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Development of a web-based interactive tool for the assessment of clinical decision-making skills

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1. Introduction and overview of project

Clinical decision-making by healthcare professionals is a complex higher level cognitive process, which involves the integration of multiple sources of information to establish a diagnosis and to determine the likely benefits, risks, and consequences of the possible management options. The development of reliable and objective assessment of clinical decision-making skills has been a long-term goal in the training and accreditation of doctors and other healthcare professionals. One particular challenge is to enable healthcare professionals in training to develop their decision-making skills and to assess their competence without compromising patient safety. Many organizations have focused their efforts on “authentic” assessments of competency using clinical scenarios. One commonly used method is the objective structured clinical examination (OSCE), which uses simulated patients or actors. Although broadly accepted as a valid and reliable form of assessment, OSCEs can be costly and students often have limited opportunities for practice or formative assessment. Feedback on performance is essential for student learning and it is particularly important for the ongoing development of learners in healthcare settings at all stages of their careers.

Clinical vignettes are an alternative method of assessing clinical decision-making that overcomes many of these limitations. Vignettes are written or computerized simulations of fictitious patients that reflect authentic clinical scenarios. Although vignettes are not the same as actual clinical practice, they have been validated in two prospective studies for the assessment of clinical decision-making against the ‘gold standard’ of unannounced standardized patients (Peabody et al 2000, Peabody et al 2004). This ‘virtual’ approach also allows students to develop their decision-making skills in a safe environment where decisions can be rehearsed and explored before application in practice.

When performing an eye examination, optometrists are required to take a relevant clinical history, assess visual function and determine the health of their patient’s eyes. In some cases, further investigative techniques will need to be performed and the results of these tests interpreted. Clinical decision-making skills are therefore necessary to select appropriate clinical investigations, make the correct diagnosis and determine an optimal management plan for the patient. The ability to make these clinical judgements depends on the integration of good theoretical background knowledge with high quality decision-making skills. The aim of this project was to develop a vignette-based assessment tool for the assessment of clinical decision-making of optometrists in training that can be used for both formative and summative assessment. The interactive tool was to be piloted using a cohort of third (final) year optometry students from the 2012/13 cohort with the aim of incorporating this form of assessment into the optometry programme in the 2013/14 academic year.

1.1 Objectives

- To develop an online computerized vignette-based interactive assessment tool for undergraduate optometry students
- To develop a scoring system for formative and summative assessment
- To conduct a pilot assessment on a cohort of undergraduate students
- To use the findings from the pilot to inform further development of the vignettes before fully integrating them into the undergraduate optometry curriculum
- To disseminate results to colleagues within the School of Health Sciences to explore how the assessment tool could be adapted for the needs of nurses, radiographers and language and speech therapists

2. Activities undertaken for project

2.1 Method

Creation of the interactive vignettes required the development of two main elements. The first was the generation of the clinical material comprising the vignettes, which required selection of appropriate clinical cases, locating suitable high quality clinical images, generating possible diagnosis and management options, allocating a “time to complete the test” for each clinical test that might be chosen etc. Although a challenge, these were tasks with which the authors were familiar. However, the second element was the computer programming expertise required to bring the vignettes to life, and this was and remains largely a mystery to the authors! Computing input was required to write the software and provide ongoing software support, to set up a secure online administrative system for student registration, to create the automatic scoring of the vignettes, to produce a structured feedback template, to provide a user guide, to house the vignettes on a secure third party server etc. All the generous funding provided by the LDC for this project was allocated for the computing element. Nevertheless, everyone involved in the project underestimated the amount of computing input required and without the dedication and skill of Mr Beju Shah, our computer wizard, we would never have achieved our objectives.

2.1.1 City Vignettes

We have named the online vignette system “City Vignettes”. These computerized vignettes are in the form of a standard ‘virtual record card’ which includes all the questions that could be asked when taking a clinical history and all the tests and investigations that could form part of a routine eye examination e.g. assessment of vision, assessment of binocular status, and examination of the anterior eye and retina. The practitioner is able to interrogate the software to ask the ‘patient’ any clinical history question or select a particular clinical test. High quality clinical images have been incorporated into each vignette (including those from normal eyes as well as examples of a variety of ocular diseases). Participants are instructed to ask the questions and select the tests they would normally perform for each patient. Upon selection, the answer to the question or the results of the clinical test appears in a pop-up window. A timer displays the length of time taken for each test in the real world and keeps a running total of the “examination time” (Figure 1). This is to discourage the participant from being over-zealous and selecting more tests than they would normally perform. At the end of the examination participants are asked to make a diagnosis and to select an appropriate patient management plan.

To summarise: Ocular Hypertension:

- Characterised by high intra-ocular pressure, but with:
 - Normal optic nerve head (optic disc)
 - Normal field of vision
- Differential diagnoses
 - “Normal” patient
 - Open Angle Glaucoma
- Requires
 - Suitable test selection and interpretation of results
 - Appropriate diagnosis and management

2.1.2. Vignette 1 - Choice of investigative tests

Guidance from the College of Optometrists (CoO 2013) states that when examining patients at risk of glaucoma optometrists “have a duty of care to carry out the appropriate tests to determine the likelihood of the condition being present.

- The eye examination for these patients **should** normally include:
 - Assessment of the optic nerve head
 - Measurement of intra-ocular pressure (IOP)
- The examination **may** also include:
 - Central visual field assessment”

So for our City Vignettes patient with ocular hypertension we would include:

- the results of an assessment of the optic nerve head, which would be presented to the student if they selected to carry out this test
- the intra-ocular pressures for each eye, presented to the student if they selected to do this test. The student could choose from two methods of taking intra-ocular pressures
- visual field plots for each eye, presented to the student if they selected to carry out a visual field test. Again the student had a choice of instrument so we supplied field plots for each instrument.

2.1.3. Appropriate diagnosis and management

The preferred management for the case we developed was for the patient to be monitored by the optometrist rather than referred to the hospital eye service for an outpatient appointment in the glaucoma clinic. But both options, plus several others could be selected.

2.1.4. Piloting Vignette 1

20 volunteer third year students were asked to complete our OHT vignette, and of these 18 completed the vignette. Students were given generic feedback on their performance (See Appendix 1), which discussed the case in detail and described the most appropriate choice of tests and the ‘correct’ interpretation of the data in relation to:

- History taking
- Patient examination and interpretation of clinical findings
- Diagnosis
- Patient management

Students were invited to give their feedback on the online tool in an online survey and there was 100% response.

2.1.5. Registered optometrists

At this point we added an additional feature to our original proposal. As part of our involvement in another project the authors were seeking the views of registered UK optometrists and this provided us with the opportunity to invite registered UK optometrists to attempt the vignette. In total 100 experienced optometrists also attempted the vignette.

2.1.6.. Development of 3 further clinical vignettes and a system for vignette scoring and feedback.

The second phase of the project involved the development of the following 3 vignettes:

- **Vignette 2: patient with normal tension glaucoma.**
Patients with normal tension glaucoma have normal eye pressures and present a diagnostic challenge. The student needs to be able to recognise glaucomatous changes in the optic nerve head and/or perform and interpret a visual field plot to make the correct diagnosis.
- **Vignette 3: patient with age-related macular degeneration (AMD).**
AMD is a common cause of visual impairment in the elderly population. The neovascular (otherwise known as 'wet') form of the disease is amenable to treatment, however there is a very narrow treatment window following the onset of symptoms. This vignette presents a patient with symptoms of visual disturbance. The student needs to be able to recognise the signs and symptoms of AMD in order to make a correct diagnosis and select the appropriate management option.
- **Vignette 4: normal patient.**
It is important that students are able to recognise 'normal' patients and so this scenario was included to reflect that fact that most of the patients seen by optometrists do not have ocular disease.

A scoring template for each vignette has been developed, based on explicit quality criteria which are in turn based on guideline recommendations and clinical consensus on best practice. Feedback can be given to participants on each stage of the examination, including the 'correct' interpretation of the data and optimal clinical decisions taken relating to:

- History taking
- Patient examination and interpretation of clinical findings
- Diagnosis
- Patient management

2.2 Results

2.2.1 Selection of key tests for detection of ocular hypertension

Results for the three key tests (ophthalmoscopy to assess the optic nerve head, measurement of the intra-ocular pressure, and visual fields) for patients at risk of glaucoma are shown in Table 1. Both groups showed consistently high percentages attempting all 3 tests, with no statistically significant difference between the proportions of each group attempting any of the tests ($p > 0.5$ in each case). Furthermore, there were no significant differences between students and experienced practitioners as regards the percentages of each group choosing to grade the optic nerve head (see below) and choosing the reference standard test for intra-ocular pressure measurement ($p > 0.5$).

TEST	Students (n = 18)	Experienced Optometrists (n= 100)
Ophthalmoscopy (% grading the optic nerve head)	94.4% 94.4%	98% 86%
Intraocular pressure (% using reference standard test)	100% 77.7%	100% 75%
Visual fields	94.4%	97%

Table 1. Percentages of students and optometrists attempting the 3 key tests for patients at risk of glaucoma (including those with ocular hypertension).

2.2.2 Grading of the optic nerve head.

When assessing the optic nerve head, one measure often used is the Cup/Disc ratio (CD ratio). As can be seen in Figure 2 this depends on the optometrist comparing the vertical height of the “cup” (the depression at the centre of the disc) to the vertical height of the disc itself. This ratio between the two heights is expressed as a decimal, and anything greater than 0.6 is suspicious of open angle glaucoma.

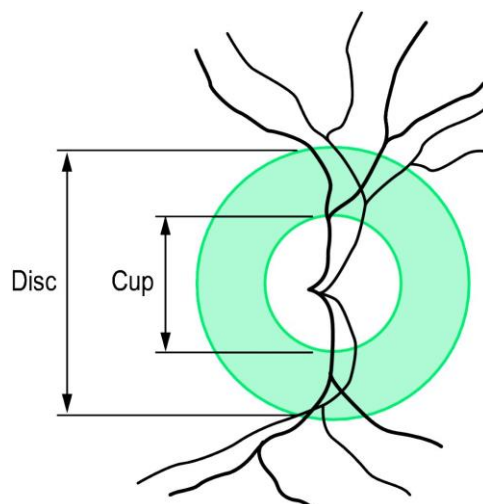
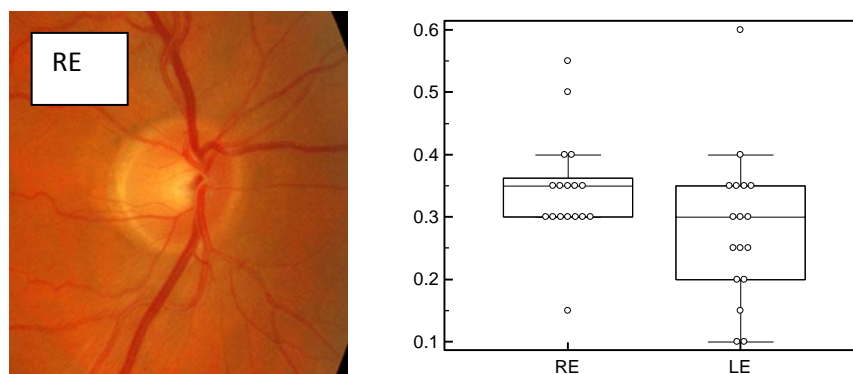


Figure 2. A schematic representation of the optic nerve head (optic disc) showing the vertical cup height and the vertical disc height.

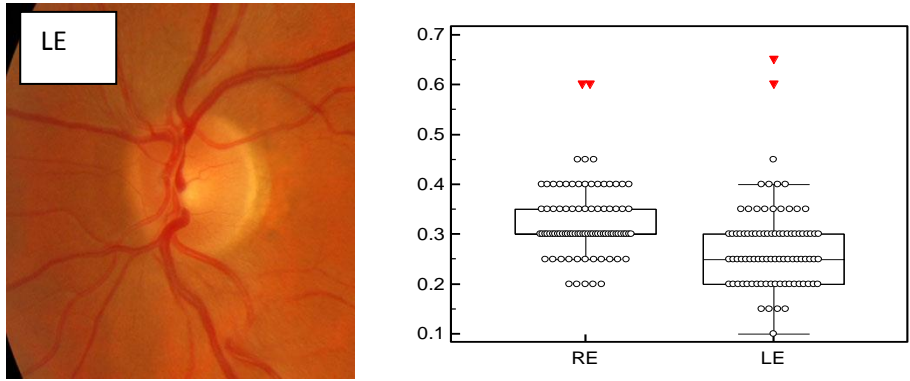
In Vignette 1 we presented the student/registered practitioner with the optic nerve head (optic disc) images for this virtual patient and they could choose to grade the C/D ratio and record their results. The disc images and results of the grading are presented in Figure 3. No significant differences between either the means or the medians for the CD ratios were found between students and registered practitioners for either eye. For the right eye $p=0.35$ (means), 0.28 (medians), for the left eye $p= 0.74$ (means), 0.66 (medians) using the t-test for independent samples, and Mann-Whitney test for independent samples.



RE: Median = 0.35, Mean = 0.34 \pm 0.09

LE: Median= 0.3, Mean = 0.28 \pm 0.1

Student data: n = 17



RE: Median = 0.3, Mean = 0.33 ± 0.7
 LE: Median = 0.25, Mean = 0.27 ± 0.09

Registered practitioner data: n = 86

Figure 3. Disc images and box and whisker plots showing estimates of C/D ratios by both students and registered optometrists. Red triangles indicate outliers.

2.2.3 Diagnosis

Results for the diagnosis selected for this patient with ocular hypertension are shown in Table 2. Experienced optometrists were much more likely to opt for the correct diagnosis (71%) than the students (27.8%) and this difference in proportions was statistically significant ($p = 0.001$). Students were much more likely to choose a diagnosis of primary open angle glaucoma (50%) than the registered optometrists (15%). There was no significant difference between the proportions of the two groups choosing the “normal” diagnosis ($p = 0.96$) or opting for another diagnosis entirely ($p = 0.94$).

DIAGNOSIS	Students (n = 18)	Experienced Optometrists (n = 100)
Ocular Hypertension	27.8%	71% ($p=0.001$)
Primary open angle glaucoma	50%	15% ($p=0.002$)
Normal	16.7%	13% ($p=0.96$)
Other diagnosis	5.6%	2% ($p=0.94$)

Table 2. Percentages of students and registered optometrists opting for each possible diagnosis of this patient with ocular hypertension.

2.2.4 Patient Management

Results for the management selected for this patient with ocular hypertension are shown in Table 3. There was no significant difference between the proportions of students (62.5%) and experienced optometrists (80%) who routinely referred the patient to either an ophthalmologist or another optometrist ($p > 0.05$). The percentages opting for the “correct” option of not referring the patient but instead choosing the original optometrist to continue to monitor the patient were low (0% and 8.3% for students and experienced optometrists respectively) and there was no significant difference between the groups ($p > 0.05$). Two students (12.5%) opted for an urgent referral for the patient, which is an inappropriate speed of referral, compared with none of the experienced optometrists. This difference was statistically significant ($p = 0.04$) but the numbers are so low that this result should be interpreted with caution.

	Students (n = 16)	Experienced Optometrists (n= 60)
Routine Referral to ophthalmologist or *monitored by an optometrist	62.5% (0%)*	80% (8.3%)*
GP referral	12.5%	1.7%
Urgent referral (1/7)	12.5%	0% ($p=0.04$)
Soon referral (3/52)	0%	5%
Total not referred or follow-up arranged	12.5%	5%

Table 3. Percentages of students and registered optometrists opting for each of the possible management options for this patient with ocular hypertension.

2.2.5 Feedback

Each student was sent a detailed breakdown of the scenario in the form of a pdf file containing information on appropriate investigation, grading of images, diagnosis and optimal management, plus suggestions for further reading. The students were then invited to repeat the scenario.

2.2.6 Student evaluation

Each student completed an online evaluation questionnaire covering the following features of City Vignettes and the results are summarised in Tables 4 to 8:

- Access, usability and quality of presentation (Table 4)
- Content and relevance (Table 5)
- Form and quality of feedback (Table 6)
- Likely impact on future practice (Table 7)
- Overall rating (Table 8)

ACCESS, USABILITY AND QUALITY OF PRESENTATION	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
The City Vignettes home page was easy to access using the log in details provided	100.0% (17)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
The instructions and examples helped me to understand how to navigate through the clinical scenario	64.7% (11)	29.4% (5)	0.0% (0)	5.9% (1)	0.0% (0)
Working through the clinical scenario was easy and intuitive	76.5% (13)	23.5% (4)	0.0% (0)	0.0% (0)	0.0% (0)
The quality of the clinical images was sufficient for interpretation of the results of the ocular examination and further investigative tests	88.2% (15)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)
The use of the timer helped me to concentrate on choosing the most appropriate tests rather than selecting all possible tests	58.8% (10)	5.9% (1)	35.3% (6)	0.0% (0)	0.0% (0)

Table 4. Responses of students to survey questions relating to access, usability and quality of presentation of City Vignettes.

It is notable that 100% of respondents strongly agreed that it was easy to gain online access to the vignettes. Two thirds strongly agreed that instructions for City Vignettes were easy to understand. The one respondent who “disagreed” had concerns with the timer, which kept a running total of the time spent on this virtual examination. This is a theme that recurs in the student feedback, with 35% of students neither agreeing nor disagreeing that the use of the timer helped them to concentrate on choosing the most appropriate tests.

We gave respondents the opportunity to enter free text comments at each stage of the survey. Typical comments are below:

“Clear, easy to use layout which allows you to choose exactly what tests and information you require.”

“I didn’t realise what the timer was for at first otherwise I would have skipped a couple of tests rather than reveal [the results of] all tests.”

CONTENT AND RELEVANCE	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
The clinical scenario was set at an appropriate level for a final year undergraduate student	100.0% (17)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
The clinical scenario provided an appropriate simulation of a 'real world' patient episode	94.1% (16)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)
The scenario has enhanced my clinical decision making skills	88.2% (15)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)

Table 5. Responses of students to survey questions relating to content and relevance of City Vignettes.

Content and relevance scored well in the survey and this was reflected in the free text comments, of which a typical comment is below:

“Everything was relevant and actually made you think how you would assess this patient in practise and how you would manage them, without the risk of missing something in a real patient in real life!”

We received some suggestions from student feedback which we have incorporated into the latest version of City Vignettes, notably:

“An additional component could be added to show a referral letter and what details you would choose to include.”

This is an excellent suggestion and we now incorporate the option for students to submit a draft referral letter when they choose to refer a patient via City Vignettes.

FORM AND QUALITY OF FEEDBACK	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
The form of the feedback was appropriate and easy to understand	94.1% (16)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)
The quality of the feedback was sufficient to further develop my clinical decision making skills	100.0% (17)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)

Table 6. Responses of students to survey questions relating to the form and quality of feedback obtained from City Vignettes.

Our feedback on the vignette was very well received, with a typical comment being:
Very detailed feedback which really explains the reasoning behind the diagnosis and relevance of the test results as well as further management. I definitely learnt a lot from it."

Another theme to emerge from the student survey was that the generic nature of the feedback, although very useful, would have been improved if it had been more personalised to each participant. One student commented:
"It was a very informative feedback sheet. However it didn't feel personalised to my answers."

It was always our intention to personalise feedback to students but this feature was not available when the first vignette was piloted. However, personalised feedback has been incorporated into the latest version.

LIKELY IMPACT ON FUTURE PRACTICE	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Clinical vignettes would be a useful learning tool during the pre-registration period to further develop clinical decision making skills	100.0% (17)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
Clinical vignettes would be valuable for ongoing continuing professional development post-qualification	88.2% (15)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)

Table 7. Responses of students to survey questions relating to the likely impact of City Vignettes on their future practice as optometrists.

Optometry students do not have placements during their BSc Optometry course, but they undertake a pre-registration period (of at least one year) in practice after they leave university before registration. These questions were designed to establish if City Vignettes would be useful for training in the pre-registration period and/or for continuing professional development post-registration. The responses were very encouraging, suggesting that City Vignettes could be extended beyond undergraduate training. Typical comments from respondents were:

"This programme is ideal for the pre-registration period especially since students have to independently revise content outside of the university environment."

"Vignettes is a really good source of revision. I think it would be really useful post-qualification as it will help in improving clinical decision making skills in scenarios that as a practitioner you may not see frequently."

OVERALL RATING	Excellent	Very Good	Good	Acceptable	Poor
How would you rate City Vignettes overall?	94.1% (16)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)

Table 8. Overall rating by students for City Vignettes.

We were encouraged that 16 of the 17 students who answered this question rated City Vignettes as excellent overall.

2.3 Scoring of vignettes

As part of the second phase of vignette development a scoring system was added to the program. The 'score' is based on the proportion of best practice choices made by the student. For example when taking a history, the key questions can be highlighted and appropriately weighted (Figure 4). Once the vignette is completed a report is generated which provides an overall score and a breakdown of the score based on performance in each component of the examination:

- History taking
- Patient examination and interpretation of clinical findings
- Diagnosis
- Patient management

In addition to the % score, feedback is provided on the optimal choices for each examination component.

QUESTIONS						
No.	Question	Sub-Question?	Answer	Best Practise?	Time	Score
1	Reason for Visit	<input type="checkbox"/>	Broken Spectacles	<input checked="" type="checkbox"/>	20	10
2	Do you wear spectacles?	<input type="checkbox"/>	Yes all the time- they are varifo	<input type="checkbox"/>	5	0
3	How is your distance vision?	<input type="checkbox"/>	Fine with spectacles	<input checked="" type="checkbox"/>	5	10
4	How is your near vision?	<input type="checkbox"/>	Not so good now	<input checked="" type="checkbox"/>	5	5
5	Do you experience any headac	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	10	10
6	Do you ever get any pain or dis	<input type="checkbox"/>	No	<input type="checkbox"/>	10	0
7	Do you ever notice your eyes b	<input type="checkbox"/>	No	<input type="checkbox"/>	10	0
8	Do you experience double visio	<input type="checkbox"/>	No	<input type="checkbox"/>	10	0
9	Do you see any floaters in your	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	10	5
10	Do you experience flashing ligh	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	10	5
11	How is your general health?	<input type="checkbox"/>	Good	<input checked="" type="checkbox"/>	10	10
12	Are you diabetic?	<input type="checkbox"/>	No	<input type="checkbox"/>	10	0
13	Do you have high blood pressu	<input type="checkbox"/>	No	<input type="checkbox"/>	10	0
14	Do you have any allergies?	<input type="checkbox"/>	No	<input type="checkbox"/>	10	0
15	Do you take any medication o	<input type="checkbox"/>	No	<input type="checkbox"/>	10	10

Figure 4. Vignette scoring system for history taking. This allows the instructor to identify 'best practice' questions that can be weighted accordingly.

2.4 Summary

- A vignette-based online tool is an effective method for the teaching and of clinical decision-making
- The vignettes were well received by students and they felt that vignettes would be useful in both the pre-registration period and post-registration
- Comparison of final year BSc Optometry students with experienced optometrists in practice demonstrated that although students selected appropriate clinical tests and graded eye features accurately they were understandably less accurate with their diagnostic and management decision making

3. Any recommendations/future work

- We will continue to test and develop systems for personalised feedback and scoring for assessment purposes.
- City Vignettes will be incorporated into BSc Optometry undergraduate teaching in 2013/14
- We presented City Vignettes and our results as a workshop at the Learning at City Conference 2013. Those present were most complimentary regarding the system and its generalisability to other professions within the School of Health Sciences. With the assistance of the LDC we would be enthusiastic to pursue this.
- The view at the workshop was that there were possible peer reviewed publications that could emerge from this work.
- Extend the use of City Vignettes to pre-registration and/or post-registration training of optometrists.

Acknowledgements

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