“My Heart Goes Boom Boom!”: Understanding the Experience of Reading Digital Comics

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The experience of reading print and digital comics differs from that of other reading in that it involves the interplay between text and art, both ‘on the page’, for example, in traditional comic books, or ‘off the page’ as in webcomic xkcd’s Alt Text of information related to the comic. This interplay and placement can communicate movement, stillness, suspense, bringing the reader along not only through content or story arc but also through the material affordances, the physical reality of the text itself. The findings of this exploratory study reveal both the varied reading experiences of digital comics among a cohort of British Library readers as well as the shared experiences of haptic interactions and emotional perception and reaction through the use of devices, comics platforms and apps, and social media.

CCS CONCEPTS • **Human Computer Interaction (HCI)** •**Information Systems** • **User Characteristics**

Additional Keywords and Phrases: Comic Books, Digital Comics, User Experience, Webcomics

1 INTRODUCTION

The experience of reading comics differs from that of other reading in that it involves the interplay between text and art. Comics make for distinctive reading, moreover, in the placement and juxtaposition of text and art on the page [1], the multiple panel layout of the comic book being most familiar. All these characteristics give comics that sense of motion and time elapsing [2]. The reader is brought along quickly for action, or slowly for more contemplative scenes. Because of these differences in experience, comics reading has the “potential to enrich our exploration of reading in our currently saturated media landscape” [3].

Digital comics, including webcomics, graphic novel ebooks, and comic book apps, have all these characteristics, along with some singular affordances that make the reading experience a uniquely digital one. In this paper, we will discuss

findings from an AHRC-funded digital comics reading experience project, where we used an interdisciplinary perspective including User Experience (UX), Human-Computer Interaction (HCI) and Digital Humanities methods to gather and analyse qualitative data collected from British Library readers. The findings of this exploratory study reveal both a varied reading experience of digital comics as well as the shared experiences of haptic interactions and emotional perception and reaction through the use of devices, comics platforms and apps, and social media.

1.1 Literature Review

This exploratory empirical research, conducted to understand the experience of reading digital comics from the reader's perspective, fills a gap in the literature [4]. There has been a tradition of theoretical scholarship in comics, some of it involving reading: for example, on comics as literature [5], as part of fan studies [6][7], and even on the materiality and mediality of comics [8][9][10].

However, there is no real tradition of empirical studies of readers. That is not to say that there have been none. In a 2012 article largely given over to digital adaptability of print texts, Murray surveyed digital comics readers regarding their reading experience using apps and devices [11]. Cohn considered the order in which readers read comics panels [12]. Royer et al. reviewed the reading practices of American comics readers in print and digital formats, albeit without empirical research [13]. Applied comics research often works with specific categories of readers in such areas as literacy or health (see, for example, [14]) or in connection to the reading practices of young people [3].

It has to be said that not much of this research has applied to digital comics. More qualitative empirical research from the readers' perspective is needed, not just to understand the digital comics reading experience, but the experience of the reader [or user] in the digital environment, encompassing devices, platforms, and physical and emotional interaction with the text. More recently, readers have been considered in research applying UX and HCI methods, from more quantitative perspectives [15] and specifically with the use of eye-tracking software and teen readers [16][17]. These considerations of the material aspects of digital comics, "the sum of an artifact's physical and signifying characteristics" [18], is an important part of a reader's experience with a digital comic but excludes the emotional reaction not just to the content but to this physical interaction. Hague analyses "the five Aristotelian senses: sight, hearing, touch, smell and taste" of interacting with a comic but because it is a theoretical consideration, there is no empirical data of how these senses work to create an emotional response [10].

While this study is part of a research landscape that includes the use of UX and HCI methods to examine comics, it approaches it from a qualitative perspective that emphasizes the "diversity with regards to reading experiences and practices with comics and thus potential variability in the comics reading experience" [3] (p.19).

2 RESEARCH METHODS

Our approach involved naturalistic observations and interviews of digital comics reading practice in a remote environment. The naturalistic observation gave readers free reign to demonstrate and talk-through their reading practices with little intervention from the researcher, allowing for disparate experiences to be expressed. These sessions were conducted with five participants [ranging in age from 20s-50s] under a remote setting, using Zoom technology. While it is customary for these types of sessions to be conducted face to face, preferably in a lab or in situ, pandemic and resource restrictions dictated the remote setting with one researcher. Regardless of this limitation, the remote approach was successful in the depth and type of data that was collected. Moreover, there is precedent for the small numbers of participants, especially in HCI. According to Makri et al. [19], "exploratory studies of this nature are suited to small participant numbers, and

frequently seen in Human Information Interaction literature" (p.8). The objective in this research was not to generalize findings, but to uncover issues indicative of further research.

The sessions were divided into two sections, the second reader-led, before which the participants were briefed on before the session started:

1. Semi-structured interview where participants were asked: reading background or habits, preferences, practices; types of comics, devices, platforms; learning about new comics; interaction with creators and publishers. Participants were also asked about their use of web archives to read or learn about comics.
2. Contextual observation where the participants took the researcher through their reading practices (on apps, social media, digitized comics etc.), how they would begin reading, what they would select, and then talking through the reading of a title, talking through the functionality of the app.

Every effort was made to minimize bias: for example, the researcher's input into the contextual observation and directed search activities were limited to clarification and confirmation-type questions. We used thematic analysis [20] where data was coded using both transcripts and screen captures from video recording. The five study participants, all digital comic readers (DCRs), have been referred to as DCR1, DCR2, DCR3, DCR4 and DCR5.

3 FINDINGS

We had set out in the study to explore, in the broadest sense, the reading experience of digital comics. Using the thematic analysis approach revealed that, despite the age range and disparate occupational backgrounds, there were shared experiences, themes, across the different reading applications, platforms, and devices.

3.1 How and Where They Read (Devices, Apps, Platforms)

Immediately before reading your email I was downloading a graphic novel I backed on Kickstarter to the Books app on my iPad via Dropbox…I read comics via Comixology, Kindle and as PDFs on both iPad and iMac (and in hard copy too). I am very familiar with 2000AD, although I must admit that 1979-1986 was my core period! (Email from digital comics reader participant DCR4).

Users reported using multiple devices: smartphones, laptops, tablets, and PCs or iMacs. However, tablets (Kindle, iPad, Kobo) were the preferred device for apps (Marvel Unlimited [21], Comixology (now Amazon) [22], GooglePlay (specifically to read Image Comics) [23], Sequential (now discontinued) [24]), and smartphones were preferred for social media platforms, such as Instagram and Twitter. The smartphone was used by the only reader using the Webtoon app (DCR5) [25], and tablets and laptops were used for PDF versions of comics. One participant, (DCR4), aside from reading on the Comixology app on their tablet, read a lot of comics in PDF form because they had supported a number of comics on Kickstarter [26] where books, mainly graphic novels, are published in PDF format.

Reading via apps predominated among the study participants, whether it be comic books or webcomics. However, one regular reader (DCR3) of Randall Munroe's webcomic xkcd [27], read it sometimes on Instagram using a smartphone, but felt the functionality was compromised. They often left their Instagram feed to go to xkcd account or web page to read it properly. For the most part, they preferred to read it on a laptop via the xkcd website. Although DCR4 read via the Comixology app on an iPad, they would only purchase ebooks via the Comixology website (now Amazon) on the iMac.

Device use was also dictated by where participants were when reading: for example, DCR3 preferred to read on the sofa with the laptop (their partner read from the PC while working from home), while DCR4 preferred a comfortable chair with the tablet. DCR5 grabbed the phone by the bedside to read -insomnia reading).

In addition, the choice of device also had an impact on the physical positioning of the body while reading: DCR5 who read primarily on the smartphone described and physically mimed their position while reading. They would sit all hunched over, clutching phone either closer or further away from their body: "if it's not a better one I'll kind of like be looser [ready to abandon that comic and go on to another]. If it's like if it's too good it almost needs to be out there too" [settles in, with a firm grip]". They often described a pleasurable reading experience as getting "cozy" or "get out of the world": "…some [comics] are just like really cute and cozy and you got to be there with it. And other ones, they're the big fight ones you got to get into like a [defensive] position".

The observations regarding the choice of devices offer an interesting correlation between 'container' or 'device' and what was being read. This is not necessarily a new approach to reading: consider the different 'containers' for print reading, including, books, magazines, newspapers, which also correlate to print comics reading. Instead of being obtrusive, these print containers 'disappear' (physical attributes fall away) when the reader is involved in the reading experience (see Kashtan's discussion of the crystal goblet method of typography, [28]). Indeed, in comics "materiality is much harder to ignore" [28] and with the devices required to read digital comics, materiality becomes even more of an issue. We believe our study has much to contribute regarding the role of materiality when reading digital comics.

Regardless of the required investment in a reading device, the print versus digital comic decision was most notably expressed by these participants from an economic perspective. Digital was cheaper, easier, quicker. Print was nice for some but was considered more of an investment.

3.2 Reading Experience

3.2.1Pace and Interaction

The experience of reading digital comics required a number of conditions in order for it to be a positive one. As mentioned above, where the reader sits and what device is used contribute to a pleasurable experience. The choice of device as noted depended upon the platform. For example, the Comixology and Marvel apps offer a 'guided view' of a comic: instead of having multiple comics panels on a single digital page (as with a digitized comic book), each panel is viewed in succession. A few readers referred to this as the 'cinematic view', which was a more pleasurable experience to read on a tablet, such as an iPad, rather than a PC or smartphone.

The touchscreen of a tablet where pages can be 'swiped' or 'tapped' also contributed to the pace of the reading: DCR4 felt that this interaction with the screen promoted a quicker space that was conducive to action scenes:

What I did realize as I was switching from hard copy book to digital was that, if anything, I preferred reading digital comics on the iPad because it's made it more gripping to be engaged actively with moving the story along.

In fact, DCR4 preferred the swiping of a tablet page as opposed to the clicking required on their IMAC: there was something about the swipe-touch that created the same sense of urgency and pace as the action on the screen. The switch to mobile devices did not always enhance the experience of reading a digital comic. The webcomic, xkcd, was originally accessible through a browser on a PC. One of its unique offerings, the 'title text' or 'mouse hover text' (alt-text) was employed within the image so that additional (but not purely descriptive) bits of information would appear when the mouse pointer hovered over certain parts on a browser version of the webcomic. To achieve this same effect on a social media feed via a smartphone the reader "[clicked] the Alt Text button near the comic title on the mobile site" (see figure 1). This difference in interacting with the comic detracted from the "best bit of fun" for DCR3, a long-term xkcd fan. It was the major reason for not reading it via social media and using their laptop instead. They maintained that the "mouse hover" was the best part of the comic and that the Alt Text option in the Instagram is "a blunt instrument".

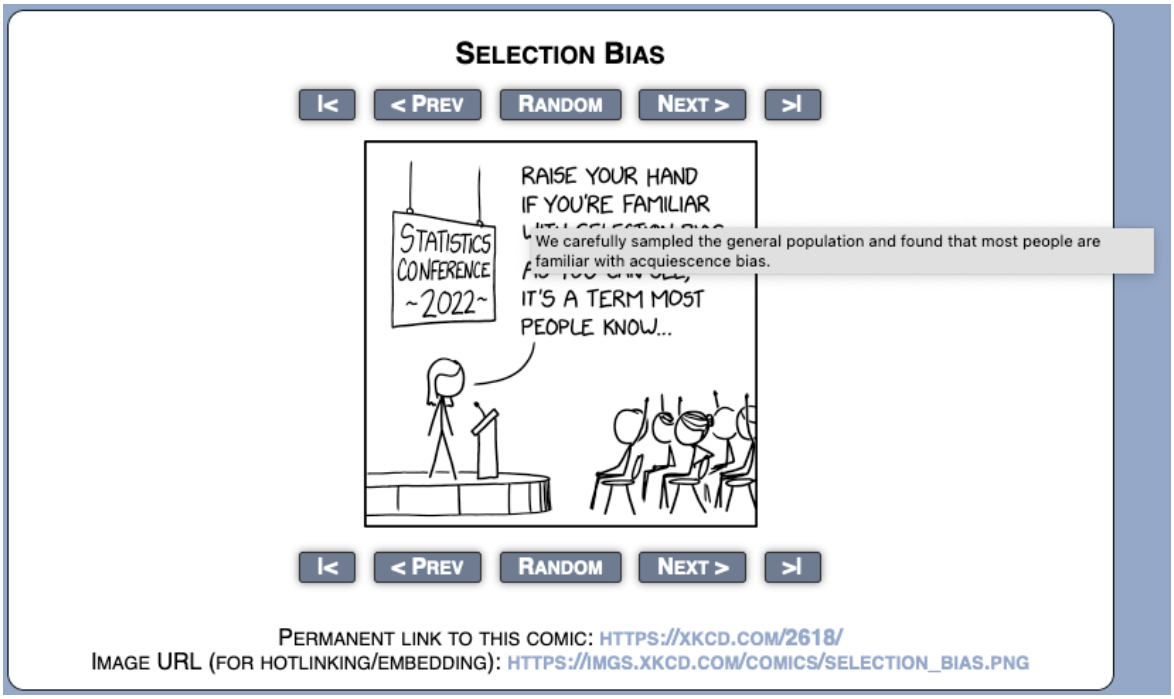

Figure 1. Selection Bias, xkcd by Randall Munroe. Retrieved from https://xkcd.com/2618/. In the above web browser version alt-text appears as a mouse hover feature. In DCR3's reader observation session, they compared this to what alt-text looks like for the same comic on Instagram.

According to Chute, "comics is, above all, a haptic form" [5]. This study raised a number of points about haptics or understanding through touch [10]. Of especial note is the desirability of different interaction, for example the hover over a text being more enjoyable, "fun", creating more anticipation than the simple click. In fact, the click was perceived as a lesser experience by at least two readers (DCR3, DCR4). For DCR4, the swipe touch made for a more enjoyable experience, whereas for DCR3 the hover of a mouse pointer made for a different, better experience than clicking with that same mouse. In both instances, the material interaction contributed to the experience: through the tactile sense they were able to seek out (through device choice) and create an experience more conducive to their enjoyment.

This connection of pace in story to the physical action of swiping is also related to control of the reading experience: in the 'guided view' or 'cinematic view', the reader has less control because they cannot see ahead as they can in a multipaneled page. So, in a sense they have less control, less preparedness for what will happen, less knowledge of what is around the corner. This can be seen as a positive as DCR4 observed that readers are protected from this additional knowledge, these spoilers. In fact, they thought it a failing of print comics, this struggle to not spoiler content that was so openly presented on a single, multi-panel page. But with the 'cinematic view', they are in control of the pace: how fast they get to the next panel, how slowly if they choose to zoom in/out to consider features in more depth and at their leisure.

3.2.2Anticipation and Suspense

Digital comics are often conflated with animation. In other words, when searching for a definition of digital comics, animation is often included. While we have adopted a broad definition of digital comics that includes the likes of graphic

novel ebooks for instance, it does not include animation where some may consider innovation lies. It has been previously argued that "comics may do things on the screen that cannot be done on paper and vice versa, but [...] synchronous animation with sound belongs to a different realm in which comics stop being comics" [29] (p.276). That this research has adopted this distinction between comics and animation is an acknowledgement that there are specific functionalities of comics in the digital environment, one of them being movement. Not movement powered by animation technology, but inherent in the sequential nature of comics themselves, present in both digital and print versions.

In essence, digital comics embody a sense of movement and time elapsing all their own. The readers in this study confirmed this view. With the more 'static' or panel-based digital comic, the reader exerted more control of the experience and was more active, interactive with the panel-by-panel or cinematic view. Animation, however, almost forced a more passive experience, and one that was not necessarily a reading experience. As mentioned by DCR3, gaining access to hypertext information through mouse hover made the experience of reading "fun", conferring an activity that would not necessarily be available in animation.

Other readers, DCR1, DCR4, and DCR5 for example, did observe that the 'cinematic view' almost approximated animation, but only in the sense that the quicker they moved from page to page, the more similarity to animation. Again, the reader determined the pace, aided by the creator. Of course, slowing down this movement from page to page also heightens what readers referred to as "the cliffhanger effect". This effect, as mentioned above present in both digital comic book and vertical webcomic apps, is a uniquely digital affordance: in fact, DCR4 observed that this difficulty in "burying" or "hiding the big reveal" has been a problem for print comics "for years".

Vertical comics, essentially the presentation of webcomics on smartphones as exemplified by Webtoon, provide a different kind of tactile interaction with the device and content, one that contributes just as much to the sense of anticipation: scrolling. Instead of clicking or swiping to the next panel, webcomics apps require scrolling, much the same action as reading social media feeds. However, this kind of scrolling is far from what is generally perceived as the negative, non-productive experience of doom-scrolling (generally defined as an obsessive scrolling through negative news, it has come to mean just scrolling obsessively). Webcomics scrolling offers a different experience, whereby the more white space between panels, the more scrolling, the more anticipation [30] [31].

Indeed, DCR5, the dedicated Webtoon reader, described the experience this way:

…The more dramatic the scene, the more white space will separate it from other scenes. Sometimes it takes quite a bit of scrolling to get to the next panel… the white space does create a lot of anticipation…It really works like that heartbeat sensation, like boom boom that happens in movies… And it had been like a heart stopping moment…gut wrenching, all of this causing anticipation, etc.

Of additional interest in the description of the scrolling experience is that the reader goes onto observe that an excessive amount of white space may not always be down to a deliberative pacing choice of the creator: "It's not always clear if this is for actual effect, or if it may be down to the creator not formatting correctly". This problem with formatting has the resulting effect of the page not loading properly which often is exacerbated by continued scrolling. What makes this observation the more interesting is that the reader maintained that this technical problem was not considered an annoyance: in fact, for them it added to the anticipation.

Moreover, they found the vertical formatting of comics for the smartphone more accessible, more inclusive than innovative print and digital comics where creators experiment with the placement of panels. For these comics, the progression of panels, which panel to read next, is not so obvious. They referred to the layout of some experimental comics as being "overwhelming", referring to autism and "sensory overload" because it's not always clear what direction they are to be read in: "there are a lot of rules to how to read a comic and, as I can tell the rules are dictated by the writer. Because

someone wants you to read left to right or right to left…some have random diagonal [layouts]. It's a lot easier in a Webtoon comic to control that flow". Here, this reader, along with others, refers to having more control over the experience in the vertical format which allows them to have a more inclusive, accessible reading experience. The material aspects of the comic page does not intrude on that experience, and the layout in a vertical digital format allows them to control the flow of the content in a way that make reading easier.

4 DISCUSSION

We did not necessarily direct readers to consider the materiality of digital comics: our questions broadly addressed the 'what', 'where', 'when' and 'how' of their experience. That they came back in the observation sessions with strong reactions and opinions about their physical interaction, especially from a tactile perspective, indicates that the reading of digital comics can be and is a compelling, multi-layered experience, and not just an electronic version of print books on the one hand and a static version of animation on the other [32].

For example, the observation of the Webtoon reader regarding the problematic directional placement (often regarded as innovative) of panels in print comics demonstrates that the vertical digital format makes for a more pleasurable reading experience for those who are visually or spatially challenged. So, the innovation is not just the technical application as it addresses the formatting for smartphone reading, but the accessibility and reading experience of the digital comic.

Moreover, the study demonstrates that the device in combination with the platform needs to work to enhance the reading experience, and that they may different for each reader. There is the problem, for example, of what happens to hypertext information, such as Alt Text, readable in a browser on a laptop or PC by hovering over images, but not as interactive when it is offered as clickable alt text in a social media feed on a phone. In addition, some comics, converted from print to digital browser reading and then fitted into a social media feed, just do not work: DCR1 discussed this experience with comic strip *Calvin and Hobbes* which they accessed primarily through Instagram. The entire comic had to be read in a browser website, the Instagram feed only offering a few panels. DCR3 noticed during the observation session that they had to go from the vertical reading in an Instagram feed to the horizontal reading in a browser in order to read the complete comic, one that had begun life digitally on a website. DCR2 maintained that they wanted digital comics "to function like books", and so sets about using the functionality on devices and apps to make what they are reading look as much like a book as possible. These manoeuvres between platforms, browsers, devices, apps to get the reading experience to adhere to their preferences indicate that readers approach the digital environment with "cognitive maps", that is preconceived mental models for what that experience should be [33][34][35].

Given the paucity of empirical qualitative studies of digital comics readers, this exploratory study seeks to encourage a tradition in such research by offering a deeper understanding of the reader perspective. The UX and HCI approaches have meant that the data collected raises a number of issues around the reading of digital comics that bear wider study. While, as we have discussed above, there is some previous research considering the different material and haptic characteristics of digital comics, this study indicates that there is much to be done on viewing these from a reader-centred perspective.

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REFERENCES

[1] Thierry Groensteen. 2007. *The System of Comics*. University Press of Mississippi, Jackson MS.

[2] Neil Cohn and Stephen Maher. 2015. The notion of the motion: The neurocognition of motion lines in visual narratives. *Brain Research*, 1601 (15 March), 73-74. https://doi.org/10.1016/j.brainres.2015.01.018.

[3] Lucia Cedeira Serantes. 2019. *Young People, Comics and Reading: Exploring a Complex Reading Experience.* Elements in Publishing and Book Culture series. Cambridge University Press, Cambridge. DOI:10.1017/9781109568845.

[4] Benjamin Woo. 2020. Readers, audiences, and fans. In Hatfield C. and Beaty B.(eds) *Comics Studies: A Guidebook.* Rutgers University Press, New Brunswick NJ.

[5] Hillary Chute. 2008. Comics as literature? Reading graphic narrative, *PMLA/Publications of the Modern Language Association of America*, 123,2, 452-465. DOI:10.1632/pmla.2008.123.2.452.

[6] Benjamin Woo. 2012. Understanding understandings of comics: Reading and collecting as media-oriented practices, *Participations: Journal of Audience and Reception Studies*, 9, 2, 180-99. Retrieved 25 July 2022 from https://www.yumpu.com/en/document/view/41544386/understanding-understandings-of-comics-reading-participations.

[7] Nicolle Lamerichs. 2020. Scrolling, swiping, selling: Understanding Webtoons and the data-driven participatory culture around comics, *Participations: Journal of Audience and Reception Studies*, 15,2 (November), 211-229. (Special issue by Einwächter, Ossa, Sina & Stollfuß). Retrieved 25 July 2022 from https://www.participations.org/Volume%2017/Issue%202/11.pdf.

[8] Ernesto Priego. 2010. The Digital Scriptoria: Textuality and Materiality in On Cultural Materialism, Comics and Digital Media, *Opticon1826* 9. UCL Press. https://www.ucl.ac.uk/opticon1826/archive/issue9/imagegallery/Image_Priego.pdf.

[9] Jan-Noël Thon & Lukas R.A. Wilde (2016) Mediality and materiality of contemporary comics, *Journal of Graphic Novels and Comics*, 7,3, 233-241, DOI: 10.1080/21504857.2016.1199468

[10] Ian Hague. 2014. *Comics and the Senses: A Multisensory Approach to Comics and Graphic Novels*. (Routledge Research in Cultural and Media Studies).Routledge, NY and Oxford.

[11] Padmini Ray Murray. 2012. Scott Pilgrim vs the Future of Comics Publishing, *Studies in Comics* 3,2(August), 129–142. https://doi.org/10.1386/stic.3.1.129_1

[12] Neil, Cohn. 2013. Navigating comics: An empirical and theoretical approach to strategies of reading comic page layouts, *Frontiers in Psychology*, 4,186 (18 April), 1-15. DOI: 10.3389/fpsyg.2013.00186.

[13] George Royer, Beth Nettels, and William Aspray. 2011. Active Readership: The case of the American Comics Reader, in Aspray, W. and Hayes, B.M. eds., *Everyday information: The evolution of information seeking in America*. MIT Press, Cambridge MA.

[14] Ernesto Priego and Anthony Farthing. 2020. Barriers remain: Perceptions and uses of comics by mental health and social care library users, *Open Library of Humanities*, 6,2 (17 July), 1–37. DOI: https://doi.org/10.16995/olh.98.

[15] Joohyung Ha and Seung-in Kim. 2016. Mobile Web-toon application service usability study -Focus on Naver Web-toon and Lezin Comics, *Journal of Digital Convergence*, 14, 431-436. DOI: 10.14400/JDC.2016.14.9.431.

[16] Kohei Arai and Ronny Mardiyanto. 2011. Eye-based human computer interaction allowing phoning, reading e-book/e-comic/e-learning, internet browsing, and tv information extraction. *International Journal of Advanced Computer Science and Applications*, 2,12, 26-32. DOI:10.14569/IJACSA.2011.021204

[17] Fang Zhao and Nina Mahrt. 2018. Influences of comics expertise and comics types in comics reading, *International Journal of Innovation and Research in Educational Sciences*, 5,2, 218-224. Retrieved 25 July 2022 from https://www.researchgate.net/publication/330753904_Influences_of_Comics_Expertise_and_Comics_Types_in_Comics_Reading.

[18] Keiron Brown. 2018. Comics, Materiality, and the Limits of Media Combinations, *Image Text Journal*, 9,3. Retrieved 25 July 2022 from https://imagetextjournal.com/comics-materiality-and-the-limits-of-media-combinations/.

[19] Stephann Makri, Yi-Chun Chen, Dana McKay, George Buchanan and Melissa Ocepek. 2019. Discovering the unfindable: The tension between findability and discoverability in a bookshop designed for serendipity. In Lamas, D. et al. (eds.). *Human-Computer Interaction – INTERACT 2019 (IFIP Conference on Human-Computer Interaction)*, Lecture notes in computer science, 11747, 3-23. Springer, Cham. DOI: 10.1007/978-3-030-29384-0_1 or Retrieved 25 July 2022 from https://openaccess.city.ac.uk/id/eprint/22383/.

[20] Virginia Braun and Victoria Clarke. 2012. Thematic Analysis. In Cooper, H. ed. *APA Handbook of Research Methods in Psychology, v2 Research Designs.* American Psychological Association, Washington DC, 57-71. https://doi.org/10.1037/13620-004.

[21] Marvel Unlimited. Retrieved 25 July 2022 from https://www.marvel.com/unlimited.

[22] ComiXology. Retrieved 25 July from https://www.amazon.co.uk/comiXology/s?k=comiXology.

[23] Image Comics (available through Google Play) Retrieved 25 July 2022 from https://play.google.com/store/books/theme/promotion_1000a03_image_comics.

[24] Sequential (formerly an app available through Apple, by publisher Panel Nine (see http://www.paulgravett.com/articles/article/sequential)

[25] Webtoon. Retrieved 25 July 2022 from https://www.webtoons.com/

[26] Kickstarter. Retrieved 25 July 2022 from https://www.kickstarter.com/.

[27] xkcd, a webcomic of romance, sarcasm, math, and language, by Randall Munroe. Retrieved 25 July 2022 from https://xkcd.com/.

[28] Aaron Kashtan. 2018. *Between Pen and Pixel: Comics, Materiality, and the Book of the Future.* Ohio State University Press, Columbus OH.

[29] Ernesto Priego. 2011. *The Comic Book in the Age of Digital Reproduction.* PhD Dissertation. University College London, London. Retrieved 25 July 2022 from https://doi.org/10.6084/m9.figshare.754575.v4.

[30] Alexandra Presser, Gilson Braviano and Eduardo Corte-Real. 2021. Webtoons. A parameter guide for developing webcomics focused on small screen reading, *Convergências - Revista de Investigação e Ensino das Artes*, 14, 28 (30 November), 67-78. https://doi.org/10.53681/c15142251875143915.28.28.

[31] Linda Berube. 2022. UK Digital Comics: More of the same but different? *British Library Digital Scholarship Blog*, (18 July). Retrieved 25 July 2022 from https://blogs.bl.uk/digital-scholarship/2022/07/uk-digital-comics-more-of-the-same-but-different.html.

[32] Martin Côme. 2017. With, Against or Beyond Print? Digital Comics in Search of a Specific Status, The *Comics Grid: Journal of Comics Scholarship*, 7, 1, 1-16. DOI: https://doi.org/10.16995/cg.106.

[33] Richard Bjornson. 1981. Cognitive mapping and the understanding of literature. *SubStance*, 10, 1, 30, 51-62. https://doi.org/10.2307/3684397 .

[34] Alexander Thayer, Charlotte P. Lee, Linda H. Hwang, Heidi Sales, Pausali Sen, and Ninad Dalal. 2011. The imposition and superimposition of digital reading technology: the academic potential of e-readers. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11). Association for Computing Machinery, New York, NY, USA, 2917–2926. https://doi.org/10.1145/1978942.1979375.

[35] Shi Zifu, Tang Ting, Yin Lin. 2020. Construction of Cognitive Maps to Improve Reading Performance by Text Signaling: Reading Text on Paper Compared to on Screen, *Frontiers in Psychology*, 11, 57 (30 September), 1-11. https://doi.org/10.3389/fpsyg.2020.57195 .