researcher to ensure that process was rigorous and consistent. The second researcher was given a sheet with instructions on how to evaluate activity awareness along with all comparison grids for the final study. The interview time was hidden, so there was no information about whether it was the first or second interviews, to ensure that it would

not affect the researcher's opinion. We reached an agreement of 80% from the first round, and we also discussed the cases that we did not agree on to refine the method if required (see Chapter 7, section 7.5).

In summary, a new method for evaluating activity awareness was proposed. The process of constructing the method was refined in each study to be more robust and consistent. In the third study, set of rules for inclusion and exclusion of interviews was added, and in the final study, a reliability check was conducted for the application of the method.

8.3.3 RQ3: What activity awareness do group members have in long-term collaborative learning groups?

This research question was answered mainly through the results of the second, third, and final studies. Activity awareness is a significant concept in collaborative work in order to understand what is going on in the work of a group. Dourish and Bellotti (1992) stated that "awareness of individual and group activities is critical to successful collaboration". Activity awareness affects group activity that takes place over an extended period of time. In order to maintain awareness of the whole activity, group members must develop and maintain common understanding of shared plans, goals, roles, and norms; monitor the resources over time; and stay aware of the actual status of the execution of the group activity and its relationship with the previous aspects (Convertino et al., 2004).

A good level of awareness can support people to make their communication simpler, have opportunities to help each other, be able to coordinate tasks, and have access to shared resources (Nacenta et al., 2007). Therefore, a lack of activity awareness could lead to a breakdown in collaboration, from this it was concluded that full awareness is desirable and students should maintain a good level of activity awareness in collaborative learning projects as it influences their collaboration success. Maintaining activity awareness could be achieved by minimising breakdowns in activity awareness and increasing the instances of being fully aware.

Activity awareness is the knowledge that a group member has about the activities of the members of their group. Each member can be fully aware, partially aware, or unaware. These ratings were sufficient for the purpose of this research, as it was

needed only to know whether a group member was fully aware, partially aware, or not aware at all; the extent of partial awareness was not considered (i.e. is a member 75% aware? 50% aware? Less or more?), because it would have been impractical to collect and analyse such data.

In the second study, the number of "fully aware" instances at the first time-point was higher than at the second time-point for most groups. In general, activity awareness at the beginning of the project was higher than in the middle or near the end. Also, for each participant, a comparison was made between his/her activity awareness at the first and second time-points, in order to identify changes in their activity awareness. Results showed that the activity awareness of five participants decreased, the activity awareness of five participants did not change, and the activity awareness of two participants increased. There was missing information for the rest of the participants.

In the third study, it was found that activity awareness was not stable and changed over time; it increased, decreased, or remained at the same level for a while. However, there was incomplete information about some participants' activities as they did not report their activities in a clear way, and also some interviews were excluded due to timing issues, i.e. when there was more than two days between interviews for participants of the same group.

In general, it was found that activity awareness of students varied over time, i.e. a member could be fully aware for some time and then became partially aware, for example. This change occurred because the project ran for several weeks, and students worked at different paces, also they had different meeting rates which might affect their activity awareness. Also, this change occurred because they did not engage in the awareness behaviours.

In the final study, after using the social actor app, results showed that the number of "fully aware" instances increased, whereas the number of "partially aware" or "unaware" instances decreased. Moreover, for each participant, a comparison was made between his/her activity awareness in the first and second interviews, in order to identify changes in their activity awareness. It shows that, after using the social actor app, the activity awareness of nine participants increased, the activity awareness of eight participants did not change and the activity awareness of three participants decreased.

As the status of any group project changed, information for activity awareness would change. Therefore, students need to update this information to be fully aware of their group's activities. Figure 8.3 illustrates how activity information changed over time.

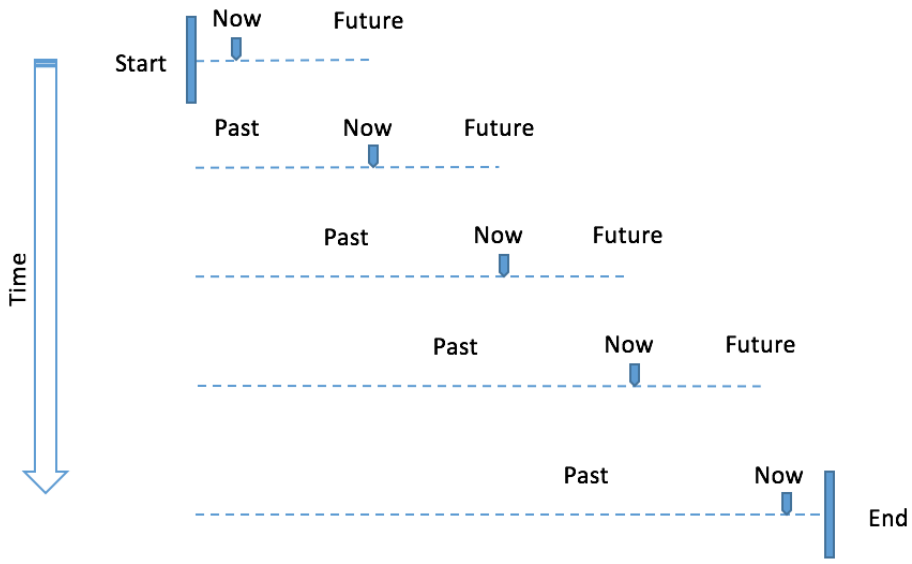


Figure 8.3: Activity information changed over time

8.3.4 RQ4: How can a persuasive social actor for activity awareness in long-term collaborative learning groups be designed and evaluated?

This research question was answered through the results of the final study where a persuasive social actor was designed and developed based on primarily the PSD model. The PSD model (Oinas-kukkonen & Harjumaa, 2009) has two components: the persuasion context and system characteristics. The persuasion context includes three main parts: the intent, the event, and the strategies. The intent can be identified by analysing the persuader and the change type. The event includes the use context, the user context, and the technology context. The strategies involve the message and route.

Accordingly, the persuasion context was analysed in order to design the persuasive social actor. Regarding the intent, the persuader was the researcher and the change type was both attitude and behaviour change. Regarding the event, the use context was to promote activity awareness in collaborative learning groups; the user context determined that the users were students in groups of three who were working on

collaborative learning projects and persuasion would promote their activity awareness which in turn would improve their collaboration and learning experience; and the technology context was a single lightweight app that works on iPhones and PCs. Finally, regarding the strategies, the message was in a form of text, sound, and animation with facial expressions delivered by a virtual social actor. The content of the message included questions, feedback, suggestions, reminders, rewards and praise. The route was mainly direct whereby the social actor asked the user to perform the target behaviours; the indirect route was also applied through the use of social cues.

The system characteristics included 28 persuasive techniques for primary task, dialogue, system credibility and social support. Each of the 28 PSD techniques was considered for its potential suitability and practicality to be applied in this context. Some techniques were deemed inappropriate; for example, the third-party endorsements technique is useful for e-commerce situations, but was not relevant in this case.

A lightweight social actor was developed for activity awareness called “Mr. Mentor”. Two versions of the app were developed, one for iPhone users, and the other for web users. A total of 15 persuasive techniques were applied in the iPhone version, and 11 persuasive techniques were applied in the web version. This difference occurred because the researcher was targeting iPhone users at the outset, but then it was found that the number of iPhone users in the participants’ sample was limited, so the web version was developed later with slightly less functionality to enable more participants to interact with the social actor.

The social actor app was also evaluated by users and experts using different techniques. In user evaluation, first a statement was created for each applied persuasive technique to represent that technique, then users were asked to rate each statement to indicate whether they agreed or disagreed with it. It was found that some techniques were successfully implemented in both versions of the app including reduction, tunnelling, praise, reminders, and surface credibility. Second, users were asked to rate other statements regarding their opinions about using the social actor app

Finally, students were asked open-ended questions about using the social actor app and how it could be improved. Some students suggested that Mr. Mentor should have

some kind of interactivity, i.e. it should have different options for asking questions. Some students suggested that the app should have more customisation options such as choosing the gender of the mentor, or choosing specific days for reminder, instead of everyday reminders.

In the expert evaluation, two expert reviewers evaluated the social actor app. Again, the PSD model was used for this purpose and the reviewers were asked to rate the existence of the applied persuasive techniques only, they were not asked to analyse the persuasion context because the aim of this evaluation was to find out whether the applied persuasive techniques were successfully implemented or not and they were already informed about the persuasion context before evaluating the app (see section 7.3.4 for detail). Results showed that three persuasive principles were highly supported in both versions of Mr. Mentor app; these were: praise, social role, and surface credibility. Five persuasive principles were between mid to high support: reduction, tunnelling, suggestion, liking, and real-world feel for both versions. On the other hand, the expert reviewers rated between low to no support for trustworthiness and cooperation. For the principles exclusive to the iPhone version, they found that personalisation and rewards were relatively well supported whereas the support for self-monitoring and competition was low or non-existent.

8.3.5 RQ5: Can a persuasive technology support students' activity awareness in long-term collaborative learning projects?

This research question was answered through the results of the final study (reported in Chapter 7). The research of this thesis on persuasive technologies was conducted based on the behaviour change support system (BCSS) framework, suggested by Oinas-Kukkonen (2010).

The social actor, Mr. Mentor, was intended to promote activity awareness in collaborative learning groups by changing the attitudes and behaviours of students. The target behaviours for Mr. Mentor were to encourage students to share their work with others in their collaborative learning group (i.e. to provide information), and vice versa, to encourage students to look at the work done by others in the group (i.e. to perceive information). Mr. Mentor is a digital character that interacts with users by asking questions, providing feedback, and making suggestions, using voice, text and facial expressions.

The social actor app was tested with Masters' students in the final study. Three measures were created and developed to identify the change in attitudes and behaviours that support activity awareness. First, pre-tests and post-tests were used to identify changes in attitudes and behaviours that related to activity awareness. Second, perceived persuasiveness and behaviour change was measured by asking participants if they perceived at the end any change in their behaviours using two statements on a 7-point Likert scale. Finally, participants were also asked whether Mr. Mentor changed their awareness of their group's activities using an open-ended question at the end.

Regarding the pre-tests and post-tests, 12 statements were created for attitudes and behaviours; eight statements for attitudes and four statements for behaviours. P-values were calculated for each statement using the Wilcoxon signed rank test. Four statements showed significant difference between the pre- and post- test measures; two for attitude statements and two for behaviour statements. After using the app during the coursework project, participants were more likely to share what they were planning to do in their project even if no one asked them. Likewise, the extent to which participants agreed that knowing what each member of a group is doing is essential in any group project changed after using the app. Also, results showed that

participants could tell what the current state of their project was at any given time more often, and they were more likely to inform group members about their progress after they used the app.

Post-test averages for both attitude and behaviour statements were higher than pre-test averages across all statements. Although the changes were limited as only a subset of statements were significantly different in the pre- and post-tests, however these changes were moving in the direction where averages of users' responses increased after using the social actor app.

Two statements in the last questionnaire focused specifically on whether participants perceived that their behaviour had changed after they used Mr. Mentor app. Participants on average agreed that Mr. Mentor encouraged them to share their work with their groups, and also persuaded them to look at the work done by other members of their groups, with an average of 4.86 on the 7-point Likert scale for both target behaviours. This shows that participants slightly agreed that Mr. Mentor persuaded them to share their work with the group and to look at the work done by their group.

Finally, it was found that almost half of the participants (10 out of 21) confirmed some degree of change in their awareness of the group's activities. This suggests that the social actor can motivate students to increase their activity awareness.

On the other hand, activity awareness was also measured at two time-points for each participant. In the final study, results showed that the number of "fully aware" instances increased after using the social actor app, while results from previous studies showed that the number of "fully aware" instances decreased, which indicates that the social actor app could influence the activity awareness of the students.

From these results, it was proposed that using a persuasive social actor during collaborative group projects may be effective in promoting activity awareness within groups, although clearly other external factors may also have influenced the outcome, such as individual differences in the students.

8.4 Contributions

This PhD thesis contributes to research in the HCI and learning communities by finding new ways to enhance learning, focusing on the learner-centred approach. This research proposes a promising approach by using a persuasive technology to encourage students to collaborate and achieve a successful collaboration, which will influence their overall learning experience and outcomes. It has focused mainly on supporting activity awareness, which is critical to the success of collaboration. This thesis contributes to the fields of HCI and collaborative learning in different ways. The main contribution is the novel approach to enhance activity awareness in collaborative learning groups by changing learners' attitudes and behaviours using a persuasive technology (HCI and collaborative learning). The second contribution is a new method to evaluate activity awareness in collaborative learning groups (HCI and collaborative learning). The third contribution is an insight into how to use the PSD model in the design and evaluation of a social actor (HCI). The fourth contribution is an analysis of how students collaborate in long-term collaborative learning projects in naturalistic settings (collaborative learning).

Wobbrock (2012) classifies seven types of research contributions in HCI. These are: empirical, artifact, methodological, theoretical, benchmark/dataset, survey, and opinion. This PhD research makes more than one type of contribution in HCI: empirical, artifact, and methodological contributions. Regarding its empirical contribution, the final study showed the potential of using the social actor app for activity awareness through conducting field studies and interviews. This PhD research makes an artifact contribution in terms of the social actor app and adding new insights into the using the PSD model in the design and evaluation. Finally, it makes a methodological contribution where a new method to evaluate activity awareness was proposed.

In this section, each contribution is discussed in detail. Table 8.1 summarises contributions, research questions and objectives in each chapter.

Table 8.1: Contributions, research questions, and objectives in each chapter

Contribution	1	2	1, 2, & 3	2 & 4	4
Research question	*RQ4*	*RQ3*	*RQ5*	*RQ2*	*RQ1*
Objective	*O4*	*O3*	*O5*	*O2*	*O1*
Chapter	6 & 7	4, 5 & 7	7	4, 5 & 7	3 & 4

8.4.1 A persuasive social actor for activity awareness

Firstly, the concept of persuasive technology involves changing people's attitudes and behaviours. From the results of the first study, it was found that students had some problems in awareness. Then, in the second and third studies, it was found that activity awareness was variable and the number of cases of being fully aware decreased in the second time-point, and several behaviours that promote activity awareness were also identified. Consequently, it was hypothesised that there is a room for employing the concept of persuasive technology to help students in promoting their activity awareness by changing their attitudes and behaviours that promote activity awareness.

This research presents a novel approach to enhance or maintain activity awareness in collaborative learning groups by changing learners' attitudes and behaviours using a persuasive social actor. This contribution includes empirical and artifact contributions and it benefits researchers in both learning technologies and persuasion in HCI as it presents advanced state of art in this area.

Accordingly, two target behaviours were chosen: students should share their work (i.e. providing information) and students should look at other members' work (i.e. perceiving information). Then, the persuasive social actor app was developed and tested. Changes in attitudes and behaviours related to activity awareness were measured as well as changes in activity awareness using the proposed method (section 8.4.2).

Regarding changes in attitudes and behaviours, three instruments were employed to measure them. Firstly, pre-test and post-test statements were used to identify changes in attitudes and behaviours that promote activity awareness. Second, perceived persuasiveness and behaviour change was measured using two 7-point Likert scale statements; one statement for each target behaviour. Finally, perceived persuasiveness and behaviour change was measured using an open-ended question about whether the social actor changed participants' awareness of their group's activities. In conclusion, changes in attitudes and behaviours were measured using two different methods: objective measures (using pre- and post-tests) and subjective measures (using self-reporting questions). Results of pre- and post-tests showed changes in attitudes and

behaviours that promote activity awareness. Participants slightly agreed that the social actor, Mr. Mentor, persuaded them to perform target behaviours. Results also showed that almost half of the participants (10 out of 21) confirmed some degree of change in their activity awareness of their group.

Regarding measuring activity awareness, results showed that the number of "fully aware" instances increased after using the social actor app, while results from previous studies showed that the number of "fully aware" instances decreased, which suggests that the social actor app influenced the activity awareness of the students.

From these results, it was found that using the persuasive social actor during collaborative group projects was promising and effective in promoting activity awareness within groups, although obviously other external factors may also have influenced the outcome, such as individual differences in the students and having other commitments.

Researchers in persuasive technology could find this helpful in terms of conducting research in persuasive technology, explaining relevant theories behind persuasion, choosing target behaviours, selecting design models, and designing a social actor to enhance activity awareness. Moreover, learning technologists and researchers in learning and education could extend the use of social actors to cover different learning contexts or target different behaviours. There is also an opportunity to investigate the use of other forms of persuasive technologies to enhance activity awareness.

8.4.2 A new method to evaluate activity awareness

This research makes a methodological contribution by proposing a new method to evaluate activity awareness. Learning technologists or researchers can use this method in collaborative learning contexts. First, a researcher or evaluator should collect data using interviews of two or three time-points (or more) across the project duration, by asking students, or collaborators, about what they did in the previous week and what each member in their group did. Then, the researcher should follow this process to measure activity awareness:

1. Transcribe interviews

2. Insert answers about activity into a comparison grid for each interview time for each group, following the inclusion and exclusion criteria (reported earlier in section 8.3.2)
3. Highlight self-reported cells to facilitate comparison
4. Identify tasks in each cell
5. Compare answers based on the following rules:
    - If participant X mentioned all tasks as reported by participant Y, then participant X will be ranked as fully aware (FA) of the activity of participant Y
    - If participant X mentioned some tasks correctly, then he/she will be ranked as partially aware (PA)
    - If participant X said "*I don't know or I can't remember*", then he/she will be ranked as unaware (UA)
    - If all members agreed that a specific member did something but he/she did not self-report it, then no enough information (NI) status will be given
    - If members mentioned skills or how a member contributes rather than reporting what tasks he/she did, then also no enough information (NI) status will be given
    - If participant X mentioned other tasks that participant Y did not self-report, then activity awareness of participant X will be evaluated based on what participant Y reported only.
    - Synonyms are treated the same (e.g. prototype and wireframes are the same).
6. Count, compare, and get results

This process was refined in each study to ensure that comparisons were done in a rigorous way. In the second study, interviews were conducted and the process was followed. Then, in the third study, the method was refined to ensure that results were reliable and a set of rules was clearly stated for inclusion and exclusion of interviews. Finally, in the final study, a reliability check was conducted to check that the application of the method was valid.

Partial awareness indicates that a member knows some of his/her colleague's activity. It is worth mentioning that I looked at higher level of detail about activity, for example, if someone stated that he conducted three interviews one with a single mother, and two with elder people; and his colleague reported that he conducted interviews, then his colleague is fully aware of his activity as he knew what task he was working on, but, for example, if someone stated that he created two personas and drew wireframes for the device, and his colleague reported that he created personas and did not mention the wireframes, then his colleague is partially aware of his activity. This would minimise information overload and cognitive overload and also make the comparisons more robust.

8.4.3 Insights into designing and evaluating social actors using the PSD model

This research investigated the use of PSD model in designing and evaluating a social actor for promoting activity awareness in small learning groups. There were different persuasive techniques or principles for designing persuasive technology; I chose the PSD model (Oinas-kukkonen & Harjumaa, 2009) for designing the persuasive social actor because the framework is structured, comprehensive, and easy to use and it includes most of the persuasive techniques. All of the PSD techniques were examined if they were suitable to be considered as part of the design.

Moreover, the PSD model was used for the evaluation by users and by experts. Regarding user evaluation, a new method was suggested using the PSD model. Accordingly, for each applied persuasive technique, a statement was created to describe the application of this technique, then users were asked to rate these statements on 7-point Likert scale after they used the Mr. Mentor app to find out whether these techniques were successfully applied or not.

Regarding expert reviews, reviewers were asked to rate the applied persuasive techniques to find out whether the applied persuasive techniques were successfully implemented or not. They were not asked to analyse the persuasion context because in the expert reviews done by other researchers (Lehto & Oinas-kukkonen, 2009; Lehto & Oinas-kukkonen, 2010; Räisänen et al., 2010; Langrial et al., 2012), they analysed the persuasion context to understand what these technologies intended to do as they were not designed using the PSD model, whereas in this PhD research, the researcher

already analysed the persuasion context as part of designing the app using the PSD model and informed the reviewers about the persuasion context. After evaluation, a narrative comparison between user evaluation and expert reviews was made. It was found that experts and users agreed on some persuasive techniques whether they were supported or not in the social actor app. They found that reduction, tunneling, praise, surface credibility were successfully supported in both version. For iPhone version, users and experts agreed that reminders, liking, and real-world feel were successfully supported. Four persuasive techniques were exclusive to the iPhone version (personalisation, self-monitoring, rewards, and competition), it was found that users and experts agreed that personalisation, rewards were successfully supported in the iPhone version. They also agreed that competition was not supported in the iPhone version and cooperation was not supported in the web version.

In conclusion, PSD model can be used in other different ways beyond the suggested ways to use it, i.e. either for designing or evaluation. The PSD model can be used in user evaluation as suggested earlier. Moreover, any developed persuasive technology that designed based on the PSD model could also be evaluated by expert reviews using the PSD. This artifact contribution benefits researchers and designers in persuasive technologies by giving further insights on how to use the PSD model.

8.4.4 Analysis of long-term collaborative learning in naturalistic settings

The fourth contribution is an incremental contribution to the existing research on collaborative learning, specifically for the long-term collaborative learning in naturalistic settings; the studies that focused on this learning situation were limited. Researchers in collaborative learning could benefit from this contribution as it gave greater insights into collaborative learning and activity awareness in this context.

This research looked at real groups to find out how students collaborate on real group project in the wild without any interventions where students decide how they collaborate and which applications and tools they wanted to use in their collaboration. Other research has looked at students worked in controlled settings and/or through a shared tool (e.g. Convertino et al., 2004; Aiken et al., 2005; Carrington et al., 2010).

It also explored the collaboration activities and behaviours that support awareness. In general, awareness-promoting behaviours could be divided into two types: perceiving

information (by asking or checking resources), and providing information (by offer clarification, updating and work reviewing).

To maintain awareness between meetings, it is significant to encourage students to become aware of their colleagues' activities and also to help their colleagues to be aware of their activities by reinforcing their attitudes and behaviours that promote activity awareness.

In long-term collaborative learning, students usually meet several times and they have both co-located face-to-face meetings and remote online meetings. The more frequently they meet, the better outcome they get, and as in the face-to-face meetings they normally practice several collaboration activities and awareness behaviours. One example of low meeting rate group was group C in the second study, and they got the lowest mark across all the groups, and they had only five meetings.

8.5 Limitations

This PhD research has focused on a specific situation of collaborative learning in which small groups of students (3 to 4) work together on real projects for around 6 weeks as part of their course. It has suffered from some limitations including the number and type of participants, the quality of some data, limited resources and some study design decisions. In this section, each of these limitations is discussed in detail.

8.5.1 Number and Type of Participants

The research involved both qualitative and quantitative approaches. Although some researchers have argued that some qualitative research does not require a large number of participants (Bertaux, 1981; Romney et al., 1986; Kuzel 1992; Crouch & McKenzie, 2006; Guest et al., 2006), the number of participants in all studies was limited. The first study had seven participants; each of them was from a different group. In the second study, five groups participated with a total of 17 participants. In the third study, four groups participated with a total of 15 participants. In the final study, 21 students participated and they were from 10 different groups.

This limitation arose because the participants were a convenience sample of students who were working on real learning projects for around 6 weeks (except the first study

where students worked for 2 semesters) and they had to commit until the end of the study. As a consequence of this limitation, we were not able to look for patterns due to the limited number of participants.

Also, participants in the first study (pilot study, Chapter 3) were different from participants in the other studies (Chapters 4, 5, & 7). Participants in the first study were undergraduate students and their group projects ran over two semesters. On the other hand, participants in the other studies were Master's students and their group projects were almost the same and ran for 6 weeks. However, this limitation was not significant as the first study was a pilot study to explore collaboration in collaborative learning groups with no focus on evaluating activity awareness.

8.5.2 Limited Data and Resources

Some data were not sufficient or limited and sometimes there was missing information in the collected data. Almost each study suffered from this limitation in some way.

In the first study, interviews were the only data collection method used and participants were from different groups and only one member of each group participated and was interviewed, so there were some chances of self-reporting bias as participants reported what they believed, but it was not the whole picture of the group work. The self-reporting limitation is discussed later in this section.

In the second study, participants of group C could not be interviewed twice due to their time constraints. In some cases, the collected data was not sufficient to evaluate activity awareness and make a decision about whether a participant was fully aware, partially aware, or unaware of the activity of his/her colleagues. Moreover, some participants from different groups reported skills rather than activities about their colleagues.

In the third study, it was hard to manage conducting interviews for each group on the same day or within two days, to get reliable data about activity awareness. This limitation occurred due to the challenge of collecting data in real learning projects, as participants were not available on the same day because some of them were part-timers and some had different commitments, and from an ethical point of view, it was

not acceptable to press them. However, a set of rules was created for inclusion and exclusion criteria to mitigate this limitation.

In the final study, there was limited time and resources for the development of the Mr. Mentor app and the researcher had to develop the app alone. The iPhone version was the main one, however, the number of iPhone users in the sample was limited (9 users). Limitations in the social actor app are described in detail later on (section 8.6.4).

In this PhD research, interviews were used in each study to collect data from students mainly to measure their activity awareness. However, in self-reporting methods such as interviews, even if respondents are trying their best to be truthful and accurate in answering questions, there are some chances of inaccuracy or they might forget to report some significant information. "Self-reports in the context of face-to-face interviews raise a host of other problems such as effects of self-consciousness, rapport, transference, and modeling" (Paulhus & Vazire, 2007).

Another potential drawback in self-reporting methods is the possibility of self-reporting bias in which participants tend to over-report behaviours they deem appropriate, and under-report behaviours viewed as inappropriate by researchers because they want to look as good as possible (Donaldson & Grant-vallone, 2002).

Although a reliability check was conducted for the data coding and for the method for activity awareness evaluation, there is a risk of research bias in the qualitative data. First, a subset of students taking the course chose to participate and maybe if all students or a different subset of students had participated, we might have obtained different results. Second, regarding interviews as a data collection method, there was a risk of inaccuracy in the self-reported data and a risk that interviewees might forget to report some significant information, which as a consequence could affect the overall results. In all studies, there was no objective verification of peoples' claims and omissions. We relied on what participants reported. Moreover, the proposed method for measuring activity awareness measured what the students knew, but it did not look at what they did not know about others' activities. Finally, it should be mentioned that what discovered was influenced by the questions asked in the data collection tasks.

8.5.3 Study Design Decisions

Some study design decisions were taken due to ethical consideration, for instance, in the final study, it was not possible to conduct a comparative study between people who use the app and people who did not use it. All students had to be able to use the app if they decided to participate in the study and it was not ethical to divide participants in two groups; one to use the app and the other not.

In the method for evaluating activity awareness, interviews were chosen to collect data. Another option would have been to use questionnaire, so students can tick the tasks they did and the tasks their colleagues did, then comparisons would be made straightforward. However, choosing this method might have chances of bias; i.e. students might tick anything or have more information than in the offered choices. So, using interviews to elicit what members did was a good option to ensure that students were not affected by the offered choices; also they were not aware that we were collecting data about their awareness.

The scope of this PhD research was limited to real-world collaborative learning situations. Hence, there was a challenge in conducting studies and collecting data in such situations as there was no control on the studies from the researcher, which influences the study design and data collection, however, some really useful data were collected. Moreover, one challenge of conducting studies with real learning projects that other undetermined external factors might affect the results.

8.5.4 Limitations in the Social Actor App

Two versions for the social actor app, Mr. Mentor, were developed and they incorporated a different number of persuasive techniques (iPhone version and web version). The web version had less functionality than the iPhone version as the web version was developed at a later stage when it was found that the number of iPhone users in the sample was limited. The overall responses of using the web version were low, whereas the overall responses of using iPhone version were higher. Some persuasive techniques were not successfully implemented in the social actor app, Mr. Mentor, either due to technical issues or due to poor design or implementation decisions. For example, reviewers found that the reminders principle was highly supported in the iPhone version only, and was poorly supported in the web version as

the reminders did not appear always as said by Mr. Mentor. In addition, in the rewards tab, the total number of collected points was reset after a while. This problem appeared because the app was installed locally on the iPhone device and was not connected to the App Store, and due to time and resource limitations, this problem was not resolved.

8.5.5 Generalisability

The work reported here had clear boundaries. It examined one kind of learning group, focussed on a specific type of problem-solving project, included projects that run over a certain period of time.

Some of the findings may be generalisable and transferable to similar learning projects. Generalisability can be defined as "the usefulness of a theoretical construct outside of its limited domain of known observations" (Baskerville, 1996). Some researchers adopt the approach of analytical generalisation (Kvale & Brinkmann, 2009), which indicates the extent to which the findings from one study can be generalised and transferred to another (Leung, 2015).

In this PhD research, the proposed method to evaluate activity awareness in collaborative learning groups is transferable and can be applied to similar collaborative learning groups to evaluate their activity awareness. Moreover, it could be useful to use this method to evaluate activity awareness for collaborative groups working in different contexts but within similar situations i.e. people working on a long-term project even for non-learning purposes.

The concept of using persuasive technologies to change learners' attitudes and behaviours is noteworthy and can be applied in different ways as suggested later in the future work (in section 8.6.5). Designing and evaluating the social actor app is a case study of using the PSD model in the design and evaluation of the social actor. Most of the applied persuasive techniques were successfully implemented based on the feedback from the users and expert reviews and they could also have been implemented in other ways. If more experts were recruited, different views might arise. Future work may include improving the social actor based on the feedback as discussed later (section 8.6.4). Moreover, if other design models are considered in

designing the social actor, the design and the outcome might proceed quite differently.

In this research, some collaboration activities and awareness behaviours were identified in the learning groups. Therefore, we expect that in similar collaborative learning situations, these collaboration activities and awareness behaviours would appear; some of these activities and behaviours are more likely to occur as they were identified in all observations (e.g. discussion and suggesting), while less common ones (e.g. updating an absent member) could appear but less frequently. In other learning settings we might find something else.

8.6 Future Work

Although this research suffered from some limitations, it gave an overview of students' collaboration in real long-term collaborative learning projects, and it investigated a novel approach to promote their activity awareness of each other's activity by using a persuasive social actor. In this section, recommendations for future work are presented.

8.6.1 Bigger Sample for Further Studies

In qualitative research, a smaller sample size is generally considered sufficient (Crouch & McKenzie, 2006), however, to identify patterns, a study with a larger number of participants is required for all studies, i.e. a study for exploring more about activity awareness and an empirical study to find out more about the changes in behaviours and attitudes that the social actor could influence. Therefore, conducting studies with a larger sample is needed in order to mitigate the first limitation, and

8.6.2 Collect Additional Data

Using more than one data collection technique to explore how students collaborate in long-term collaborative learning projects would enrich the findings.

The method of measuring activity awareness could be improved by asking students to provide more information as they sometimes have reported information about their

colleague's skills rather than their activities, or the researcher could have a check list on the side so he/she can check if the given information were sufficient. Moreover, having more control on the timing of data collection would improve the results of measuring activity awareness.

8.6.3 Different Study Design Decisions

In testing the social actor app, it would be valuable to conduct a comparative study between two groups; one group would use the app and the other group would not use it, in order to identify clearly the impact of using the social actor app.

Another option that could be considered in designing and analysing a persuasive technology is using the Fogg Behaviour Model (FBM) (Fogg, 2009a). This model helps in understanding human behaviour and it has three factors: motivation, ability, and triggers. Each factor has subcomponents. No data was collected from users about their motivation and ability to perform the target behaviours of sharing work with the group and looking at group work; Mr. Mentor and the study focused on triggers. However, the FBM could be used to analyse motivation and ability. Regarding motivation, the pleasure/pain and hope/fear sub-components seem to be suitable in this context where the social actor enhances motivation by rewarding users whenever they perform the target behaviours (pleasure) and becomes sad if they do not perform the target behaviours (pain). Furthermore, students hope to succeed by the end of their group projects and fear failing. Students are also motivated to perform these behaviours to be a good team member – this is a social acceptance motivator. Regarding ability, students in this context had the ability to perform the target behaviours except that they might have had limited time; however, the Mr. Mentor app does not focus on this factor. Given that students have high motivation to succeed in their projects and to be good team members, it was found that the appropriate triggers were signals in the form of reminders and notifications, which were used in the Mr. Mentor app in several places. Mr. Mentor did not take into account supporting ability which makes the perceived usefulness low.

8.6.4 Improvements to the Social Actor App

The social actor app meant to be a lightweight app, therefore, having a web version was not helpful as results showed that the overall responses of using the web version was low, whereas the overall responses of using the iPhone version was higher. Therefore, the social actor could be improved by developing a version for other mobile platforms such as Android, as some participants suggested developing a version for Android, rather than using the web version.

Based on the users' feedback, there are a number of opportunities for modifying the social actor. It would be more effective if the social actor had more interactive features, such as asking different questions, especially if people will use it over a long period of time.

Based on the expert reviews (Chapter 7), we can see that some persuasive principles were not supported in the Mr. Mentor app. The app could have better support for trustworthiness, cooperation, self-monitoring and competition.

Some improvements are related to technical issues. For example, the iPhone version of the app should be connected to the App Store to solve the problem of resetting the total number of collected points in rewards tab.

Also, it would be valuable to find out if the changes in attitudes and behaviours would persist after using the app in other projects, i.e. are they permanent or temporary changes? Specifically, if students would work in any learning group project in the future.

8.6.5 Future Ideas

Collaborative learning has been investigated widely over the last 20 years. However, limited work has focused on identifying collaboration styles in collaborative learning groups, therefore, collaboration styles could be investigated further as this could benefit students and enhance their collaboration.

Technologies are widely used in education and learning for several purposes. There are interesting possibilities for incorporating persuasive technologies into education and learning (e.g. Firpo et al., 2009; Janssen, 2012; Mintz & Aagaard, 2012; Behringer et al., 2013), however, they are not fully explored in this area and can be

investigated further by targeting different behaviours and attitudes that could enhance the learning process and outcomes.

The persuasive social actor in this PhD research was used to encourage students to share what they did with their group members, and to look at what their colleagues did. However, persuasive technologies can also be used to reinforce other behaviours to promote activity awareness. One option that could be useful in promoting activity awareness of collaborative learning groups is using another form of persuasive technology such as media or virtual reality to see the cause-and-effects of not being aware of groups' activities. Another option in collaborative learning situations, might be to use persuasive technologies to encourage students to attend more group meetings.

There are several interesting possibilities for using persuasive technologies in other learning contexts. For example, persuasive technologies can be incorporated to support distance learners who study remotely to be more self-directed and persuade them to learn and find resources. Moreover, persuasive technologies could be used to encourage students to solve more critical-thinking problems or to learn a new programming language for example.

8.7 Conclusion

This thesis has provided insight into how students collaborate in long-term collaborative learning projects and has suggested a method to evaluate their activity awareness. It has presented a novel approach to support students in long-term collaborative learning projects by changing their attitudes and behaviours in order to increase their activity awareness and has demonstrated this approach through the design and evaluation of a persuasive social actor.

Research questions were answered through four studies. There were four contributions to the fields of HCI and collaborative learning: a persuasive social actor for activity awareness in collaborative learning groups; a new method to evaluate activity awareness in collaborative learning groups; insights into designing and evaluating a social actor app using the PSD model; and analysis of long-term collaborative learning in naturalistic settings.

Research limitations were highlighted and explained including the number and type of participants, the quality of the collected data, some design decisions, limitations in the social actor app, research bias of qualitative data and generalisability of findings. Finally, this thesis has briefly touched upon some possible future work that would mitigate these limitations, including suggestions to improve the design of the social actor, and possible alternative persuasive technologies that could be used in a collaborative learning context or in other learning contexts.

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Appendix A: First Study

Appendix A.1
First Study: Interview Questions

First section about the group:

- How many students in your group?
- How often do you meet? e.g weekly, twice a week,..?
- For how long do you meet?
- How do you run/manage your meetings?
- How do you communicate with you group members? Emails, Facebook, whatsapp, messages?
- Do you use any tool during your meetings? e.g. Laptops, pen and paper?
- Do you use any software or application to keep records for your meetings? e.g. project manager
- Do you use any software or application to share your documents?
- Is there any particular role for you in the team? e.g. leader, note-taker, designer, …
- Have you faced any problems during your group-project?
    - If yes: what are they? How do you overcome them?
- Do you choose your group members or is it done by the module leaders?

Second section about learning styles:

- Have you ever come across "learning styles" terminology?
- Do you know what learning style is?
    - If yes: Do you know what your learning style is?
- Do you know what collaborative learning is?
    - If yes: Can you describe it in some words?
- Do you discuss with your team members about different solutions for each task?
- How do you distribute the project tasks?
- In your team: do you usually distribute the tasks in parallel or sequential way?
    - Parallel: everyone perform tasks at the same time (independent tasks)
    - Sequential: one's task depends on the solution of another's task to perform his/her task(dependent tasks)
- For any single task: could you please describe how do you usually produce the solution? What steps do you follow as a group?
- For any single task: have you discussed what everyone should do?
- For any single task: have you worked independently without telling your team what are you doing?
- For any single task: have you insisted that your solution or opinion should be selected or applied?

Third section about your attitudes:

- What do you think about collaboration in your team?

- If you can describe your group work by two or three words, what are they?
- Do you prefer to work with friends or professional?
- Do you prefer to learn by using discussion with your team members or learn privately?
- Do you prefer to use prepared plans or tend to explore new options?
- Are you emotional or logical person?
- To what extent you are satisfied /happy working with this group? From 1-5 (where 1=strongly unsatisfied, 5=strongly satisfied)
- If you have the chance to choose your group members: (why?)
    - Choose the same group members, some of them, none

Appendix A.2
First Study: Coding Scheme

Theme	Sub-theme	Code	Description	Example	Participants
Meeting	1. Number of members	6 Members	There are 6 members in the group	There are 6 members including myself	P3, P4, p7
		5 members	There are 5 members in the group	how many students in your group? Including me 5	P1, p2, p5
		4 members	There are 4 members in the group	It was supposed to be 6, one dropped out after the 1st week so we went to 5, and then one dropped out 2 weeks before the deadlines, then it was 4	P6
	2. Meeting rate	Frequent meetings	All group members meet 3 to 5 times per week	I'll say about on average 3 to 5 times a week	P4
		Regular meetings	All group members meet 2 to 3 times per week	How often did you meet? 2 to 3 times a week	P1, p3, p5
		Average meeting rate	All group members meet 2 to 4 times per month	How often did you meet? Once a week	P6, p7
		Low meeting rate	All group members meet less than 5 times overall	Team meeting maybe 3 times overall	P2
		Everyday meetings	Group members meet everyday before the deadline	I'll say nearing the deadline, it will be everyday	P4, p6
		Early meetings	Group members carry out early meetings	I think that in our team it worked out well, because we met earlier	P3
	3. Meeting structure	Take attendance	Group members take attendance	We took attendance on an online spreadsheet.	P1, p6
		Booked a room	Group members booked a room for their meetings	We normally have a room booked for like an hour and a half,	P6, p7
		Write all tasks	Project manager writes all the tasks at the beginning of each meeting	It was literally the case where we, as I said we did a lot of documents on a piece of paper, so we write out all tasks on piece of paper	P6, P7
		Less documentation	There is no much documentation about how tasks were completed	there wasn't a lot of documentation	P1
		Write notes	Project manager take notes about opinion and things to discuss	when they had opinions and things to discuss I would always take note of it	P3
		Initial plan	Group members have an initial plan to complete their project	We did think about the start that we should draw a chart and see how each task effects the other	P1, p2
		Subgroup meeting	Some group members meet regularly	We have 2 or 3 of us but actually to have every single person there was less than a handful times	P2
		No specific time	There is no specific time for the meetings	for how long do you meet? Specific time? It was when we arrive together till basically when we had to go	P2
		Not formally managed	Meetings are not formally managed	It wasn't formally managed	P2
		No one member	One member cannot do the whole work	you can't just assign one member to doing the whole thing	P3, p6
		Audio recording	Group members audio-record meeting and find this useless	We only once did we actually tape a session but that seems a bit useless	P1
	4. Participants' roles	Project manager	Participant is the project manager	I was the project manager	P1, p3, p6, p7
		Programmer	Participant is a programmer in his/her group	I'm a programmer	P1, p2, p3, p4, p5, p6
		Designer	Participant is a designer in	I was involved in designing,	P3, P4, p5

			his/her group	designing UML diagrams	
		Tester	Participant is a tester in his/her group	Originally the primary tester	P4
		System analyst	Participant is a system analyst in his/her group	I was kind of the business analyst	P3, p4
Applications and Tools	5. Applications used	Use email for formal	Group members use email for formal communication	Email would be for formal occasions	P1, p2, p6
		Use email	Group members use email to communicate and transfer the work	Email was basically the initial one	P3, p7
		Use Facebook	Group members use Facebook for communication	we used Facebook, we had a Facebook group	P1, p2, p5, p6, p7
		Use WhatsApp	Group members use WhatsApp to communicate	We created a WhatsApp group as well, so we would communicate by that	P3, p4, p6, p7
		Use Trello	Group members use Trello for communication	the actual work would happen on "Trello" so we used project management tool	P1
		Use Dropbox	Group members use Dropbox to share documents	we have a Dropbox to share documents	P3, p4, p5, p6, p7
		Use Excel	Group members use Excel or style sheet for writing meeting minutes or attendance	we had an excel sheet as well showing who attended and who didn't attend and if they didn't attend the reason why they never attended	P1, p3, p5, p6
		Use Word	Group members use Word for writing meeting minutes, personal diaries, or documentation	Word is for what we done exactly in each meeting	P4, p5, p6, p7
		Use PowerPoint	Group members use PowerPoint for writing meeting minutes	I used PowerPoint, so I made each minute into a slide	P6
		Use phone calls	Group members use phone calls for direct contact	We also did a bit of phone calls	P1, p3, p5
		Use SMS	Group members use SMS to text each other in the university	we used SMS … SMS is more of "where are you?" in uni.	P2
		Use Moodle	Group members use Moodle for blogging and sharing documents	Moodle was for blogging	P2
		Use video chat	Group members use Skype or Google+ for video chat	We also did a bit of phone calls and skype-ing We used Google+	P1, P6
		Use other application	Group members use other application for storage or to manage coding	we use another application towards the end, we sign up to get it and I explained to all the members of the team which supposed to be coding how to use it	P1, p2
	6. Tools used	Use laptops	Group members use laptops in their meetings	2 were used laptops	P1, p2, p3, p4, p5, p6, p7
		Use pen and paper	Group members use pen and paper in their meetings	All the meetings that we conducted was like keep a minutes of what's actually happen during meeting, by pen and paper	P4, p7
		Use white board	Group members use white board in their meetings	I wrote down on the board what we were going to discuss	P6
	7. Positive comments on applications	Positive comment on Trello	Participant states a positive comment on Trello	all of the communications is actually kept in a really nice manner	P1
		Positive comment on Facebook	Participant states a positive comment on Facebook	I think Facebook was defiantly most effective	P1, P7
	8. Negative	Negative	Participant states a negative	rather than go through the moodle	P1

	comments on applications	comment on Moodle	comment on Moodle	which is …	
		Negative comment on Dropbox	Participant states a negative comment on Dropbox	I found Dropbox was a bit of hindered	P7
Collaboration	9. Collaboration activities	Discussion about tasks	Group members discuss about tasks and how to complete it	Well when we start our meeting we discuss who was asked to do which task	p1, p2, p3, p4, p5, p6, p7
		Discussion about roles	Group members discuss about the role for each member	we can discuss not just about the roles	p1, p3, p5
		Discussion about skills	Group members discuss about their skills	We discussed with each other's what our strong skills	P3, p4, p6
		Discussion about progress	Group members discuss about their progress in completing tasks	and what the progress happen	P1, p7
		Discussion with other groups	Participant discuss about different parts of the project with other group	I felt that it was easier to meet and discussed things with other teams	P1
		Helping each other	Group members help each other to complete their tasks	We would also trying to see if we can lend us/ if someone had finish a task, we tried to lend a hand to another team member so we can get the task done as soon as possible	P1, P5, p7
		Clarifying	Group members clarify any difficult part to each other	I just explained to them what I knew	P1, P3, p4
		Revising	Group members revise each others work and check it is right	it's gonna be checked by other team members to make sure it's right	P4, p5
		Persuading	At least one member persuades his group in some solutions	while admitting and persuading everyone on that, I thought that something was the best solution	P1
		Awareness	Group members are aware of each other's work and progress	We up to date with each other's work, so I knew, or how much this guy done for this part of the programming or that part of the diagram, I would know	p4, p5, p6, p7
	10. Tasks assigning	Task assigning based on skills	Tasks are assigned to group members based on skills	we can see where we are strong points where, and we basically used that to assign people on different diagrams	P3, p4, p5, p6
		Task assigning by volunteering	Tasks are assigned to group members by volunteering	We will set around on a table in a meeting and literally a case when I say Ok that's what we need to do who feel confident in completing this task and people just volunteer	P1, p4, p7
		Task assigning by project manager	Tasks are assigned to group members by the project manager	team leader probably is allocating the work	P2, p3, p7
	11. Collaboration styles	Parallel work	Group members usually work in parallel way	I would say it is much more parallel	P1, p2
		Sequential work	Group members usually work in sequential way	it was sequential in this case, because it was a step-by-step	P3, p4, p5, p6, p7
		Independent work	Group members usually work independently	Everyone was given or had to work independently	P2, p4, P5, p6, p7
		Domination	There is a dominant member in the group	Have you insisted that your solution or your opinion should be selected or should be applied for a specific task? I think I did do that quite a number of times	P1, p7
	12. Finding	Iterative process	There is an iterative process of	It's quite an iterative process, where	P1, p2, p4

	solutions		refining the work to reach a final solution	it's constantly revising the diagram and finally we reach to the point where we say ok, this is good, that's final	
		Easier choices	Group members prefer easier choices to complete their tasks	so we went to PHP and JavaScript and MySQL, and the coding was much easier	P3
		Use resources	Group members use different resources to complete their tasks such as books, lecture notes, YouTube videos, etc.	First thing I did was to see the lecture notes and see if anything can help me out	P1, p3, p5, p6, p7
		Talk to consultant	Group members talk to consultant to ask and discuss about the solutions	solutions will be discussed with the consultant	P1, P5
		Conduct research	Group members conduct research to complete their tasks	Research just conduct a research	P3, P5, p6
		Previous experience	Group members have previous experience to complete their tasks	And because I've got previous experience with doing	P4
		Give opinions	Group members give their opinions to each others to complete their tasks	one of them was struggling how to go bond and stuff like that, so we have to give our opinions saying that you should do this and if you think it's right way do it	P3, P5
		Improvisation	Group members improvise to complete their tasks	improvisation, which isn't good but at the moment that's what we did in the team project	P4
	13. Positive aspects of group or work	Work done on time	Group members complete their tasks and deliverables on time	we did finish the work on time	P3, p6, p7
		Get good marks	Group members get good marks in their deliverables	we all kind of receive good marks	P3, p4, p5, p7
		Remain calm	Group members remain calm	We tend to remain calm and just do as much as we can	P4
		Better understanding	Group members get better understanding of each other	we got a better understanding of each other	P3
		Feel responsibility	Participant shows some sense of responsibility	I do feel like there is some failure on my part, where I failed to get them in a room	P1, p6
		Show up on time	Group members show up on time	everyone was showing up on time	P6
		Learning experience	Participant learns from working in group project	I think it was learning experience	P1, p5, p6
		Motivate members	A case when there is at least one member motivate other members in the group	and even though we mostly anger of the rest of them I kept going on like we can do this and try to motivate them and they were motivated	P3, p6
		Enthusiastic member	A case when there is at least one enthusiastic member in the group	I think is my collaboration with, I would say the more enthusiastic teammates	P4
		Focused members	A case when there is one or more focused member in the group	there was 3 of us in the team were really focus and we kept going	P6
		Strong members	Some group members are strong	usually I had about 4 members, 4 out of 6, including myself that were strong members	P3
		Fun	Participant states that working with his/her group is fun	working with them is quite fun	P4
		Democratic group	Participant states that he/she has a democratic group	We had a democratic group	P4, p6
		Try their best	Participant states that his/her group members try their best to	At the end they try their best. Some of them didn't have the knowledge	P5

			complete the project	but still they try their best	
		Good experience	Participant states that working with his/her group is good experience	we got very well and it was good experience	P5
		Game playing	Participant suggests that playing games will help group members to bond	I felt that the people I was playing with I would probably be able to do a team project much better than the people I was that were in my team	P1
		Social activities	Participant suggests that social activities will help group members to bond	Exactly, I mean the people that work, that 2 guys were quite good and focus we did had time together, we did have fun, we went out for dinner try to get like the group more expose, we all out for dinner, so we don't always have to be working	P6
	14. Negative aspects of group or work	Weak group	Participant states that his/her group is weak	our group is kind of weak	P6
		Bad group	Participant states that his/her group is bad	I had really bad group	P6
		Not actual team	Participant states that his/her group is not actual team	We weren't actually team together	P2
		Hassle	Participant states that group project is quite hassle	team project is quite hassle	P4
		Struggle	Group members struggle a lot in their project	this team is the only one that struggled the most	P6
		Bad experience	Participant states that his/her experience in the group project is bad	this experience was pretty bad	P1
		Stressful	Participant states that working in his/her group is stressful	this was the stressful	P3, P6
		Lots of arguments	There is a lot of arguments between group members	there is a lot of arguments	P6
		Unfair	Participant states that working in his/her group is unfair	that's quite unfair	P6
	15. Problems with members	Member dropped out	A case when at least one member didn't stay in the group	Initially they was 6 including me and after term 2, well during term 2, we had 5, one person dropped out	P1, p5, p6
		People disappearing	A case when one or more members are not showing up and disappearing	but people disappearing and throw my team work bring things down	P2
		Ignorant member	A case when one or more members are ignoring messages from other members	we know that they know we are trying to get in touch with them so anything after that is down to the person that simply either ignoring it or they being oblivious to it	P1
		Absent member	A case when at least one member is absent for a while	the worst thing about that meeting was half of the team wasn't present	P1, p7
		Some working members	A case when not all the group members are working just some of them are working very hard	4 out of 6 of the members were actually doing work properly	P2, p3, p4, p5, p6
		Free-riding member	A case when at least one member is relying on other members to complete his/her task	One of the guys in the team was helping another guy and feel like the other guy wasn't doing anything if you don't tell him to do this he won't do it, you have literally told him do this this this, follow this website and then I want this result, it's pretty much you give him the whole answer	P6
		No strong	A case when there is no strong	we don't have a strong programmer	P6

		programmer	programmer in the group	in our team	
		Lack of motivation	Some group members don't have the motivation to come into the meetings or participant failed to motivate them	actually it was very difficult to get people, force people, motivate people into coming into consulting meetings, coming in to working sessions	P1, p6
		Lack of knowledge	Some group members don't have the knowledge to complete their tasks	they kind of lacking the knowledge of designing	P5
		Irresponsibility	A case when some members are not taking their responsibilities	So I had to build everything because others wouldn't do, wouldn't take on their responsibilities	P4
		Low contribution	A case when one or more members didn't contribute that much	that we're really unhappy about the levels of contribution in this team	P1, p4
		Slow working	Group members work slowly	I mean we're working slower	P1
		Failed to manage	Participant failed to manage the group members	I failed getting my team together in a room and getting the team to bond	P1
		Different timetables	Group members have different timetables, which cause some difficulties to set meetings with their supervisor	It was falling because our timetables dates always different, they are totally different	P7
		Different goals	Group members have different goals in their project	their aims were different, I was aiming to something else	P1
		Compare	Participant compares between his/her group and other groups	I felt like I was getting more requests from other groups to work with them and solve problems they had rather than I was getting from my own team	P1, p6
		Lazy member	Participant states that his/her group is lazy	People being very lazy	P2, p6
		No awareness	Some g members are not aware of each other's work and progress	literally person who is designing IP has no attention to the design when I was going making my one	P1, p2, p3
	16. Communication problems	No discussion	There is no discussion about the tasks between group members	As a general rule of thumb, persons sorts of did what they did and don't really discuss it	P2
		No full communication	No full communication with one or more members	there was like a wall or something that's blocking, so we couldn't get that full communications of them	P3
		Difficulty at the beginning	There is some difficulties in communication at the beginning	In the beginning it was really really difficult because none of us have met each other before	P7
		No reply	A case when one or more group members don't reply on messages	And any time I post any code to them, no one will reply	p2, p3, p4, p6
		Late reply	A case when one or more group members don't reply immediately on messages	just a few members who wouldn't reply immediately or within the same day	P1, p3, p4, p6
		No answer	A case when one or more group members don't answer his/her phone	why did you give people your phone number when you can't answer it	P1
		Unchecked accounts	People don't check their accounts on email, facebook, or other tool	the one who never had WhatsApp will never go on his WhatsApp	P1, p6
		Bad communication	There is a bad communication between the group members	We had a really bad communication going on	P1, p6
	17. Problems with tasks	Start from scratch	Participant start from scratch and do the work again	I throw all the work and just starting again from scratch	P2
		Mismatch work	A case when there is mismatch work	when we submitted the lecturer said none of these diagrams match	P1
		Duplicated	A case when there is duplicated	there wasn't really risk for anyone	P2

		work	work	to duplicating work	
		Incorrect choices	Participant persuades his group in some solutions but they were incorrect choices	that was a lot of things that I persuaded people to do, that were incorrect	P1
		Poor quality work	A case when some group members produce a poor quality work	At the start of the deliverables, we used to give them the task, and they were in charge of it and happy to take it and do it but at the end they found it hard and if they do it, the quality was lacking, we, out of 10, we got about 5 or 4 which is not good	P5
	18. Submission problems	Late submission	A case when group members submit their deliverables late	that's probably why we kept submitting late	P1
		Printing issue	Group members faced a printing problem before the submission	there was a brief problem with printing so when we tried to print it, the print stop midway	P1
	19. Suggestions	Game playing	Participant suggests that playing games will help group members to bond	I felt that the people I was playing with I would probably be able to do a team project much better than the people I was that were in my team	P1
		Social activities	Participant suggests that social activities will help group members to bond	Exactly, I mean the people that work, that 2 guys were quite good and focus we did had time together, we did have fun, we went out for dinner try to get like the group more expose, we all out for dinner, so we don't always have to be working	P6
	20. Group work description	Positive description	Participant has a positive description on his/her group work	If you can describe your group work by two or three words, what are they? I'll say very professional	P5, p7
		Neutral description	Participant has a neutral description on his/her group work	If you can describe your group work by two or three words, what are they? Good and bad	P3, p4
		Negative description	Participant has a negative description on his/her group work	If you want to describe your group work by two or three words, what are they? Load of rubbish	P1, p2, p6
	21. Satisfaction	Neutral attitude	Participant has a neutral attitude towards working in his/her group	To what extent you are satisfied working with your group? From 1 to 5? I will probably have to say 3	P1, p2
		Satisfied	Participant is satisfied to work in his/her group	I'll say about 4, I'll give them 4	P3, p4, p5, p6
		Strongly satisfied	Participant is strongly satisfied to work in his/her group	5 definitely	P7
	22. Collaboration success	Successful collaboration	Collaboration between group members is successful	We did collaborate successfully	P3, p4, p7
		Good collaboration	Collaboration between group members is good	it was good enough because we did our tasks, everyone was responsible of doing their own stuff and did it	P5
		Half good collaboration	Collaboration between group members is half good	Within the meeting I would say it was half good	P1, p6
		No collaboration	There is general collaboration between group members, but no real collaboration to complete tasks	again it sort of because we are taking in different parts. In general level, yes, but in any given task other than CSS instants not so much, no	P2
efe re nc	23. Choosing members	Choose same members	The participant prefers to choose the same members of	Yeah, I will definitely have to choose the same	P1, p7

			his/her group		
		Choose some members	The participant prefers to choose some members of his/her group	I would choose some of them	P2, p3, p4, p5, p6
	24. Manner of processing	Working individually	Participant prefers to work individually	I prefer working by my own. I study much better by myself than with group	P1, p5, p6, p7
		Working with someone	Participant prefers to work with someone	if it something which I don't really like then learn with people is the best	P1, P2, p3, p4, p7
	25. Orientation to change	Prepared plan	Participant prefers to follow prepared plan	Ideally I like to have a structured prepared plan	P4, p5, p6, p7
		Explore new options	Participant prefers to explore new options	I haven't been prepared in quite a long time, I think if it comes I'll explore	P1, p2, p3, p4
	26. Deciding	Logical person	Participant is a logical person	I'll say more into logical	P1, p2, p4, p3, p5, p6, p7
		Emotional person	Participant is an emotional person	I can be emotional	P3
	27. Working and learning preferences	Working with friends	Participant prefers to work with friends	I'll say working with friends, because you know more better what they good at	P1, p4, p5
		Working with professionals	Participant prefers to work with professionals	I prefer to work with professionals	P2, p3, p6, p7
		Look at diagrams	Participant prefers to look at diagrams instead of reading notes	I'm a visual learner so I having pictures and all that stuff	P3, p4, p5
		Read notes	Participant prefers to read notes instead of looking at diagrams	I'd say read notes	P6, p7
		Attend a lecture	Participant prefers to attend a lecture instead of reading a book	I would prefer lecture	P3, p5, p7
		Read a book	Participant prefers to read a book instead of attending a lecture	I would rather just read a book	P4, p6
	28. Learning styles	Visual person	Participant has a "Visual" learning style	I would always been told that visual is my best way	P3, p5
		Auditory person	Participant has an "Auditory" learning style	I think I would prefer the audio-book simply because I'm hear it from somebody else's voice, I'm being taught by somebody else	P7

Appendix B: Second Study

Appendix B.1
Second Study: First Questionnaire

Please complete this questionnaire as appropriate:

1. Your age group is: ▢ 18-29 ▢ 30-39 ▢ 40-49 ▢ 50+

2. Your gender is: ▢ M ▢ F

3. What is your education or professional background:
   …….....

4. Your MSc programme is:
   - ▢ Business Systems Analysis and Design
   - ▢ E-Business Systems
   - ▢ Electronic Publishing
   - ▢ Health Informatics
   - ▢ Human-Centered Systems

5. You are: ▢ Full-time student ▢ Part-time student

6. What is your basic role in the team?
   …….....

7. List your skills that will help you to complete the INM355 coursework:
   …….....…….....
   ..…….....…….....
   ...…….....…….....

8. You communicate with your group members by: (you can choose more than one if applicable)

   - ▢ Email
   - ▢ Facebook
   - ▢ WhatsApp
   - ▢ Other (please specify:…….....**.....**)

9. You prefer to:
   - ▢ Have a prepared plan
   - ▢ Explore new options

- ▢ Both

10. You prefer to work:
    - ▢ With someone
    - ▢ Individually
    - ▢ Both

11. You prefer to work with:
    - ▢ Professionals
    - ▢ Friends
    - ▢ Both

Appendix B.2
Second Study: First Questionnaire Results

Group A

Question No.	Participant		
	A1	A2	A3
1	30-39	30-39	18-29
2	M	F	M
3	n/a	B. Com from UCL	Developer
4	HCS	HCS	HCS
5	PT	PT	PT
6	No roles at the moment	Team member, equal roles	n/a
7	Charting, copywriting, analytical, leadership, research, structuring	Completing large projects for work (in advertisings), Problem solving, Research skills	Listening, research, creativity, problem solving
8	Google drive Hangouts	Email Google Hangouts	Email Google Hangouts Google drive
9	Explore new options	Have a prepared plan	In between
10	Individually	Individually	In between
11	Friends	Professionals	Professionals

Group B

Question No.	Participant		
	B1	B2	B3
1	30-39	30-39	18-29
2	M	F	F
3	Civil Engineering	Management information system (Bachelor degree)	BSc (Hons) Business Computing Systems
4	BSAD	BSAD	BSAD
5	FT	FT	FT
6	No specific	Member of the team	Nothing specific
7	Organising skills, time management skills	Analysing skills, leadership skills	Team worker, well organised, able to work under pressure, good communication (oral and written)
8	Email Text messages	Email Messages	Email
9	Have a prepared plan	Have a prepared plan	Have a prepared plan
10	With someone	With someone	Individually
11	Professionals	Friends	Friends

Group C

Question No.	Participant		
	C1	C2	C3
1	30-39	50+	18-29

2	F	F	F
3	Web design (BSc)	BSc in Mathematics and computing	2 undergraduate degrees, professional qualifications
4	HCS	HCS	HCS
5	PT	PT	FT
6	Nothing specific	Gathering requirements	Team member
7	Done web design, wireframes, IA at work, and BSc uni	Survey and design	Previous experience with interaction design, some knowledge of UI and UX, ood team player who works well under pressure
8	Email Texts	Email Facebook	Email Facebook
9	Have a prepared plan	Both	Both
10	Both	With someone	Individually
11	Both	Both	Professionals

Group D

Question No.	Participant			
	D1	D2	D3	D4
1	18-29	18-29	30-39	18-29
2	F	F	F	F
3	Bachelor's degree from Rollins Collage (USA) in Critical Media and Postmodern Theory; work- PR/ marketing/ design in Florida, New York, and Singapore	Bachelor degree in Media and Communication	Bachelor of Art	Psychology
4	EP	EP	HCS	HCS
5	FT	FT	FT	FT
6	Leader, organiser	I collaborate with my group trying to incremate our design research	Group work, drawing scenario, gathering data, creative ideas, participation	Just a member of team
7	Organisation skills, copy writing skills	Attention to details and to users' needs, collaboration	Using Adobe programs, MS office programs, have HCI work experiences (around five years)	Design thinking, the knowledge about human
8	Email WhatsApp Face to face between classes	WhatsApp	Email WhatsApp	Email WhatsApp

9	Have a prepared plan	Have a prepared plan	Both	Have a prepared plan
10	Both	Both	Both	Both
11	Both	Friends	Both	Both

Group E

Question No.	Participant			
	E1	E2	E3	E4
1	18-29	40-49	18-29	30-39
2	M	M	F	F
3	Student Information Technology	n/a	Designer	First degree in Computer Science, IT teacher
4	HCS	HCS	HCS	HCS
5	FT	FT	FT	FT
6	No roles	No roles	We don't have any fixed roles	Not specific
7	Technology based knowledge, worked in a lot of projects already, know how to combine work	We investigated by asking, investigative, analytical, design, interpersonal	Experience in the area, attention to details	Organised
8	Facebook Google Hangouts	Facebook Google Hangouts	Email Facebook Google Hangouts	Facebook Google Hangouts
9	Both	Explore new options	Have a prepared plan	Both
10	Both	With someone	Individually	Both
11	Friends	Both	Professionals	Both

Appendix B.3
Second Study: Second Questionnaire

Please rate the following statements from 1 to 7 based on your experience in working as group in the coursework for the Interaction Design module INM355: (Where: 1 = Strongly Disagree, 4 = Neutral, and 7 = Strongly Agree)

1. I found it difficult to tell what work my group members had done during the last week.

Disagree 1 2 3 4 5 6 7 *Agree*

2. It was easy to find what my group members had done using the collaborative tool (e.g. Google Drive or email).

Disagree 1 2 3 4 5 6 7 *Agree*

3. I could tell what my group members were doing while we were collaborating remotely.

Disagree 1 2 3 4 5 6 7 *Agree*

4. I always knew what my group members were going to work on over the week.

Disagree 1 2 3 4 5 6 7 *Agree*

5. It was always clear what my group members were going to do.

Disagree 1 2 3 4 5 6 7 *Agree*

6. I found the tools we used to share documents were effective.

Disagree 1 2 3 4 5 6 7 *Agree*

7. I could tell what the current state of our project was at any given time.

Disagree 1 2 3 4 5 6 7 *Agree*

8. I became more aware of my group members' plans over time.

Disagree 1 2 3 4 5 6 7 *Agree*

9. My group members and I planned adequately

Disagree 1 2 3 4 5 6 7 *Agree*

10. My group members and I communicated well with each other.

Disagree 1 2 3 4 5 6 7 *Agree*

11. My group members collaborated with me to complete the project.

Disagree 1 2 3 4 5 6 7 *Agree*

12. My group members contributed equally to this project.

Disagree 1 2 3 4 5 6 7 *Agree*

13. I enjoyed collaborating with group members.

Disagree 1 2 3 4 5 6 7 *Agree*

Please rate the following statements from 1 to 7 based on your preferences:

14. I would prefer to work on group projects over other types of learning activities.

Disagree 1 2 3 4 5 6 7 *Agree*

15. I would prefer to:

Have a prepared plan 1 2 3 4 5 6 7 *Explore new options*

16. I would prefer to work:

With someone 1 2 3 4 5 6 7 *Individually*

17. I would prefer to work with:

Professionals 1 2 3 4 5 6 7 *Friends*

Appendix B.4

Second Study: Second questionnaire Results

Group A

Question No.	Participant			SD	Average
	A1	A2	A3		
1	2	1	2	0.58	1.67
2	5	7	2	2.52	4.67
3	2	7	5	2.52	4.67
4	6	5	3	1.53	4.67
5	6	5	5	0.58	5.33
6	6	7	1	3.21	4.67
7	6	7	6	0.58	6.33
8	4	6	1	2.52	3.67
9	5	4	3	1	4
10	4	6	n/a	1.41	5
11	6	6	2	2.31	4.67
12	6	4	2	2	4
13	6	5	2	2.08	4.33
Average/ participant	5.23	5.85	3.17	1.4	4.75

Question No.	Participant			SD
	A1	A2	A3	
14	4	4	4	0
15	4	4	4	0
16	6	5	4	1
17	4	2	3	1

Group B

Question No.	Participant			SD	Average
	B1	B2	B3		
1	2	n/a	1	0.71	1.5
2	6	n/a	7	0.71	6.5
3	5	n/a	4	0.71	4.5
4	7	n/a	6	0.71	6.5
5	7	n/a	7	0	7
6	5	n/a	7	1.41	6
7	6	n/a	5	0.71	5.5
8	5	n/a	2	2.12	3.5
9	5	n/a	7	1.41	6
10	6	n/a	7	0.71	6.5
11	6	n/a	7	0.71	6.5
12	6	n/a	7	0.71	6.5

13	6	n/a	7	0.71	6.5
Average/ participant	5.85	n/a	6.15	0.21	6

Question No.	Participant			SD
	B1	B2	B3	
14	6	n/a	2	2.83
15	5	n/a	1	2.83
16	3	n/a	7	2.83
17	2	n/a	5	2.12

Group C

Question No.	Participant			SD	Average
	C1	C2	C3		
1	1	3	1	1.15	1.67
2	7	6	7	0.58	6.67
3	7	6	5	1	6
4	7	4	4	1.73	5
5	7	6	7	0.58	6.67
6	7	6	7	0.58	6.67
7	7	3	6	2.08	5.33
8	1	5	6	2.65	4
9	4	5	3	1	4
10	7	5	6	1	6
11	7	5	7	1.15	6.33
12	7	5	4	1.53	5.33
13	7	7	6	0.58	6.67
Average/ participant	6.31	5.23	5.77	0.54	5.77

Question No.	Participant			SD
	C1	C2	C3	
14	4	6	1	2.52
15	1	2	4	1.53
16	4	3	7	2.08
17	4	2	4	1.15

Group D

Question No.	Participant				SD	Average
	D1	D2	D3	D4		
1	1	1	3	5	1.91	2.5
2	7	7	6	6	0.58	6.5
3	7	7	4	5	1.5	5.75
4	7	7	4	7	1.5	6.25
5	7	7	6	7	0.5	6.75
6	7	6	5	5	0.96	5.75

7	7	7	4	5	1.5	5.75
8	1	2	3	4	1.29	2.5
9	7	6	5	7	0.96	6.25
10	7	7	6	5	0.96	6.25
11	7	7	6	7	0.5	6.75
12	7	7	6	7	0.5	6.75
13	7	7	6	7	0.5	6.75
Average/ participant	6.54	6.46	5.08	5.77	0.68	5.96

Question No.	Participant				SD
	D1	D2	D3	D4	
14	3	6	5	5	1.26
15	1	4	5	1	2.06
16	5	5	5	3	1
17	4	3	4	3	0.58

Group E

Question No.	Participant				SD	Average
	E1	E2	E3	E4		
1	2	2	2	2	0	2
2	6	6	6	3	1.5	5.25
3	5	6	3	2	1.83	4
4	7	4	5	3	1.71	4.75
5	5	5	4	3	0.96	4.25
6	6	3	5	5	1.26	4.75
7	4	3	5	5	0.96	4.25
8	5	4	6	6	0.96	5.25
9	4	4	4	3	0.5	3.75
10	5	4	2	4	1.26	3.75
11	7	6	4	5	1.29	5.5
12	5	5	3	5	1	4.5
13	5	5	3	6	1.26	4.75
Average/ participant	5.38	4.69	4.31	4.31	0.5	4.67

Question No.	Participant				SD
	E1	E2	E3	E4	
14	4	5	5	2	1.41
15	3	3	6	1	2.06
16	4	4	6	3	1.26
17	5	3	1	4	1.71

Appendix B.5
Original questionnaire from Convertino et al. (2004) paper

7-point scale questionnaire:

1. I found it difficult to tell what work my partner had done after being absent from the workspace for a week.

2. It was easy to find what my partner had worked on in the collaborative space.

3. I could tell what my partner was doing while we were collaborating online.

4. I always knew what my partner was going to work on over the week.

5. It was always clear what my partner was going to do.

6. I became more aware of my partner's plans over time.

7. My partner and I planned adequately

8. My partner and I communicated well with each other.

9. My partner collaborated with me to complete the project.

10. My partner contributed equally to this project.

11. I enjoyed collaborating with a partner online.

12. I would enjoy interacting with others in the community (outside of the school system with interest or knowledge in science) on my group science project.

13. I would prefer to work on group projects over other types of school learning activities.

Appendix B.6
Second Study: Interview Questions

First interview questions:

- Do you know each other before this course?
- Do you use any tool to share documents with your group members?
- What is the current state of your project?
- What have you done last week?
- What has student X done last week? (for each member in the group)
- How do you distribute or choose tasks?
- How often do you meet?
- For how long do you meet?
- Have you faced any problem in your assignment so far?

Second interview questions:

- What happened since last time I observed you?
- What have you done last week?
- What has student X done last week? (for each member in the group)
- What is working well in your project?
- What goes bad in your project?
- What tools do you use to collaborate?
- How did your group work? In parallel or sequential way?

Appendix B.7
Second Study: Comparison Grids for Activity Awareness

Grey: What participant did

Green: Fully aware

Blue: Partly aware

Red: Unaware

Yellow: No enough information

Group A
First interview:

Participant	What he/she reported about		
	A1	A2	A3
A1	I did observation last week. There is a separate research done by everyone, read different books and just kind of summarising them, just like literature.	She has contributed a few things using Google documents, she is also extends what she is doing. She is doing a Google research.	I'm not sure what he did, like I know from here [he opens the goggle docs] that he did enter his previous observations, but he didn't …… he just extend his observations
A2	We worked out the plan together of kind of, timings and when we are free to do stuff and then he went and put that into a schedule document and he did lots of research on interviews and observations as well and he went and did the interviews, and he kind of organise docs for the Google drive. Oh sorry I mean not interviews, observation activities, whenever I said interviews I mean observation activities,	I have to look at the Google drive, cause I did do some, figure, Google search for where they were doing for high street stuff, and figure out research on observation and where are goals go lines with observation activities	He did lots of the observation activities
A3	A1 did observe, when observing as well, but also uploaded a lot of background information and organised or collated the data correctly on the drive	She searches for, she went to the Google and come and get a list of the most searched words for certain words and the associated words with that search term and to list of them for locations that we visited to observe so far	I went out to Stoke Newington high street/church street and just to observing, and do some reading on
Summary	A2 is fully aware of A1 activity A3 is fully aware of A1 activity	A1 is fully aware of A2 activity A3 is fully aware of A2 activity	A1 is partly aware of A3 activity A2 is fully aware of A3 activity

Second interview:

Participant	What he/she reported about		
	A1	A2	A3
A1	and I did one….. (he means interview) and me and A3 transcribed it	A2 did 2 interviews	Did 2 interviews as well, and me and A3 transcribed it
A2	A1 did an interview and we talked about interviews on Google Hangouts	I summarised all of the research so did some interviews, and worked out and analyzed those, looked at online for more research about the high street that we are looking at, did some Google in terms of search analysis and find what we needed and then we got,	A3 did a couple of interviews as well, and he also started working on the personas for the task
A3	Last week, [oh god thoroughly quite slow week], I don't know	A2 did summary of the data, create the summary sheet and yes, create summary sheet of the data and analyze all the data	I read a lot on sort of how to analyze data and I tried to start creating personas and I found it quite difficult cause I think we did 5 demographics, so the way we're doing the interview, I don't think we should done that
Summary	A2 is fully aware of A1 activity A3 is not aware of A1 activity	A1 is partly aware of A2 activity A3 is partly aware of A2 activity A1 didn't mention the summary A3 didn't mention the interviews	A1 is partly aware of A3 activity A2 is fully aware of A3 activity A1 didn't mention the personas A3 didn't mention that he did 2 interviews

Group B

First interview:

Participant	What he/she reported about		
	B1	B2	B3
B1	Conduct interviews and I just fill the excel spread sheet	B2 also did the interviews	Actually she did the interviews, she contacted the professor in order to book an appointment in order to discuss our coursework
B2	He does questionnaires this week, and observation also, he design and prototype the interviews, the questionnaire this week	Interviews, observations, questionnaires	She did the interviews, re-write it again, and what happen in the interviews, she always writing what happened in the meetings
B3	Interviews	Interviews	We have carrying out the interviews, basically we went three days for the interviews, two-two for each one, like the first day B1 and B2 went for interviews, second day me and B1 went, and third day me and B2 went, so basically we all did the interviews like that but before that we met and wrote down the interview questions and all of that I take most of the notes

Summary	B2 is fully aware of B1 activity B3 is fully aware of B1 activity	B1 is partly aware of B2 activity B3 is partly aware of B2 activity B1 & B3 just mention the interviews	B1 is fully aware of B3 activity B2 is fully aware of B3 activity

Second interview:

Participant	What he/she reported about		
	B1	B2	B3
B1	I designed 2 storyboards	B2 did the HTA for the project and the scenario	B3 did the requirements and one storyboard also
B2	B1 writes the personas	I start to write the report from now	B3 writes the requirements
B3	B1, he was doing storyboards so there were 4 storyboards, B1 did 2	and then B2 did one storyboard and she started with the report,	Last week my job was to write down all the requirements and I took the requirements and I took one storyboard
Summary	B2 is not aware of B1 activity B2 mention personas instead of storyboards for B1 B3 is fully aware of B1 activity	B1 is not aware of B2 activity B3 is fully aware of B2 activity B2 didn't mention her storyboard	B1 is fully aware of B3 activity B2 is partly aware of B3 activity B2 didn't mention the storyboard

Group C

First interview

Participant	What he/she reported about		
	C1	C2	C3
C1	I worked on the wireframes (2 weeks ago)	C2 was gathering requirements to do some testing, and also putting reports together	Was working on persona and other partitions ... Its other parts persona, storyboards, yeah
C2	She has been working on the prototype or actually have done some testing on the prototype	Last week I have been working on the individually section cause that's the last part of the project What about inside the coursework? What I've done is I've produce like template with like a checklist to make sure we haven't miss out of anything I've done the testing myself I've got my husband & my sister in law to do the testing as well	C3 has been doing persona, I think she's doing storyboard as well I think that's quite difficult to do, because of the pictures and things. I haven't seen it yet. I'm looking forward to see it
C3	She is working on the wireframes	C2 was compiling some documentations based on the data we have, so she is working on that for the report	Basically we discussed all the stuff we put together, so we analyzed all the data and then made an action plan to sort of create the personas and all of that, so that's to, you know, get to the wireframe stage, which in conceptual design really, so we discussed that
Summary	C2 is fully aware of C1 activity C3 is fully aware of C1 activity	C1 is fully aware of C2 activity C3 is fully aware of C2 activity *C3 was interviewed one week before her colleagues	C1 is fully aware of C3 activity C2 is fully aware of C3 activity

Group D
First interview:

Participant	What he/she reported about			
	D1	D2	D3	D4
D1	I went and did my follow-up interviews with my original interview subject just to get in more details and then we did the rest collaboratively, we set down and talk about the wireframes and kind of everybody suggesting things	The same thing as I did (Interview + talk about wireframes)	I think all of us do the same except D3 did the storyboards, so we talked about different scenarios, she draw and last week she draw them all in more detail and perfective the wireframes, so we talked about them all and she was the artist	I think all of us do the same (Interview + talk about wireframes)
D2	She did the same, she ask I think one guy about more information (interview) we did the wireframes as well, we created personas, scenarios	So we gather some more information from interviewing people about the needs, trying to find out people's needs we did the wireframes as well, we created personas, scenarios	Last week she begin drawing our prototypes and wireframes because she is the best in doing this we did the wireframes as well, we created personas, scenarios	I think she do some interviews as well we did the wireframes as well, we created personas, scenarios
D3	She know how to work we do, because she speaks English very well, so always we have to deal with discussion and read to them and if we have some problem like English she already solved (Interview)	When we have to work as group work, she always write down some summary or process, reaching the computer and writing them again (Interview)	Just draw scenario and the wireframe in detail (in other part of interview she said: For the interview, we did it individually and then after gathering the data and we gonna discuss and if we, when we after that have some problems, so we gonna discuss how to solve it after that we had interview again…)	She already share creative idea (Interview)
D4	She done a lot and she combine our opinions	She gives us a lot of ideas about putting some …	She is really good at drawing, so she draw all the storyboards and prototype	I took some pictures for the personas and re.. in more details
Summary	D2 is fully aware of D1 activity D3 is partly aware of D1 activity D3 mentioned the interview in another section D4 talked about skill not activity	D1 is fully aware of D2 activity D3 is partly aware of D2 activity D3 mentioned the interview in another section D4 talked about skill not activity	D1 is fully aware of D3 activity D2 is fully aware of D3 activity D4 is fully aware of D3 activity	D1 & D2 mentioned interviews and wireframes D3 mentioned the interview in another section D4 didn't mention that she did interviews and wireframes

Second interview:

Participant	What he/she reported about			
	D1	D2	D3	D4
D1	Can I look in my calendar? Yeah sure I have it over done, that's how I live life, let's see, so I met with you on last Monday-Tuesday And before that, what we were doing? I see, so we worked on our re-review our interviews or second round of interviews and we worked on paper prototype that was a big session that day then the wireframe	Ok starting with D2 did her second round of interviews	D3 she did her second round of interviews but also worked on storyboards because she's the best artist in the group	And D4 interviews as well
D2	She's really good in taking, I mean, notes and to, she's like the one that is always writing, so that she let us.. the notes when our ideas come out, and she's really good We were just drawing some wireframes and storyboards in order to have them ready and to let them check to Stephanie as well we just came up with some ideas so wasn't really hard work, we were just thinking about what Stephanie told us, trying to figure out how to better our …	we thought about the things we have to change according to Stephanie suggestions and we tried to schedule a little bit out meetings but last week wasn't we wanted to meet on Friday I think or on Thursday morning but I had to do something and D3 wasn't able to come on the afternoon, so we decided to skip to today We were just drawing some wireframes and storyboards in order to have them ready and to let them check to Stephanie as well we just came up with some ideas so wasn't really hard work, we were just thinking about what Stephanie told us, trying to figure out how to better our …	She does the usual part, so the drawing, and she really has a good imagination, she is really good in abstracting, she comes up with so many ideas We were just drawing some wireframes and storyboards	she always comes out with more options We were just drawing some wireframes and storyboards
D3	She worked, she always read in our coursework in our team and sometimes we don't understand exactly our	She suggests some good opinions and ideas, we also discussed together we need to make the	Last week, I also draw the wireframes and scenarios as well, I do search for some smart watch, because our	Brought some posted, and some …. (because we need to make the wireframes and scenarios for the

	coursework, how to work, she explains we need to make the wireframes and scenarios for the usability test	wireframes and scenarios for the usability test	device is not watch	usability test)
D4	Take notes, and share with us Together we done wireframes	She gives a lot of ideas even when we are meeting with Stephanie Together we done wireframes	She draw storyboards and try to modify our paper prototype Together we done wireframes	Together we done wireframes and I think our paper prototype and I think maybe we usually work together
Summary	D2 is partly aware of D1 activity D3 is partly aware of D1 activity D4 is partly aware of D1 activity D1 looked at her calendar to check their activity	D1 mentioned what D2 done (the 2nd round of interview), but D2 didn't mention that D3 & D4 are partly aware of D2 activity D2, D3 & D4 mentioned what they did in other section D3 & D4 are aware of D2 skills	D1 is fully aware of D3 activity D2 is fully aware of D3 activity D4 is fully aware of D3 activity D1 mentioned what D3 also done (the 2nd round of interview), but D3 didn't mention that	D1 mentioned what D4 done (the 2nd round of interview), but D4 didn't mention that D2 & D3 mentioned what they did in other section There is an overlapping between storyboards and scenarios D2 & D3 are partly aware of D4 activity

Group E

First interview:

Participant	What he/she reported about			
	E1	E2	E3	E4
E1	I created the work plan with the work we have to do in the next week. I created 2 personas, I created 1 scenario for one persona and I took some pictures of the work we've done here and uploaded it on web drive	He created one persona, He also took pictures of the work we done here, wrote some requirements	Also she created one persona, wrote a digital information to the existing personas, she was also part of the build boards stuff that we took some papers and wrote some summaries about the personas	E4 wrote 2 personas, she worked most of the requirements and she wrote 2 scenarios just yesterday that's also a good thing about Google drive because we always see who created what and who was editing and documenting and what time
E2	He organised all the documents in Google drive and he outlined what we should do based on the original document that we got, so he is very organised, extremely organised, he organised everything, put folders up and we submit our work in the folders that he is prescribed he was away, it was a reading week, I think,	in the last week we wrote some scenarios individually and a lot of the work done collaboratively, but individually, we did some scenarios building, but what I realised after come a session with Graham, we hadn't done this properly, so we had to go back and did the task analysis again	she did a proper task analysis, she is the only one of us did a proper task analysis, she is totally know what she did more than, I think, more than anybody, so she's done the task analysis, she's done, we're all done personas, and she did wrote personas, she did one	She did a scenario and we had a Google, so she did a scenario and I think she did a lot of the user gathering stuff, and she works with E1 on something, I can't remember exactly what she did, I think she help E1 to organise all the stuff, so E1 and her did that and then, going back further, she did a lot of the interviewing stuff, which E1 wasn't

	I'm not sure, I think he did some of the initial ones, we did pilot interviews, and we didn't actually use those, but he did some of the pilot interviews we're all done personas			here for
E3	He done some, he was trying to pull some quantitative data from our information from the interviews, he also did a couple of personas we are sharing and doing the same thing	He did one persona and also did HTA	I did one persona and I added some comments to the persona and now .. we are doing the hierarchal task analysis we I did this yesterday	The same thing (persona)
E4	The same thing (requirements + personas + scenarios)	The same thing (requirements + personas + scenarios)	The same thing (requirements + personas + scenarios)	Last week we made the requirements and we talked about the personas So do you do anything specifically? No, We haven't divided anything, we divided the scenarios and each one of us make one scenario for one persona
Summary	E2 is fully aware of E1 activity E3 is partly aware of E1 activity E4 is fully aware of E1 activity	E1 is partly aware of E2 activity E3 is fully aware of E2 activity E4 is partly aware of E2 activity	E1 is partly aware of E3 activity E2 is fully aware of E3 activity E4 is partly aware of E3 activity	E1 is fully aware of E4 activity E2 is fully aware of E4 activity E3 is fully aware of E4 activity

Second interview:

Participant	What he/she reported about			
	E1	E2	E3	E4
E1	I did my own with E4 Only did the storyboards me and E2 are doing the written documentation that we have to deliver	One storyboard me and E2 are doing the written documentation that we have to deliver	She did the storyboard we have one person who is making the wireframes	I did my own with E4 (storyboard)
E2	E1 did the task analysis, I think he did all stuff, he kept everybody on track and kept all the documents up to date, and he did the initial writing of the report and I did then	I helped in the paper prototype but a lot of this work was done by E3, so we are kind of waiting for her to finish it, and then I helped print it out and then she put it together	E3 did a lot in the storyboarding and she designed a paper prototype, she did even the testing, she did everything and we all did, not E1, the other 3 of us drew	Yeah, I shared the storyboard, and we all did, not E1, the other 3 of us drew initial wireframes for the squeeze, so E4, E3, and I, we all arrived on the day together with

	second cut	and I did then second cut (in writing the report) I shared the storyboard and we all did, not E1, the other 3 of us drew initial wireframes for the squeeze	initial wireframes for the squeeze	different ideas about how it should be, now that was the best days actually in terms of collaboration, because we all came with ideas together Ok, anything special for E4? She had some, no not really
E3	E1 has helped with the report, he is always looking at the other things we are producing and giving his opinion when we asked mainly and he helped on the technical specification and I guess that is mainly what he did	He also was working on the report, and he was also working with me on the storyboards, and he was also giving some ideas about the wireframes yesterday	I have done the wireframes, well I worked a little bit on the storyboard and wireframes maybe that is all I am not looking at the report because I guess it is not going to help a lot	She did as well some storyboards, she was actually drawing and when she worked with E1 she is actually doing everything that is missing everything we have to do, so she has done some, like I guess, detailed design of the final hardware
E4	The other parts I think they were in, except the wireframes and the analysis of the data, was E1 made the analysis in his computer, everything else we worked it together	We started making the wireframes and writing down all the tasks and after these parts we were all together, we were working in different things but with questions to each other just to know that we are doing the The other parts I think they were in, except the wireframes and the analysis of the data, was E1 made the analysis in his computer, everything else we worked it together	She designed the wireframes by herself we couldn't work all in one tool in the Visio I think	We started making the wireframes and writing down all the tasks and after these parts we were all together, we were working in different things but with questions to each other just to know that we are doing the So, you are working together in the same time? Yeah, but in different things The other parts I think they were in, except the wireframes and the analysis of the data, was E1 made the analysis in his computer, everything else we worked it together
Summary	E2 is partly aware of E1 activity E3 is partly aware of E1 activity E4 is partly aware of E1 activity	E1 is fully aware of E2 activity E3 is fully aware of E2 activity E4 is partly aware of E2 activity E4 didn't mention something specifically	E1 is fully aware of E3 activity E2 is fully aware of E3 activity E4 is partly aware of E3 activity	E1 is partly aware of E4 activity E2 is fully aware of E4 activity E3 is fully aware of E4 activity E1 and E3 mentioned that E4 did storyboards, but she didn't mention that

Appendix B.8
Second Study: The coding scheme

Themes	Sub-themes	Codes	Code description	Example
Applications and Tools	Applications used	Use email	Group members use email to communicate or share documents	We use email
		Use Facebook	Group members use Facebook to communicate	At the beginning we started with Facebook messenger
		Use Google drive	Group members use Google drive to share documents	we use the Google drive
		Use Google Hangouts	Group members use Google Hangouts for online meeting	I mean we communicate with Google Hangouts
		Use SMS	Group members use SMS to communicate	We use email and messages
		Use WhatsApp	Group members use WhatsApp to communicate	We use WhatsApp
	Tools used	Use iPad	At least one participant uses iPad in the meeting	D1: Write notes in her mini iPad
		Use iPhone	At least one participant uses iPhone in the meeting	D4: Show app on her iPhone for bus
		Use laptop	At least one participant uses laptop in the meeting	A1: Work on his laptop
	Positive comments on applications	Positive comment on Google drive	Participant states a positive comment on Google drive	that's also a good thing about Google drive because you always see who created what and who was editing a document and at what time
		Positive comment on Google Hangouts	Participant states a positive comment on Google Hangouts	I mean the great advantage of Hangouts is I can be at home and like we decide it will take an hour because usually it takes between an hour- an hour an half but it starts when the Hangouts starts and finishes when the Hangouts finishes
		Positive comment on WhatsApp	Participant states a positive comment on WhatsApp	we already share the phone numbers we already contact on WhatsApp because it's a really easy to contact
	Negative comments on applications	Negative comment on Google drive	Participant states a negative comment on Google drive	it's just sort of spitting information and we don't spend too much time making it organised, so the thing is a lot of things and stuff are very hard to catch up with
		Negative comment	Participant states a negative	on google Hangouts it is for

		on Google Hangouts	comment on Google Hangouts	chatting but we can also do video conferences but they are not that efficient because everybody speaks at the same time.
Awareness	Awareness behaviour	Ask direct question	Participant asks direct question to gain common knowledge or to be aware of what other members are doing in the meeting	E3: Ask E1 "what are you doing?"
		Ask external person	Participants are aware of what they need to ask their module leaders	A3: Say "that's what we need to ask in the surgery"
		Ask for clarification	Participant asks other members to clarify their work or make sure that he/she is aware of what they did correctly	A1: Ask question for A2 to clarify her work
		Catch up	Participant asks for a minute or 2 to catch up with them	E2: Ask for a minute to catch up and read (Catharine) persona
		Checking	Participant checks notes, lecture slides, coursework description, or resources;	A1: Check the Interaction Design book looking for framework
		Offer clarification	Group members clarify their work or any difficult part to each other	A2: Read from the screen and clarify each point
		Update absent group member	Participant updates other members if they miss any part of the meeting	A2: Update A1 about what they chatted before he comes
		Work review	Participant reviews what he/she did before the meeting	D2: Review her work on interview (first)
	Awareness type	Activity awareness	Participant is aware of other member's activity	A3 did a couple of interviews as well, and he also started working on the personas for the task
		Current state awareness	Participant is aware of the current state of their project	We finish the data gathering, and we are trying to analyse the data in order to list the requirements to do the second phase
		Next-step-awareness	Participant is aware of the next step in their project	D1: Say "I think storyboards might be our next step"
		Skill awareness	Participant is aware of other member's skill	she's the best artist in the group
		Time awareness	Participant is aware of the time	C1: Aware of time of submission
Collaboration	Collaboration activities	Agreement	When participant agrees on something	D4: Agree to simplify the device and not to add the weather checking feature
		Disagreement	When participant disagrees on something	B1: Disagree with B2 for not mention the storyboard
		Pair discussion	Discussion about any point is done by only 2 members of the group	E1: Discuss with E4 about the drawing E4: Discuss with E1 about the drawing

		Group discussion	Discussion about any point is done by all group members	A3: Discuss about personas and technology A2: Discuss about people and technology A1: Discuss about people and technology
		Editing	Group members edit and modify their work in the meeting	B3: Review and edit one requirement by writing on the printed note (device weight)
		Engage	Participant engages other members to make decisions or give their opinions	B1: Ask to decide whether to add storyboard or no
		Help	Group members help each other to complete their tasks in the meetings	B1: Continue reading and help B3 to count
		Review	Group members review what they did during the meeting	B1: Review the results of questionnaires
		Suggesting	When participant suggests something to complete a task	D1: Suggest to use pictures for people who don't speak English
	Reported collaboration styles	Parallel	Group members work in parallel way	Probably in parallel way
		Sequential	Group members work in sequential way	in a group of approach to the task, it's been it's quite linear or sequential way
		Mix of both	Group members work in parallel and sequential way	We are working, it's a bit of both
	Problems	Different thinking	Group members have different ways of thinking	each and every one of us had a slightly different thinking about how to move forward
		Communication problem	When there is a communication problem between group members	but mainly the problem is communication
		Coursework understanding	When group members have a problem in understanding the coursework description	we misunderstood part of the course briefs
		Redo work	When group members need to redo the work	We skipped the hierarchal task analysis, and already did the scenarios with design implementations included, without really analyzing what the task is, so that's kind of problem because now we did some work based on nothing, so now we have to redo it
		Language	When language becomes a barrier between group members	but I guess the most we are having some language barrier that's why we get a little bit nervous
Meeting	Activities	Drawing	Participant draws in the meeting (e.g. storyboards, or prototype)	D3: Draw the storyboard picture
		Working	Participant works in the meeting. This includes:	B2: create new category "government facilities"

			counting; calculating; analysing; creating categories or craftworks	
		Writing	Participant writes in the meeting (e.g. the report)	D3: Write the steps for drawing storyboards
	Meeting structure	Book a room	Group members book a room for their meeting	Location: Library- room 3E
		Initial plan	Group members have an initial plan to complete their project	I created the work plan with the work that we have to do in the next week.
		Write notes	Participant take notes about tasks and deadlines	D1: Write notes in her mini iPad
	Task assigning	Task assigning by availability	Tasks are assigned to group members by the availability	So far, it is about availability, it's currently based on availability
		Task assigning by experience	Tasks are assigned to group members based on experience	so I had more experience with doing the requirements, that's why I took the task
		Task assigning by skills	Tasks are assigned to group members based on skills	Yes based on skills
		Task assigning by volunteering	Tasks are assigned to group members by volunteering	C2: Volunteer to do some tasks (requirements)
		No criteria	Tasks are assigned to group members with no specific criteria	so kind of just splitted up and there wasn't certain criteria or such, no

Appendix B.9
Second Study: Observation Schedule

Group ID: A
Observation No.: 1
Date: 6-11-2013
Time: 9:55am
Location: Library- room 3E
Names of group members:
1- A1 (mac laptop)
2- A2 (mini laptop)
3- A3 (iPad)

Time (mins)	***Participants'* Activities**	**Comments**
5	– A2: Update A1 about what they chatted before he comes – A1: Ask A2 if the documents that she talked about are on Google drive – A3: Clarify to A1 and say "It's kind of interpretation of the data" – A2: Answer A1 – A1: Say "could you go again into these questions" – A2: Discuss about the interview questions (how are the actors, what information needed) – A1: Discuss about the interview questions – A3: Discuss about the interview questions – A2: Suggest to go through these questions quicly and answer them – A1: Discuss about users of high street (old people) – A2: Discuss about users of high street – A3: Discuss about disabled user of the high street – A1: Discuss about one of his observation of elderly lady with carer – A2: Discuss A1's observation – A3: Discuss A1's observation	
10	– A2: Discuss about users (family with young kids or older kids) – A1: Discuss about users (specific cases) – A3: Discuss about users – A2: Ask "How about other disabilities?" and mention design for extreme – A2: Ask "Do we find the information they need?" – A1: Discuss about what assumptions and observation – A3: Discuss about what assumptions and observation – A1: Discuss about his observations on Sunday which last for 3 hours	

	– A3: Discuss about his observation – A3: Say "that's what we need to ask in the surgery" – A3: Talk about something A1 mentioned it before – A1: Say "yes I remember it" – A1: Agree with A3 about assumptions	
15	– A1: Discuss about observation method they chose (to be unconstructive) – A3: Discuss about observation method they chose (to be un-intrusive) – A2: Agree with A1 – A2: Say "It's a good place to start" – A1: Say "It's an exploratory research" – A1: Prepare questions to be asked in surgery session – A3: Say "we provide feedback on the method" – A2: Discuss about what information needed from observation (e.g. food) – A3: Discuss about what information needed (e.g. food and restaurants) – A1: Work on his laptop – A1: Say “I organised the drive” – A1: Discuss about what information needed (e.g. finding specific place or restaurant, know when buses arrive)	
20	– A1: Discuss about observation (charity shops, old lady with a carer don't know the nearest crossing) – A2: Discuss about the needs for disabled users – A3: Discuss about users – A1: Ask about item and show it’s picture on his laptop – A2: Answer A1 (pot) – A3: Answer A1 (tableware) – A1: Discuss about what information needed – A2: Discuss about what information needed – A3: Discuss about what information needed – A1: Discuss about another observation (a woman faced a problem when she went to Rayman and ask for tagging gun and the shop assistant said sorry, we don't have it in the stock and she was really disappointed and she complained about the fact that she looked online and it says it's available in shops) – A2: Discuss about users and their needs – A2: Suggest: 2 types of users (purposeful versus browsing users) – A1: Discuss about browsers of the high street – A1: Think that interviews will be clearer than observations	
25	– A1: Say “let me just look at the observations” – A3: Suggest to do comparison between browsing people and purposeful people "like with the diaries”	

	– A1: Discuss about browsing people – A3: Discuss about browsing people – A2: Discuss about engaging browsing people to the high street – A2: Say "we can summarise it" – A3: Ask to leave to boot camp – A1: Say “we will update you” to A3 – A1: Say "we need to meet again" – A2: Say "I will finish at 1pm" – A3: Agree to meet at 1pm – A1: Check the surgery session time and location to give it to A3 and say "let me just double check" – A2: Discuss about resources for interaction – A3: Discuss about resources for interaction – A1: Give resource to A3 (book name)	
30	– A3: Leave to boot camp – A1: Say "shall we just finish this off" – A1: Discuss about purposeful users (they need urgent information) – A2: Discuss about purposeful users and their needs – A2: Discuss about browsing users and their needs – A1: Summarise what they have discussed – A2: Help A1 to summarise – A1: Say "how they found what they are looking for?" – A1: Discuss about one observation (about lady who asking people about specific shop and kept asking people every 10-15 steps) – A2: Discuss about people anxious – A1: Discuss about Rayman lady again – A2: Discuss the needs to users – A1: Write into his laptop	

Notes:
It is kind of brain storming session about users they observed and others and what information they need in high street

Observation Schedule

Group ID: A
Observation No.: 2
Date: 23-11-2013
Time: 10:35am
Location: Library- room 3H
Names of group members:
1- A1 (his laptop connected to the big screen in the room)
2- A2 (she brings book and notes with her, she summarises everything in style sheet)
3- A3 (he brings his laptop)

Time (mins)	***Participants'* Activities**	**Comments**
5	– A2: Start to review her work – A2: Say "the word document is recap of what we done so far, so it's a trianulation document" – A1: Ask question for A2 to clarify her work – A2: Describe her work and answer questions – A3: Clarify with A2 and say yeah, ok	
10	– A2: Continue explaining her work – A2: Say ".. looked at information about high street on website by local council community " – A1: Manage the screen from his laptop – A3: Check the book – A2: Reading from the screen and clarify each point – A2: Say "the next step is understand consumers' needs and engagement behaviours of the high street in more details, so that we got the interviews" – A2: Say "I think you updated last night"- to A3 (about interviews) – A3: Say "yeah" to A2 – A2: Continue reviewing the summary of the interviews	
15	– A1: Say: "I want to ask" – A1: Say "this is fantastic, could you give us just 2 minutes to catch up" – A3: Look at his laptop to check some resources – A3: Discuss with A2 about observation and groups they created on the style sheet – A2: Discuss with A3 about observation and groups they created on the style sheet – A3: Discuss about personas and technology – A2: Discuss about people and technology – A1: Discuss about people and technology – A3: Discuss about demographic groups	Discussion done by all

	– A2: Discuss about demographic groups – A1: Review to make sure everything is right with A2 and say "this is the summary of everything?" – A1: Ask "where these come from?" – A2: Answer A1 and clarify – A1: Ask A2 for clarification about a point in the summary – A2: Say: "maybe I phrased it wrongly" – A1: Write and edit the style sheet file on his laptop – A2: Discuss about editing	
20	– A3: Suggest and say "can we put more stuff in the opportunities for engagement" – A1: Say "yes, where is it?" – A3: Say "I think every shop keeper have something available to talk about their product" – A1: Write into the style sheet file on his laptop (continue) – A2: Discuss what to write in the style sheet file – A1: Ask A3 about terminology – A3: Answer A1 about the terminology – A3: Suggest to write something in the style sheet file – A2: Clarifying about passion to educate – A3: Discuss about passion to educate people – A1: Ask "what do you mean by educated?" – A3: Answer A1	
25	– A1: Write into the style sheet file on his laptop (continue) – A2: Discuss what to write – A2: Point at the screen to help A1 to write at specific point – A1: Ask question “that’s the summary of observation, are we going to do this for all the interviews?” – A2: Answer A1 – A3: Answer A1 – A2: Say ".. transcript of the interviews in the appendix, say if someone ask what did you did in your project? you can say we did this and this and this, like that" – A1: Discuss about summary and what to report in general – A3: Discuss about summary and what to report in general – A2: Discuss about summary and what to report in general	
30	– A1: Ask "what criteria are we taking for this?" – A2: Say "I think if you go to the requirements thing" – A3: Discuss about forms – A2: Discuss about forms – A1: Search for a file in Google drive – A2: Start writing notes – A2: Say "I see framework in the lecture" – A2: Point on the data show to clarify	

	– A2: Ask "do we have overall research objectives?" – A1: Say "I don't think so" – A2: Say "we have them individually" – A1: Say "you mean this?" and point to something – A2: Say "yeah" – A1: Check the Interaction Design book looking for framework – A3: Check another book to search for framework – A2: She says “I think person place thing is nice” – A1: Say "where you will put barriers" – A2: Say "there are barriers against each individual" – A1: Give A2 the book to clarify his point – A3: Discuss about deliverables – A3: Suggest to summarise everything – A2: Discuss about what to focus in design	

Appendix C: Third Study

Appendix C.1
First Questionnaire

Study Title: Investigating collaborative activities in long-term group projects

Please complete this questionnaire as appropriate:

1. Your age group is: ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50+

2. Your gender is: ☐ M ☐ F

3. What is your education or professional background:
   …….....**.....**

4. Your MSc programme is:
   - ☐ Business Systems Analysis and Design
   - ☐ E-Business Systems
   - ☐ Electronic Publishing
   - ☐ Health Informatics
   - ☐ Human-Centered Systems

5. You are: ☐ Full-time student ☐ Part-time student

6. You communicate with your group members by:
   (you can choose more than one if applicable)
   - ☐ Email
   - ☐ Facebook
   - ☐ WhatsApp
   - ☐ Google Drive
   - ☐ Google Hangouts
   - ☐ Other (please specify) …….....

Thank you..

Appendix C.2
Second Questionnaire

Study Title: Investigating collaborative activities in long-term group projects

Please rate the following statements from 1 to 7 based on your experience in working as group in the coursework for the Interaction Design module INM355:
(Where: 1 = Strongly Disagree, 4 = Neutral, and 7 = Strongly Agree)

1. I found it difficult to tell what work my group members had done during the last week.

   1 2 3 4 5 6 7

2. It was easy to find what my group members had worked on.

   1 2 3 4 5 6 7

3. I always knew what my group members were going to work on over the week.

   1 2 3 4 5 6 7

4. It was always clear what my group members were going to do.

   1 2 3 4 5 6 7

5. I found the tools we used to communicate were effective.

   1 2 3 4 5 6 7

6. I could tell what the current state of our project was at any given time.

   1 2 3 4 5 6 7

7. I became more aware of my group members' work plans over time.

   1 2 3 4 5 6 7

8. My group members and I planned adequately

   1 2 3 4 5 6 7

9. My group members and I communicated well with each other.

1 2 3 4 5 6 7

10. My group members collaborated with me to complete the project.

1 2 3 4 5 6 7

11. My group members contributed equally to this project.

1 2 3 4 5 6 7

12. I enjoyed collaborating with group members.

1 2 3 4 5 6 7

13. I would prefer to work on group projects over other types of learning activities (e.g. individual assignment).

1 2 3 4 5 6 7

Appendix C.3
First Questionnaire Answers

Group A:

Questions	A1	A2	A3
1	30-39	18-29	18-29
2	F	F	F
3	Marketing and quality assurance	Marketing strategy consultant	BSc computer science
4	HCS	HCS	HCS
5	Part time	Part time	Full time
6	Email Google Drive In person	Email Google Drive Text+In person	Email Google Drive SMS

Group B:

Questions	B1	B2	B3	B4
1	30-39	30-39	18-29	18-29
2	M	M	F	M
3	Software tester/ developer	Working in IT company	Study + working (BA in film and video with minor in computer science Worked as a technology coordinator at an elementary school)	Business management
4	E-business	E-business	E-business	E-business
5	Part time	Full time	Full time	Full time
6	Wechat	Dropbox Wechat	Facebook Wechat Dropbox	Wechat

Group C:

Questions	C1	C2	C3	C4
1	30-39	40-49	40-49	30-39
2	M	M	F	M
3	Civil servant (now full time student)	Civil servant UX researcher	Graphic designer (university)	Publisher
4	HCS	HCS	HCS	HCS
5	Full time	Part time	Part time	Part time
6	Email Texting Also use Google	Email Facebook Google drive	Email In person Merely	Email Facebook Google drive

	calendar Dropbox	Text message Dropbox		Drpobox

Group D:

Questions	D1	D2	D3	D4
1	18-29	18-29	30-39	18-29
2	F	M	M	F
3	Bachelor in computer technology	Student	BSc	BSc in interaction multimedia design
4	HCS	Health Informatics	HCS	HCS
5	Full time	Full time	Part time	Full time
6	WhatsApp Google Drive	WhatsApp Google Drive	Facebook WhatsApp Google Drive	Email (one or two) Facebook WhatsApp Google Drive

Appendix C.4
Second Questionnaire Answers

Question	A1	A2	A3	Average	SD
1	1	2	6	3	2.65
2	7	7	7	7	0
3	7	5	7	6.33	1.15
4	7	6	6	6.33	0.58
5	4	7	7	6	1.73
6	7	5	7	6.33	1.15
7	2	6	7	5	2.65
8	6	3	7	5.33	2.08
9	7	6	7	6.67	0.58
10	7	7	7	7	0
11	7	5	5	5.67	1.15
12	7	6	6	6.33	0.58
13	5	2	3	3.33	1.53

Question	B1	B2	B3	B4	Average	SD
1	6	2	2	1	2.75	2.22
2	6	6	6	7	6.25	0.5
3	7	6	6	7	6.5	0.58
4	7	5	6	7	6.25	0.96
5	7	7	7	7	7	0
6	5	6	6	7	6	0.82
7	6	6	6	7	6.25	0.5
8	6	4	6	7	5.75	1.26
9	5	5	6	6	5.5	0.58
10	7	5	6	7	6.25	0.96
11	6	4	7	6	5.75	1.26
12	6	6	6	7	6.25	0.5
13	4	6	4	6	5	1.15

Question	C1	C2	C3	C4	Average	SD
1	2	2	2	2	2	0
2	6	6	6	6	6	0
3	5	6	6	6	5.75	0.5
4	5	6	3	6	5	1.41
5	7	7	6	5	6.25	0.96

6	6	6	5	4	5.25	0.96
7	5	6	6	6	5.75	0.5
8	7	6	3	4	5	1.83
9	7	7	5	6	6.25	0.96
10	6	7	7	6	6.5	0.58
11	6	7	7	6	6.5	0.58
12	7	7	7	7	7	0
13	5	5	7	5	5.5	1

Question	D1	D2	D3	D4	Average	SD
1	4	5	3	2	3.5	1.29
2	6	5	2	6	4.75	1.89
3	6	4	2	6	4.5	1.91
4	6	3	3	6	4.5	1.73
5	5	1	5	3	3.5	1.91
6	4	1	4	4	3.25	1.5
7	5	2	3	5	3.75	1.5
8	2	1	4	5	3	1.83
9	4	1	2	4	2.75	1.5
10	6	3	1	6	4	2.45
11	6	2	2	6	4	2.31
12	3	3	2	5	3.25	1.26
13	4	4	2	5	3.75	1.26

Q	A1	A2	A3	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	Avg	SD
1	1	2	6	6	2	2	1	2	2	2	2	4	5	3	2	2.8	1.66
2	7	7	7	6	6	6	7	6	6	6	6	6	5	2	6	5.93	1.22
3	7	5	7	7	6	6	7	5	6	6	6	6	4	2	6	5.73	1.33
4	7	6	6	7	5	6	7	5	6	3	6	6	3	3	6	5.47	1.41
5	4	7	7	7	7	7	7	7	7	6	5	5	1	5	3	5.67	1.84
6	7	5	7	5	6	6	7	6	6	5	4	4	1	4	4	5.13	1.6
7	2	6	7	6	6	6	7	5	6	6	6	5	2	3	5	5.2	1.61
8	6	3	7	6	4	6	7	7	6	3	4	2	1	4	5	4.73	1.91
9	7	6	7	5	5	6	6	7	7	5	6	4	1	2	4	5.2	1.82
10	7	7	7	7	5	6	7	6	7	7	6	6	3	1	6	5.87	1.73
11	7	5	5	6	4	7	6	6	7	7	6	6	2	2	6	5.47	1.64
12	7	6	6	6	6	6	7	7	7	7	7	3	3	2	5	5.67	1.68
13	5	2	3	4	6	4	6	5	5	7	5	4	4	2	5	4.47	1.41

Appendix C.5
Interviews' Questions

First Interview Questions:

1. How do you find working in group?
2. What is the current state of your project?
3. What have you done last week?
4. What has your group member done last week? (for each member)
5. How did you know about your group member work?
6. How did you choose the task you worked on last week?
7. Did you discuss with your group member about each member skills?
8. Did you set a plan as a group to complete your project?

Second Interview Questions:

1. What's happen since last time I interviewed you?
2. What is the current state of your project?
3. What have you done last week?
4. What has your group member done last week? (for each member)
5. How did you know about your group member work?
6. How did you choose the task you worked on last week?

Third Interview Questions:

1. What's happen since last time I interviewed you?
2. What is the current state of your project?
3. What have you done last week?
4. What has your group member done last week? (for each member)
5. How did you know about your group member work?
6. How did you choose the task you worked on last week?
7. What is working well in your project?
8. Have you faced any problem in your project?

Appendix C.6
Activity Awareness Analysis

Group A

P	Week 17/11 -23/11							Week 24/11 - 30/11							Week 1/12 – 7/12							Week 8/12 – 14/12				
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12
A1			1							2							3									
A2			1							2									3							
A3			1							2									3							

- 1st interviews are on the same day
- 2nd interviews are on the same day
- 3rd interviews are within 3 days (the difference is 2 days)

	First interview	Second interview	Third interview
A1	1 FA, 1PA	2 FA	1 FA, 1PA
A2	1 FA, 1PA	2 FA	1 FA, 1PA
A3	1 PA, 1UA	2 FA	1 FA, 1PA
Total	FA: 2 PA: 3 UA: 1	FA: 6 PA: 0 UA: 0	FA: 3 PA: 3 UA: 0

First interview

Participant	What they reported about		
	A1	A2	A3
A1	We kind of moving from conceptual design to detailed design like starting on it really just design the device but not the software for it - Any specific? Yes, design like how the device will look like - Prototype or..? No we haven't done prototype, well just paper prototype and started going into software design.	Like in the session we had? - In the session or during the week, even for individual work? Put some notes on Google drive that we agreed before she typed them, and at the session, she gave, well she was doing sketches and she gave input	She is done a lot of work during the week, put stuff on the drive and propose some reading before the session and give input on
A2	She has been more involved when it comes to the group, time together, she doesn't really be do anything outside when we meet up in person but she tries to do as much as she can. Last week we're doing paper prototype, so we met on Saturday, and set in the café sketching out what the actual product should look like, what the device should look like.	Last week we're doing paper prototype, so we met on Saturday, and set in the café sketching out what the actual product should look like, what the device should look like. Mainly that was A1 and myself, but we all discussed it and see what modifications needed to be made. - Yourself? Write up some notes from the	Last week she, from the week before she took the … which is the storyboard created by A1, A1 was the main one drawing them and A3 took those and then actually frame them all, actually it is clear in one page for every single storyboard. She took everything away to scan, but I don't think I've received anything yet

	Mainly that was A1 and myself, but we all discussed it and see what modifications needed to be made.	interviews and observations and then share that on Google drive and maybe upload some photos or create the personas but we would all discussed it or write something down previously as a group.	
A3	Not sure, she did conversation in meeting	Brainstorming, upload stuff on Google drive and observation	Write notations on storyboard And put them on Google drive
Summary	1 FA, 1UA A2 is fully aware of A1 A3 is unaware of A1 A1 & A2 are mutual fully aware A2 & A3 are mutual partially aware	1 FA, 1PA A1 is fully aware of A2 A3 is partially aware of A2	2 PA A1 is partially aware of A3 A2 is partially aware of A3

Second interview

Participant	What they reported about		
	A1	A2	A3
A1	Personally I draw some sketches and took part in discussion of design - Sketching for device? For paper prototype, well both device and the software	She did the same, so prototype and sketching with just talking about this and do it together	She took part in discussions and she took notes and then uploaded everything on drive
A2	A1 did one interview for user testing A1 and me were working together mainly to get the prototype drawing, going through scenario and storyboard, so make sure we including everything	We all did it together, so I haven't did anything apart from what we did together - So you just finish the prototype and write everything related to interviews and the storyboards? But I guess I was the main person drawing the paper prototype	She is gonna find at least one person to do with So we said we should at least have 5 people and not trying to get more than 5 people A3 was documenting all of that (interviews) And she turning them to requirements She also added annotations, storyboards after A1 is writing them up as well and she's writing them also looking at maybe other things should be including in our coursework, maybe reviewing what other people done, so we all trying to do something but it's difficult to have 3 people trying to draw a paper prototype
A3	So when we met, like all the 3 of us, A1 and A2 were working on the paper prototype Between meetings Not really	Paper prototype Between meetings Not really	I did annotations for the storyboard, because I actually ... last week, so I wrote them, put them on the computer, Wrote paper prototypes, start to structure the report, the body of the final report,

			Between meetings: I remember I did some scanning, so I scanned some stuff, I put it in the drive, I organise folders and move some information around (with content as well)
Summary	2 FA A1 & A2 are mutual fully aware A1 & A3 are mutual fully aware A2 & A3 are mutual fully aware	2 FA	2 FA

Third interview

Participant	What they reported about		
	A1	A2	A3
A1	I interviewed 2 users I put notes for evaluation	Interviewed users and prepared form prototype	She interviewed some users and she put some notes for them And she put some stuff on the Google docs as well, like ,,, for writing reports and some findings from previous weeks
A2	Last week she did usability test. This week she didn't do anything	We have met up last Wednesday and we had a call earlier this week to discuss like what we need to do And in terms of actual work, I did usability test with a potential user of the device (I have only done one) I wrote up my findings of that and share that with the other two people	At some point I think she had some usability test (one each) she also output the structure for our report
A3	She did some annotations for the project and she is now suppose to do the prototyping part of the report (but not yet)	Let me think.. She also did her part of evaluation And now she started working on the report, on the first part	I did one evaluation and then I started writing requirements part for the report and also the evaluation part of the report
Summary	2 PA A1 & A2 are mutual partially aware A2 & A3 are mutual fully aware	1 FA, 1 PA	2 FA

Group B

Participant	Week 17/11 -23/11							Week 24/11 - 30/11							Week 1/12 – 7/12							Week 8/12 – 14/12				
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12
B1			1							2							3									
B2					1										2				3							
B3					1							2							3							
B4								1				2							3							

- 1st interviews are within 6 days (the difference is 5 days)

- 2nd interviews are within 6 days (the difference is 5 days)
  (but B4 1st interview is on the same week as 2nd interview for B1, B3, and B4, while B2 2nd interview is on the next week)
- 3rd interviews are within 3 days (the difference is 2 days)

	First interview	Second interview	Third interview
B1	1 FA, 1 PA	1 FA, 1 N/I	2 PA, 1N/I
B2	1 FA, 1 PA	n/a	2 PA, 1N/I
B3	1 FA, 1 PA	2 N/I	1 FA, 1 PA, 1N/I
B4	n/a	2 FA	2 FA, 1N/I
Total	FA: 3 PA: 3 UA: 0 N/I: 0 (6)	FA: 3 PA:0 UA: 0 N/I: 3 (9)	FA: 3 PA: 5 UA: 0 N/I: 4

First interview (B1, B2, & B3)

Participant	What they reported about		
	B1	B2	B3
B1	I was writing up, I ask questions for interviews, so myself with 2 other colleagues (one couldn't make it), so I ask questions for maybe 2-3 people, within a space of an hour, and my other colleagues when it's turn so I wrote the notes. (B3 and B4)	At the time he wasn't there But we did another section before (a week before we did the same thing but we did it in pairs: so B3 & B4 went off as a pair, and did the interviews , me and B2 … then we alternated)	Interview a couple (mother and son, and mother with disability)
B2	B1 is a part time, he has no much time to communicate with others, so we always meet after 6 pm, after he is finish his work (Observation, interview)	We proceed another interview We have 4 groups, so 2 is pairs, and 2 is individual observation	Interview She is very fluent in English She is making a document when we speaking and she typed document very simultaneously
B3	Same thing (Analyse observation and interviews, personas and storyboard)	Same thing Analyse observation and interviews, personas and storyboard) (not the last interview)	Last week we had a meeting where we went, we analyse our observation information, our interviews and questionnaires, after that we create our personas, we did like a generic storyboard (rough first draft)
Summary	1 FA, 1 PA B1 & B2 are mutual fully aware	2 FA	2 PA

Second interview (B1, B3, & B4)

Participant	What they reported about		
	B1	B3	B4
B1	I was in charges with looking at other devices in museums, guides, to see what happens, compare against, to get some ideas	She was going to write up everything that we had discussed on Friday, post that on Dropbox (she already post it? I haven't checked yet)	B4 was just going to draw up nicely the storyboards

B3	B2 and B1 were in charge of looking at other open-air devices, to see where we can get inspiration	I was in charge of finishing the persona, like quieting them, tiding them up	B4 was in charge of storyboard, drawing our storyboards
B4	B1 design the homepage and other part, because we have 5 parts, it should be one person control 2 parts	B3 control flower part, the flower segment because in our design there is flower segment I remember she control 2 parts, I can't remember the other part	I controlled the statues and monument part, so for that part I'm going to draw paper prototype and then to show what should be import what should be export
Summary	1 FA, 1 N/I	2 N/I B2 and B4 agreed that B3 did flower section prototype	2 FA Storyboard=Paper prototype

Third interview

Participant	What they reported about			
	B1	B2	B3	B4
B1	We drawing the paper prototype for menus, so we each did a section, so I did the welcome page, how it should look like, and another option called information and the others did say 2 each as well, and we scanned them on and on Monday B3 did the electronic version to present it to our users for evaluation	B2 did the entertainment section	She did the wireframe in PowerPoint, B3 did the restaurant guide	I think monument and statues was B4 because he is talking always about them
B2	B1 also conduct the user testing with 2 users from their colleagues in the company	We discuss prototype … I conducted the user testing using prototype with one user, so making evaluation, and show my prototype to user and I didn't do anything for the device, just writing down the response, and post on our common sharing document on the Dropbox	B3 make prototype using PowerPoint, so she gives an idea to do this prototype instead of paper prototype	B4 continue to writing storyboard, because he is in charge of making 2-3 storyboards #He will conduct user testing#
B3	B1 conducted user testing (B1 did more than me, did the first iteration)	Conducting user testing (1) (did the second iteration)	I was in charge of creating the interactive prototype to be use in the testing I did a couple (user testing) (did the first iteration)	He also did conducting user testing (1) (did the second iteration)
B4	B1 ask his colleagues to help in the user	B2 ask his wife to do the user test as well	B3 design the device She link them together	I finish storyboard, I finish my part, which

	testing as well (2 users)	(1 user)	and then we can use them on the phone She did the user test as well	is: monuments and statues and then I give it to B3, everyone did the individual part and give it to B3 I do one user testing (1) for the latest version
Summary	3 N/I B2, B3, and B4 agreed that B1 did user testing	2 FA, 1 N/I	2 PA, 1 FA	3 PA

Group C

Participant	Week 17/11 -23/11							Week 24/11 - 30/11							Week 1/12 – 7/12							Week 8/12 – 14/12				
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12
C1					1							2												3		
C2					1							2												3		
C3					1										2									3		
C4					1											2									3	

- 1st interviews are on the same day
- 2nd interviews are within 5 days (the difference is 4 days, but on the 2 weeks)
- 3rd interviews are within 2 days (the difference is 1 day)

	First interview	Second interview	Third interview
C1	1 FA, 2 PA	1 FA	1 FA, 2 PA
C2	1 FA, 2 PA	1 FA	3 FA
C3	3 PA	1 FA	3 PA
C4	3 PA	1 FA	3 FA
Total	FA: 2 PA: 10 UA: 0 N/I: 0	FA: 4 PA: 0 UA: 0 N/I: 0 (8)	FA: 7 PA: 5 UA: 0 N/I: 0

First interview

Participant	What they reported about			
	C1	C2	C3	C4
C1	Personally I did another couple of interviews, so I spoke to one person on phone and one person on Skype, also tried to get another couple of interviews, but they didn't work	C2 again he did interviews, he also worked around white chapel with a couple of apps which kind of mimic, something similar to what we think he might doing to	She I think she might finish 2 interviews Just like last week, she's setup a merely, which is basically a system where you can add sticky notes but online so it's look like	I know he was on work on persona with So he did the majority of that He I think did 1 or maybe 2 interviews, write them up, He's doing a lot of

	out unfortunately, there is also use Dropbox folder for all of the group work so I've edit it, a few documents on that, nothing major but just one of the personas add a bit and uploaded a bit of information as well, we had a coursework surgery with of the tutors yesterday, so that was really helpful listened to him and I uploaded the sound file discussed with the course with the team members what we said cause I'm the only full-time where the others are part-time so they can't always make or meeting	user testing them Again I think he also did interview maybe 2, I think went around when someone is testing the app as well just to see what the exceptive was in that And he also came with me to the surgery yesterday	posted notes and so she puts a lot of ideas into that	work on the domain model, He's doing that .., so but he did most of the work before last week So I think He's kind of amending kind of doing little touches to that as well
C2	He did a couple of interviews, and he had put stuff to personas, he is also put stuff to affinity diagram, and he was trying to talk to the tour guide	I did my user interviews, so I spoke to the tour guide, and a spoke to someone being on the tour and people who engaged in tour, so writing up notes, and we're using an online tool called merely to do affinity diagramming, so writing notes, putting sticky on in affinity diagram	She also did a number of interviews as well, and she written those up, and she produced the merely thing, so she did the affinity diagram etc., and she also put the outline structure of our written report together as well	He did a couple of interviews as well, and he put stuff to personas with C1 together
C3	Not sure Excel sheet Each member did interview and observation	Each member did interview and observation	More interviews Affinity diagram Each member did interview and observation group framework, 4 sections: C1: evaluation C2: observation C3: conceptual design C4: detailed design	When we met agree Each member did interview and observation
C4	C1 did a couple of interviews	C2 did a number of interviews and write them up	C3 created a number of affinity diagrams and she is also writing up her interviews	I did 2 interviews, and I worked on domain model, and I created a persona, they did interviews more than me agreed basic framework: C1: evaluation

				C2: research C3: conceptual design C4: detailed design
Summary	1 FA, 2 PA C1 & C3 are mutual partially aware C2 & C3 are mutual partially aware C3 & C4 are mutual partially aware C2 & C4 are mutual partially aware	3 PA	3 PA	1 FA, 2 PA

Second interview (C1 & C2)

Participant	What they reported about	
	C1	C2
C1	Interview grid Workshop Storyboard ideas/ design ideas Wednesday: given jobs, find images	Writing the first part of the report Interactive audio, sound files, script
C2	C1 has been providing images for the detailed design, and contributing his ideas to discussion, he also updated some of the interview notes they took, so he can wrote up the research write up	I've been concentrating on writing up the research part for the final report, which I still doing now, the analysis of the observations and interviews which we did, I've prepared some text for the wireframes of the prototype, I found an audio file that we going to use for the evaluation while doing our testing with people, I just do reading around to give the right references citation for the report
Summary	1FA C1 & C2 are mutual fully aware	1 FA

Second interview (C3 & C4)

Participant	What they reported about	
	C3	C4
C3	The storyboards were done and after that we got together on Wednesday to discuss what we're going to do next, and we decided, we looked at the storyboards, and then re-decided that some consequences should move, should work the other way around, so we start thinking about, we defined what the artifact is going to be, and we start talking about evaluation, and discussing what we will do and what kind of themes we would looking at for the evaluation And I thought we needed to look at what kind of gestures we would use, cause some of the interface design got some gestures, so I had looked at that, then I had looked at storyboards and some input regarding how we will do the evaluation, I worked on the script as well for the evaluation (ambiance town)	C4 is in charge and lead that section on detailed design, not evaluation, he would going to put that bit together, there was a bit of discussion weather we should do low- fi, high-fi, and then so C4 started working on that (C4 is working on the detailed version)
C4	C3 has been giving me lots of input on the design, she has provided images for the design, she has written a number of goals, she has written the	I made an interactive prototype of the product, …, presented different versions of that to the team to get feedback, we had a meeting on Sunday via

	script for the prototype annotation, she is wrote some questionnaires for the participants (for user testing)	skype, we reviewed current of our state, so my work is really building the prototype and also updating the hypothesis that we're going to evaluate
Summary	1 FA C3 & C4 are mutual fully aware	1 FA

Third interview

Participant	What they reported about			
	C1	C2	C3	C4
C1	So we handed in the project this Monday, so 2 days ago. Over the last week, the main thing we did is we engaged in testing of our wireframe, so we took out some users and show them what we done and get feedback from them for the evaluation so what we did we split up into 2 groups: me and C4, C2 and C3, and we went out and about to show people what we did a mini tour, which seems go down quite well, me and C4 did it last Thursday, C2 and C3 did it a day before on Wednesday and then we all met up on Sunday in the university library and we kind of sat down and just flush out the project and write it all with appendices	Testing wireframe C2 and C3: Wednesday (2 users)	Testing wireframe C2 and C3: Wednesday (2 users) we all met up on Sunday in the university library and we kind of sat down and just flush out the project and write it all with appendices	Testing wireframe C1 and C4: last Thursday (2 users)
C2	He did on the evaluation, in terms of making and preparing the scripts and he did 2 user testing in the evening (he did 2 people on Wednesday, 2 people on Thursday, so 4 in total) and for the write up his part is about the evaluation	A lot of structuring the final report, and we kind of shared out in terms of what we wrote, so I did the design summary, and also all the stuff about research and research analysis, Also I've did 2 user testing on Wednesday evening with C3 and the preparation for the … afterwards, and then on Sunday we met here	So the user testing and her part of the writing up is on the conceptual design	He built the paper prototype, and he also did the interactive prototype as well, when came to write up he detailed design part of it, also he did testing on Thursday with C1

		in the library just to go through the document and finish it all off and then on Monday after during the day I work on the individual reflection		
C3	C1 organised and wrote most of the evaluation section, and kind of organised the logic of the document and making sure the appendices were in the right place and the references	C2 was doing a bit more of organising the data gathering section and looking at the findings from the interviews	Reviewed the project document I think about 100 times, and just making sure it makes sense and everything tighten with each other and the progression and the way we did the project: data, detailed design, conceptual design, evaluation, useful references	He uploaded all the images and the information about the prototype which he had worked on, mostly him, and then he wrote the initial piece about the design section, the detailed design section
C4	C1wrote the evaluation section of the final hand in, and he did testing as well in white chapel, and wrote up the interviews	C2 wrote and created the structure of the document we hand in, and did a significant amount of work on writing up the research phase, the observation, and also did testing in white chapel with C3	C3 contributed to the detailed design section and also wrote the conceptual design section, she tested the product with 2 participants, she helped me present showcase, we do it together, she did a lot of the task analysis on the document as well	I built the prototype, I tested it with 2 participants along with C1we did that together and C3 and C2 did another 2 participants, I built the presentation for the showcase and presented that, and did all of the referencing of the document and hand in, and also wrote the detailed design section for the assignment
Summary	2 FA, 1 PA	2 PA, 1 FA C2 & C4 are mutual fully aware	3 FA C1, C2, and C4 agreed that C3 did user testing and wrote up conceptual design	2 PA, 1 FA

Group D

Participant	Week 17/11 -23/11							Week 24/11 - 30/11							Week 1/12 – 7/12							Week 8/12 – 14/12				
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12
D1					1							2													3	
D2								1											2						3	
D3										1							2							3		
D4												1							2					3		

- 1st interviews are within 8 days (the difference is 7 days)

- 2nd interviews are within 8 days (the difference is 7 days)
  D1 2nd interview on the same day as D4 1st interview
- 3rd interviews are within 2 days (the difference is 1 day)

	First interview	Second interview	Third interview
D1	2 PA	n/a	2 FA, 1 PA
D2	1 PA	2 PA	2 FA, 1 PA
D3	1 PA, 1 UA, 1 N/I	2 PA	1 FA, 2 PA
D4	1 FA, 1 PA	1 FA, 1 PA	2 FA, 1 PA
Total	FA: 1 PA: 5 UA: 1 N/I: 1 (5)	FA: 1 PA: 5 UA: 0 N/I: 0 (3)	FA: 7 PA: 5 UA: 0 N/I: 0

First interview (D2 & D3)

Participant	What they reported about	
	D2	D3
D2	I was finalising user research, so I was just looking for the interviews, so the user research consisted of the interviews, not with users, but with the visitors of the site and we did observations In another section All do interviews and observation	D3 has also been looking at user research, and also has been summarising interviews data
D3	I don't actually know what each member done, I think as a whole the rest of the group was looking at persona, they did seem complete them last week, so D1 and D4 did them and he reviewed them and made amendments	I was consolidating all of the interviews into an easy to use spread sheet, and making kind of functional requirements, and these what leads us to personas
Summary	1 UA	1 PA

First interview (D1, D3, & D4)

Participant	What they reported about		
	D1	D3	D4
D1 (Actual 2nd)	I don't remember, I don't think any of us did that much, cause we had requirement coursework ended today, but I don't remember - so you told me that you worked on the wireframe and the prototype? We are going to do this weekend, everyone is doing wireframe, so we can look at it together and see what we like, and we also made some storyboards and then decided to make 3	Probably almost the same (as D2), but not the data cloud (persona and user research)	Me and D4 did the personas and then they looked it over and we changed it, and she wrote some more about observation and interview I think, like the final text
D3	Completed persona	I was consolidating all of the interviews into an easy to use spread sheet, and making kind of	Completed persona

		functional requirements, and these what leads us to personas	
D4	She did 2 personas, she did the same thing I did, she made some changes, reviewed other people's work, and she also wrote part of the general document, why we using personas, and then we all did storyboard	Basically the same, so everyone doing this and everyone checks everyone's work, so he also reviewed personas, reviewed we've talked about in the meeting and the brainstorm and then also storyboard	We've done the personas, we've changed the personas, so they would be better, so we had a meeting with Stephanie, and she told us we need to change something, o we did, and also we came up with some scenarios, and then I drew them in illustrator to make sure they readable enough - What you did exactly? First I wrote 2 personas and D1 also wrote 2 personas, and D2 and D3 reviewed them, and the we went to a meeting, and then re-changed them again, and then me and D1 reviewed them again
Summary	1 FA 1 N/I	2 PA D3 & D4 are mutual partially aware	2 PA

Second interview (D2, D3, & D4)

Participant	What they reported about		
	D2	D3	D4
D2	Sketch wireframe Finish research analysis	Finishing storyboard Contribute in wireframe	She had user stories, image data
D3	He added to the stuff he did on the write up, so he started doing bits of the write up as well	I started the overall write up, so we had different bits and pieces in the Google shared drive, and I started up like condensed it and putting it in our finished article, and completing various bits and pieces of the user research, so that was the main thing, also we did a brainstorming session, and creating various documents to show how we come up with our prototype	She did the storyboards and she's just going to do wireframes, which is pretty good
D4	Wireframe and user testing	He's written up most about why we did the storyboard and wireframes, but also about wrote up why the product would work, like assumptions we made, how users could use it He and D2 did that together, so divided the work and checked it each other	We created our storyboards, and I was drawing them up, and I finished them, and then we each made a first version of the wireframe, how we saw the product, and then we had a meeting to discuss them and we decided we would keep mine and change them a little, so the elements of the other wireframes would be in it too, because the others made it on paper, and I did it in illustrator, so we can easily add their elements to my wireframes Testing:

			2 students 7 students 6 more
Summary	2 PA	1 PA 1 FA	2 PA

Third interview

Participant	What they reported about			
	D1	D2	D3	D4
D1	Sorry that's difficult to remember so I have to think, I draw storyboards, also did the references list, and then wrote the citations in the text, we also did D4, D2, and me did some evaluation stuff for the device, so went out and ask people, when I get home I wrote down all of our observations (Observing the testing)	He was part of some of evaluation, I'm not sure if D2 or D4, who wrote down the specification of the device, or if he D3	He wrote almost the same thing In charge of writing (first) I don't remember	She was making the prototype and wireframes, we all did a sketching f the wireframes, but she did the main document, because she's really good at doing drawings, she was in charge of doing the testing, (conducting the testing)
D2	She wrote up some of the user evaluation testing	I've corrected other peoples' work, did that by annotating pictures that they put on as well as bits and bobs, small things needed to be done	D3 wrote up the user evaluation, and also the further work to be done in future	D4 finished doing the wireframes, she also made a second version of the prototype, D4 did some user testing on her flat mates, they were 7 people
D3	I'm going to be honest, I'm not really sure, I know she went down to do the testing, I don't think she did much, she hasn't contributed much generally overall	He went down did the testing, also he's been really helpful doing a big part of the write up, doing different sections with me	In the last week is being mainly doing the write up, so we had to meet on Saturday and making sure everything is ok and do through editing it	She did more wireframes for us, that was really helpful, and she was quite good getting all the document together
D4	She was with me, trying to figure out how it should look, the wireframe itself, how they would blend with the document, she helped me with the drawing of the document a little, and then also she reviewed the appendix, and then she re-read the requirements, make sure everything was in there	D2 was the one who went through everything to make sure that we had everything in there, and then in our meeting, he was also writing and trying to correct all the sentences and make sure that everything consistent, and he was the second one to review the entire document	He wrote more text about our evaluation process, and in the meeting itself he was the one who was reading the text out loud, so we can hear it instead of just reading it because it helps us to know what sentences, and then he corrected them, and then he was the first one to review the final document, and then at the end he did it again as well	I made drawings for the final product in illustrator so I can do real view, and then in our meeting I put everything together and then we also went over every sentence every part and then we put everything together everything need to be in there, and then on Sunday I added all the appendix, then when someone else had reviewed it, then I re-read it again, and again

				(D1 & D4: the content D2 & D3: writing)
Summary	2 PA, 1 FA D1 & D2 are mutual partially aware	3 PA	3 FA D3 & D4 are mutual fully aware	3 FA D1 & D4 are mutual fully aware

Appendix C.7

Group A

	First interview	Second interview	Third interview
A1	1 FA, 1PA	2 FA	1 FA, 1PA
A2	1 FA, 1PA	2 FA	1 FA, 1PA
A3	1 PA, 1UA	2 FA	1 FA, 1PA
Total	FA: 2 PA: 3 UA: 1	FA: 6 PA: 0 UA: 0	FA: 3 PA: 3 UA: 0
Maximum counts	6	6	6
Included counts	6	6	6
Maximum points	12	12	12
Received points	7	12	9
%	58.33	100	75
Mutual awareness?	A1 & A2 are mutual fully aware A2 & A3 are mutual partially aware	A1 & A2 are mutual fully aware A2 & A3 are mutual fully aware A1 & A3 are mutual fully aware	A1 & A2 are mutual partially aware A2 & A3 are mutual fully aware

Group B

	First interview	Second interview	Third interview
B1	1 FA, 1 PA	1 FA, 1 N/I	2 PA, 1N/I
B2	1 FA, 1 PA	n/a	2 PA, 1N/I
B3	1 FA, 1 PA	2 N/I	1 FA, 1 PA, 1N/I
B4	n/a	2 FA	2 FA, 1N/I
Total	FA: 3 PA: 3 UA: 0 N/I: 0 (6)	FA: 3 PA:0 UA: 0 N/I: 3 (9)	FA: 3 PA: 5 UA: 0 N/I: 4
Maximum counts	6	6	12

Included counts	6	3	8
Maximum points	12	6	16
Received points	9	6	11
%	75	100	68.75
Mutual awareness?	B1 & B2 are mutual fully aware	No	No

Group C

	First interview	Second interview	Third interview
C1	1 FA, 2 PA	1 FA	1 FA, 2 PA
C2	1 FA, 2 PA	1 FA	3 FA
C3	3 PA	1 FA	3 PA
C4	3 PA	1 FA	3 FA
Total	FA: 2 PA: 10 UA: 0 N/I: 0	FA: 4 PA: 0 UA: 0 N/I: 0 (8)	FA: 7 PA: 5 UA: 0 N/I: 0
Maximum counts	12	4 (12)	12
Included counts	12	4	12
Maximum points	24	8	24
Received points	14	8	19
%	58.33	100	79.17
Mutual awareness?	C1 & C3 are mutual partially aware C2 & C3 are mutual partially aware C3 & C4 are mutual partially aware C2 & C4 are mutual partially aware	C1 & C2 are mutual fully aware C3 & C4 are mutual fully aware	C2 & C4 are mutual fully aware

Group D

	First interview	Second interview	Third interview
D1	2 PA	n/a	2 FA, 1 PA
D2	1 PA	2 PA	2 FA, 1 PA
D3	1 PA, 1 UA, 1 N/I	2 PA	1 FA, 2 PA
D4	1 FA, 1 PA	1 FA, 1 PA	2 FA, 1 PA
Total	FA: 1	FA: 1	FA: 7

	PA: 5 UA: 1 N/I: 1 (5)	PA: 5 UA: 0 N/I: 0 (6)	PA: 5 UA: 0 N/I: 0
Maximum counts	8	6	12
Included counts	7	6	12
Maximum points	14	12	24
Received points	7	7	19
%	50	58.33	79.17
Mutual awareness?	D3 & D4 are mutual partially aware	No	D1 & D2 are mutual partially aware D1 & D4 are mutual fully aware D3 & D4 are mutual fully aware

Appendix D: Social Actor Design

Appendix D.1
Applied Persuasive Design Techniques

Persuasive System Design model:
The following four tables present the persuasive techniques identified in the PSD model, and how we can apply these techniques in a persuasive social actor for activity awareness in learning group also it shows which persuasive techniques were applied in Mr. Mentor app.

Primary task support

Persuasive technique	Definition	How to apply it	Applied?	Possible?
Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour.	The app will minimise interaction by using buttons, no need to write text	Y	Y
Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.	The app will lead the user through a series of questions to complete the interaction with Mr. Mentor.	Y	Y
Personalisation	A system that offers personalised content or services has a greater capability for persuasion.	The app will offer some setting features, so the user can customise notifications.	Y (i)	Y
Self-monitoring	A system that keeps track of one's own performance or status supports the user in achieving goals.	The app will provide a reward page, so the user can see their points	Y (i)	Y
Tailoring	Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group.	The app could provide specific information for each group based on their progress and needs	N	Y
Simulation	Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect.	n/a	N	N
Rehearsal	A system providing means with which to rehearse a behaviour can enable people to change their attitudes or behaviour in the real world.	n/a	N	N

Computer-human dialogue support

Persuasive technique	Definition	How to apply it	Applied?	Possible?
Praise	By offering praise, a system can make users more open to persuasion.	The app will offer praise if users shared their work or looked at others work.	Y	Y
Rewards	Systems that reward target behaviours may have great persuasive powers.	The app will give virtual points for users when they shared their work or looked at others work.	Y (i)	Y
Reminders	If a system reminds users of their target behaviour, the users will more likely achieve their goals.	The app will send notification to remind members to share their completed work or look at the work done by members of their group.	Y	Y
Suggestion	Systems offering fitting suggestions will have greater persuasive powers.	The app will suggest sharing completed work with others in the case if the user didn't share yet. Also, the app will suggest looking at completed work by group members in the case if the user didn't look yet.	Y	Y
Similarity	People are more readily persuaded through systems that remind them of themselves in some meaningful way.	The app will use informal/friendly language	N	Y
Liking	A system that is visually attractive for its users is likely to be more persuasive.	The app will display an interactive virtual mentor	Y	Y
Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.	The app adopts a social role for the virtual mentor	Y	Y

Perceived system credibility

Persuasive technique	Definition	How to apply it	Applied?	Possible?
Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.	The app will provide true and reliable information about the app and study	Y	Y
Expertise	A system that is viewed as incorporating expertise will have increased powers of persuasion.	The app will be updated regularly and no out-of-date information or dangling links	N	Y
Surface credibility	People make initial assessments of the system credibility based on a first-hand inspection.	No ads in the app	Y	Y

Real-world feel	A system that highlights people or organisation behind its content or services will have more credibility.	The app will display information about the author (i.e. name, and email)	Y	Y
Authority	A system that leverages roles of authority will have enhanced powers of persuasion.	n/a	N	N
Third-party endorsements	Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility.	n/a	N	N
Verifiability	Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.	n/a	N	N

Social influence

Persuasive technique	Definition	How to apply it	Applied?	Possible?
Cooperation	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to co-operate.	The app will help group members to collaborate	Y	Y
Competition	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to compete.	The app will provide means of competing between users by displaying the total gained points	Y (i)	Y
Social learning	A person will be more motivated to perform a target behaviour if (s)he can use a system to observe others performing the behaviour.	n/a	N	N
Social comparison	System users will have a greater motivation to perform the target behaviour if they can compare their performance with the performance of others.	n/a	N	N
Normative influence	A system can leverage normative influence or peer pressure to increase the likelihood that a person will	n/a	N	N

	adopt a target behaviour.			
Social facilitation	System users are more likely to perform target behaviour if they discern via the system that others are performing the behaviour along with them.	n/a	N	N
Recognition	By offering public recognition for an individual or group, a system can increase the likelihood that a person/group will adopt a target behaviour.	n/a	N	N

Social cues for social actors:

This table shows the social cues identified by Fogg for social actors and the persuasive techniques that are suitable for them i.e. that give the characteristics of social actors, and whether they were applied in Mr. Mentor app or not.

Cue	Examples	Cues in Mr. Mentor App
Physical	Face, eyes, body, movement	Face, body, movement, expressions
Psychological	Preferences, humor, personality, feelings, empathy, "I'm sorry"	Personalisation, self-monitoring
Language	Interactive language use, spoken language, language recognition	Spoken language
Social dynamics	Turn taking, cooperation, praise for good work, answering questions, reciprocity	Praise, rewards, reminders, suggestion
Social roles	Doctor, teammate, opponent, teacher, pet, guide	Mentor

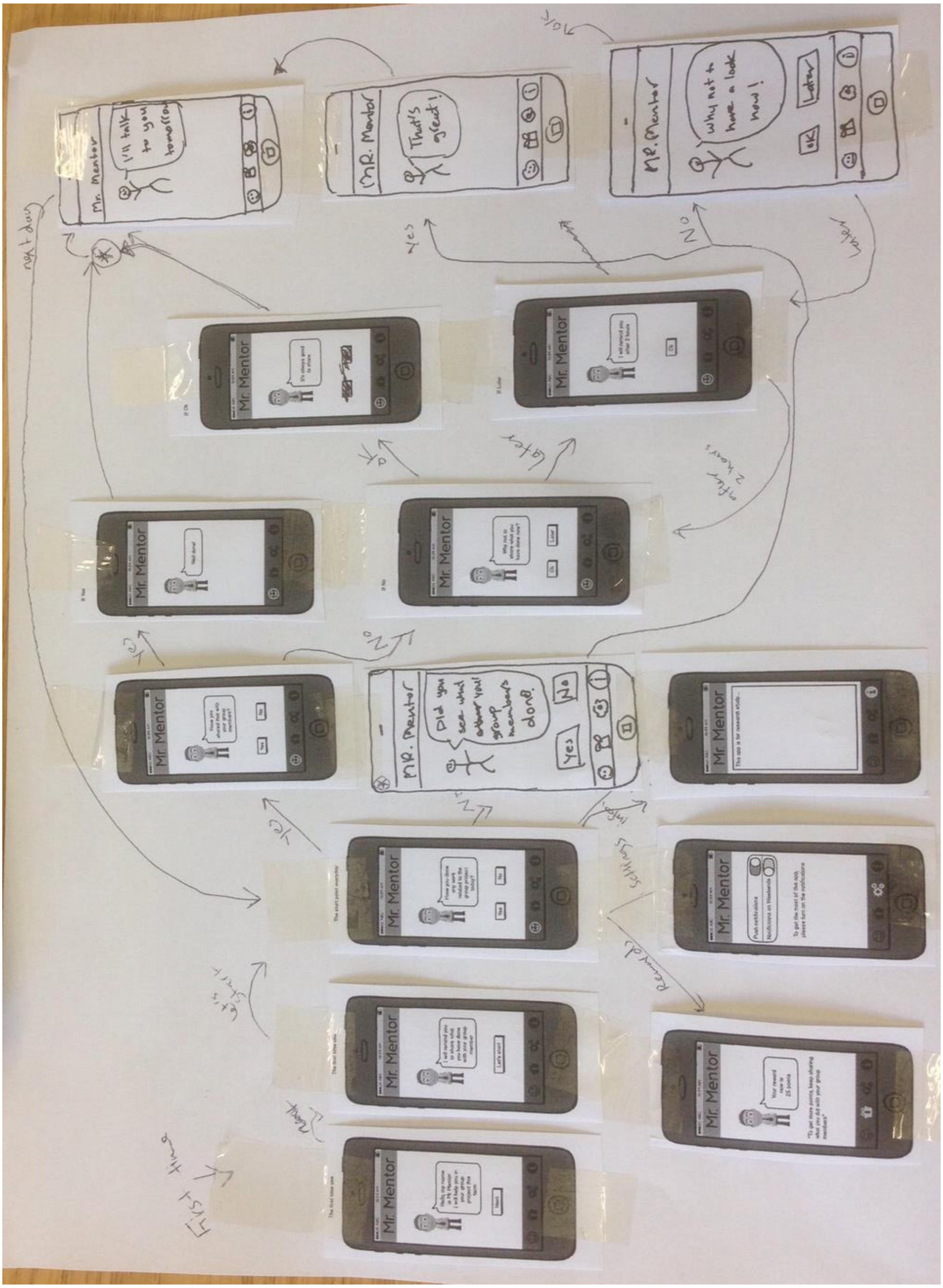
Persuasive techniques in learning contexts:

Last table shows the persuasive techniques that used in different learning and educational contexts for specific persuasive technologies.

Learning context example	Persuasive techniques	Comments
Academic Business Computing (Business context)	Reduction and interactivity	
Language Learning (Business context)	Reduction, conditioning, and suggestion,	Conditioning includes praise and rewards with more subtle manner
SISATSpace (Persuasive tool, medium, and social actor)	Social facilitation, social comparison, social learning, cooperation, competition, recognition, credibility, trustworthiness,	Similarity used as psychological cues for social actor

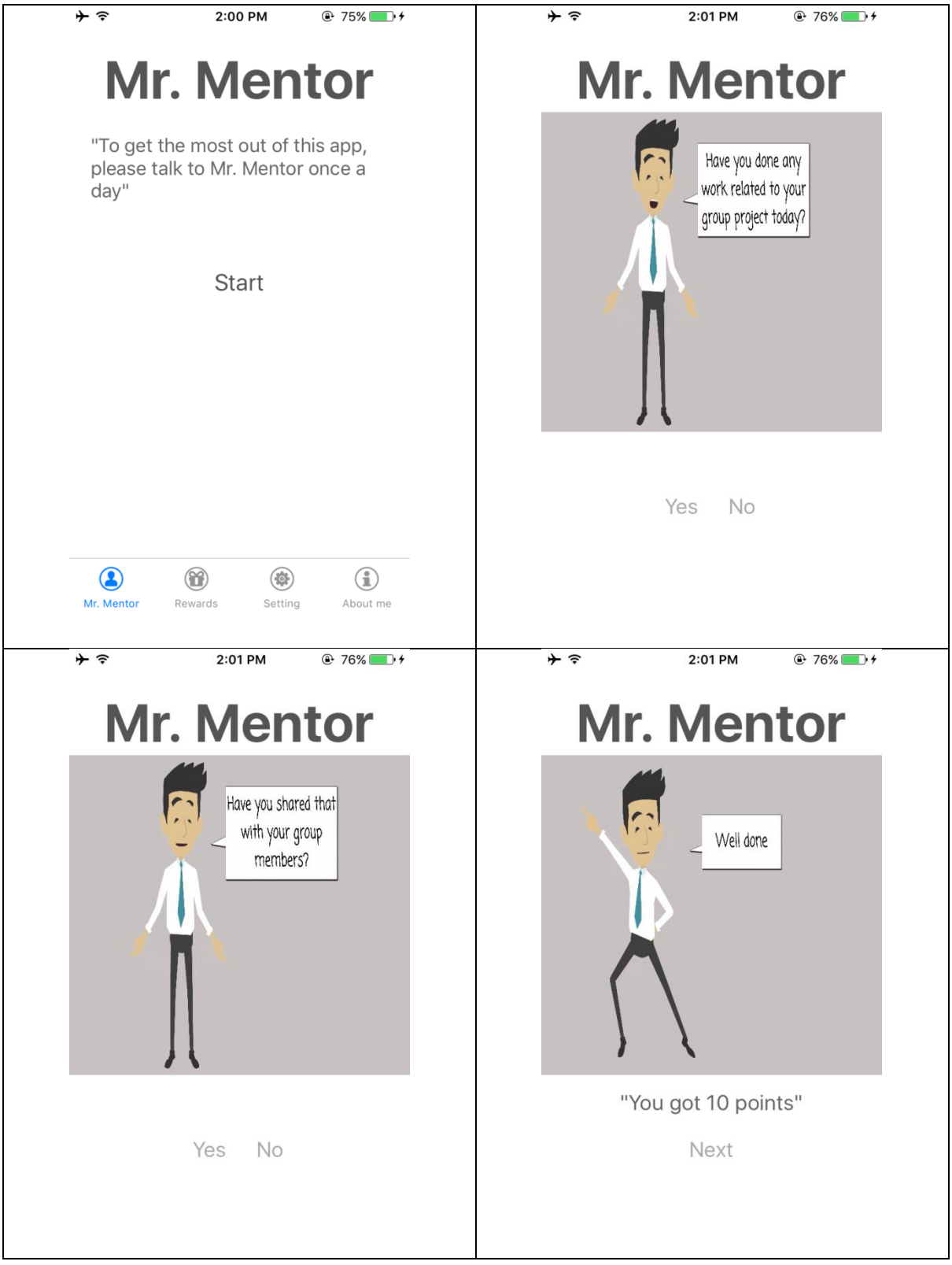
	expertise, and similarity	
HANDS project (Instructional design for school settings)	Reduction, tunneling, tailoring, personalisation, self-monitoring, credibility, praise and rewards	They create 4 design principles: Principle 1: Tasks that children have high motivation to engage with and that can be clearly delineated are most likely to be amenable to persuasive interventions. Principle 2: Using the technology in an educational context for persuasive aims offers the potential to leverage the perceived credibility of the teacher. Principle 3: Persuasive interventions are most effective when they are interwoven with the face-to-face ("offline") involvement of the teacher. Principle 4: Kairos: interventions provided at the right time and place will be more persuasive, and more likely to bring about behavior change. They argued that credibility and Kairos are the most important persuasive techniques to be considered in designing mobile applications for educational settings.

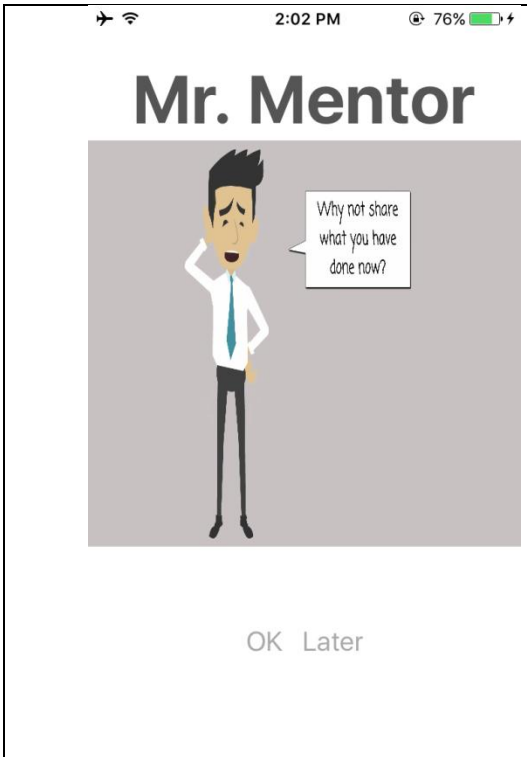
Appendix D.2
Paper prototype

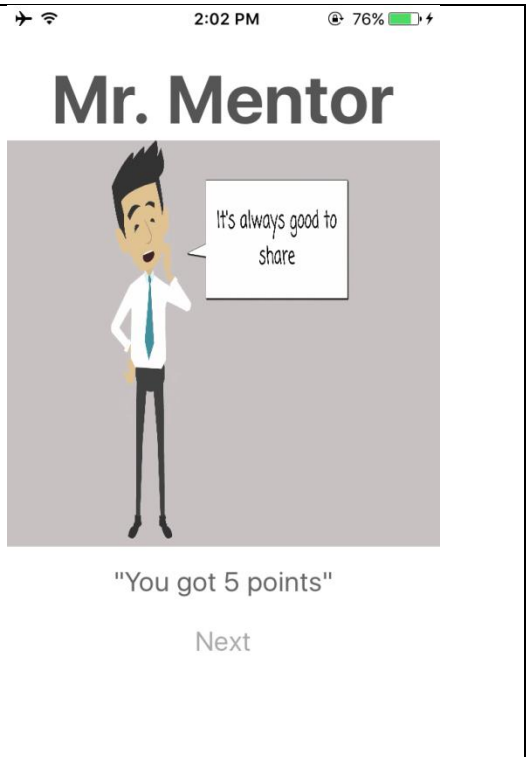


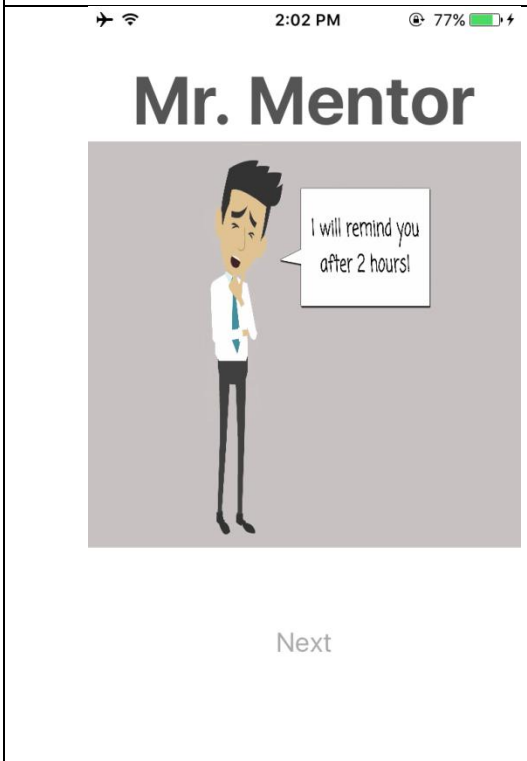
Appendix D.3

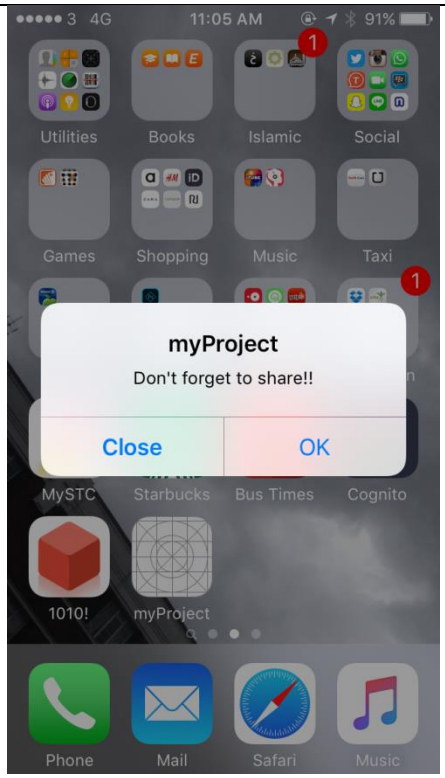
iPhone app screenshots




2:02 PM
76%
Mr. Mentor
Why not share what you have done now?
OK
Later


2:02 PM
76%
Mr. Mentor
It's always good to share
"You got 5 points"
Next


2:02 PM
77%
Mr. Mentor
I will remind you after 2 hours!
Next


3 4G
11:05 AM
91%
Utilities
Books
Islamic
Social
Games
Shopping
Music
Taxi
myProject
Don't forget to share!!
Close
OK
MySTC
Starbucks
Bus Times
Cognito
1010!
myProject
Phone
Mail
Safari
Music

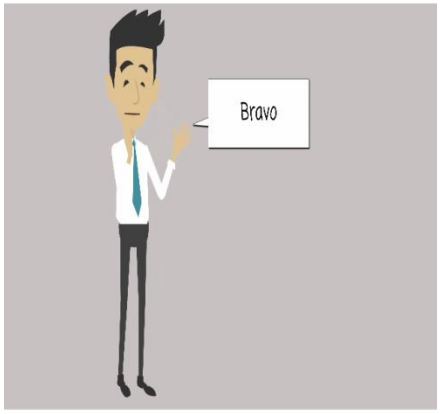
2:01 PM 76%

Mr. Mentor

Yes No

2:01 PM 76%

Mr. Mentor



"You got 10 points"

Next

2:02 PM 76%

Mr. Mentor

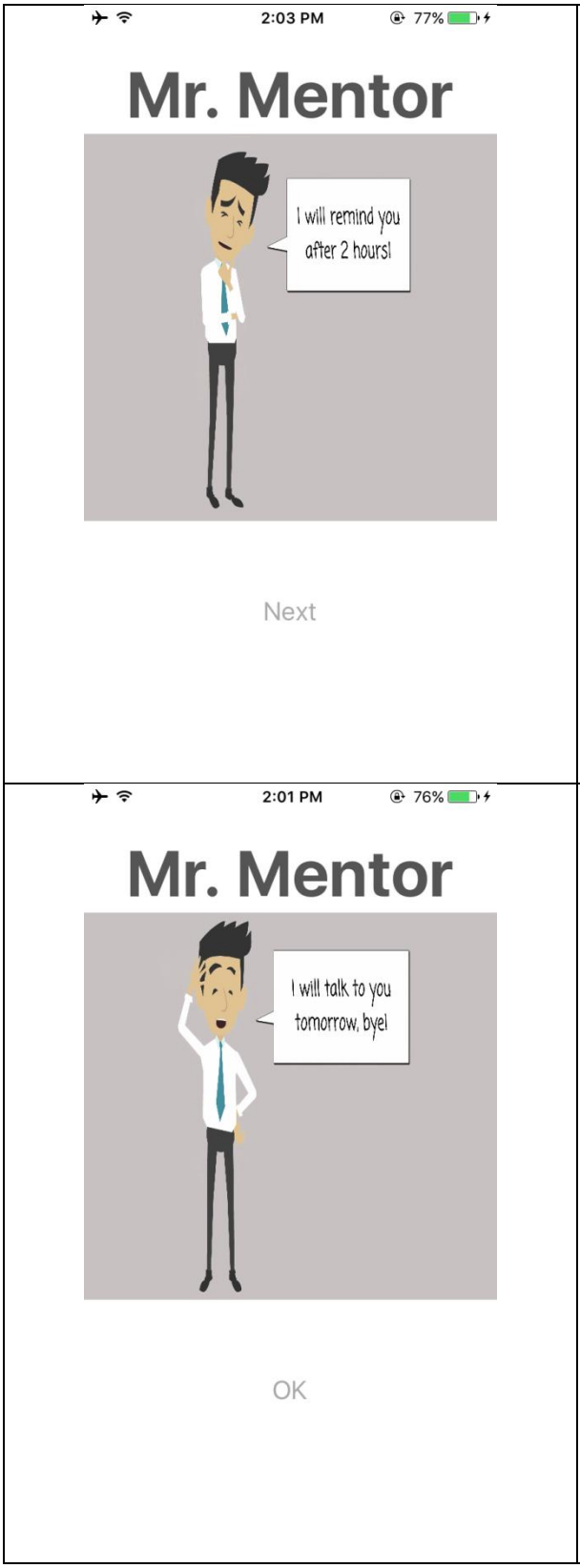
OK Later

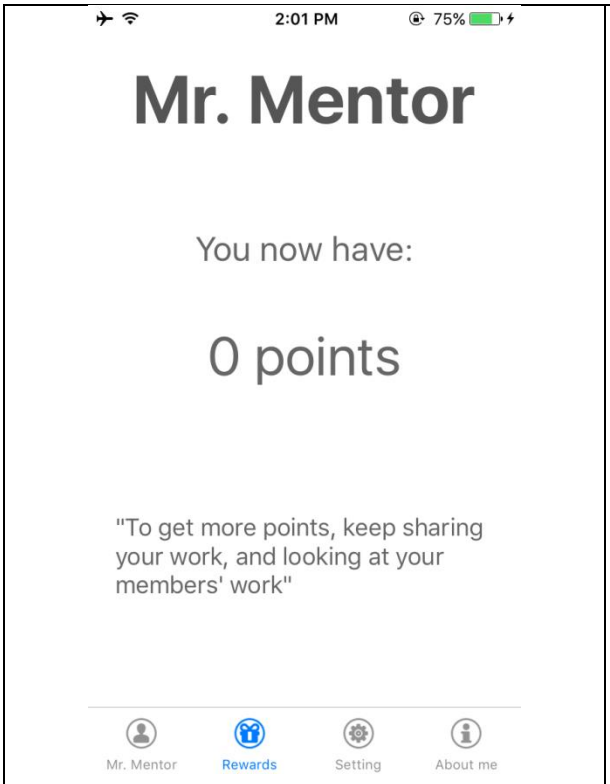
2:02 PM 76%

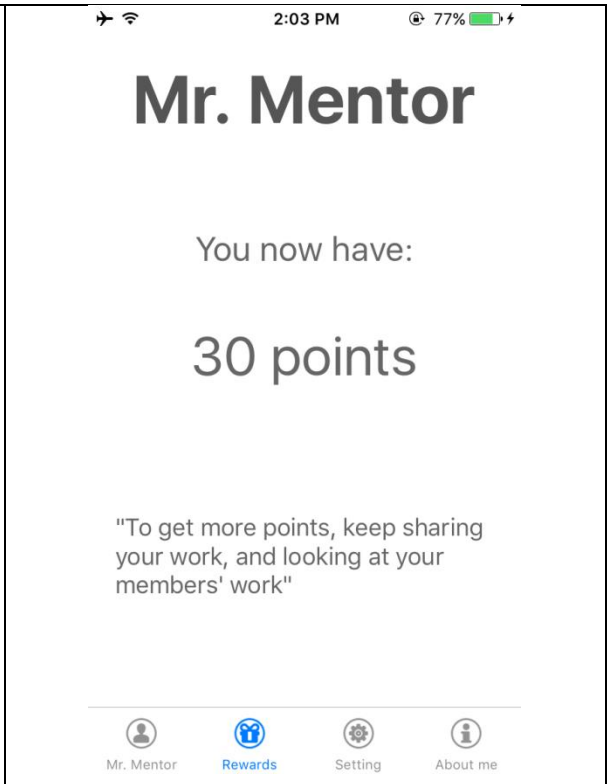
Mr. Mentor

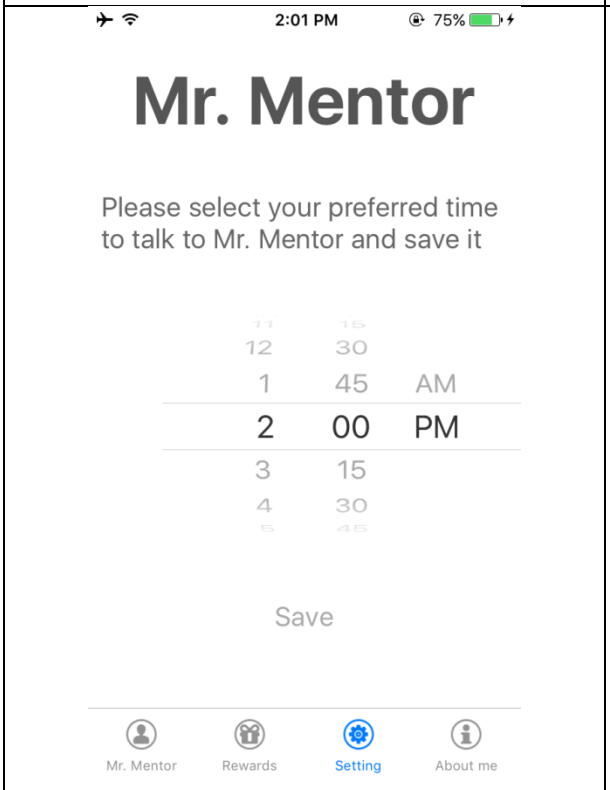
"You got 5 points"

Next

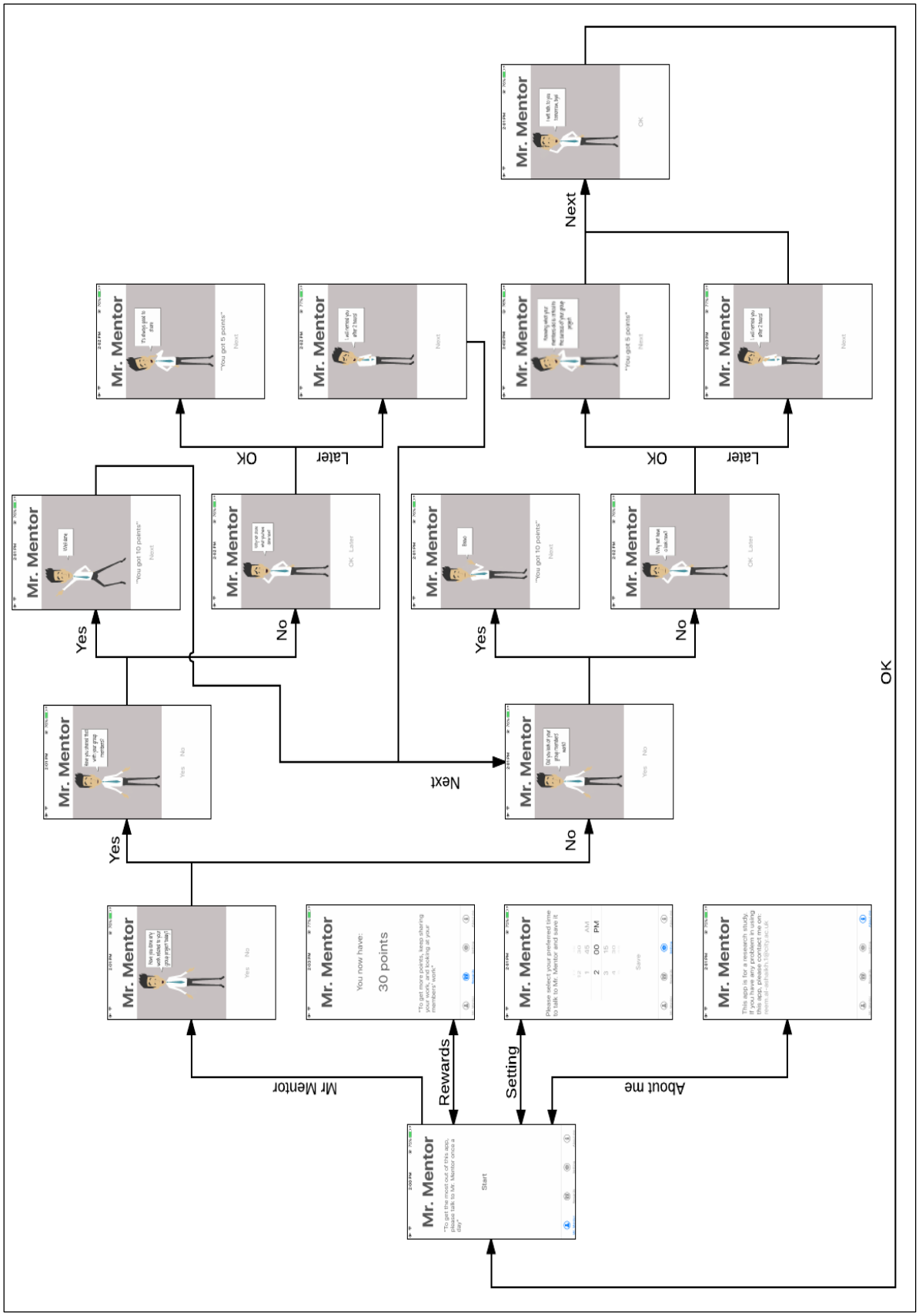

2:03 PM
77%
Mr. Mentor
I will remind you after 2 hours!
Next
1:20 PM
15%
App
Mr Mentor
Guide...
2:01 PM
76%
Mr. Mentor
I will talk to you tomorrow, bye!
OK
2:00 PM
75%
Mr. Mentor
"To get the most out of this app, please talk to Mr. Mentor once a day"
Start
Mr. Mentor
Rewards
Setting
About me


2:01 PM
75%
Mr. Mentor
You now have:
0 points
"To get more points, keep sharing your work, and looking at your members' work"
Mr. Mentor
Rewards
Setting
About me

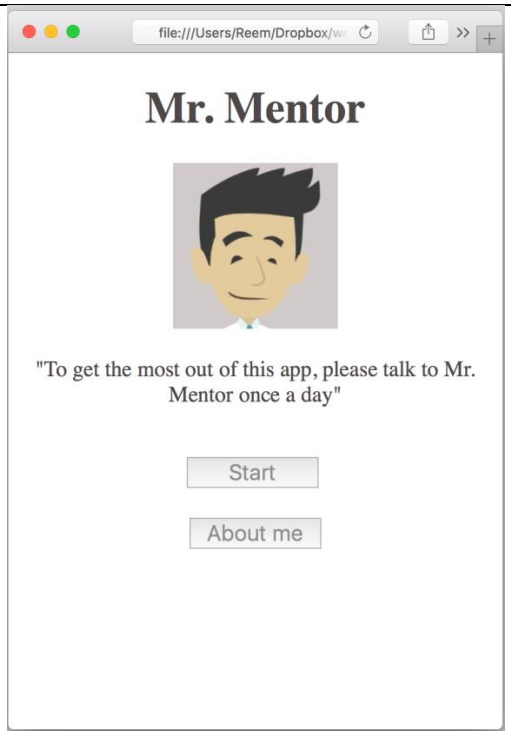

2:03 PM
77%
Mr. Mentor
You now have:
30 points
"To get more points, keep sharing your work, and looking at your members' work"
Mr. Mentor
Rewards
Setting
About me

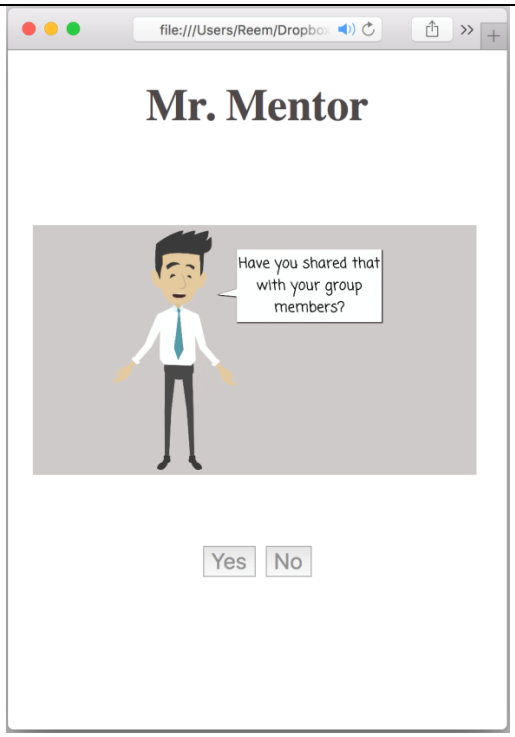

2:01 PM
75%
Mr. Mentor
Please select your preferred time to talk to Mr. Mentor and save it
12 30
1 45 AM
2 00 PM
3 15
4 30
Save
Mr. Mentor
Rewards
Setting
About me

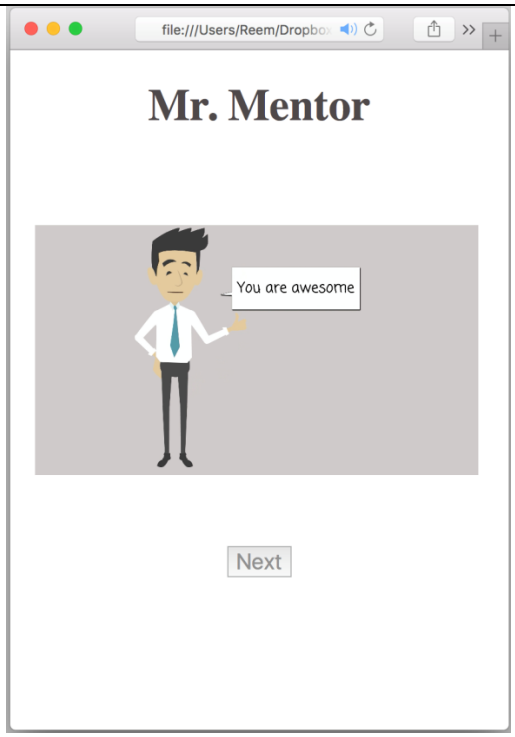

2:01 PM
75%
Mr. Mentor
This app is for a research study. If you have any problem in using this app, please contact me on:
reem.al-ashaikh.1@city.ac.uk
Mr. Mentor
Rewards
Setting
About me

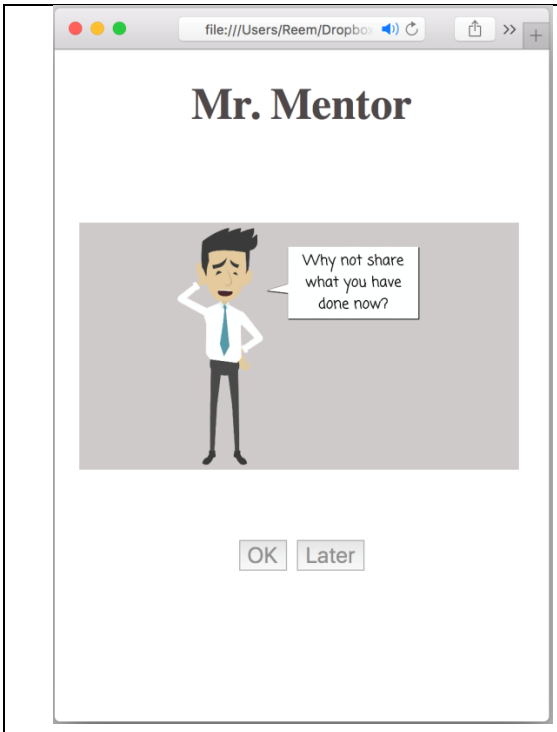

Mr. Mentor
Start
Mr Mentor
Rewards
Setting
About me
You now have:
30 points
Yes
No
Next
OK
Later

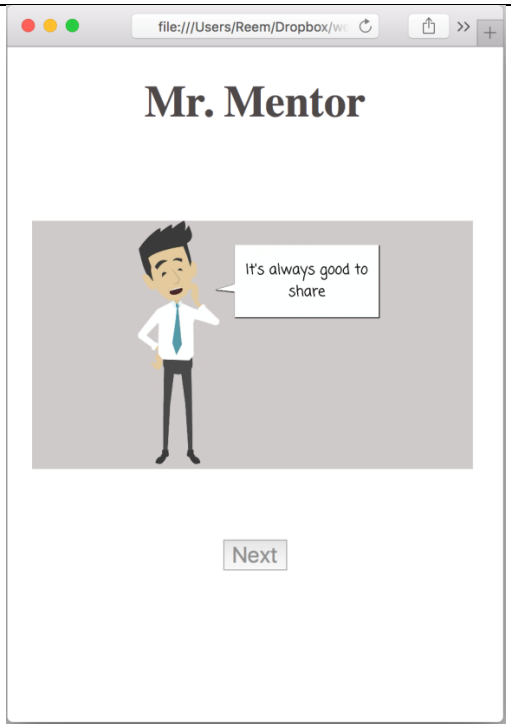
Appendix D.4
Web app screenshots

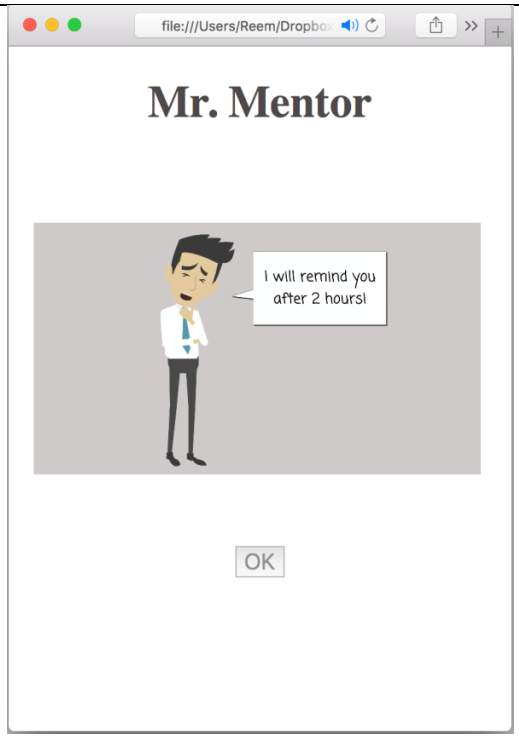


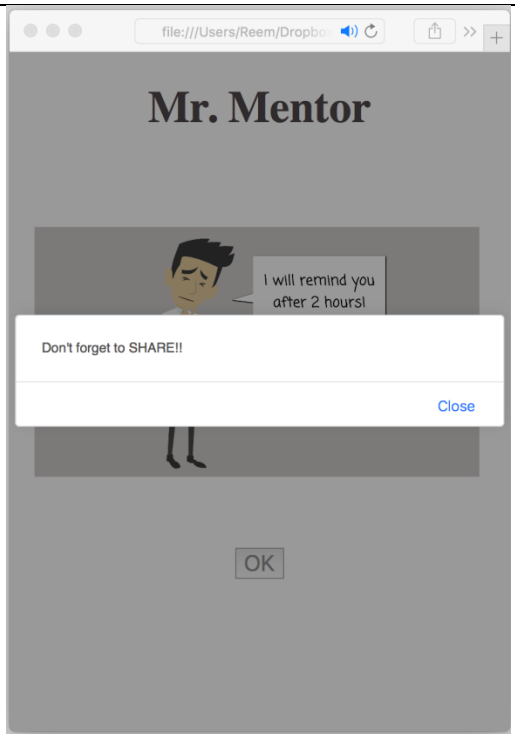




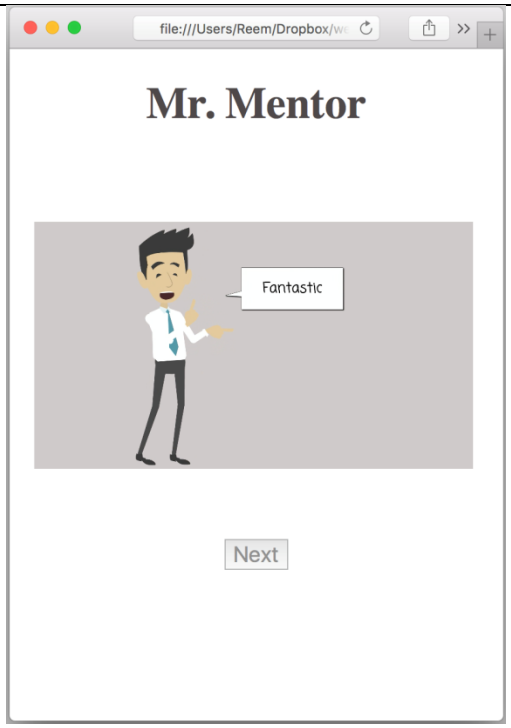

Mr. Mentor
Why not share what you have done now?
OK
Later


Mr. Mentor
It's always good to share
Next


Mr. Mentor
I will remind you after 2 hours!
OK


Mr. Mentor
I will remind you after 2 hours!
Don't forget to SHARE!!
Close
OK


file:///Users/Reem/Dropbox/
Mr. Mentor
Did you look at your group members' work?
Yes
No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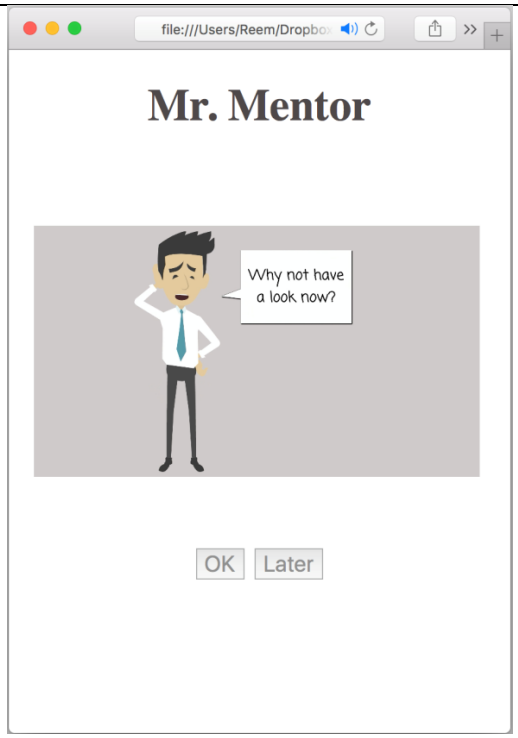
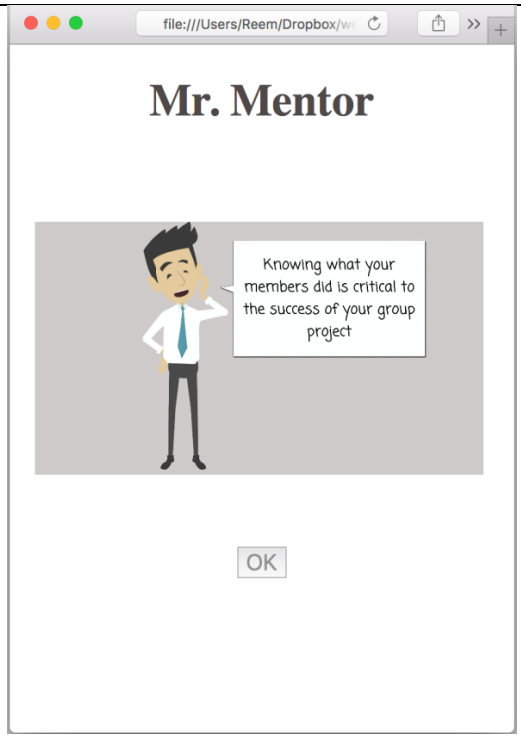
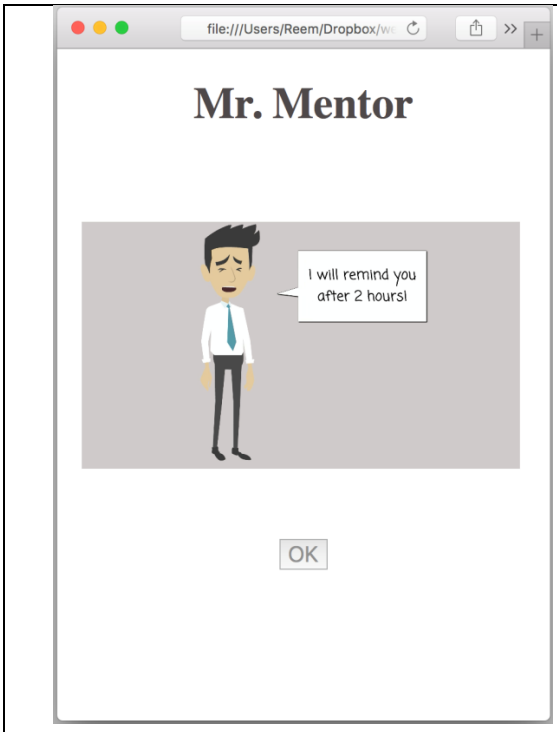
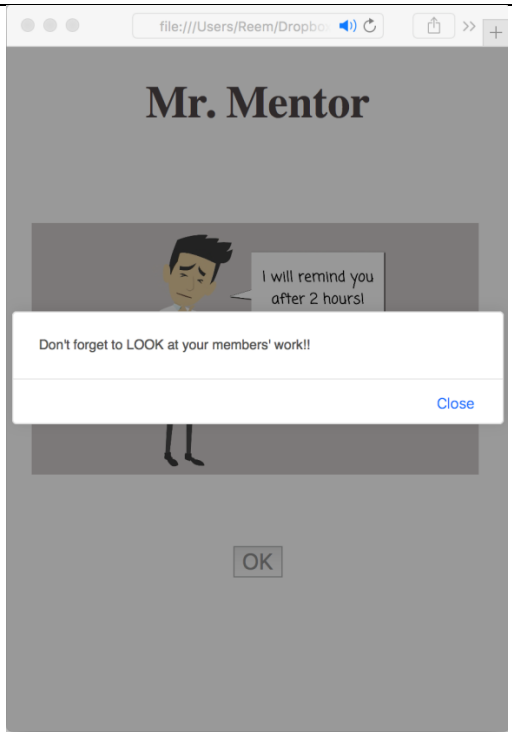
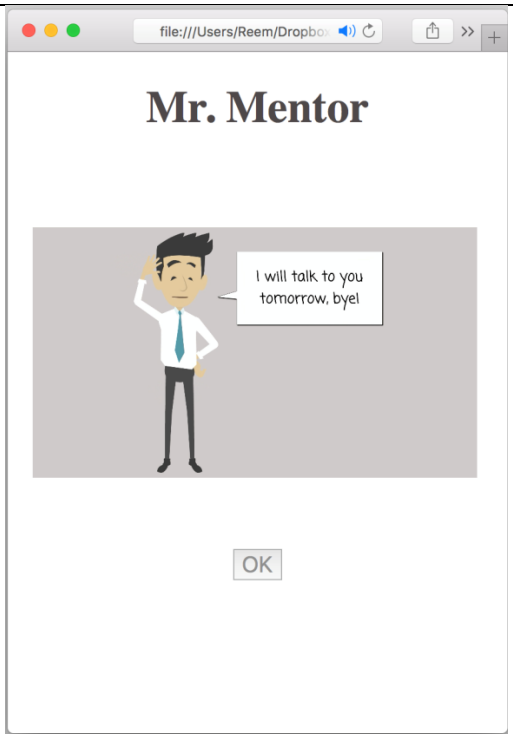
Mr. Mentor
Fantastic
Next

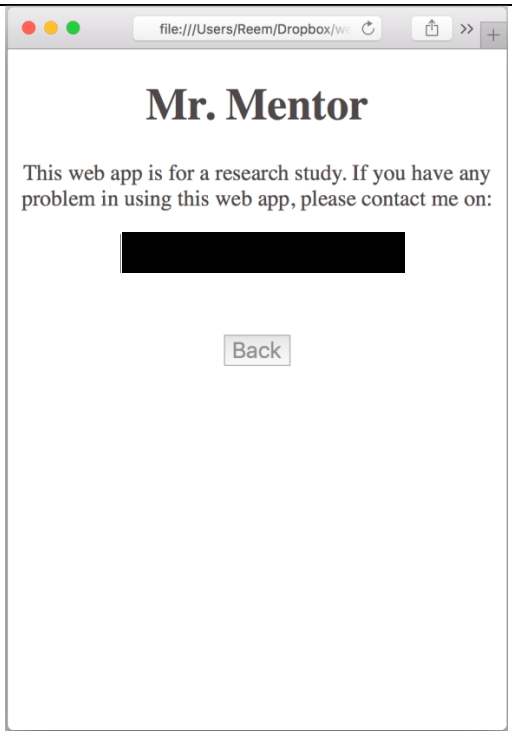

file:///Users/Reem/Dropbo
Mr. Mentor
Why not have a look now?
OK
Later


file:///Users/Reem/Dropbox/
Mr. Mentor
Knowing what your members did is critical to the success of your group project
OK


file:///Users/Reem/Dropbox/we
Mr. Mentor
I will remind you after 2 hours!
OK


file:///Users/Reem/Dropbo
Mr. Mentor
I will remind you after 2 hours!
Don't forget to LOOK at your members' work!!
Close
OK


file:///Users/Reem/Dropbo
Mr. Mentor
I will talk to you tomorrow, bye!
OK


file:///Users/Reem/Dropbox/we
Mr. Mentor
This web app is for a research study. If you have any problem in using this web app, please contact me on:
[redacted]
Back

Appendix E: Last Study

Appendix E.1
First Questionnaire

Study Title: Using social actors in learning groups.

Please complete this questionnaire as appropriate:

1. Your age group is: ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50+ 2. Your gender is: ☐M ☐F

– What is your education or professional background:

.....

– You are: ☐ Full-time student ☐ Part-time student

Please rate the following statements from 1 to 7; where 1 is strongly disagree, 4 is neutral, and 7 is strongly agree:

1. I believe that knowing what each member is doing is essential in any group project.	1	2	3	4	5	6	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	1	2	3	4	5	6	7
3. I think looking at other members' work enhances collaboration in a group project.	1	2	3	4	5	6	7
4. I prefer working in groups rather than individually.	1	2	3	4	5	6	7
5. I believe that students should update their group members whenever they have completed a task.	1	2	3	4	5	6	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	2	3	4	5	6	7
7. I think that each member should know about others' progress in his/her group.	1	2	3	4	5	6	7
8. In any group project, each member should know about the progress of other groups as well.	1	2	3	4	5	6	7
9. In a group project, only the final product matters.	1	2	3	4	5	6	7
10. I believe that each member should look at the work completed by his/her group members.	1	2	3	4	5	6	7

Please rate the following statements from 1 to 7; where 1 is strongly disagree, 4 is neutral, and 7 is strongly agree, based on your previous experience in working in group projects:

11. Based on my experience, it has been difficult to find out what my group members had worked on.	1	2	3	4	5	6	7
12. In any group project, usually I know what my group members are going to work on.	1	2	3	4	5	6	7
13. In any group project, I could tell what the current state of the project was at any given time.	1	2	3	4	5	6	7
14. In any group project, usually I tell my group members about my progress.	1	2	3	4	5	6	7

Appendix E.2
Second Questionnaire

Study Title: Using social actors in learning groups.

Section 1:

Please rate the following statements from 1 to 7; where 1 is strongly disagree, 4 is neutral, and 7 is strongly agree:

	Strongly disagree						Strongly agree
1. I believe that knowing what each member is doing is essential in any group project.	1	2	3	4	5	6	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	1	2	3	4	5	6	7
3. I think looking at other members' work enhances collaboration in a group project.	1	2	3	4	5	6	7
4. I prefer working in groups rather than individually.	1	2	3	4	5	6	7
5. I believe that students should update their group members whenever they have completed a task.	1	2	3	4	5	6	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	2	3	4	5	6	7
7. I think that each member should know about others' progress in his/her group.	1	2	3	4	5	6	7
8. In any group project, each member should know about the progress of other groups as well.	1	2	3	4	5	6	7
9. In a group project, only the final product matters.	1	2	3	4	5	6	7
10. I believe that each member should look at the work completed by his/her group members.	1	2	3	4	5	6	7

In the interaction design group project:

11. It was difficult to find out what my group members had worked on.	1	2	3	4	5	6	7
12. Usually I knew what my group members were going to work on.	1	2	3	4	5	6	7
13. I could tell what the current state of the project was at any given time.	1	2	3	4	5	6	7
14. Usually I told my group members about my progress.	1	2	3	4	5	6	7

Section 2:

Did you use Mr. Mentor app? □ Yes □ No (if No, please don't answer this section)

Which version did you use? □ iPhone app version □ Web version

Please rate the following statements from 1 to 7 based on <u>your experience of using "Mr. Mentor" app</u>; where 1 is strongly disagree, 7 is strongly agree:

	Strongly disagree						Strongly agree
1. The app enabled me to accomplish tasks more quickly.	1	2	3	4	5	6	7
2. Using the app improved my coursework performance.	1	2	3	4	5	6	7
3. Using the app increased my productivity.	1	2	3	4	5	6	7
4. Using the app enhanced my effectiveness on the coursework.	1	2	3	4	5	6	7
5. Using the app made it easier to do my coursework.	1	2	3	4	5	6	7
6. Overall, I found the app useful in my coursework.	1	2	3	4	5	6	7
7. Learning to operate the app was easy for me.	1	2	3	4	5	6	7
8. I found it easy to get the app to do what I want it to do.	1	2	3	4	5	6	7
9. My interaction with the app was clear and understandable.	1	2	3	4	5	6	7
10. I found the app to be flexible to interact with.	1	2	3	4	5	6	7
11. It was easy for me to become skillful at using the app.	1	2	3	4	5	6	7
12. Overall, I found the app easy to use.	1	2	3	4	5	6	7
13. The app simplified the interaction with Mr. Mentor by using buttons for answers, and no need to write them.	1	2	3	4	5	6	7
14. The app led me through a series of questions to complete the interaction with Mr. Mentor.	1	2	3	4	5	6	7
15. The app offered a personalised service such as selecting a preferred time for notifications.	1	2	3	4	5	6	7
16. The app provided a reward page, so I could see my total earned points.	1	2	3	4	5	6	7
17. The app offered praise if I shared my work or looked at the group's work.	1	2	3	4	5	6	7
18. The app rewarded me whenever I shared my work or looked at the group's work.	1	2	3	4	5	6	7
19. The app reminded me to share my work and to look at the group's work.	1	2	3	4	5	6	7
20. The app offered appropriate suggestions.	1	2	3	4	5	6	7
21. The app was visually attractive.	1	2	3	4	5	6	7
22. The app adopted a social role for a mentor.	1	2	3	4	5	6	7
23. The app was trustworthy by providing true and reliable information about the app and study.	1	2	3	4	5	6	7
24. The app was credible (i.e. no ads in the app).	1	2	3	4	5	6	7
25. The app had a real-world feel by displaying researcher's name and her email.	1	2	3	4	5	6	7
26. The app motivated users to cooperate.	1	2	3	4	5	6	7
27. The app supported competition between users by displaying the total earned points.	1	2	3	4	5	6	7
28. Sometimes, I didn't complete the interaction with Mr. Mentor.	1	2	3	4	5	6	7
29. I felt bored using Mr. Mentor by the end of the project.	1	2	3	4	5	6	7
30. I did not like the sound of Mr. Mentor.	1	2	3	4	5	6	7

31. I interacted with Mr. Mentor as a real human.	1	2	3	4	5	6	7
32. I enjoyed using this app.	1	2	3	4	5	6	7
33. I understand the goal of this app.	1	2	3	4	5	6	7
34. I am satisfied with using this app to remind me to share my work and look at my group work.	1	2	3	4	5	6	7
35. Mr. Mentor encouraged me to share my work with the group.	1	2	3	4	5	6	7
36. Mr. Mentor persuaded me to look at the work done by my group.	1	2	3	4	5	6	7
37. I answered Mr. Mentor's questions honestly.	1	2	3	4	5	6	7
38. I used the app frequently.	1	2	3	4	5	6	7

Section 3:

Please answer the following questions as appropriate:

1. How do you feel about Mr. Mentor?

2. What do you think of using Mr. Mentor as a reminder?

3. Do you think that you would work in a different way if you didn't use Mr. Mentor?

4. Did Mr. Mentor change your awareness of your group's activities?

5. Do you have any suggestions to improve Mr. Mentor app?

Thank you ☺

Appendix E.3
Interview Questions

First Interview

9. How do you find working in group?
10. What is the current state of your project? When do you start?
11. What have you done last week?
12. What has your group member done last week? (for each member)
13. How did you know about your group member work?
14. How did you choose the task you worked on last week?
15. Did you discuss with your group member about each member skills?
16. Did you set a plan as a group to complete your project?

Second Interview

7. What happens since last time I interviewed you in your project?
8. What is the current state of your project?
9. What have you done since last week?
10. What has your group member done since last week? (for each member)
11. How did you know about your group member work?
12. How did you choose the task you worked on last week?
13. What is working well in your project?
14. Have you faced any problem in your project?

Appendix E.4
Expert Reviews

Expert Evaluation Instructions

Mr. Mentor app is intended to persuade students to share what they did in the group project with their colleagues and also to look at what their colleagues did. There are 2 versions of the app: iPhone version and web version. Your task is to evaluate the app using the system characteristics of the Persuasive Systems Design (PSD) model for both versions. Please follow these instructions to complete the evaluation:

- Explore the Mr. Mentor app and familiarise yourself with it (iPhone app and web app)
- Check for each persuasive technique listed in the table in the given evaluation sheet
    - If the persuasive technique is applied then rate how strongly it is applied from 1 point to 3 points (1=low support, 2=medium support, 3=high support)
    - If it is not applied then, give 0 (0=no support)
    - Write comments to explain your rate for each persuasive technique

Expert evaluation using the PSD model

iPhone app

Support	Persuasive technique	Definition	Support?				Comments
			No	Low	Medium	High	
			0	1	2	3	
Primary task support	Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour.					
	Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.					
	Personalisation	A system that offers personalised content or services has a greater capability for persuasion.					

	Self-monitoring	A system that keeps track of one's own performance or status supports the user in achieving goals.					
Dialogue support	Praise	By offering praise, a system can make users more open to persuasion.					
	Rewards	Systems that reward target behaviours may have great persuasive powers.					
	Reminders	If a system reminds users of their target behaviour, the users will more likely achieve their goals.					
	Suggestion	Systems offering fitting suggestions will have greater persuasive powers.					
	Liking	A system that is visually attractive for its users is likely to be more persuasive.					
	Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.					
Perceived system credibility	Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.					
	Surface credibility	People make initial assessments of the system credibility based on a first-hand inspection.					
	Real-world feel	A system that highlights people or organisation behind its content or services will have more credibility.					
Social	Cooperation	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to co-operate.					

	Competition	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to compete.					

Web app

Support	Persuasive technique	Definition	Support?				Comments
			No	Low	Medium	High	
			0	1	2	3	
Primary task support	Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour.					
	Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.					
Dialogue support	Praise	By offering praise, a system can make users more open to persuasion.					
	Reminders	If a system reminds users of their target behaviour, the users will more likely achieve their goals.					
	Suggestion	Systems offering fitting suggestions will have greater persuasive powers.					
	Liking	A system that is visually attractive for its users is likely to be more persuasive.					
	Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.					
Perceived system credibility	Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.					
	Surface credibility	People make initial assessments of the system credibility based on a first-hand inspection.					

	Real-world feel	A system that highlights people or organisation behind its content or services will have more credibility.					
Social	Cooperation	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to co-operate.					

Appendix E.5
Pre-test and Post-test Answers
First Questionnaire & Second Questionnaire (section 1) Answers

18-29 (14), 30-39(5), 40-49(2)
M (9), F (12)

Participant: A1
Age:18-29
Gender: M
Education/professional background: Digital Media Design/ Product Owner
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	6	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	6
3. I think looking at other members' work enhances collaboration in a group project.	6	6
4. I prefer working in groups rather than individually.	7	6
5. I believe that students should update their group members whenever they have completed a task.	6	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	2
7. I think that each member should know about others' progress in his/her group.	6	6
8. In any group project, each member should know about the progress of other groups as well.	1	2
9. In a group project, only the final product matters.	6	2
10. I believe that each member should look at the work completed by his/her group members.	6	7
11. Based on my experience, it has been difficult to find out what my group members had worked on.	2	5
12. In previous group project, usually I know what my group members are going to work on.	6	5
13. In any group project, I could tell what the current state of the project was at any given time.	5	6
14. In any group project, usually I tell my group members about my progress.	6	6

Participant: A2
Age: 18-29
Gender: F
Education/professional background: Product design engineer
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	6	6
2. I like to say what I'm planning to do in a group project even if no one asks me.	5	7
3. I think looking at other members' work enhances collaboration in a group project.	6	6
4. I prefer working in groups rather than individually.	6	5
5. I believe that students should update their group members whenever they have completed a task.	6	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	2	3
7. I think that each member should know about others' progress in his/her group.	6	6
8. In any group project, each member should know about the progress of other groups as well.	4	5
9. In a group project, only the final product matters.	2	2
10. I believe that each member should look at the work completed by his/her group members.	6	6
11. Based on my experience, it has been difficult to find out what my group members had worked	2	3

on.		
12. In previous group project, usually I know what my group members are going to work on.	6	6
13. In any group project, I could tell what the current state of the project was at any given time.	6	6
14. In any group project, usually I tell my group members about my progress.	7	6

Participant: B1
Age: 18-29
Gender: F
Education/professional background: Msc HCS
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	6
2. I like to say what I'm planning to do in a group project even if no one asks me.	5	5
3. I think looking at other members' work enhances collaboration in a group project.	5	6
4. I prefer working in groups rather than individually.	4	1
5. I believe that students should update their group members whenever they have completed a task.	4	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	1
7. I think that each member should know about others' progress in his/her group.	6	7
8. In any group project, each member should know about the progress of other groups as well.	3	4
9. In a group project, only the final product matters.	1	3
10. I believe that each member should look at the work completed by his/her group members.	5	7
11. Based on my experience, it has been difficult to find out what my group members had worked on.	3	5
12. In previous group project, usually I know what my group members are going to work on.	5	4
13. In any group project, I could tell what the current state of the project was at any given time.	4	2
14. In any group project, usually I tell my group members about my progress.	6	6

Participant: B2
Age: 18-29
Gender: F
Education/professional background: BA Psychology and Linguistics
FT/PT: PT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	5	6
2. I like to say what I'm planning to do in a group project even if no one asks me.	3	5
3. I think looking at other members' work enhances collaboration in a group project.	5	7
4. I prefer working in groups rather than individually.	5	4
5. I believe that students should update their group members whenever they have completed a task.	3	5
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	3	3
7. I think that each member should know about others' progress in his/her group.	5	5
8. In any group project, each member should know about the progress of other groups as well.	2	4
9. In a group project, only the final product matters.	6	5
10. I believe that each member should look at the work completed by his/her group members.	6	7

11. Based on my experience, it has been difficult to find out what my group members had worked on.	2	5
12. In previous group project, usually I know what my group members are going to work on.	6	7
13. In any group project, I could tell what the current state of the project was at any given time.	4	6
14. In any group project, usually I tell my group members about my progress.	5	5

Participant: B3
Age: 18-29
Gender: M
Education/professional background: Psychologist
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	6
2. I like to say what I'm planning to do in a group project even if no one asks me.	5	6
3. I think looking at other members' work enhances collaboration in a group project.	6	6
4. I prefer working in groups rather than individually.	6	5
5. I believe that students should update their group members whenever they have completed a task.	7	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	2	2
7. I think that each member should know about others' progress in his/her group.	6	5
8. In any group project, each member should know about the progress of other groups as well.	4	4
9. In a group project, only the final product matters.	3	3
10. I believe that each member should look at the work completed by his/her group members.	6	5
11. Based on my experience, it has been difficult to find out what my group members had worked on.	6	2
12. In previous group project, usually I know what my group members are going to work on.	3	6
13. In any group project, I could tell what the current state of the project was at any given time.	4	5
14. In any group project, usually I tell my group members about my progress.	5	6

Participant: C1
Age: 40-49
Gender: M
Education/professional background: Business Administration degree
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	6	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	6
3. I think looking at other members' work enhances collaboration in a group project.	5	6
4. I prefer working in groups rather than individually.	5	4
5. I believe that students should update their group members whenever they have completed a task.	6	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	2	2
7. I think that each member should know about others' progress in his/her group.	5	6
8. In any group project, each member should know about the progress of other groups as well.	3	4
9. In a group project, only the final product matters.	5	3
10. I believe that each member should look at the work completed by his/her group members.	6	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	4	5
12. In previous group project, usually I know what my group members are going to work on.	5	5
13. In any group project, I could tell what the current state of the project was at any given time.	4	5

14. In any group project, usually I tell my group members about my progress.	6	6

Participant: D1 Age: 30-39 Gender: F Education/professional background: Online content manager FT/PT: FT		
Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	1	n/a
3. I think looking at other members' work enhances collaboration in a group project.	5	5
4. I prefer working in groups rather than individually.	5	6
5. I believe that students should update their group members whenever they have completed a task.	4	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	6	1
7. I think that each member should know about others' progress in his/her group.	4	5
8. In any group project, each member should know about the progress of other groups as well.	3	7
9. In a group project, only the final product matters.	5	3
10. I believe that each member should look at the work completed by his/her group members.	7	7
11. Based on my experience, it has been difficult to find out what my group members had worked on.	4	3
12. In previous group project, usually I know what my group members are going to work on.	5	7
13. In any group project, I could tell what the current state of the project was at any given time.	3	7
14. In any group project, usually I tell my group members about my progress.	6	7

Participant: D2 Age: 18-29 Gender: F Education/professional background: Master's (post grad) FT/PT: FT		
Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	5	5
3. I think looking at other members' work enhances collaboration in a group project.	7	6
4. I prefer working in groups rather than individually.	2	1
5. I believe that students should update their group members whenever they have completed a task.	7	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	4	2
7. I think that each member should know about others' progress in his/her group.	7	7
8. In any group project, each member should know about the progress of other groups as well.	4	3
9. In a group project, only the final product matters.	2	2
10. I believe that each member should look at the work completed by his/her group members.	5	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	2	4
12. In previous group project, usually I know what my group members are going to work on.	5	5
13. In any group project, I could tell what the current state of the project was at any given time.	5	4
14. In any group project, usually I tell my group members about my progress.	6	5

Participant: E1
Age: 18-29
Gender: M
Education/professional background: UX Architect
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	7
3. I think looking at other members' work enhances collaboration in a group project.	7	7
4. I prefer working in groups rather than individually.	7	6
5. I believe that students should update their group members whenever they have completed a task.	2	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	1
7. I think that each member should know about others' progress in his/her group.	7	6
8. In any group project, each member should know about the progress of other groups as well.	1	3
9. In a group project, only the final product matters.	1	1
10. I believe that each member should look at the work completed by his/her group members.	5	7
11. Based on my experience, it has been difficult to find out what my group members had worked on.	1	1
12. In previous group project, usually I know what my group members are going to work on.	6	6
13. In any group project, I could tell what the current state of the project was at any given time.	4	7
14. In any group project, usually I tell my group members about my progress.	6	7

Participant: E2
Age: 40-49
Gender: M
Education/professional background: A-Levels, then in industry for 25 years, now doing HCS MSc part time
FT/PT: PT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	6	6
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	5
3. I think looking at other members' work enhances collaboration in a group project.	6	7
4. I prefer working in groups rather than individually.	4	3
5. I believe that students should update their group members whenever they have completed a task.	5	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	2	2
7. I think that each member should know about others' progress in his/her group.	5	6
8. In any group project, each member should know about the progress of other groups as well.	4	2
9. In a group project, only the final product matters.	3	2
10. I believe that each member should look at the work completed by his/her group members.	5	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	3	5
12. In previous group project, usually I know what my group members are going to work on.	5	5
13. In any group project, I could tell what the current state of the project was at any given time.	5	5
14. In any group project, usually I tell my group members about my progress.	5	6

Participant: E3
Age: 18-29
Gender: F
Education/professional background: Digital content marketing/ social media
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	3	7
3. I think looking at other members' work enhances collaboration in a group project.	7	7
4. I prefer working in groups rather than individually.	1	3
5. I believe that students should update their group members whenever they have completed a task.	7	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	1
7. I think that each member should know about others' progress in his/her group.	7	7
8. In any group project, each member should know about the progress of other groups as well.	4	4
9. In a group project, only the final product matters.	6	3
10. I believe that each member should look at the work completed by his/her group members.	7	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	2	1
12. In previous group project, usually I know what my group members are going to work on.	6	5
13. In any group project, I could tell what the current state of the project was at any given time.	5	6
14. In any group project, usually I tell my group members about my progress.	5	6

Participant: F1
Age: 18-29
Gender: M
Education/professional background: Undergraduate degree
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	6	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	5
3. I think looking at other members' work enhances collaboration in a group project.	5	6
4. I prefer working in groups rather than individually.	4	4
5. I believe that students should update their group members whenever they have completed a task.	4	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	2	2
7. I think that each member should know about others' progress in his/her group.	5	6
8. In any group project, each member should know about the progress of other groups as well.	3	2
9. In a group project, only the final product matters.	1	2
10. I believe that each member should look at the work completed by his/her group members.	6	7
11. Based on my experience, it has been difficult to find out what my group members had worked on.	5	1
12. In previous group project, usually I know what my group members are going to work on.	3	6
13. In any group project, I could tell what the current state of the project was at any given time.	3	5
14. In any group project, usually I tell my group members about my progress.	5	6

Participant: F2 Age: 18-29 Gender: M Education/professional background: Computer science FT/PT: FT		
Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	5	6
3. I think looking at other members' work enhances collaboration in a group project.	6	6
4. I prefer working in groups rather than individually.	4	4
5. I believe that students should update their group members whenever they have completed a task.	7	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	1
7. I think that each member should know about others' progress in his/her group.	6	6
8. In any group project, each member should know about the progress of other groups as well.	5	4
9. In a group project, only the final product matters.	4	5
10. I believe that each member should look at the work completed by his/her group members.	6	7
11. Based on my experience, it has been difficult to find out what my group members had worked on.	3	1
12. In previous group project, usually I know what my group members are going to work on.	6	7
13. In any group project, I could tell what the current state of the project was at any given time.	7	6
14. In any group project, usually I tell my group members about my progress.	7	7

Participant: F3 Age: 18-29 Gender: F Education/professional background: Worked in service industry for airlines FT/PT: FT		
Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	7
3. I think looking at other members' work enhances collaboration in a group project.	7	7
4. I prefer working in groups rather than individually.	4	2
5. I believe that students should update their group members whenever they have completed a task.	6	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	2	1
7. I think that each member should know about others' progress in his/her group.	6	6
8. In any group project, each member should know about the progress of other groups as well.	4	5
9. In a group project, only the final product matters.	1	2
10. I believe that each member should look at the work completed by his/her group members.	7	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	3	6
12. In previous group project, usually I know what my group members are going to work on.	5	5
13. In any group project, I could tell what the current state of the project was at any given time.	3	5
14. In any group project, usually I tell my group members about my progress.	6	6

Participant: G1
Age: 30-39
Gender: M
Education/professional background: BA + 10 years in industry
FT/PT: PT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	4	6
2. I like to say what I'm planning to do in a group project even if no one asks me.	5	7
3. I think looking at other members' work enhances collaboration in a group project.	5	6
4. I prefer working in groups rather than individually.	6	4
5. I believe that students should update their group members whenever they have completed a task.	5	2
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	1
7. I think that each member should know about others' progress in his/her group.	5	5
8. In any group project, each member should know about the progress of other groups as well.	3	1
9. In a group project, only the final product matters.	1	1
10. I believe that each member should look at the work completed by his/her group members.	7	5
11. Based on my experience, it has been difficult to find out what my group members had worked on.	4	2
12. In previous group project, usually I know what my group members are going to work on.	5	6
13. In any group project, I could tell what the current state of the project was at any given time.	4	5
14. In any group project, usually I tell my group members about my progress.	5	7

Participant: G2
Age: 18-29
Gender: F
Education/professional background: N/A
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	7
3. I think looking at other members' work enhances collaboration in a group project.	6	6
4. I prefer working in groups rather than individually.	5	5
5. I believe that students should update their group members whenever they have completed a task.	5	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	1
7. I think that each member should know about others' progress in his/her group.	7	6
8. In any group project, each member should know about the progress of other groups as well.	4	5
9. In a group project, only the final product matters.	2	2
10. I believe that each member should look at the work completed by his/her group members.	6	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	1	1
12. In previous group project, usually I know what my group members are going to work on.	7	7
13. In any group project, I could tell what the current state of the project was at any given time.	6	6
14. In any group project, usually I tell my group members about my progress.	6	6

Participant: G3
Age: 30-39
Gender: F
Education/professional background: BA Cultural Studies. Now studying MSc HCS
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	6
3. I think looking at other members' work enhances collaboration in a group project.	7	6
4. I prefer working in groups rather than individually.	4	3
5. I believe that students should update their group members whenever they have completed a task.	7	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	2	1
7. I think that each member should know about others' progress in his/her group.	7	6
8. In any group project, each member should know about the progress of other groups as well.	2	2
9. In a group project, only the final product matters.	5	3
10. I believe that each member should look at the work completed by his/her group members.	7	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	2	2
12. In previous group project, usually I know what my group members are going to work on.	6	6
13. In any group project, I could tell what the current state of the project was at any given time.	6	5
14. In any group project, usually I tell my group members about my progress.	7	6

Participant: H1
Age: 30-39
Gender: F
Education/professional background: PR & Marketing, Film, Digital Production
FT/PT: PT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	6	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	7
3. I think looking at other members' work enhances collaboration in a group project.	7	7
4. I prefer working in groups rather than individually.	5	4
5. I believe that students should update their group members whenever they have completed a task.	6	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	1
7. I think that each member should know about others' progress in his/her group.	6	7
8. In any group project, each member should know about the progress of other groups as well.	2	4
9. In a group project, only the final product matters.	2	1
10. I believe that each member should look at the work completed by his/her group members.	5	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	4	1
12. In previous group project, usually I know what my group members are going to work on.	5	7
13. In any group project, I could tell what the current state of the project was at any given time.	3	7
14. In any group project, usually I tell my group members about my progress.	5	7

Participant: H2
Age: 18-29
Gender: F
Education/professional background: BSc Psychology 2010-14, MSc HCS 2015-2017, Mix of professional background, largely healthcare
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	6	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	7	7
3. I think looking at other members' work enhances collaboration in a group project.	7	6
4. I prefer working in groups rather than individually.	3	4
5. I believe that students should update their group members whenever they have completed a task.	6	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	3	3
7. I think that each member should know about others' progress in his/her group.	5	5
8. In any group project, each member should know about the progress of other groups as well.	3	3
9. In a group project, only the final product matters.	1	2
10. I believe that each member should look at the work completed by his/her group members.	7	5
11. Based on my experience, it has been difficult to find out what my group members had worked on.	3	2
12. In previous group project, usually I know what my group members are going to work on.	5	5
13. In any group project, I could tell what the current state of the project was at any given time.	6	5
14. In any group project, usually I tell my group members about my progress.	7	6

Participant: I1
Age: 30-39
Gender: F
Education/professional background: BA Hons Fine Art, PGCE in Design Technology, Have worked as teacher + various admin roles
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	7
3. I think looking at other members' work enhances collaboration in a group project.	7	7
4. I prefer working in groups rather than individually.	4	4
5. I believe that students should update their group members whenever they have completed a task.	6	6
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	2	6
7. I think that each member should know about others' progress in his/her group.	7	6
8. In any group project, each member should know about the progress of other groups as well.	6	5
9. In a group project, only the final product matters.	1	2
10. I believe that each member should look at the work completed by his/her group members.	7	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	5	3
12. In previous group project, usually I know what my group members are going to work on.	6	5
13. In any group project, I could tell what the current state of the project was at any given time.	5	5
14. In any group project, usually I tell my group members about my progress.	7	6

Participant: I2 Age: 18-29 Gender: M Education/professional background: Manager FT/PT: FT		
Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	6	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	5	7
3. I think looking at other members' work enhances collaboration in a group project.	7	7
4. I prefer working in groups rather than individually.	7	4
5. I believe that students should update their group members whenever they have completed a task.	7	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	4	4
7. I think that each member should know about others' progress in his/her group.	7	6
8. In any group project, each member should know about the progress of other groups as well.	3	1
9. In a group project, only the final product matters.	4	7
10. I believe that each member should look at the work completed by his/her group members.	7	7
11. Based on my experience, it has been difficult to find out what my group members had worked on.	6	6
12. In previous group project, usually I know what my group members are going to work on.	7	3
13. In any group project, I could tell what the current state of the project was at any given time.	1	6
14. In any group project, usually I tell my group members about my progress.	2	7

Participant: J1 Age: 30-39 Gender: M Education/professional background: UI/UX Designer FT/PT: PT		
Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	7
3. I think looking at other members' work enhances collaboration in a group project.	6	5
4. I prefer working in groups rather than individually.	3	3
5. I believe that students should update their group members whenever they have completed a task.	6	4
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	1
7. I think that each member should know about others' progress in his/her group.	6	7
8. In any group project, each member should know about the progress of other groups as well.	4	6
9. In a group project, only the final product matters.	4	4
10. I believe that each member should look at the work completed by his/her group members.	6	6
11. Based on my experience, it has been difficult to find out what my group members had worked on.	5	2
12. In previous group project, usually I know what my group members are going to work on.	4	5
13. In any group project, I could tell what the current state of the project was at any given time.	6	5
14. In any group project, usually I tell my group members about my progress.	5	6

Participant: J2
Age: 18-29
Gender: F
Education/professional background: Student in HCS
FT/PT: FT

Questions	Pre-test	Post-test
1. I believe that knowing what each member is doing is essential in any group project.	7	7
2. I like to say what I'm planning to do in a group project even if no one asks me.	6	6
3. I think looking at other members' work enhances collaboration in a group project.	6	6
4. I prefer working in groups rather than individually.	7	7
5. I believe that students should update their group members whenever they have completed a task.	7	7
6. In any group project, each member is responsible for a specific task and doesn't need to know about the others.	1	2
7. I think that each member should know about others' progress in his/her group.	7	6
8. In any group project, each member should know about the progress of other groups as well.	4	2
9. In a group project, only the final product matters.	3	2
10. I believe that each member should look at the work completed by his/her group members.	2	7
11. Based on my experience, it has been difficult to find out what my group members had worked on.	3	5
12. In previous group project, usually I know what my group members are going to work on.	4	4
13. In any group project, I could tell what the current state of the project was at any given time.	3	4
14. In any group project, usually I tell my group members about my progress.	6	6

Appendix E.6
Comparisons Grids

First interview
Group A

Participant	What he/she reported about		
	A1	A2	Third member
A1	I've build a persona, I've done a research on the geographic, the area of the county we are working with, we've done of mentored the group about the work I've done in the same field -Like literature review? Just past work I've done a literature review and kind of yeah	She's looked at user journeys, and got other examples on user journeys, it's all in a field that all mixed up together because our collaboration tool separate peoples' work, from what I remember from Facebook, done the user journey research, she's done some reading up as well, but physical output I think she, we don't get anything	L done the second persona, our secondary persona, we worked it together at the kitchen in a couple of days ago, ..was I missing something, most of our work was done together, so it was rarely anytime we done work separately
A2	He does everything He does the persona, he send it to us, he is very practical and creative, He did the persona, - How many personas? he did one persona, and then the second persona we did it all of us Usually we create everything together	I did some research for the personas, and now, the last 3 days I'm doing the research for the user journeys and how we can/what layout we have to choose, if we have to make 1 or 3 user journeys because we have 2 personas, and we want a general user journey that we observed inside the customer service and how are we including the happy points, sad points, confusion points, how can we saw the emotional thing/perspective of the user in the user journey - You did interviews or observation? When we went to the centre, we all did observation, and then for interviews we split into 3, I was inside the centre grapping the customers "hello, we are doing this" and explain what we are doing, recruiter, then I was taking the customers and A1 was waiting with a recorder and asking the questions, and L was taking the notes	L is very good, because I mean when we go to the customer service, he is from London, so he spoke a lot with the employees - So interviews with staff? Yes, he is very good at writing notes from the people we took the interviews because he can understand all the accents, and this very helpful
Summary	1 PA A2 is PA of A1	1 PA A1 is PA of A2	

Group B

Participant	What he/she reported about		
	B1	B2	B3
B1	We went to visit the centre, and we did some observations and wrote up the observation, and start writing some requirements, and I made a plan for the team	Same thing, so she went to the centre twice, and she has been, oh she made a user journey, she also did the interviews when we were at there at the centre, so she was writing those up	He has written up his observations and he also started writing the first, kind of intro to our plan/ to our project, and he also went to the centre one other time before me, and he just need to put his ideas input (2:00)
B2	She's been written up observations, and the same as what I did, and made some, kind of, summaries of the observations, kind of summary comments, and also started writing up requirements and trying to think about requirements because that's part of our task	I've written up my own observations that I did last week, also transcribed, not transcribed it in detail, -observation only or observations and interviews? So I've written up the observations and have taking notes from the interviews, transcribed it but didn't go into that much detail and from that kind of, I made a couple of existing user journeys, and I'm started thinking also about making a persona or possibly 2 personas (but I haven't, that's just all in my head so actually I haven't done anything of that)	he sent me the recordings from the interviews, which, because he has those, I'm not actually sure what he has done, I'm sure he has done something, I'm not sure he has done much
B3	She has, oh written up observations as well, and made a plan of, like a schedule for us to stick to	B2 also wrote, she is written up observations and the interviews, and she created user journeys yesterday	I've written up observations and just generally talked to the group about how we are progressing, in terms of deliverables, it was writing up observations
Summary	2 PA B2 is PA of B1 B3 is PA of B1	2 FA B1 is FA of B2 B3 is FA of B2	1 FA, 1 UA B1 is FA of B3 B2 is UA of B3

Group D

Participant	What he/she reported about		
	D1	D2	Third member
D1	Personally, I'v been going to the Lembeth council, so I conducted interviews and questionnaires	She participated into interviews, and questionnaires, and group observations	same
D2	Basically I felt we've all done the same elements, where except D1 and A both did interviews with stakeholders, while I did with users. And the last meeting they do user - by stakeholders, do you mean staff? Yeah staff And both did observation? D1 did observation, but I can't	Last week was the last time we went to the centre, so I did 9 user interviews while I was there, we are all doing users interviews, and then did some observations as well when we were there in the morning like we started of doing it, but then there are other 2 groups there so we have to go away and that when start do observation and	interview with staff and users, but I can't remember if A did observation

	remember if A did observation,	then we came back to get more interviews -you did questionnaire? So it was basically we wrote up questionnaire but the we kind of deliver it in a format of like semi-structured interview	
Summary	1 FA D2 is FA of D1	1 FA D1 is FA of D2	

Group E

Participant	What he/she reported about		
	E1	E2	E3
E1	Personally I have collected all the forms, so all the observations forms, I've scanned those, so we have them all on the basecamp So we have everything in one file, it's a way we tried to be structured, and I've taken notes, taking notes in terms of the most important research findings, and I've prepared for a meeting which we're going to have today after our class to discuss our findings	E2 has created a domain map, which he shared with us yesterday, and then basically the domain is just a collection of what he has done, so that allows us to look at what his thinking is, so how the centre works, what are the issues, what are the problems, what are the areas that we need to look at	She uploaded the audio recordings to the basecamp, she said she will transcribed them, but I don't know actually if she has done that yet or not
E2	I think in the last week he has been very much focused on other coursework that he has been doing, and he posted up the stuff he, the research that him and E3 both uploaded some research that they have done, because the second visit to the centre they went on their own because I wasn't around so they loaded the stuff they have found, so it's a mixture of interviews recordings and observation forms that he had filled in	Yesterday in fact, I took, so we have bunch of audio recordings, I transcribed one of the interviews, we have bunch of forms, small observations forms that we filled out and some notes and stuff and they are all on our basecamp project , so yesterday what I did I draw up like a domain model of all this research so they are in one place like who the people are, and what the issues are, and what they are trying to do, and linking things together, so you have like one picture that takes all of this research and put in to something that you can look at and then put that into slack	Same (like E1), so they took different notes and interviewed different peoples, and both uploaded the information And then I've been using that and trying to create this domain model, so we have something that we can make a decision about what we can do
E3	I know E1 has, E1 and I have discussing what design we want to do, so I'm not sure if he has any actual work, but we have been discussing ideas between each other because we were closer so it is easier to discuss things we went twice to the centre	I know that he's gone over the information both E1 and I got from last week's visiting the centre because he lives in Cambridge, So E1 and I went on our own and updated him with everything, so I think he just coming through all of our notes and all of our audio recordings which could takes some more	I did lots of audio recordings for interviews, so I've been transcribing them, so we can get a better idea for things, what's going on, I'm also been trying to think of design ideas like I said but I didn't put that for now

		time because we have some interviews that are about half an hour E2 went with us once, the first time	
Summary	1 FA, 1 PA E2 is FA of E1 E3 is PA of E1	2 PA E1 is PA of E2 E3 is PA of E2	1 FA, 1PA E1 is PA of E3 E2 is FA of E3

Group F

Participant	What he/she reported about		
	F1	F2	F3
F1	We went to the centre to do some observations and collect some more interviews, we also set together to wrote up user personas and thought about user journeys and then individually, I've started work on making up the personas to put with the submission part, and writing up interviews, so we can sort of get ideas from them	He has looked at requirements for the software that we're going to be designing, and he's also drawing up some HTA model for the tasks involved in our personas, like a user journey, what the tasks would be throughout like the user journey we made so he's draw up them as well	She's been doing user journeys, so she's drown some on like sketch pad, she's drown some user journeys, she's also written up the interviews that we took and observations, and she's also with the personas, she's written up like a sort of script thing with all the details that we going to be using on them
F2	same thing, basically we did the same thing (interviews, personas and user journeys, and HTA) so me and F1 did the note taking,	Last week we went to the centre again to do a bit of interviews, like just to have more data that we have already, -and personally? Interview like I took notes, and last week we created personas and user journeys as well, and HTA, so I put in some ideas to the HTA -for the HTA, any one helped you? No everyone did it so me and F1 did the note taking,	She did the interview, so me and F1 did the note taking, because she did the interview and she's also given some ideas for the personas and stuff
F3	In the centre, he and F2 alternated taking notes or observing from far, he created personas, so we kind of split our work, and he scanned his notes for us to see	He like F1 alternated taking notes or observing from far, while I was interviewing, and he also scanned his notes for us to see, and then he did the HTA, All of these things kind of we did all together, but then we split it to kind of all make it nice by ourselves	Last week I did the customer journeys, I draw them, and then re-draw them kind of nicer for this week, I went back over the notes so I did during the interviews, I asked all the questions, so I don't have any notes, so I went over their notes and trying to get an idea to be able to do the.. - so you conducted the interviews in the centre? yes
Summary	1 FA, 1 PA F2 is FA of F1 F3 is PA of F1	2 PA F1 is PA of F2 F3 is PA of F2	1 FA, 1 PA F1 is FA of F3 F2 is PA of F3

Group G

Participant	What he/she reported about		
	G1	G2	G3
G1	I have updated some of our user journeys, I have done the wireframe for the solution the we are going to propose, and then I've reviewed work my team make	We had a meeting where we decided what to do, so we did that together, and then G2 has done the thing she said in the meeting which where to create a new persona and a new user journey, and to update some existing ones	G3 commented on work by myself and G2, and she created a new mock for an app which was going to be a secondary solution (different from the one I did)
G2	He created his own persona as well, he created some prototypes/mockups for one of the route we are going to take, and right now I think he is working on trying to see if he can consolidate all the user journeys into one page	I created and refined my personas, for these personas I created current and future user journeys, and I also storyboarded one of the potential routes that we are going to take, and then I also kind of wrote background descriptions on 2 of the alternatives that we are going to be describing, so a lot of the stuff has also done by me working on stuff but looking at others people and then seeing how we can integrate it, where editing theirs	G3 created a really good user journey for one of the alternatives we are looking at, and she is kind of like also consolidating the user journeys, so she took mine and then created a really good PowerPoint, she took my work and then put it into a format
G3	He has started a few different kind of documents, put things together, he did a mockup for one of other products, he did a storyboard, and a user journey	She did her storyboard, user journey, and she also put together some of the write up for one of the product (all did storyboard and user journey one for each) and put them together and kind of give feedback on each	I've put together some mockups, basically storyboards mockups for 2 ideas that we had, one of them I designed the storyboard and did the mockup, and the other one I just did mockup based on someone else's storyboard, also we have some group meetings just talk about where we are, what we are doing
Summary	2 FA G2 is FA of G1 G3 is FA of G1	1 FA, 1 PA G1 is PA of G2 G3 is FA of G2	2 PA G1 is PA of G3 G2 is PA of G3

Group H

Participant	What he/she reported about		
	H1	H2	Third member
H1	Last week I was focus on processing observation notes, and I prepared the layout of the centre (I think it is the week before), after that I've done creating, doing some research of what are the current solution they got online at the moment and preparing user journeys for	She was focus on interview staff, so processing information that goes from the interviews, and also defining some user journeys and some research as well (partially)	She was focus on the questionnaires to the visitors, and also because she is a graphic designer, she is started drafting, preparing some quick mockups to suggest ideas about the style we could use in the appendices for user journeys

	the current solution that we going to select, and also doing, after checking with the rest of team, is kind of assuming a little bit project manager role in sort of doing bit of planning, we are taking approach that we are treating the coursework as if it was a little bit of a project, we don't have a Gantt chart or anything, just put together some tables.. we assign some of the work to a specific people.., it gives us a little of structure, and considering time constraints		
H2	She's done quite a lot of user journeys (she's done probably most of them), and she's put a document which shows, she's basically gone through the website, she looked at the different tasks and method to complete a task, She organised our folder on Google documents and Google drive, I think she's also put some changes for the floor plan she did (not sure) Project manager	I've been putting a few personas together from the interview data, and look at the user journey for what I look at one component of one group of people that come in they come but can't do online I started kind of sort collection of notes with what email (decisions) draw the main point and why we decided to go for this research, I decided to log reflection justify	She has started some personas, she's done some visuals for the user journeys
Summary	1 FA H2 is FA of H1	1 FA H1 is FA of H2	

Group I

Participant	What he/she reported about		
	I1	I2	Third member
I1	Personally, so I've looked at all of data we got from speaking to some peoples, so we do kind of working around with a bit of survey, so I've taken this into an excel and trying to make some patterns, and also transcribed some interviews that D has done and again make them sensible and trying to see if there are patterns relate to the other peoples I have made 3 personas and I've done a user journey	He hasn't done anything last week, he was in Berlin doing some work, but we spoke yesterday, last night he probably going to do another persona, actually we going to catch up today. -so what is the last thing he did in the group project? The last thing he did, he went to the centre, he made a survey, and he went to the centre with that survey on Monday before last (2 weeks ago)	Not managed to get any answer from her, I knew that she's certainly, towards the end of last week, she did an interview and I believe she's got another one tonight
I2	Last week she and D went to the customer centre, and did a couple of interviews, unfortunately there are not a lot	Last week I didn't really do much of interaction design coursework, I was doing another coursework	D was doing interviews with people she knows from Brixton, recording it, and transcribing it in spreadsheet

	of visitors there, so they could interview just 2 people, but they did interviews with staff too, and I1 draw up, I think yesterday, some personas she made, start doing sketch of some personas	-so what is the last thing you did? I went to the customer centre by myself doing research, doing some interviews with users, I had an app with questionnaire, and going around, and afterward I put all the questions and data I collected in an excel spreadsheet and I uploaded it on the space we have on the internet (ASANA)	
Summary	1 PA I2 is PA of I1	1 FA I1 is FA of I2	

Group J

Participant	What he/she reported about		
	J1	J2	Third member
J1	On Monday I went to the centre, so I did some observations, I did some interviews with the manager, and then I've also wrote few scenarios like existing scenario and future scenario that we want to achieve And with the guys yesterday talk what we are going to do next	We met on Sunday in a group here, we looked through the data, and created personas She wrote out with few Volere requirements, and she draw a user journey	Again we met on that Sunday, did all that things together in a group, and then he looked at housing benefit calculator user journey, so he wrote all that journey out, and then he created a persona for that specific journey
J2	He also went to the centre to did some questionnaires, pictures, like observation in general, and he still had to do something, like user journey for book an appointment, he wanted to do that	I went to the centre to some interviews and some observations And also we, together we did like we sat together and did some personas and things like this, I actually started searching for requirements for the system, and putting them in like Volere template They are not completed but I just did further exploration of what the system might need and just shared it with my team mates	He created that persona to the ones we already created, and he went through the housing benefit process on the internet and actually count how many steps do they have to take and shared that with us
Summary	1 FA J2 is FA of J1	1 PA J1 is PA of J2	

Second interview

Group A

Participant	What he/she reported about		
	A1	A2	Third member
A1	I've done the design section of the report, I've done the wireframes in order to build a prototype so we can evaluate it, yes so this 2 pages of the report of the design section, the second section within the report, and the wireframes using balsamiq, and obviously taking part in the brainstorming and finding out and research reading a lot within the group, so individually we were rarely work individually	She's done the user journey, and conceptual design sketches, so most of the creative stuff because she has a really good idea	L done the first section of the report, which is summary, and helping us, me and A2, in proofreading our work, or mainly mine because I did more text, but there is a bit obviously some sentences on the storyboard
A2	A1 is doing the implementation of the system, the prototyping (balsamiq)	User journeys, storyboards, and a little bit of my individual reflection I start it, and references, I found some references for the report	And L writes the report, his language is very good
Summary	1 PA A2 is PA of A1	1 PA A1 is PA of A2	

Group B

Participant	What he/she reported about		
	B1	B2	B3
B1	I made the prototype, I helped with the testing and interviews, and wrote up the notes, all the observations from the testing and listening to them - how many testing you did? We tested 6 people in total	She conducted the interview tests, she did the interviews and she has been writing up the draft version and preparing that, she also did the personas and existing user journeys	he says he's working on requirements but he hasn't send it yet, he helped with the prototype and the write up
B2	So she started the poster, and you finished it? Yeah and she also, we were all working together, …, she was the one who actually doing the Photoshop of making the prototype, and making it interactive with inVision as well, and after that she tweaked little things when we suggested editing different things, and she also edited the report that I started writing -what about the user testing? We all did that together, we decided to be just 2 people going around, so we wouldn't kind of intermediate people, so B1 and me basically working around	I finished up doing personas, which I'd pretty much in working on from the beginning, and I finished up some user journeys, and actually I did pretty much most of the report, basically I'd like started writing the report and stuff, like everybody else like doing appendix stuff, and I was the one who started to writing up the report with a bit feedback, in like some people can edit it, and then for the poster, B1 started making and she's kind of made like a draft, and then I edited it and finished it up, which was tricky because I had to learn how to use Photoshop for the first time, it was useful	He did requirements, he actually helped me did the personas as well, because he kind of made them, and he digitalised them, he is mainly worked on requirements

	and doing the actual testing and it went quite well,	-what about the user testing? We all did that together, we decided to be just 2 people going around, so we wouldn't kind of intermediate people, so B2 and me basically working around and doing the actual testing and it went quite well, although there was one participant who was a Spanish speaking, and she was struggling with English and understanding the task that we're trying to give her, and I tried like my very verbal Spanish and like it got very confusing and that helped in how we realise that we should of made some language options, which we had implement, we had included, but then wasn't visible enough, she didn't even see the language option, so those helpful	
B3	User testing	User testing	We've made the poster -yourself? No we collaborate in that, so one person did the draft, and other person adjusted it and then everyone did some corrections, so it's a team effort with completed the report which was also a group effort, we have lots of pullet points, so we've actually done all of the proper writing and basically everything we worked on was a group effort - which part exactly in the report, for example are you responsible for the first part about the research? No we actually go back and forth - so no one was responsible for a specific part? No not really, I mean we kind of split them up into halves, then different people worked on different one, but then we switched over and everybody checked, so there was back and forth with it, so there was not approach that somebody complete something -what about user testing? User testing, 2 out of 3 people of

			the group have done, because they were the ones asking the questions the ones they were writing them up, otherwise it would be (B2 and B3), it wasn't me, I was just observing them do it because we don't want crowd people
Summary	1 FA, 1 PA B2 is FA of B1 B3 is PA of B1	1 FA, 1 PA B1 is FA of B2 B3 is PA of B2	2 PA B1 is PA of B3 B2 is PA of B3

Group D

Participant	What he/she reported about		
	D1	D2	Third member
D1	I did a little bit of summary for the report, I did give my feedback on poster design, and I did the wireframes for our project	She has been contributing in the form of like feedback on poster as well as she is writing the report, actually writing what she is doing, and we are giving a summary feedback on our observations, interviews, and questionnaires	He is doing poster, so all the visual graphic design things is done by A, but at the same time he is also giving his feedback, we are discussing, we have this triangulation of all our techniques
D2	She is done the wireframe for the final design, also during the meeting, she is been sort of writing down what we need to be doing…. to keep us on track, as well as write up the summary of the user research	I was in charge of doing the storyboarding, so we come together brainstorming like conceptual ideas, I mean we are able to come up with requirements for what we want it, and have finalised then I was in charge of storyboarding just because I like drawing, so I'm doing that part of it, I'm doing the write up of the report as well, so everybody gave me like some summary and things, what I'm doing write that up and then I did the, so we have the user journey template, it wasn't pretty, so I'm in charge of making user journeys look nice for the appendices	He was in charge of doing, so we did initially 5 personas and then we weld it down to like 3, and he was finishing up 2 out of 3, he is also in charge of laying out all of our process and everything on the poster, and he is done that and uploaded it like draft on the drive folder
Summary	1 FA D2 is FA of D1	1 PA D1 is PA of D2	

Group E

Participant	What he/she reported about		
	E1	E2	E3
E1	Basically I made all personas consistent, so we had some on papers, some on other files and I also revisited all the personas, they were actually just some	He's done a lot, E2 creates the whole structure of the project, so he has started basically the whole thing, so he started getting the research sort of	I'm a bit disappointed, she actually was covering a lot but I don't think she done that much, she has done only last couple of days

	random people but when we actually take the holistic view of our users, then I've done 4 user journeys for 5 personas, and we decide to dig one so we keeping them 4, and I also designed, I actually done like conceptual design on one of the flows, so we decided the interaction technology, and I created now a conceptual design flow for that, and I also been sort of doing all the research, listening to all the interviews, adding notes to appendices .. oh I did HTA as well	creating a specific model, of how the information flows, so he basically provided us with a framework to continue working on, and so me and E3 sort of dropping things on, he has also done lots of design, so I think he has done 2 at the routs of the flows, so we basically revisiting the kiosk, we making it more interactive, so he created a few more interesting routs	And I know she has done user flow sort of HTA flow,… but she did it like more like a user flow rather than a HTA, so then we have to redo it, and then she done some, she went from conceptual design to detailed design which I think she done for making an appointment part, so I think she has done that yesterday
E2	E1 been doing more design related user journeys and personas, lots of stuff, it looks really neat doing stuff and sketch, make them like professional	I did a first draft of the write up, I've done screen designs, I've done lots of sketches for physical forms, but we haven't really decided on any of those yet	E3 been doing user flows, and task description, also she is doing some screen designs
E3	He redid our personas to make them consistent, so just kind of took the information we created and drop them into a template, him and E2 have also been working on other wireframes between the 2 of them, but they work on the graph a little faster than I do, -how many wireframes do you have? A lot, I think per interaction I think we have at least 6 or at least 4 of them, … we worked on separate interactions…, I think he also did, so we had handwritten user journeys, and he just put them in a template to also make those consistent	E2 wrote up a good portion of the appendix, which is really impressive because he was like I've done that much … and put them all in one document, but it's pretty thorough, and he is also been working on wireframes and things like that	I created wireframes for one of our interactions for make an appointment, I've also been going through the appendices, because E2 threw to it together really quick and E1 has been adding things to it, but their grammar and language not so great so I've been semi re-writing it,… we definitely been discussing between the 3 of us how certain interactions should work or what kind of things we want to include that's new, kind of like when you sign up for an appointment, you can get a text reminder or something like that
Summary	2 PA E2 is PA of E1 E3 is PA of E1	2 FA E1 is PA of E2 E3 is PA of E2	2 PA E1 is PA of E3 E3 is PA of E3

Group F

Participant	What he/she reported about		
	F1	F2	F3
F1	I've done wireframe, I've done work on the report, which is what a lot of the work goes into it, I've also done some drawing up and scanning of designs, so conceptual and detailed designs	F2 is done lots of user journeys, and he's also done a bit on requirements, and I think he done some work on some HTAs, and finishing off personas	She's done work on the report, she's done quite a lot of work on the report, and she has also written up lots of requirements in actual format, and also done work on scanning various bit of the paper work we have so, she

			has uploaded all the consent forms and bits of paper work we have
F2	He created the wireframe for it, and did some of the report as well	I drew all of the user journeys and storyboards, and trying to help with the report a bit	She created the requirements and the report
F3	He's been working on the wireframes, so all the screens that users would go through, and again as a group we had work on user journeys, and he wrote the design part of the report, so he wrote the ideas down, and like what our process..	F2 been drawing up all the user journeys, so a lot of them were not in a digital copy or a nice copy, so all of them whether for conceptual design or detailed design, he's been drawing up (partially)	I wrote the report, looked up all the references, and then I, because we changed our detailed design, we had to change our requirements, so I re-wrote the requirements, and then worked as a team on new user journeys which drown by someone else
Summary	2 FA F2 is FA of F1 F3 is FA of F1	2 FA F1 is FA of F2 F3 is FA of F2	2 FA F1 is FA of F3 F2 is FA of F3

Group G

Participant	What he/she reported about		
	G1	G2	G3
G1	I created all the future user journeys, I updated the wireframe, and then I set up the evaluation testing we were doing, but I didn't run the testing, I acted as a observer	G2 was done a lot of the written work, and she has run one of the evaluation tests with one of our subjects	G3 done a lot of the visual stuff, she has updated all of the personas, didn't change information but make them prettier, she has created the storyboards, all of them
G2	G1 did some edits on the final wireframe that we have, then he reviewed the tasks and the questionnaires that I had, and then he observed one of the evaluations	We modified like couple of things, and specifically some of the descriptions that we're going to be like some of pros and cons we have for each route as well as some description that we potentially used in the write up, then I also wrote the discussion guide, or the tasks and questionnaires that we used in our evaluation, and then I conducted an evaluation, I conducted one, the team conducted 2	She also reviewed the tasks and the questionnaires that I had, and she conducted an interview, and she also set into another interview, taking notes for the evaluation, and I think also a couple of like smaller things to do take care with them like the consent form like re-writing them up, or recruiting people, and I think there are some storyboards needed to be finished up
G3	He did the wireframes for the final idea, like proper working wireframes, he's done that, I think for the past week we did less than before because we had another coursework deadline	Actually she did some writings, she wrote some task scenario, like some questions, prompts and things to ask for the evaluation, and she's also been very good in check the status of the coursework like where we up to, what we need to do, and things like that and G2 also did requirements as well	I redid the storyboards for 2 of the ideas, so mainly that since last week, if it's last week or the week before, but me and G2 also did requirements as well but it might be a little bit more than week ago, I can't remember,
Summary	2 PA G2 is PA of G1 G3 is PA of G1	1 FA, 1 PA G1 is FA of G2 G3 is PA of G2	2 FA G1 is FA of G3 G2 is FA of G3

Group H

Participant	What he/she reported about		
	H1	H2	Third member
H1	I was try to assume project manager role, so I've being kind of tracking .. and prepared like a list of tasks , and we assigned that to each member, then I was focus on the user journeys, I prepared one of the storyboards for one of the concepts, and I kind of defined that, then I started consolidating appendices to make sure they look consistent, H2 is in charge of leading the writing bit, so we all of us are putting ideas and stuff but she is more focus on that bit,	Ok, to summarise it, the way we organise the work in the main area, so H2 is leading the writing, L is leading the visual kind of thing, all the designs bits, and I'm leading the management of the project	She is being preparing the final version of the storyboards, a draft for the poster, and then we got the final version of the personas, she was also doing some of the conceptual design as well
H2	She's putting together lots of user journeys, and she went through the requirements, she used to checking through them as well, we had like a Skype discussion where we distributed different jobs, so H1 is still up keeping that document for managing the document mainly	So mainly it' been the report I'm doing, I've done the summary design stage, so basically writing up how all the research methods that we did, why we chose them, and doing the appendices, I've collected together the personas and put together the final version for them, … our the observation notes that we have, put them in the same format, some other parts in the user research just put together mainly for presentation	L is doing the wireframes and the storyboards most of the last 2 days
Summary	1 FA H1 is FA of H2	1 FA H1 is FA of H2	

Group I

Participant	What he/she reported about		
	I1	I2	Third member
I1	I done a lot of the conceptual design sketches, and I have written up the section of the write up about the personas and conceptual designs stage, and somebody else wrote the research but I wrote the next bit, personas, user journeys and conceptual designs, I think there was a group orientation actually… A section of detailed design, so we took a section each),	He has made a start on the poster, and he took the designs that we all did together and put them into X to make the wireframe, so he did that physically yesterday, he sketched the user journey, he hasn't done any of the writing yet He made them to be tested (about wireframes)	She also did quite lot of the design, I did sketched some papers and she put them onto illustrator, and I2 kind of made them functional, she redesigned personas just to make them a little bit prettier, taking the information we already did and putting them into basic template, and she wrote up the research part of the writing, and she tested with 2 people

	I did one testing on the wireframe		
I2	I1 did a lot of sketching and scenario for the basic idea, and she wrote report on the evaluation, no not evaluation, the research part	I sketched a lot of scenarios, and we have this idea and I sketched what the system can do, what it should do, and then I made wireframes and the prototype, and I did the poster, but is' not done yet	D posted some designs and ideas, actually we all sketched up ideas and then we put it together and see what works what doesn't work - you told me she did one user testing? Actually 2 user testing remotely via skype
Summary	1 PA I2 is PA of I1	1 FA I1 is FA of I2	

Group J

Participant	What he/she reported about		
	J1	J2	Third member
J1	I've built a prototype, together with J2, so I've built it and then she amended it, and also I wrote the first part of the design, not the design, the overview of our work	She helped me with the prototype, and she wrote a lot of the design process, and the justification of our decisions that we made in the design	G was doing the conceptual and detailed design writing about it
J2	He did most of the actual prototype, so he actually done most of the documents for that, the documents are available for everybody, so put a lot of effort into putting the paper prototype interaction, he also wrote parts of the report which is about the user research mainly, like observations and interviews	Actually during the team sessions, everyone of us like develop certain options for like specific interaction, for example last time I painted or drew the paper prototype, I wrote most of the part for the design for the report, I changed some features of the actual prototype, wrote down the tasks for people to do, like the scenario for the evaluation for the end-users	G actually started writing the report and also in our meetings he came up with different options during the conceptual design, and je found some questions that we could ask during the evaluation
Summary	1 FA J2 is FA of J1	1 FA J1 is FA of J2	

Appendix E.7
Reliability check for activity awareness evaluation

Note that:

- These data are from interviews
- All answers about activity were inserted into a comparison grid
- Each cell contains answers about what participants self-reported about their activities or what they reported about their colleagues' activities.
- The self-reported cells are coloured in grey

The process:

- Identify tasks in each cell (by underlining them)
- Compare answers: For each column, compare between the answers in grey cell and each cell in the column, and write down your answer in the comments.
    - If participant X mentioned all tasks as reported by participant Y, then participant X will be ranked as fully aware (FA) of the activity of participant Y
    - If participant X mentioned some tasks correctly, then he/she will be ranked as partially aware (PA)
    - If participant X said "I don't know or I can't remember", then he/she will be ranked as unaware (UA)
    - If all members agreed that a specific member did something but he/she did not self-report it, then no enough information (NI) status will be given
    - If members mentioned skills or how a member contributes rather than reporting what tasks he/she did, then also no enough information (NI) status will be given
    - If participant X mentioned other tasks that participant Y didn't self-report, then participant X will be evaluated based on what participant Y reported only.
- Count and get results

Participant	What he/she reported about	
	A1	A2
A1	I've build a persona, I've done a research on the geographic, the area of the county we are working with, we've done of mentored the group about the work I've done in the same field -Like literature review? Just past work I've done a literature review and kind of yeah	She's looked at user journeys, and got other examples on user journeys, it's all in a field that all mixed up together because our collaboration tool separate peoples' work, from what I remember from Facebook, done the user journey research, she's done some reading up as well, but physical output I think she, we don't get anything
A2	He does everything He does the persona, he send it to us, he is very practical and creative, He did the persona, - How many personas? he did one persona, and then the second persona we did it all of us Usually we create everything together	I did some research for the personas, and now, the last 3 days I'm doing the research for the user journeys and how we can/what layout we have to choose, if we have to make 1 or 3 user journeys because we have 2 personas, and we want a general user journey that we observed inside the customer service and how are we including the happy points, sad points, confusion points, how can we saw the emotional thing/perspective of the user in the user journey - You did interviews or observation? When we went to the centre, we all did observation, and then for interviews we split into 3, I was inside the centre grapping the customers "hello, we are doing this" and explain what we are doing, recruiter, then I was taking the customers and A1 was waiting with a recorder and asking the questions, and L was taking the notes
Summary		

Participant	What he/she reported about		
	B1	B2	B3
B1	We went to visit the centre, and we did some observations and wrote up the observation, and start writing some requirements, and I made a plan for the team	Same thing, so she went to the centre twice, and she has been, oh she made a user journey, she also did the interviews when we were at there at the centre, so she was writing those up	He has written up his observations and he also started writing the first, kind of intro to our plan/ to our project, and he also went to the centre one other time before me, and he just need to put his ideas input (2:00)
B2	She's been written up observations, and the same as what I did, and made some, kind of, summaries of the observations, kind of summary comments, and also started writing up requirements and trying to think about requirements because that's	I've written up my own observations that I did last week, also transcribed, not transcribed it in detail, -observation only or observations and interviews? So I've written up the observations and have taking notes from the interviews,	he sent me the recordings from the interviews, which, because he has those, I'm not actually sure what he has done, I'm sure he has done something, I'm not sure he has done much

	part of our task	transcribed it but didn't go into that much detail and from that kind of, I made a couple of existing user journeys, and I'm started thinking also about making a persona or possibly 2 personas (but I haven't, that's just all in my head so actually I haven't done anything of that)	
B3	She has, oh written up observations as well, and made a plan of, like a schedule for us to stick to	B2 also wrote, she is written up observations and the interviews, and she created user journeys yesterday	I've written up observations and just generally talked to the group about how we are progressing, in terms of deliverables, it was writing up observations
Summary			

Participant	What he/she reported about	
	D1	D2
D1	Personally, I'v been going to the Lembeth council, so I conducted interviews and questionnaires	She participated into interviews, and questionnaires, and group observations
D2	Basically I felt we've all done the same elements, where except D1 and A both did interviews with stakeholders, while I did with users. And the last meeting they do user - by stakeholders, do you mean staff? Yeah staff And both did observation? D1 did observation, but I can't remember if A did observation,	Last week was the last time we went to the centre, so I did 9 user interviews while I was there, we are all doing users interviews, and then did some observations as well when we were there in the morning like we started of doing it, but then there are other 2 groups there so we have to go away and that when start do observation and then we came back to get more interviews -you did questionnaire? So it was basically we wrote up questionnaire but the we kind of deliver it in a format of like semi-structured interview
Summary		

Participant	What he/she reported about		
	E1	E2	E3
E1	Personally I have collected all the forms, so all the observations forms, I've scanned those, so we have them all on the basecamp So we have everything in one file, it's a way we tried to be structured, and I've taken notes, taking notes in terms of the most important research findings, and I've prepared for	E2 has created a domain map, which he shared with us yesterday, and then basically the domain is just a collection of what he has done, so that allows us to look at what his thinking is, so how the centre works, what are the issues, what are the problems, what are the areas that we need to look at	She uploaded the audio recordings to the basecamp, she said she will transcribed them, but I don't know actually if she has done that yet or not

	a meeting which we're going to have today after our class to discuss our findings		
E2	I think in the last week he has been very much focused on other coursework that he has been doing, and he posted up the stuff he, the research that him and E3 both uploaded some research that they have done, because the second visit to the centre they went on their own because I wasn't around so they loaded the stuff they have found, so it's a mixture of interviews recordings and observation forms that he had filled in	Yesterday in fact, I took, so we have bunch of audio recordings, I transcribed one of the interviews, we have bunch of forms, small observations forms that we filled out and some notes and stuff and they are all on our basecamp project , so yesterday what I did I draw up like a domain model of all this research so they are in one place like who the people are, and what the issues are, and what they are trying to do, and linking things together, so you have like one picture that takes all of this research and put in to something that you can look at and then put that into slack	Same (like E1), so they took different notes and interviewed different peoples, and both uploaded the information And then I've been using that and trying to create this domain model, so we have something that we can make a decision about what we can do
E3	I know E1 has, E1 and I have discussing what design we want to do, so I'm not sure if he has any actual work, but we have been discussing ideas between each other because we were closer so it is easier to discuss things we went twice to the centre	I know that he's gone over the information both E1 and I got from last week's visiting the centre because he lives in Cambridge, So E1 and I went on our own and updated him with everything, so I think he just coming through all of our notes and all of our audio recordings which could takes some more time because we have some interviews that are about half an hour E2 went with us once, the first time	I did lots of audio recordings for interviews, so I've been transcribing them, so we can get a better idea for things, what's going on, I'm also been trying to think of design ideas like I said but I didn't put that for now
Summary			

Participant	What he/she reported about		
	F1	F2	F3
F1	We went to the centre to do some observations and collect some more interviews, we also set together to wrote up user personas and thought about user journeys and then individually, I've started work on making up the personas to put with the submission part, and writing up interviews, so we can sort of get ideas from them	He has looked at requirements for the software that we're going to be designing, and he's also drawing up some HTA model for the tasks involved in our personas, like a user journey, what the tasks would be throughout like the user journey we made so he's draw up them as well	She's been doing user journeys, so she's drown some on like sketch pad, she's drown some user journeys, she's also written up the interviews that we took and observations, and she's also with the personas, she's written up like a sort of script thing with all the details that we going to be using on them

F2	same thing, basically we did the same thing (interviews, personas and user journeys, and HTA) so me and F1 did the note taking,	Last week we went to the centre again to do a bit of interviews, like just to have more data that we have already, -and personally? Interview like I took notes, and last week we created personas and user journeys as well, and HTA, so I put in some ideas to the HTA -for the HTA, any one helped you? No everyone did it so me and F1 did the note taking,	She did the interview, so me and F1 did the note taking, because she did the interview and she's also given some ideas for the personas and stuff
F3	In the centre, he and F2 alternated taking notes or observing from far, he created personas, so we kind of split our work, and he scanned his notes for us to see	He like F1 alternated taking notes or observing from far, while I was interviewing, and he also scanned his notes for us to see, and then he did the HTA, All of these things kind of we did all together, but then we split it to kind of all make it nice by ourselves	Last week I did the customer journeys, I draw them, and then re-draw them kind of nicer for this week, I went back over the notes so I did during the interviews, I asked all the questions, so I don't have any notes, so I went over their notes and trying to get an idea to be able to do the.. - so you conducted the interviews in the centre? Yes
Summary			

Participant	What he/she reported about		
	G1	G2	G3
G1	I have updated some of our user journeys, I have done the wireframe for the solution the we are going to propose, and then I've reviewed work my team make	We had a meeting where we decided what to do, so we did that together, and then G2 has done the thing she said in the meeting which where to create a new persona and a new user journey, and to update some existing ones	G3 commented on work by myself and G2, and she created a new mock for an app which was going to be a secondary solution (different from the one I did)
G2	He created his own persona as well, he created some prototypes/mockups for one of the route we are going to take, and right now I think he is working on trying to see if he can consolidate all the user journeys into one page	I created and refined my personas, for these personas I created current and future user journeys, and I also storyboarded one of the potential routes that we are going to take, and then I also kind of wrote background descriptions on 2 of the alternatives that we are going to be describing, so a lot of the stuff has also done by me	G3 created a really good user journey for one of the alternatives we are looking at, and she is kind of like also consolidating the user journeys, so she took mine and then created a really good powerpoint, she took my work and then put it into a format

		working on stuff but looking at others people and then seeing how we can integrate it, where editing theirs	
G3	He has started a few different kind of documents, put things together, he did a mockup for one of other products, he did a storyboard, and a user journey	She did her storyboard, user journey, and she also put together some of the write up for one of the product (all did storyboard and user journey one for each) and put them together and kind of give feedback on each	I've put together some mockups, basically storyboards mockups for 2 ideas that we had, one of them I designed the storyboard and did the mockup, and the other one I just did mockup based on someone else's storyboard, also we have some group meetings just talk about where we are, what we are doing
Summary			

Participant	What he/she reported about	
	H1	H2
H1	Last week I was focus on processing observation notes, and I prepared the layout of the centre (I think it is the week before), after that I've done creating, doing some research of what are the current solution they got online at the moment and preparing user journeys for the current solution that we going to select, and also doing, after checking with the rest of team, is kind of assuming a little bit project manager role in sort of doing bit of planning, we are taking approach that we are treating the coursework as if it was a little bit of a project, we don't have a Gantt chart or anything, just put together some tables.. we assign some of the work to a specific people.., it gives us a little of structure, and considering time constraints	She was focus on interview staff, so processing information that goes from the interviews, and also defining some user journeys and some research as well
H2	She's done quite a lot of user journeys (she's done probably most of them), and she's put a document which shows, she's basically gone through the website, she looked at the different tasks and method to complete a task, She organised our folder on Google documents and Google drive, I think she's also put some changes for the floor plan she did (not sure) Project manager	I've been putting a few personas together from the interview data, and look at the user journey for what I look at one component of one group of people that come in they come but can't do online I started kind of sort collection of notes with what email (decisions) draw the main point and why we decided to go for this research, I decided to log reflection justify
Summary		

Participant	What he/she reported about	
	I1	I2
I1	Personally, so I've looked at all of data we got	He hasn't done anything last week, he was in

	from speaking to some peoples, so we do kind of working around with a bit of survey, so I've taken this into an excel and trying to make some patterns, and also transcribed some interviews that D has done and again make them sensible and trying to see if there are patterns relate to the other peoples I have made 3 personas and I've done a user journey	Berlin doing some work, but we spoke yesterday, last night he probably going to do another persona, actually we going to catch up today. -so what is the last thing he did in the group project? The last thing he did, he went to the centre, he made a survey, and he went to the centre with that survey on Monday before last (2 weeks ago)
I2	Last week she and D went to the customer centre, and did a couple of interviews, unfortunately there are not a lot of visitors there, so they could interview just 2 people, but they did interviews with staff too, and I1 draw up, I think yesterday, some personas she made, start doing sketch of some personas	Last week I didn't really do much of interaction design coursework, I was doing another coursework -so what is the last thing you did? I went to the customer centre by myself doing research, doing some interviews with users, I had an app with questionnaire, and going around, and afterward I put all the questions and data I collected in an excel spreadsheet and I uploaded it on the space we have on the internet (ASANA)
Summary		

Participant	What he/she reported about	
	J1	J2
J1	On Monday I went to the centre, so I did some observations, I did some interviews with the manager, and then I've also wrote few scenarios like existing scenario and future scenario that we want to achieve And with the guys yesterday talk what we are going to do next	We met on Sunday in a group here, we looked through the data, and created personas She wrote out with few Volere requirements, and she draw a user journey
J2	He also went to the centre to did some questionnaires, pictures, like observation in general, and he still had to do something, like user journey for book an appointment, he wanted to do that	I went to the centre to some interviews and some observations And also we, together we did like we sat together and did some personas and things like this, I actually started searching for requirements for the system, and putting them in like Volere template They are not completed but I just did further exploration of what the system might need and just shared it with my team mates
Summary		

Participant	What he/she reported about	
	A1	A2
A1	I've done the design section of the report, I've done the wireframes in order to build a prototype so we can evaluate it, yes so this 2 pages of the report of the design section, the second section within the report, and the wireframes using balsamiq, and obviously taking part in the brainstorming and finding out and research reading a lot within the group, so individually we were rarely work individually	She's done the user journey, and conceptual design sketches, so most of the creative stuff because she has a really good idea
A2	A1 is doing the implementation of the system, the prototyping (balsamiq)	User journeys, storyboards, and a little bit of my individual reflection I start it, and references, I found some references for the report
Summary		

Participant	What he/she reported about		
	B1	B2	B3
B1	I made the prototype, I helped with the testing and interviews, and wrote up the notes, all the observations from the testing and listening to them - how many testing you did? We tested 6 people in total	She conducted the interview tests, she did the interviews and she has been writing up the draft version and preparing that, she also did the personas and existing user journeys	he says he's working on requirements but he hasn't send it yet, he helped with the prototype and the write up
B2	So she started the poster, and you finished it? Yeah and she also, we were all working together, …, she was the one who actually doing the Photoshop of making the prototype, and making it interactive with inVision as well, and after that she tweaked little things when we suggested editing different things, and she also edited the report that I started writing -what about the user testing? We all did that together, we decided to be just 2 people going around, so we wouldn't kind of intermediate people, so B1 and me basically working around and doing the actual testing and it went quite well,	I finished up doing personas, which I'd pretty much in working on from the beginning, and I finished up some user journeys, and actually I did pretty much most of the report, basically I'd like started writing the report and stuff, like everybody else like doing appendix stuff, and I was the one who started to writing up the report with a bit feedback, in like some people can edit it, and then for the poster, B2 started making and she's kind of made like a draft, and then I edited it and finished it up, which was tricky because I had to learn how to use Photoshop for the first time, it was useful -what about the user testing? We all did that together, we decided to be just 2 people going around, so we wouldn't kind of intermediate people, so B2 and me basically working around and doing the actual	He did requirements, he actually helped me did the personas as well, because he kind of made them, and he digitalised them, he is mainly worked on requirements

		testing and it went quite well, although there was one participant who was a Spanish speaking, and she was struggling with English and understanding the task that we're trying to give her, and I tried like my very verbal Spanish and like it got very confusing and that helped in how we realise that we should of made some language options, which we had implement, we had included, but then wasn't visible enough, she didn't even see the language option, so those helpful	
B3	User testing	User testing	We've made the poster -yourself? No we collaborate in that, so one person did the draft, and other person adjusted it and then everyone did some corrections, so it's a team effort with completed the report which was also a group effort, we have lots of pullet points, so we've actually done all of the proper writing and basically everything we worked on was a group effort - which part exactly in the report, for example are you responsible for the first part about the research? No we actually go back and forth - so no one was responsible for a specific part? No not really, I mean we kind of split them up into halves, then different people worked on different one, but then we switched over and everybody checked, so there was back and forth with it, so there was not approach that somebody complete something -what about user testing? User testing, 2 out of 3 people of the group have done, because they were the ones asking the questions the ones they were writing them up,

			otherwise it would be (B2 and B3), it wasn't me, I was just observing them do it because we don't want crowd people
Summary			

Participant	What he/she reported about	
	D1	D2
D1	I did a little bit of summary for the report, I did give my feedback on poster design, and I did the wireframes for our project	She has been contributing in the form of like feedback on poster as well as she is writing the report, actually writing what she is doing, and we are giving a summary feedback on our observations, interviews, and questionnaires
D2	She is done the wireframe for the final design, also during the meeting, she is been sort of writing down what we need to be doing…. to keep us on track, as well as write up the summary of the user research	I was in charge of doing the storyboarding, so we come together brainstorming like conceptual ideas, I mean we are able to come up with requirements for what we want it, and have finalised then I was in charge of storyboarding just because I like drawing, so I'm doing that part of it, I'm doing the write up of the report as well, so everybody gave me like some summary and things, what I'm doing write that up and then I did the, so we have the user journey template, it wasn't pretty, so I'm in charge of making user journeys look nice for the appendices
Summary		

Participant	What he/she reported about		
	E1	E2	E3
E1	Basically I made all personas consistent, so we had some on papers, some on other files and I also revisited all the personas, they were actually just some random people but when we actually take the holistic view of our users, then I've done 4 user journeys for 5 personas, and we decide to dig one so we keeping them 4, and I also designed, I actually done like conceptual design on one of the flows, so we decided the interaction technology, and I created now a conceptual design flow for that, and I also been sort of doing all the research, listening to all the	He's done a lot, E2 creates the whole structure of the project, so he has started basically the whole thing, so he started getting the research sort of creating a specific model, of how the information flows, so he basically provided us with a framework to continue working on, and so me and E3 sort of dropping things on, he has also done lots of design, so I think he has done 2 at the routs of the flows, so we basically revisiting the kiosk, we making it more interactive, so he created a few more interesting routs	I'm a bit disappointed, she actually was covering a lot but I don't think she done that much, she has done only last couple of days And I know she has done user flow sort of HTA flow,… but she did it like more like a user flow rather than a HTA, so then we have to redo it, and then she done some, she went from conceptual design to detailed design which I think she done for making an appointment part, so I think she has done that yesterday

	interviews, adding notes to appendices .. oh I did HTA as well		
E2	E1 been doing more design related user journeys and personas, lots of stuff, it looks really neat doing stuff and sketch, make them like professional	I did a first draft of the write up, I've done screen designs, I've done lots of sketches for physical forms, but we haven't really decided on any of those yet	E3 been doing user flows, and task description, also she is doing some screen designs
E3	He redid our personas to make them consistent, so just kind of took the information we created and drop them into a template, him and E2 have also been working on other wireframes between the 2 of them, but they work on the graph a little faster than I do, -how many wireframes do you have? A lot, I think per interaction I think we have at least 6 or at least 4 of them, … we worked on separate interactions…, I think he also did, so we had handwritten user journeys, and he just put them in a template to also make those consistent	E2 wrote up a good portion of the appendix, which is really impressive because he was like I've done that much … and put them all in one document, but it's pretty thorough, and he is also been working on wireframes and things like that	I created wireframes for one of our interactions for make an appointment, I've also been going through the appendices, because E2 threw to it together really quick and E1 has been adding things to it, but their grammar and language not so great so I've been semi re-writing it,… we definitely been discussing between the 3 of us how certain interactions should work or what kind of things we want to include that's new, kind of like when you sign up for an appointment, you can get a text reminder or something like that
Summary			

Participant	What he/she reported about		
	F1	F2	F3
F1	I've done wireframe, I've done work on the report, which is what a lot of the work goes into it, I've also done some drawing up and scanning of designs, so conceptual and detailed designs	F2 is done lots of user journeys, and he's also done a bit on requirements, and I think he done some work on some HTAs, and finishing off personas	She's done work on the report, she's done quite a lot of work on the report, and she has also written up lots of requirements in actual format, and also done work on scanning various bit of the paper work we have so, she has uploaded all the consent forms and bits of paper work we have
F2	He created the wireframe for it, and did some of the report as well	I drew all of the user journeys and storyboards, and trying to help with the report a bit	She created the requirements and the report
F3	He's been working on the wireframes, so all the screens that users would go through, and again as a group we had work on user journeys, and he wrote the design part of the report, so he wrote the ideas down, and like what our	F2 been drawing up all the user journeys, so a lot of them were not in a digital copy or a nice copy, so all of them whether for conceptual design or detailed design, he's been drawing up	I wrote the report, looked up all the references, and then I, because we changed our detailed design, we had to change our requirements, so I re-wrote the requirements, and then worked as a team on new user journeys which drown by

	process..		someone else
Summary			

Participant	What he/she reported about		
	G1	G2	G3
G1	I created all the future user journeys, I updated the wireframe, and then I set up the evaluation testing we were doing, but I didn't run the testing, I acted as a observer	G2 was done a lot of the written work, and she has run one of the evaluation tests with one of our subjects	G3 done a lot of the visual stuff, she has updated all of the personas, didn't change information but make them prettier, she has created the storyboards, all of them
G2	G1 did some edits on the final wireframe that we have, then he reviewed the tasks and the questionnaires that I had, and then he observed one of the evaluations	We modified like couple of things, and specifically some of the descriptions that we're going to be like some of pros and cons we have for each route as well as some description that we potentially used in the write up, then I also wrote the discussion guide, or the tasks and questionnaires that we used in our evaluation, and then I conducted an evaluation, I conducted one, the team conducted 2	She also reviewed the tasks and the questionnaires that I had, and she conducted an interview, and she also set into another interview, taking notes for the evaluation, and I think also a couple of like smaller things to do take care with them like the consent form like re-writing them up, or recruiting people, and I think there are some storyboards needed to be finished up
G3	He did the wireframes for the final idea, like proper working wireframes, he's done that, I think for the past week we did less than before because we had another coursework deadline	Actually she did some writings, she wrote some task scenario, like some questions, prompts and things to ask for the evaluation, and she's also been very good in check the status of the coursework like where we up to, what we need to do, and things like that and G2 also did requirements as well	I redid the storyboards for 2 of the ideas, so mainly that since last week, if it's last week or the week before, but me and G2 also did requirements as well but it might be a little bit more than week ago, I can't remember,
Summary			

Participant	What he/she reported about	
	H1	H2
H1	I was try to assume project manager role, so I've being kind of tracking .. and prepared like a list of tasks , and we assigned that to each member, then I was focus on the user journeys, I prepared one of the storyboards for one of the concepts, and I kind of defined that, then I started consolidating appendices to make sure they look consistent, H2 is in charge of leading the writing bit, so we all of us are putting ideas and stuff but she is more focus on that bit,	Ok, to summarise it, the way we organise the work in the main area, so H2 is leading the writing, L is leading the visual kind of thing, all the designs bits, and I'm leading the management of the project

H2	She's putting together lots of user journeys, and she went through the requirements, she used to checking through them as well, we had like a Skype discussion where we distributed different jobs, so H1 is still up keeping that document for managing the document mainly	So mainly it' been the report I'm doing, I've done the summary design stage, so basically writing up how all the research methods that we did, why we chose them, and doing the appendices, I've collected together the personas and put together the final version for them, … our the observation notes that we have, put them in the same format, some other parts in the user research just put together mainly for presentation
Summary		

Participant	What he/she reported about	
	I1	I2
I1	I done a lot of the conceptual design sketches, and I have written up the section of the write up about the personas and conceptual designs stage, and somebody else wrote the research but I wrote the next bit, personas, user journeys and conceptual designs, I think there was a group orientation actually… A section of detailed design, so we took a section each), I did one testing on the wireframe	He has made a start on the poster, and he took the designs that we all did together and put them into X to make the wireframe, so he did that physically yesterday, he sketched the user journey, he hasn't done any of the writing yet He made them to be tested (about wireframes)
I2	I1 did a lot of sketching and scenario for the basic idea, and she wrote report on the evaluation, no not evaluation, the research part	I sketched a lot of scenarios, and we have this idea and I sketched what the system can do, what it should do, and then I made wireframes and the prototype, and I did the poster, but is' not done yet
Summary		

Participant	What he/she reported about	
	J1	J2
J1	I've built a prototype, together with J2, so I've built it and then she amended it, and also I wrote the first part of the design, not the design, the overview of our work	She helped me with the prototype, and she wrote a lot of the design process, and the justification of our decisions that we made in the design
J2	He did most of the actual prototype, so he actually done most of the documents for that, the documents are available for everybody, so put a lot of effort into putting the paper prototype interaction, he also wrote parts of the report which is about the user research mainly, like observations and interviews	Actually during the team sessions, everyone of us like develop certain options for like specific interaction, for example last time I painted or drew the paper prototype, I wrote most of the part for the design for the report, I changed some features of the actual prototype, wrote down the tasks for people to do, like the scenario for the evaluation for the end-users
Summary		

Appendix E.8
Answers for Open-ended Questions

Q1: How do you feel about Mr. Mentor?

P#	Answer
A1	Not sure
A2	As the … says mentor. Could be useful as if working in groups is very complicated and needs to talked about your group all the time
B1	I didn't encounter the interactions mentioned previously, such as, personalised reminder and rewards, so I feel I missed out on its full functional
B2	It was annoying to use and made me stressed rather than being helpful
C1	I'm not sure what is it supposed to achieve, how can I benefit from it, what problem is solving
D1	Mr. Mentor app is visually good, just that it didn't showed my collected points overall for all the weeks together
D2	I felt Mr. Mentor was a sand app, but hard to remember to use as I was using it on my computer as a web app. So I only used it sparingly
E1	Since I used web app, my interaction was not that often
E2	I like the idea, but the coursework was fairly full-on anyway, so we were already interacting all the time
E3	It was enjoyable
F1	I thought Mr. Mentor was useful at persuading me to do some work for the group project when otherwise I might not have done
F2	It's easy to use and help remind people to share their work with other group member
F3	I think the idea is great, but as my phone didn't have the right configuration, I used it very little as I forget to access the web version
G1	I did not find the web app useful
G2	I feel my thoughts are limited as I may not have seen its full view/potential just using the web version. That being said, just using it as a web version, I found it to be easy to use yet unhelpful
H1	The app is cool and I find useful to have the reminders some days, but overall I feel I proactively shared info with members of the team without the app
H2	On the web version of Mr. Mentor I felt the main purpose was to remind me to do things like complete work, view others work and share my own work. I didn't feel as though I was taught anything new or coached as a real mentor might. It was more of a useful reminder service
I1	I think I missed out or quite a few of its features as I used the web version. I felt a bit confused by what it aimed to gather from me and whilst it said it would remind me to work + share my work, it didn't. Therefore, I tend to fill it in with no goal other than assist me in data collection for the project
I2	I didn't see the point
J1	Positive feelings overall, sometimes annoyed but usually it was because I had to answer "No"
J2	It's a good reminder to do work for your group project every day and to actually have a look at other member's work

Q2: What do you think of using Mr. Mentor as a reminder?

P#	Answer
A1	daily reminders are annoying
A2	I believe it was not applicable because I didn't use it so often but only because I had some phone problems
B1	It was slightly annoying, because it asked the same questions with same responses to my answers, wasn't like a proper reminder
B2	Mr. Mentor would remind me to do things when I was in the middle of working on something else. Distracting and annoying. Also the website would pop up out of nowhere
C1	Sometimes it would work, but a couple of days it didn't work
D1	It's a nice way to get reminded of your group work to share with your colleague or team members
D2	Having a set reminder on my android phone would have been very helpful, as I often forgot to check-in. It would make me more likely to engage with my teammates
E1	I think it's a bit childish, could be more serious and take into consideration that group work can be stressful
E2	Reminder is good
E3	I would, it definitely reminded me to work sometimes
F1	I used the web app which didn't appear to have a reminder
F2	I don't personally take reminder to remind me do something, I prefer to just use my own mind to remember something
F3	I used it too rarely
G1	It was not used as a reminder tool. Existing reminders, i.e. calendar apps, were much more useful during this project
G2	I didn't have it giving me reminders (again, maybe because I did the web version). It did at one point tell me it would remind me again in 2 hrs, but it never did. Thinking about it, I think I would have been annoyed for it to remind me bc I don't like the idea of taking orders from someone. I trust myself and work on projects when suits me and/or my team not when a machine/system tells me.
H1	Yes, that was the most useful functionality
H2	I found it useful to be reminded to view my group members work, especially because beforehand if I didn't have time to look at the work properly I probably wouldn't have looked at all. Mr Mentor got me into the habit of at least viewing the work and returning later to respond. If the reminders came later in the day it would have been more helpful as first thing in the morning I may not have viewed any work yet or received any to view. This meant I just ignored it or clicked 'later'
I1	I've not seen the app version in action, but potentially it could be a good tool, however I also think that it shouldn't be something that we need to be reminded of, w/that sharing & collaboration, a group cannot work
I2	I would use calendar
J1	I think it's a great idea, definitely prompted me to look at work few times
J2	It's okay to use the app as a reminder, but after some time it would probably annoy me to use it daily

Q3: Do you think that you would work in a different way if you didn't use Mr. Mentor?

P#	Answer
A1	Yes, works as a good reminder. But it's useless to remind me to look at my team's work if they haven't done any or didn't share
A2	To be honest no because of the timetable for.. the project not because Mr. Mentor wasn't

	helpful
B1	n/a
B2	In its current state I would work better without it. I stopped using it
C1	No, Mr. Mentor didn't change my way of working
D1	No it didn't made any difference on mini scale but on highest level it motivated me
D2	I think I roughly worked the same because I didn't use it as often as I should have
E1	Probably not. I reported to Mr. Mentor rather than ask for advice. I wasn't sure what benefit I'm going to get from Mr. Mentor
E2	Not sure – maybe for work that was more intermittent or spaced over a longer period
E3	No I would probably work the same way
F1	I don't think so (see above)
F2	No
F3	I think it suggested good ideas, which influenced my work, but I didn't use it much throughout the process
G1	No
G2	No, I'm pretty on top of my work, telling myself/others what to work on
H1	To be honest, I'm not sure if it'd make a significant difference
H2	I think my communication with my group may have been less frequent and I don't think I would have reviewed others works often
I1	No, I don't feel it influenced my working methods at all
I2	I would look at groupwork more often
J1	Yeah probably wouldn't have shared my work as often, I would have forgot to check what others did
J2	Yes, I think, I would not have looked at other team member's work

Q4: Did Mr. Mentor change your awareness of your group's activities?

P#	Answer
A1	No, but it did motivate me to ask my team members for more visibility
A2	Yes kind of as I was interacting I was realising the activities I need to do
B1	A little. It encouraged us to discuss Mr. Mentor. But not our group activities
B2	No
C1	I'm afraid not
D1	No
D2	Yes, it would make me feel a bit guilty/ self-conscious if I didn't check in on group activity
E1	Yes it did. It did raise some questions, which made me think about my group and our work
E2	Not really, we collaborated using other technology anyway (slack, Bascamp etc.)
E3	No, I tried to always keep up with them regardless
F1	It made me more likely to check with the others
F2	Not really. I'm already aware of what my group members are doing
F3	Not really, we spoke on another group forum about the work
G1	No
G2	No
H1	Not really. I think email communication and regular catch ups were the key
H2	I didn't necessarily become more aware of what my group was doing, but often I felt as though I should know. Beforehand I was probably more inclined to let everyone get on with individual pieces of work but this made me think a bit more about what the others were doing.
I1	No, I'm afraid not

I2	Yes
J1	Yeah feels like I was engaged more with the process overall
J2	Yes, it made me aware of what other people did for the coursework

Q5: Do you have any suggestions to improve Mr. Mentor app?

P#	Answer
A1	Option to use/change different gender? Mr. vs Ms. Mentor? Maybe? would be nice if the app recognise the days I do project related work
A2	The ability to personalised more
B1	Perhaps Mr. Mentor could be informed of all tasks required in our group work and assign these to specific group members. Then a reminder is sent to the person to complete. And once completed the whole group is informed. Also a better interface would be good
B2	Make it more personalised? Notify only when I've said I'm working on the group project
C1	Maybe if it was linked to a shared drive where you directly could see your team members activities, would be of help. Also to alert you when your team members have completed something
D1	Yes the app is good just it need to show us our collected points through allover interactions not only the current one
D2	A version for android
E1	It should have more questions, perhaps be a bit more intelligent
E2	Maybe a way to customise periods where you know you are going to need to work more than other periods? Rather than just every day?
E3	Maybe more interaction options? A way for a group to use the app together?
F1	n/a
F2	Integrate between group members app, so it can be used as a place where group members interact with each other and share their work there
F3	n/a
G1	n/a
G2	Have a fual portion of it that allows you to explain WHY you marked "No", maybe you'll review later with your team. Also, have a section that allows you to customise based on your project
H1	I found a problem to complete the interaction with the app when other members of the team didn't do any work on a specific date. Found that a bit frustrating
H2	n/a
I1	As mentioned I've not seen the app, only the web version which I appreciate didn't fully function. Perhaps it could collect reasons for not working in a group on a particular day (i.e. other commitment) instead of being disappointed?
I2	The point system didn't worked
J1	Better look and feel, maybe a choice of personalities as a mentor?
J2	Should be available for android phones as well, because using the web application sometimes disrupted my current work flow by switching to the tab with the app open

Appendix E.9
Expert Reviews Results

Expert Review 1

iPhone app

Support	Persuasive technique	Definition	Support?				Comments
			No	Low	Medium	High	
			0	1	2	3	
Primary task support	Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour.				•	Mr. mentor is precise and to the point, asks users direct questions whether they have done and looked at group members work.
	Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.			•		Users go through a series of events; however, there is no way for a user to go back to a previous question. A new user may be unaware of how many questions there are.
	Personalisation	A system that offers personalised content or services has a greater capability for persuasion.			•		Not high because there is no option to enter my name, group name, etc. not fully personalised.
	Self-monitoring	A system that keeps track of one's own performance or status supports the user in achieving goals.		•			User is not able to fully track his performance, because he/she cannot set his/her goals with the app. It only reminds him to complete work, not see whether he achieved his target.
Dialogue support	Praise	By offering praise, a system can make users more open to persuasion.				•	Mr. mentor praises you if you have completed and/or shared your work.
	Rewards	Systems that reward target behaviours may have great persuasive powers.				•	You get points every time you complete or look at your group members work.
	Reminders	If a system reminds users of their target behaviour, the users will more likely achieve their goals.				•	Mr. mentor sends the user a notification daily in two ways, either the user sets a time, or the app notifies the user reminding them to look at their group work in 2

							hours
	Suggestion	Systems offering fitting suggestions will have greater persuasive powers.			•		Mr. mentor suggests to look at group members work now. The app does not suggest completing the work now (is I say I haven't done any work related to the group project today). However, it should also be kept in mind that the users are not setting any goals or targets with/through the app.
	Liking	A system that is visually attractive for its users is likely to be more persuasive.				•	The app is visually appealing, with a nice avatar talking to you.
	Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.				•	The app has a virtual mentor persuading you to share work with group members and look at their work.
Perceived system credibility	Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.	•				The app is not giving any information. It asks the user to enter or fill out the information.
	Surface credibility	People make initial assessments of the system credibility based on a first-hand inspection.				•	The app has a competent look and feel.
	Real-world feel	A system that highlights people or organisation behind its content or services will have more credibility.				•	The app has an "about me" tab, where you can contact a specific person via email about feedback and questions.
Social	Cooperation	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to co-operate.	•				The group members are not connected via the app, so there is no way to tell whether they are using the app for the group project or not.
	Competition	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to compete.		•			The app has a point system, but the user is not able to share his/her points with his group members. They could maybe talk to each other about their points, but they cannot share or compare their points with their group

							members in order to compete.

Web app

Support	Persuasive technique	Definition	Support?				Comments
			No	Low	Medium	High	
			0	1	2	3	
Primary task support	Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour.				•	The web app is precise and to the point, asks users direct questions whether they have done and looked at group members work.
	Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.			•		The app does guide users to take an action, however it could be a bit clearer, so that users know exactly how many steps there are and are able to go back one step.
Dialogue support	Praise	By offering praise, a system can make users more open to persuasion.				•	Users are praised when they share work and/or look at a group members work.
	Reminders	If a system reminds users of their target behaviour, the users will more likely achieve their goals.		•			
	Suggestion	Systems offering fitting suggestions will have greater persuasive powers.				•	Users are suggested to share their work with group members and to look at members work.
	Liking	A system that is visually attractive for its users is likely to be more persuasive.				•	Mr. mentor avatar makes the app very likable.
	Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.				•	The web app has a virtual mentor persuading you to share his work with group members and to look at their work.
Perceived system credibility	Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.	•				The web app is asking users to fill in information it's not providing any information itself.
	Surface credibility	People make initial assessments of the system credibility based on a first-hand inspection.				•	The app has a competent look and feel. Having the "about me" button on the homepage makes it more credible as you can contact a person

							regarding the app.
	Real-world feel	A system that highlights people or organisation behind its content or services will have more credibility.				•	The app has a "about me" button, allowing the user to contact a person via email regarding the app.
Social	Cooperation	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to co-operate.	•				The group members are not connected via the app, so there is no way to tell (through the app) whether the members are all using the app for the group project.

Expert Review 2

iPhone app

Support	Persuasive technique	Definition	Support?				Comments
			No	Low	Medium	High	
			0	1	2	3	
Primary task support	Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour.			•		The number of interaction is minimum between the system and user. The tasks required to do is considered simple.
	Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.				•	Found in yes/no questions all the way to the end of the process.
	Personalisation	A system that offers personalised content or services has a greater capability for persuasion.			•		Personalisation is only found in reminder setting where the user chooses the time that suits him/her.
	Self-monitoring	A system that keeps track of one's own performance or status supports the user in achieving goals.		•			In the reward, because it reflects the user performance. But it isn't applied in a proper way.
Dialogue support	Praise	By offering praise, a system can make users more open to persuasion.				•	Found in most responses by Mr. mentor animation, words, and sounds.
	Rewards	Systems that reward target behaviours may have great persuasive powers.			•		There is reward tab for this and the system rewards the user by points whenever he/she does a task, but after sometime the rewards resets to zero.
	Reminders	If a system reminds users of their target behaviour, the users will more likely achieve their goals.				•	I found 2 reminders; the first is a daily reminder and the time is chosen by the user. The second is a reminder after 2 hours if the user didn't perform any of the tasks.
	Suggestion	Systems offering fitting suggestions will have greater persuasive powers.			•		Only 2 suggestions found in the system: 1- Why not to have a look now? 2- Why not share what you have

							done now?
	Liking	A system that is visually attractive for its users is likely to be more persuasive.			•		Yes very attractive specially while using animation all the way, and I like the tab bar. I think the margins should be adjusted a little bit.
	Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.				•	The whole system is based on the social role of "Mr. mentor" that interacts with the user while using the system.
Perceived system credibility	Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.		•			The system reminder is done as said. When the user does a task he/she gets points, these points are added to rewards tab as said.
	Surface credibility	People make initial assessments of the system credibility based on a first-hand inspection.				•	No ads in the application throughout. This increases its credibility.
	Real-world feel	A system that highlights people or organisation behind its content or services will have more credibility.			•		In the "about me" tab, there is some information about the people behind it.
Social	Cooperation	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to co-operate.		•			The system suggesting to share and to look at the work of the group members motivates users to cooperate.
	Competition	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to compete.	•				No competition is found.

Web app

Support	Persuasive technique	Definition	Support?				Comments
			No	Low	Medium	High	
			0	1	2	3	
Primary task support	Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour.			•		It is found in the minimal number of interaction between the system and the user as well as how the tasks are simplified.
	Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.				•	It is observed in yes/no questions provided in the system.
Dialogue support	Praise	By offering praise, a system can make users more open to persuasion.				•	The system complements the user if they share or look at the group work.
	Reminders	If a system reminds users of their target behaviour, the users will more likely achieve their goals.		•			The system reminds the user after 2 hours if they choose to be reminded "later", and there is a daily reminder.
	Suggestion	Systems offering fitting suggestions will have greater persuasive powers.			•		1- Why not to have a look now? 2- Why not share what you have done now? These are the suggestions the system made
	Liking	A system that is visually attractive for its users is likely to be more persuasive.			•		The combinations of Mr. mentor character, the sound, the speech balloons, and the music are attractive and likeable.
	Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.				•	Mr. mentor as a social role.
Perceived system credibility	Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.		•			When the system reminds the user.
	Surface credibility	People make initial assessments of the system credibility based on a first-hand inspection.				•	The non-existence of ads in the website increases the credibility of the system.

	Real-world feel	A system that highlights people or organisation behind its content or services will have more credibility.			•		In the "about me" section, there is information and contact info.
Social	Cooperation	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to co-operate.		•			Yes, by suggesting to share the work and look to the group member work.

Appendix F: Publications

Appendix F.1

Exploring Awareness Behaviours and Collaboration Activities in Learning Groups

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Collaborative learning is a useful approach in which learners work jointly to achieve learning goals. Awareness plays a significant role in promoting collaboration opportunities and enhancing the effectiveness of the collaborative learning. This poster reports a study to explore awareness behaviours in a long-term collaborative project. The research questions focus on awareness behaviours, the changes in awareness over time, and the applications used to communicate and collaborate. Three main data collection methods were used: observations, short interviews and questionnaires. Participants were students who were working on collaborative coursework for 6 weeks. Results show that different awareness types and behaviours were evident and activity awareness was higher at the beginning of the collaborative project than it was towards the middle or the end. In addition, groups used different general-purpose applications to support their collaborations.

Awareness, Activity Awareness, Collaborative Learning Project, Long-term Collaborative Project

1. INTRODUCTION

Collaborative learning is an effective approach to support the learning process (Dillenbourg, 1999). It can be described as the situation in which a group of learners work together to complete a common task (Dillenbourg, 1999). Awareness is a useful concept in promoting collaboration opportunities and improving the effectiveness of collaborative learning (Paletta & Herrero, 2011). There are different types of awareness such as activity awareness and situation awareness. Carroll et al. (2006) defined activity awareness as "a dynamic process in which a variety of information is constantly shared, tested, and updated to guide group behavior". Previous studies have reported on the significant role of awareness in enhancing collaboration in groups (Gutwin et al., 2004) (Convertino et al., 2004); however studies to understand awareness in collaborative groups for longitudinal learning projects are limited. Convertino et al. (2004) stated that many breakdowns in longitudinal collaboration happen because of a lack of activity awareness.

An exploratory study was undertaken to understand awareness in groups working on a longitudinal project. The main research questions were:

(i) What awareness behaviours and awareness types were exhibited in the learning groups?
(ii) What collaboration activities were identified in the learning groups?
(iii) Did awareness and collaboration change over time?
(iv) What applications and tools did the groups use during meetings and to collaborate afterwards?

2. METHODOLOGY

As the research questions were open-ended and exploratory, a qualitative approach was adopted. Three main data collection methods were used; observations, short interviews and questionnaires.

2.1 Participants

The participants were a convenience sample of MSc students who were working on a collaborative coursework for 6 weeks. The coursework involved the design of an interactive device as part of an introductory module on interaction design. Group members had not worked together previously and had different educational backgrounds, skills, and experiences. Five groups participated in the study with 3 or 4 members in each group and a total of 17 participants. Each group determined its own working methods and selected various software applications to collaborate.

2.2 Data collection methods

Observations: groups were observed at least twice for about 30 minutes during their regular meetings in the City University premises.

Interviews: each participant was interviewed individually twice for about 4 to 7 minutes, except for one group, where each member was interviewed once only. The interview questions were mostly designed to probe awareness, collaboration, and tools they used.

Questionnaires: each participant was given 2 questionnaires; one at the beginning of the study to collect factual data; and the other at the end of the project which used Likert-scale questions to assess students' awareness and satisfaction towards their learning experience and learning preferences. Table 1 shows the timeline of the collected data.

Table 1: *The timeline for data collection (Obs = observation, Int = interview, Que = questionnaire)*

Groups	Weeks					
	1	***2***	***3***	***4***	***5***	***6***
A	***Obs1 Int1 Que1***		***Obs2 Int2***			***Que2***
B	***Obs1 Int1 Que1***		***Obs2 Int2***	***Obs3***		***Que2***
C		***Obs1 Que1***		***Int1***	***Int1 Obs2***	***Que2***
D		***Obs1 Que1***	***Int1***	***Obs2 Int2***		***Que2***
E		***Obs1 Que1***	***Int1***		***Obs2 Int2***	***Int2 Que2***

2.3 Data analysis

Mixed approaches were used to code and analyse the qualitative data: top-down and bottom-up approaches. The coded data were collaboration activities and styles, awareness behaviours, awareness types, and tools and applications used. Colour coding was used to differentiate between different levels of activity awareness. The "accuracy" of participants' activity awareness was explored by comparing their answers to interview questions about the activity of their colleagues against the reality of what those colleagues had been doing.

3. RESULTS AND DISCUSSION

Different *types of awareness* were evident including activity awareness, skills awareness, current-state awareness, next-step awareness, and time awareness. Some of these emergent awareness types were new and have not been reported in the literature, such as skills awareness and next-step awareness.

In addition, several *awareness-promoting behaviours* were identified in the collaborative groups, such as reviewing work, asking direct questions, and looking at Google drive or notes.

Results showed that *activity awareness* was higher at the beginning of the collaborative project than at the middle or the end. In addition, *work reviews* were higher at the beginning than near the end.

Collaboration activities included discussion, suggesting, and helping each other to complete a task.

Groups used different existing applications during their collaborations such as Email, WhatsApp, Google drive and Hangout. It seemed that participants preferred to use general-purpose applications to collaborate rather than trying to use any specific collaborative learning environment.

A synthesis of these results will deliver a model of awareness that will be introduced to reinforce awareness throughout learning projects.

4. CONCLUSIONS

In conclusion, understanding awareness behaviours in collaborative learning groups will help to find out how technology could enhance awareness and support such collaborations. The next steps will focus on investigating different applications and tools that are specifically used in collaborative learning environments to determine their strengths and limitations in supporting awareness for longitudinal projects.

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Appendix F.2

A Persuasive Social Actor for Activity Awareness in Learning Groups

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In collaborative learning groups, students' awareness of each others' activities is key to enhancing the effectiveness of collaboration. Some studies have reported that many of the breakdowns in collaboration in learning groups happen because of a lack of activity awareness. While some technologies have been developed to support activity awareness, the potential of persuasive technology has not yet been explored. We report the design, development and evaluation of a persuasive technology for this purpose in the form of a digital social actor. The design of the social actor was shaped by persuasive design principles. The evaluation involved 21 participants who used the app during group projects as part of a postgraduate course. Results showed that activity awareness increased towards the end of the project work and that participants felt the social actor changed their awareness behaviour. This research makes two contributions: it investigates a novel approach to promoting activity awareness in small learning groups by using a social actor to change students' attitudes and behaviours, and it reports a first attempt to design, develop and evaluate a persuasive social actor based on the Persuasive Systems Design model.

Persuasive technology, social actors, activity awareness, changing behaviours, collaborative learning

1. INTRODUCTION

Collaborative learning involves students working together to achieve learning outcomes in the shape of new skills and knowledge. It comes from the constructivist tradition and emphasises learners contributing differing expertise and depending on each other in the creation of new knowledge. Within this paradigm, we define a *collaborative learning group* to be a small group of students who work collaboratively on a project for learning purposes. We are interested in how the collaboration within such groups can be enhanced.

One factor that has been reported as influencing the success of collaborative groups more generally is the awareness that members have of each others' activities - so-called activity awareness (Gutwin et al., 2004). However, Al Ashaikh et al. (2014), in a study of collaborative learning groups working on projects over extended periods of time, found that activity awareness was variable and that it decreased over time. While some attempts have been made to develop software systems to enhance activity awareness in collaborative learning groups (e.g. (Ganoe et al., 2003 & Carroll et al., 2003)) these typically do so by capturing and sharing details of the activity. We have investigated an alternative approach to accomplish the same outcome – enhancing activity awareness – by using persuasive technology to change the attitudes and behaviours of the learners.

Fogg (2003) defines persuasive technology as “any interactive computing system designed to change people's attitudes or behaviours or both (without using coercion or deception)”. He coins the term "captology", an acronym for "computers as persuasive technologies" and presents a framework for captology called the “Functional triad” which identifies the role of computers as tools, media, or social actors. Persuasive technologies have been used in diverse areas to change users’ attitudes or behaviours or both, but have not previously been used in the context of activity awareness.

This paper reports research to investigate how a persuasive technology, in the form of a digital social actor, could be designed to support collaborative learning groups by encouraging students to have greater awareness of each others' activities. We describe the social actor, how it was developed in line with design principles from the Persuasive Systems Design (PSD) model (Oinas-kukkonen & Harjumaa, 2009) and an empirical study to investigate its effectiveness in naturalistic settings, i.e. real collaborative learning projects.

2. BACKGROUND AND RELATED WORK

Several types of awareness have been reported as significant in supporting collaboration, including activity awareness, workspace awareness, situation awareness and knowledge awareness (Ganoe et al., 2003; Gutwin & Greenberg, 2001; Salmon et al., 2009; & Ogata & Yano, 2000). Activity awareness is a widely adopted concept in studying collaboration. Carroll et al. (2006) define activity awareness as an active process in which different kinds of information are continuously shared, tested, and updated to guide group behaviour. Activity awareness in the context of collaborative learning includes knowledge of what other group members did, are doing, and are planning to do throughout the project. Activity awareness in collaborative learning is significant in order to enable students to coordinate tasks effectively (Dourish & Bellotti, 1992).

Convertino et al (2004) state that activity awareness requires awareness of synchronous and asynchronous interactions over long periods of time, and many breakdowns in longitudinal collaboration in learning groups happen because of a lack of activity awareness. They describe a method to evaluate activity awareness and collaborative activities in a controlled setting. They conducted an experimental study in the laboratory where participants worked in pairs on a long-term remote project over several experimental sessions for 4 weeks. They found that students were not fully aware of each other's activity for the duration of the project.

Al Ashaikh et al (2014) report an exploratory study conducted with 5 collaborative learning groups who worked on an assessed learning project for 6 weeks. The groups were relatively small, consisting of 3 or 4 students. The study explored awareness behaviours and collaborative activities. As in the Convertino et al (2004) study, the results showed that in spite of the small group size, the students did not maintain full activity awareness over the course of the project. Specifically, activity awareness was found to be higher at the beginning of the project than in the middle or near the end. It appears that maintaining activity awareness can be problematic even in small learning groups.

Different kinds of technologies have been used to support collaborative learning including general-purpose applications (e.g. email, discussion forums (Phielix et al., 2010), blogs and user groups (Anderson & Lin, 2009)); and CSCL tools (e.g. Blackboard and Wimba Live Classroom (Sugimoto et al., 2002)). Most of these technologies have been used to communicate, share documents and materials, track the work of the group, or distribute and allocate tasks, i.e. to support sharing of data and/or the functional activities of the group. Usually these systems tend to be "heavyweight" and are used to support the actual collaborative activities. In contrast, there is no lightweight supportive tool that focuses on the learners and their attitude to collaboration without considering the functional aspects of the group's work.

Persuasive technologies have been used in different areas such as health, wellbeing, e-commerce, and learning (Fogg, 2003). Within the area of learning, examples of persuasive technology have included Behringer et al. (2013) who investigated how to use persuasive technology for learning in a business context. They present two case studies of academic business computing and language learning. They describe how they designed persuasive tools to help business students in their learning and the design principles they applied for each case study. They concluded that persuasive technologies are beneficial for encouraging learning and that it is not practical to apply a common set of persuasive design principles to all learning contexts, i.e. each learning situation needs a specific set of persuasive designs. Other examples of persuasive technologies in learning have included the HANDS project (Mintz & Aagaard, 2012) and SISATSpace (Firpo et al., 2009). The HANDS project is a persuasive technology designed for children with autism in special schools to improve their social skills, while SISATSpace is a persuasive technology designed to increase the sense of community among a group of students. However, we are not aware of any work that has utilised persuasive technology to promote activity awareness in a collaborative learning situation.

In higher education, it is common for the syllabus of subjects such as computer science to incorporate collaborative group projects that run over several weeks. In order to maximize the benefit of collaboration in such groups, it is important to support students by promoting their activity awareness over the course of the project. We hypothesized that persuasive technologies may offer a novel way of achieving this by changing learners' behaviours and persuading them to be more aware of fellow group members' activities.

3. SOCIAL ACTOR DESIGN

In this section, we report the design and development of a lightweight persuasive technology to promote activity awareness in collaborative learning groups by changing the attitudes and behaviours of students. The persuasive technology takes the form of a digital social actor. A social actor is a persuasive technology that gives different social cues to elicit social responses from users (Fogg, 2003). Possible social cues include physical cues (e.g. face and

body), psychological cues (e.g. empathy and humour), language (e.g. spoken language), social dynamics (e.g. praise for good work), and social roles (e.g. guide). Social actors can persuade people to change their attitudes or behaviours by rewarding them with positive feedback, providing social support, or modelling target behaviours or attitudes (Fogg, 2003). Social actors have been used as persuasive technologies for purposes such as encouraging people to stop smoking (Barbat & Cretulscu, 2003) and minimizing electricity consumption (Ham et al., 2009).

We developed a lightweight social actor for activity awareness called "Mr. Mentor"[1]. The target behaviours for Mr. Mentor were to encourage students to share their work with others in their collaborative learning group and, vice versa, to encourage students to look at the work done by others in the group. Mr. Mentor is a digital character that interacts with users by asking questions, providing feedback and making suggestions; it uses voice, text and facial expressions. Two versions of Mr. Mentor were implemented: an iOS version that runs on iPhones and a web version that works on desktop and laptop computers.

Initially, only the iPhone version was created; a web version with slightly less functionality was developed later to enable more people to use the social actor. The iPhone version was developed using *Xcode*, while *html* was used for the web version. For the animation, the *GoAnimate*[2] tool was used to generate Mr. Mentor's face, body, movement, sound, and visual effects.

The Mr. Mentor app was developed based on two persuasive design models: the eight-step design process suggested by Fogg (2009) and the Persuasive Systems Design (PSD) model by Oinas-kukkonen and Harjumaa (2009). Fogg's eight-step design process was followed in designing the app, and the PSD model was used to determine the features of the app.

Fogg (2009) suggests an eight-step design process to follow in order to create a robust persuasive technology. The steps involve choosing a target behaviour, an audience, and a common technology channel, finding what prevents that behaviour, finding relevant examples, reproducing successful ones, testing and iterating quickly, and finally expanding on success. In this case, the intended behaviour change was to motivate students to share their work with other members of their group on an on-going basis and to look at the work of other group members for the duration of a learning project. This was "reinforcement" of existing behaviours: the target behaviours already existed but they were not exhibited consistently (Al Ashaikh et al. 2014). The audience was students who were working in small collaborative learning groups on projects of several weeks in duration. The chosen technology channels were mobile and web apps.

The PSD model offers guidance regarding the features of a persuasive technology and consists of two parts: the persuasion context and the system characteristics. The persuasion context is used to determine the intent, the event, and the strategies for the persuasion. The system characteristics identify four categories of persuasive techniques: primary task support, dialogue support, system credibility support and social support. Each of these categories includes seven persuasive techniques, giving a total of 28 persuasive techniques. For instance, reduction, which is defined as reducing a complex behaviour into simple tasks, is a persuasive technique for primary task support.

The PSD model has not been used previously to develop a persuasive social actor that promotes activity awareness. We drew on the persuasive techniques of the PSD model in designing the Mr. Mentor app. Each of the 28 PSD techniques was considered for its potential suitability and practicality to be applied in this context. Some techniques were deemed inappropriate; for example, third-party endorsements and expertise are useful for e-commerce situations, but were not relevant in this case. Table 1 shows all the persuasive techniques from the PSD model that were applied in designing the iPhone and web versions of the app and how they were applied. The iPhone version was shaped by 15 techniques whereas, due to the time constraints, only 11 were applied in the web version.

For each persuasive technique applied in the design of the app, we also created a statement to describe the implementation of that technique. For example, the statement S1 "The app simplified the interaction with Mr. Mentor by using buttons for answers, and no need to write them" was created for the reduction technique. These statements were used later in evaluating the effectiveness of the approach (see section 4).

Mr. Mentor runs continuously on the device (iPhone or desktop web browser). It interacts with users by asking them on a regular basis whether they have carried out behaviours that support activity awareness (Figure 1). Firstly, Mr. Mentor asks users if they have shared completed tasks with their group, praises them if they have done so, and awards 10 virtual reward points (Figure 2). If the user has not shared their work, Mr. Mentor suggests that they should share what they have done now, and the user can choose either 'Ok' or 'Later'. If the user chooses 'Ok', Mr. Mentor will be

[1] The name "Mr. Mentor" denotes the fact that the social actor "mentors" the collaboration; it does not mentor people, or give advice or support about the activities of the project itself.

[2] https://goanimate.com/

happy and award 5 points. On the other hand, if the user chooses 'Later', Mr. Mentor will be sad and suggest that he will remind the user again after 2 hours (Figure 3). Secondly, Mr. Mentors asks users whether they have looked at others' work, rewards them if they have done so and is sad if they have not done so.

Table 1: *PSD persuasive techniques applied in each app version and corresponding statement numbers*

Categories of support	Applied persuasive techniques	#S	iPhone	Web
Primary task support	*Reduction: simplifying the interaction with Mr. Mentor by incorporating buttons for answers*	*S1*	•	•
	Tunneling: guiding users through a series of questions to complete the interaction with Mr. Mentor	*S2*	•	•
	Personalisation: offering a personalized service, by allowing the user to select a preferred time for notifications	*S3*	•	
	Self-monitoring: providing a reward page, so users can see their total earned points	*S4*	•	
Dialogue support	*Praise: offering praise when users share their work or look at the group's work*	*S5*	•	•
	Rewards: rewarding users with virtual points whenever they share their work or look at the group's work	*S6*	•	
	Reminders: reminding users to share their work and to look at the group's work	*S7*	•	•
	Suggestion: offering appropriate suggestions when users don't perform the target behaviours	*S8*	•	•
	Liking: making the app visually attractive	*S9*	•	•
	Social role: adopting a mentor that promotes activity awareness	*S10*	•	•
Perceived credibility support	*Trustworthiness: providing true and reliable information about the app and the study*	*S11*	•	•
	Surface credibility: no ads in the app	*S12*	•	•
	Real-world feel: displaying the researcher's info	*S13*	•	•
Social support	*Cooperation: use of the app is to support collaboration*	*S14*	•	•
	Competition: displaying the total earned points, to support competition between users	*S15*	•	

Figure 1: *Mr. Mentor asks the user whether they carried out project work (iPhone version)*

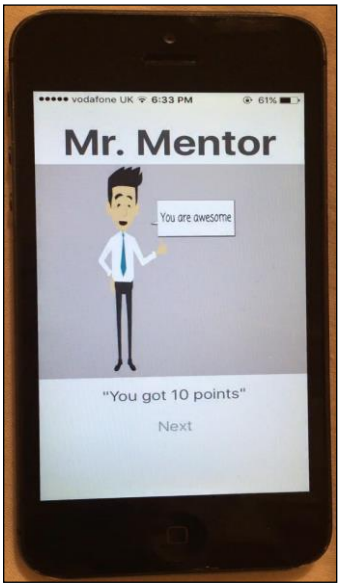

Figure 2: *An example of the praise that Mr. Mentor offers to the user saying: "You are awesome" (iPhone version)*

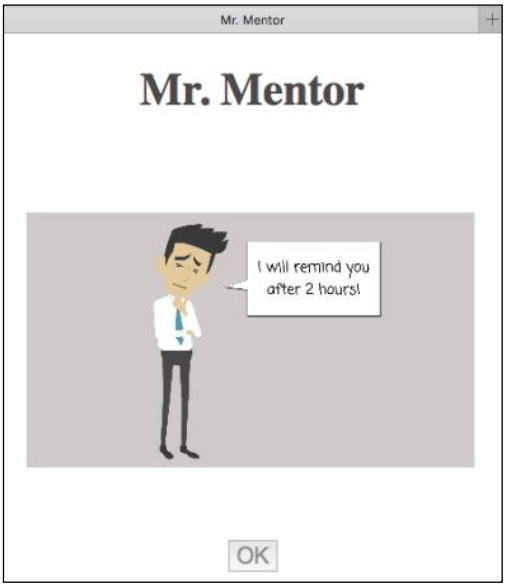

Figure 3: *Mr. Mentor feels sad and suggests reminding the user to share their work after 2 hours (web version)*

4. EXPLORING THE EFFECT OF USING A SOCIAL ACTOR ON ACTIVITY AWARENESS

The effectiveness of the social actor app was investigated in an empirical study. The aim of the study was to investigate the effect of using Mr. Mentor on collaborative learning groups working on learning projects over an extended period of time. We chose to do this by evaluating Mr. Mentor in an authentic learning situation, a postgraduate course module, rather than by running a more controlled, but ultimately artificial, study. Approval for the study was obtained from the departmental ethics committee.

The main objectives were:

1. To identify any changes in attitudes or behaviours that support activity awareness in collaborative learning groups.
2. To evaluate the success of the applied persuasive techniques in the app from users' point of view.

4.1 Study Design

The study was run during a postgraduate module on Interaction Design delivered as part of a Masters programme in HCI. All students taking the module were invited to participate. A repeated measures design was employed: all participants were provided with the app and comparisons were made between participants' attitudes and behaviours at baseline and after using the app. Ethics considerations dictated that students participating in the study were not advantaged or disadvantaged relative to each other. This imposed the constraint that it was not possible to run a comparative study in which some participants used the app while others did not.

4.2. Participants

Participants were a convenience sample of Masters students who were working on a compulsory collaborative coursework project for the Interaction Design module over a period of 6 weeks. Twenty-one of the 30 students taking the module were recruited to the study. None of the students had been involved in the design of the app and they were not aware that it was intended to influence their activity awareness.

The coursework project involved the design of an interactive system and was worth 40% of the total grade for the module. Students worked in assigned groups of 3 members. However, not all the members of a given group participated in the study: Table 2 shows how many students participated from each group. Twelve participants were female and 9 were male, most were in the 18-29 age group, with different backgrounds and experiences. Of the 21 participants, 9 used the iPhone version of the app and 12 used the web version. Participants who possessed iPhones used the iPhone app; otherwise they used the web version. The app was installed on the participants' iPhones at the outset of the project, or they were provided with a link to the web version.

***Table 2**: Number of participants from each group*

Group	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Number of participants	*2*	*2*	*1*	*2*	*3*	*3*	*2*	*2*	*2*	*2*

4.3 Data Collection Methods

Two data collection methods were used: questionnaires and interviews.

4.3.1. Questionnaires
Questionnaires were used to measure users' attitudes and behaviours related to activity awareness, their perception of whether Mr. Mentor had changed their behaviour and their views on the features of Mr. Mentor that arose from implementing the PSD techniques.

Two questionnaires were given to each participant. The first was administered at the beginning of the project before using the app to collect factual data about demographics and pre-test (baseline) data about students' attitudes and behaviours towards activity awareness and collaborative learning. For the latter, participants were asked to rate 12 statements using 7-point Likert scales; 8 statements for attitudes and 4 statements for behaviours. The second questionnaire was administered at the end of the project, after the students had submitted their work, to collect post-test data about students' attitudes and behaviours towards activity awareness and collaborative learning after using the app, using the same 12 statements with 7-point Likert scales. The second questionnaire additionally collected data about students' opinions of the "Mr. Mentor" app, using both open and closed questions. It examined to what extent participants perceived that the social actor had changed the target behaviours, using two 7-point Likert scales. Finally, the second questionnaire contained statements regarding features introduced as a result of applying the persuasive techniques of the PSD model, and participants were asked to rate these statements using 7-point Likert scales. We used this data to examine whether the PSD techniques had been successfully implemented, (Figure 8).

4.3.2. Interviews
Interviews were used to explore activity awareness. Two interviews were conducted with each participant, one in the fourth week and one in the

last week of the project. The interview questions were structured and were designed to probe awareness, collaboration, and the tools that students used to communicate and share information. Participants were not asked directly about awareness; they were asked what they had done on the project since last week and what each other member of their group had done.

5. RESULTS

One-tailed Wilcoxon signed rank tests were used to test for differences between participants' responses in the pre-test and post-test questions about attitudes and behaviours. The Wilcoxon signed rank test is a non-parametric statistical test and can be used on repeated measures from the same sample. The one-tailed test was applied as we hypothesized that changes might occur in one direction, i.e. the ratings for attitudes and behaviours would increase after using the social actor app.

5.1. Changes in Attitudes

Table 3 shows the 8 attitude statements with averages from the pre-tests and post-tests along with p-values for the Wilcoxon signed rank test. The statements are ordered based on the p-values and negative statements were reversed. The first two statements, SA1 and SA2, show significant differences in the pre- and post- test measures. After using the app during the project, participants were more likely to say what they were planning to do in their group project even if no one asked them (SA1), with a p-value of 0.003 (<0.01). Also, the extent to which participants agreed that knowing what each member of a group is doing is essential in any group project changed after using the app (SA2) with a p-value of 0.011 (<0.05). Pre-test and post-test averages for all attitude statements are also presented in Figure 4, showing that post-test averages were higher than pre-test averages across all statements.

Table 3: *Attitude statements with averages in pre- and post-test questions and their corresponding p-values for Wilcoxon signed rank test*

Statement	Pre. Avg.	Post. Avg.	p-value
SA1: I like to say what I'm planning to do in a group project even if no one asks me.	*5.24*	*6.3*	*0.003***
SA2: I believe that knowing what each member is doing is essential in any group project.	*6.38*	*6.76*	*0.011**
SA3: I think looking at other members' work enhances collaboration in a group project.	*6.1*	*6.33*	*0.095*
SA4: I believe that students should update their group members whenever they have completed a task.	*5.48*	*5.95*	*0.102*
SA5: I believe that each member should look at the work completed by his/her group members.	*5.9*	*6.33*	*0.138*
SA6: In a group project, only the final product matters. (Reversed)	*5.1*	*5.33*	*0.271*
SA7: I think that each member should know about others' progress in his/her group.	*5.95*	*6.05*	*0.282*
SA8: In any group project, each member is responsible for a specific task and doesn't need to know about the others. (Reversed)	*6*	*6.05*	*0.466*

** Significant at p<0.05; ** significant at p<0.01*

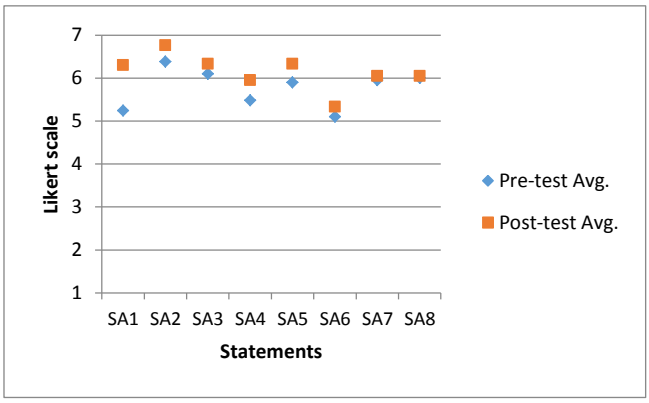

Figure 4: *Pre-test and post-test averages for attitudes' statements*

5.2. Changes in Behaviours

Table 4 presents the 4 behaviour statements with the pre-test and post-test averages and their p-values for Wilcoxon signed rank test. Participants were asked to rate the statements based on their previous experience of working in collaborative groups for the pre-test, and their experience of working in this collaborative group for the post-test. Results show that participants could tell what the current state of their project was at any given time more often after they used the app (SB1), where the p-value is 0.015 (<0.05). Also, they were more likely to inform group members about their progress (SB2), where p-value is 0.042 (<0.05).

Figure 5 presents pre- and post-test averages for all behaviour statements. This shows that there are changes in students' behaviours in the positive direction, i.e. averages of users' responses increased, but the changes are limited as only a subset of statements were significantly different in the pre- and post-tests.

Table 4: *Behaviour statements with averages in pre- and post-test questions and their corresponding p-values for Wilcoxon signed rank test*

Statement	Pre. Avg.	Post. Avg.	p-value
SB1: In any group project, I could tell what the current state of the project was at any given time.	*4.38*	*5.38*	*0.015**
SB2: In any group project, usually I tell my group members about my progress.	*5.67*	*6.19*	*0.042**
SB3: In previous group project, usually I know what my group members are going to work on.	*5.33*	*5.48*	*0.233*
SB4: Based on my experience, it has been difficult to find out what my group members had worked on. (Reversed)	*4.81*	*4.81*	*0.474*

** Significant at p<0.05*

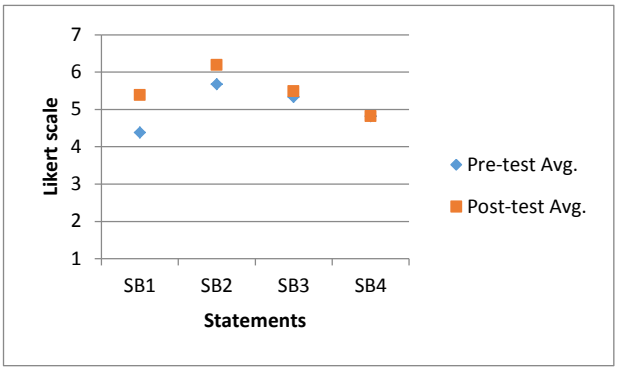

Figure 5: *Pre-test and post-test averages for behaviour statements*

5.3 Perceived Behaviour Change

Two statements in the post-test questionnaire focused specifically on whether participants perceived that their behaviour had changed after they used Mr. Mentor. Table 5 presents these statements, A and B, and the averages across responses. Participants on average agreed that Mr. Mentor encouraged them to share their work with their groups, and also persuaded them to look at the work done by other members of their groups, with an average of 4.86 on the 7-point Likert scale for both target behaviours.

Table 5: *Statements A and B and their averages*

Statement	Average
A: Mr. Mentor encouraged me to share my work with the group.	*4.86*
B: Mr. Mentor persuaded me to look at the work done by my group.	*4.86*

It shows that participants slightly agreed that Mr. Mentor persuaded them to share their work with the group and to look at the work done by their group. In more detail, Figure 6 illustrates individual participants' responses for statements A and B.

In one of the open-ended questions on the second questionnaire, participants were asked: "Did Mr. Mentor change your awareness of your group's activities?". In answer to this question, 10 participants confirmed some degree of change in their awareness of the group's work. For instance, participant E1 answered: "Yes it did. It did raise some questions, which made me think about my group and our work". This suggests that social actors can motivate students to increase their activity awareness.

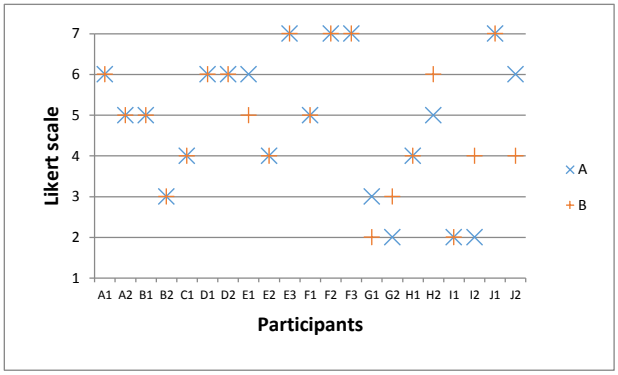

Figure 6: *Participants' responses to statement A and B (where 1 = strongly disagree and 7 = strongly agree)*

5.4. Activity Awareness Analysis

We wanted to obtain an objective evaluation of activity awareness based on the participants' answers in the first and second interviews about what they and their colleagues in the group had done during the previous week of the project. The "accuracy" of participants' activity awareness was explored by comparing their answers to interview questions about the activity of their colleagues against the reality of what those colleagues had been doing. Therefore comparisons were made between what each individual reported they had done and what the other members of their group reported they had done in the first and second interviews.

Convertino et al. (2004) categorized activity awareness into three levels: fully aware (FA), partially aware (PA), and unaware (UA). In this study the same levels were used but in a different way. The comparisons were made in a rigorous way, using pairwise comparisons. Participants were ranked as fully aware if they reported what a colleague did correctly/exactly. Participants were ranked as partially aware if they reported some of what a colleague did. Participants were ranked as unaware if they did not report what their colleague did accurately or if they did not know what their colleagues did.

Participant C1 was excluded from the activity awareness analysis because he was the only person in his group who participated in this study and therefore it was not possible to make the comparison.

Table 6 presents the number of instances of evaluating the activity awareness for each group: a total of 30 pairwise comparisons were made. For example, 2 participants were from group A, and the activity awareness for A1 was examined by his awareness of A2's activity (1 instance); and the activity awareness of A2 was examined by her awareness of A1's activity (1 instance). The total number of instances for group A is two. Whereas for group E, in which all members participated in the study, the activity awareness of E1 was examined by his awareness of E2's activity and E3's activity (2 instances) and the same for the rest of the group members, giving 6 instances. So groups with 2 participants resulted in 2 activity awareness instances; and groups with 3 participants had 6 activity awareness instances. However, for groups B and G, the third member of these groups was interviewed twice but did not use the app and their activity awareness of their colleagues was excluded. For example, for group B, the activity awareness of B1 was examined by her awareness of B2's activity and B3's activity (2 instances), and the activity awareness of B2 was examined by her awareness of B1's activity and B3's activity (2 instances), with a total of 4 instances of examinations. B3 and G3 are not included in Table 2.

Table 6: *Number of activity awareness instances*

Group	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Number of instances	*2*	*4*	*0*	*2*	*6*	*6*	*4*	*2*	*2*	*2*

Figure 7 shows the breakdown of the 30 activity awareness instances for the first and second interviews. At the time of the first interview, just after halfway through the project, approximately half of the activity awareness instances were "fully aware" (14 out of 30) and half were "partially aware" (15 out of 30). Activity awareness was higher in the second interview, which was conducted in the last week of the coursework. The number of "fully aware" instances increased (19 out of 30), whereas the number of "partially aware" or "unaware" instances decreased. In contrast with the study reported in (Al Ashaikh et al, 2014), activity awareness was not just maintained but actually increased in the later stages of the coursework projects. This suggests that using a persuasive social actor during collaborative group projects may be effective in promoting activity awareness within groups, although clearly other factors may also have influenced the outcome, such as individual differences in the students.

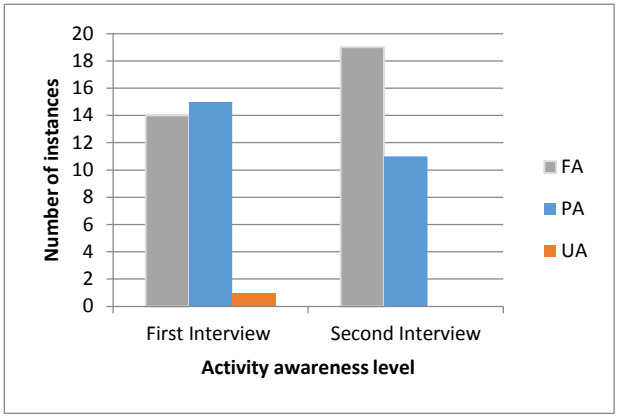

Figure 7: *Activity awareness level for all participants*

Moreover, for each participant, a comparison was made between his/her activity awareness in the first and second interviews, in order to identify changes in their activity awareness. Table 7 presents the results of this comparison for each participant. It shows that the activity awareness of 7 participants increased, the activity awareness of 10 participants did not change and the activity awareness of 3 participants decreased.

Table 7: *Changes in activity awareness of each participant*

Participant	**Change in activity awareness**
A1	*No change*
A2	*No change*
B1	*Decreased*
B2	*Increased*
D1	*Decreased*
D2	*No changed*
E1	*Increased*
E2	*Decreased*
E3	*Increased*
F1	*Increased*
F2	*No change*
F3	*Increased*
G1	*Increased*
G2	*No change*
H1	*No change*
H2	*No change*
I1	*No change*
I2	*No change*
J1	*Increased*
J2	*No change*

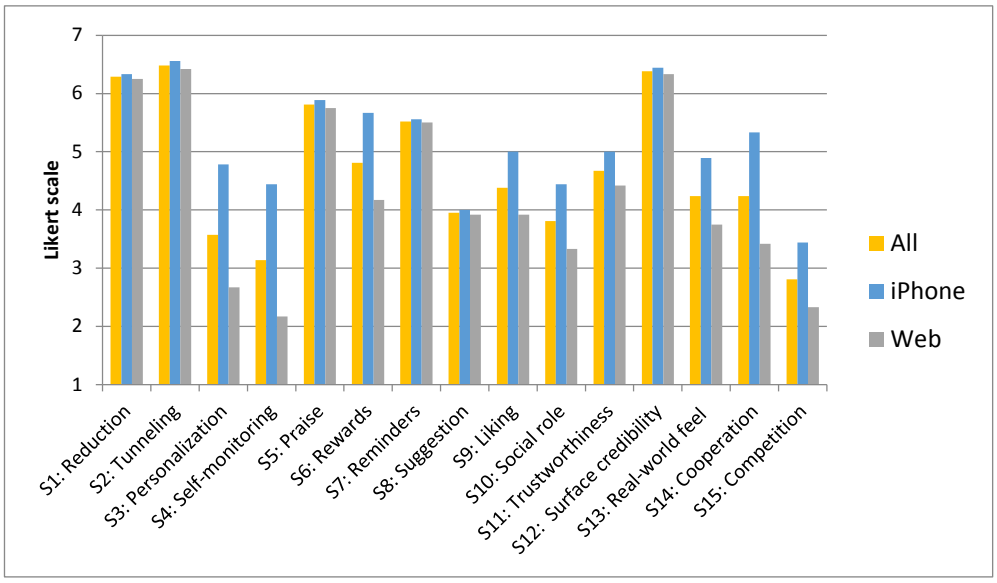

Figure 8: *Users' evaluation of features resulting from persuasive techniques (1 strongly disagree, 7 strongly agree)*

5.5. Evaluation of PSD Techniques

The persuasiveness of a system is more about system qualities or non-functional requirements (Oinas-kukkonen & Harjumaa, 2009), and the perceived persuasiveness is more about the users' satisfaction level with the system qualities (Alhammad & Gulliver, 2014). The persuasive features were evaluated by calculating averages across all participants for each statement on the questionnaire relating to the features introduced as a result of applying persuasive techniques from the PSD model (Table 1). As shown in Figure 8, there was strong agreement with statements S1, S2, S5, S7 and S12, which means that participants thought the features related to reduction, tunneling, praise, reminders, and surface credibility were successfully implemented in the app. In the web version, personalisation, self-monitoring, rewards, and competition (statements S3, S4, S6 and S15) were not explicitly implemented, however for rewards (statement S6) some web users thought it was applied because rewards sometimes seem similar to praise. On the other hand, participants did not think that competition (S15) was successfully implemented in either version of the app. For techniques that were applied in both versions, it was clear that the ratings from iPhone users were higher than the ratings from web users. This could be as a result of the number of persuasive techniques applied in the iPhone version, and also the characteristics of the iPhone as a small portable device. Results show strong evidence of the success of some of the persuasive features but clear potential to improve the way in which other persuasive techniques were applied in the design of the social actor. As mentioned earlier, overall averages were calculated for students' opinions towards the app at the end of the study. It was found that some participants felt bored when using the app by the end of the project.

6. DISCUSSION

The empirical study was undertaken in the challenging context of real-world collaborative learning groups, using several complementary data collection techniques to tease apart the effect of the social actor app.

6.1 Activity awareness

Objective 1 was addressed primarily through pre- and post-test ratings of attitudes and behaviours; the results show that participants had a more positive attitude towards behaviours that enhance activity awareness at the end of the project than they did at the beginning. Although these changes are limited, they were in the positive direction.

Participants' responses to statements A and B also addressed objective 1, this time looking at self-reports of change. The ratings indicate that participants agreed to some extent that Mr. Mentor encouraged them to share their work with the group and to look at the work done by the group. Also, when asked explicitly if they thought that Mr. Mentor changed their awareness of the group's activities, almost half of the participants confirmed that it did change their awareness to some degree. This indicates that social actors can motivate students and change their behaviours to increase their activity awareness.

The study of a collaborative learning group project reported in (Al Ashaikh et al, 2014) showed that activity awareness was higher at the beginning of the project than near the end, i.e. that activity awareness decreased. However, in this study, we

found that activity awareness increased towards the end of the project. While it is not appropriate to make a direct comparison, the fact that all participants were at least partially aware of each others' activities, and many were fully aware, suggests that persuasive social actors have potential as a mechanism for promoting activity awareness in collaborative learning groups.

6.2 Social actor design

Persuasive techniques from the PSD model guided the design of the social actor. Evaluating the success of our implementation of these persuasive techniques (objective 2) through the 15 statements showed that we had been more successful in some cases than others. Improvements here may well lead to increased persuasiveness and hence further changes in attitudes and behaviours. For example, some participants felt bored when using the app by the end of the project. This may have been a consequence of the daily reminder that Mr. Mentor produced, and could be improved in the future by varying the reminders. Another example is that some participants reported they did not work on the project everyday and that it would be helpful if the reminder times could be personalized.

There is also an argument for extending the set of persuasive techniques applied here. For example, *interactivity*, which has been used in learning in a business context (Behringer et al., 2013), may be a useful persuasive technique. Its implementation could result in a social actor that produces more varied interaction responses, as some participants suggested that the social actor could have more interaction options or ask different questions.

Participants who used the web version of Mr. Mentor suggested that an Android version of the app should be developed. They highlighted the fact that the web app had less functionality than the iPhone version. Also, they felt that using such an app on a PC was not effective as they forgot to use it sometimes or it disrupted them when they were working on something else. This suggests that the social actor would be improved if it was more sensitive to what people are doing and minimised the disruption. Although reminding is a useful persuasive technique, implementing it in an inefficient or irksome way can clearly decrease the persuasiveness of the technology i.e. when reminders arrive at the wrong time, people will not interact with the social actor.

6.3 Challenges and limitations

The empirical study was an appropriate, but challenging, approach to evaluating the social actor. The challenges of running a long-term study in a naturalistic setting included recruiting participants, collecting data at different intervals from the same participants, then analysing these data to get some sense of the actual effect of using social actors on activity awareness. The study also suffered from a limited number of groups and participants used two different versions of the app. Nonetheless, it yielded insights into the real-world use of a persuasive technology that could not be obtained from a more contrived lab-based study.

Pre- and post-tests are valid instruments to measure changes in human behaviour (Dimitrov & Rumrill, 2003); this study used pre- and post- test self-reported ratings to measure changes in attitudes and behaviours. Salmon et al. (2009) used subjective self-ratings in measuring users' perceived situation awareness; however, in order to obtain a more objective measure, we used a method to elicit the actual activity awareness at two time points during the project and then compared these to get a sense of the change in activity awareness. This gave an account of the levels of activity awareness but was limited insomuch as we could not compare this against a control condition.

7. CONCLUSION

This paper makes two contributions to the field. First, we investigated a novel approach to promote activity awareness in small learning groups by changing students' attitudes and behaviours using a social actor. This approach shows promise: testing the social actor in practice showed a positive effect on the students' attitudes and behaviours with regard to activity awareness. The second contribution is reporting a first attempt to design, develop and evaluate a persuasive social actor based primarily on the PSD model.

We found that the social actor could promote activity awareness in learning groups by motivating students to share their work with other members of their group and also to look at the work of others in the group. Users self-reported changes in behaviours that would be likely to increase their activity awareness in other group projects. Also, the more objective measure of actual activity awareness showed that it was maintained or increased near the end of the project.

In summary, using this social actor seems a promising approach to changing students' behaviours and attitudes in a way that supports activity awareness, and may therefore be able to enhance their collaboration. Future work will focus on continuing improvements to the design of Mr. Mentor, based on the results described above, and on conducting further empirical studies to investigate the extent to which this social actor influences students' behaviour in other learning contexts. In terms of evaluating the app, expert reviews will be conducted in the future work to triangulate our findings.

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