# Engineering Student Attitudes to Digital Reading Teaching Technology in the post-coronavirus era

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***Abstract*—Purpose: The purpose of this paper is to evaluate engineering student attitudes to using a digital reader device for reading digital texts in a post-coronavirus academic teaching environment. The results of this study could help to inform pedagogies for online teaching and student transitions into university technology-enabled educational innovation for engineering.**

**Design/methodology/approach: An online survey was distributed to engineering student participants and a student focus group was conducted. The survey contained 14 student experience questions related to the use of the digital reader; most questions were quantitative in nature. The focus group concentrated on 4 areas: the new contexts, pandemic and post-pandemic; the digital reader; digital reading behaviours; and, the impact on current and future student learning.**

**Findings: Student digital reading of engineering academic texts cannot be separated from distinct research investigation processes, such as finding information and writing. Engineering students rarely just read. They read, write, and find information in interconnected academic processes of inquiry.**

**Research limitations/implications: This study was limited to engineering students using the Kindle digital reading device and specific engineering academic texts.**

**Practical implications: The study makes recommendation to inform the development of digital reading in online teaching environments and student transitions to higher education.**

**Originality/value: The study builds on existing research with students describing interconnected digital reading, writing, and finding activities in post-pandemic contexts.**

***Keywords—Digital readers, digital reading, digital teaching, online teaching, university instruction, digital technologies, university engineering teaching, engineering students, digital texts, university students.***

## I. Introduction

Digital reading is a key feature of technology-enabled educational innovation. Both "digital reading" and "academic texts" are difficult to define. "Any word in a text is subject to wrangling over its definition" [1]. Labels are used, such as essay, laboratory report, or case study, but you cannot assume that knowledge and expectations for texts are shared [2]. One study [3] discussed the evolving nature and definitions for etextbooks, identifying several distinct characteristics, including multimodal, hardware-mediated, and connectable (p.178-179). Academic texts could be anything students write or read during their academic work; in this study, however, we have selected specific engineering academic texts. Baron [4] asked whether the medium for reading mattered, as the superior technology of the first Kindle and then the iPad emerged, using "online reading," "digital reading," and "ereading" to describe dealing with words onscreen; digital reading is preferred in this study to mean student reading of engineering academic texts in a specific, digital format (PDF), using a selected digital reader (Kindle).

The coronavirus first appeared in 2019 [5]. The World Health Organization published their first Situation Report in January [6] and characterised COVID-19 as a pandemic in March [7]. China was the first country to introduce measures to contain the outbreak, including extending the Spring Festival holiday [8] and closing all universities and schools [9]. International students were unable to travel [10]. The pandemic became "perhaps the biggest crisis of our generation" [11]. Sino-foreign universities were at the front of the global transition to online education, providing new models four course delivery [12]. The pandemic closed university campuses forcing rapid improvisation and adoption of online teaching [13], with many teachers "working to deliver content and online pedagogies" [14], through "emergency remote teaching" [15]. Accelerating the move to technology-based teaching innovation added to a "digital divide" [16] and "illuminated, and further exacerbated, the inequities in education both in terms of access and success" [17]. Distinctive practical challenges were created, such as quarantining all returned print materials for 72 hours before making them available again [18], leading to science-based information about how materials can be handled to mitigate coronavirus exposure to staff and visitors of archives, libraries, and museums [19].

## II. Literature Review

The literature on digital readers, digital reading, and digital academic texts is complex and interconnected. Researchers have investigated "portable technological contraptions that have the capacity to store thousands of books" as part of the universal library concept [20] for more than a decade. Early studies investigated implications for publishing [21], including user perceptions of the Kindle [22]. In one study faculty reported "unsatisfactory experiences in using e-books in their research and teaching owing to the unreliability of access, lack of manipulability, and the steep learning curve of the various interfaces" [23]. Research indicated that the use of the Kindle in an academic setting was limited due to content availability, licensing issues, graphic display capabilities, organizational issues, and prohibitive costs [24]. The use of digital readers in libraries has been investigated [25], with studies revealing a trend of students selecting general reading and rarely selecting academic texts [26], or the use of digital readers for leisure reading, a continuing reliance on print for reading, with price the greatest barrier to digital reader adoption [27], or the student preference for popular titles [28]. When digital readers were given to students there were incompatibilities with university licensed digital materials [29]. When a Kindle was liked for its readability it was found to be a poor substitute for the published print version of a

2021 IEEE International Conference on Engineering, Technology & Education (TALE) | 978-1-6654-3687-8/21/$31.00 ©2021 IEEE | DOI: 10.1109/TALE52509.2021.9678598

newspaper [30]. A study in a medical setting identified portability and searchability" to be advantages of the Kindle, but "connection speed, navigation, and display" were problems [31]. One study investigated the iPad and found the majority of participants read faster on an iPad than paper and that comprehension scores did not differ significantly between digital and paper, indicating digital readers were suitable technologies for student learning [32]. One study concluded that it was "challenging but feasible to make diverse learning materials compatible with ereaders" [33] and investigation focused on digital technologies in the classroom [34]. One study demonstrated how the number of digital books, the number of viewings, and the number of searches had increased in libraries [35]. Students, however, begin researching assignments using digital texts, but print sources were needed for high-quality assignments [36]. Online teaching was not a perfect solution, leading to a "digital divide" and some students "losing the will to live as the situation goes on" [37].

Research continued to investigate digital technologies and digital reading. Studies reported dissatisfaction with reading digital texts: it is content that never contents [38]; historians were open to experimenting with digital texts, but reported "the loss of serendipity in digital environments, the lack of availability of key resources, and the need for technological transparency" [39]; and, for some, a digital experience that is "nerve-wrecking," and "an absolute pain" [40]. In dental hygiene, a study found students strongly disliked the digital platform and did not frequently access digital textbooks, relying on handouts for studying, with academic staff claiming digital textbooks do not align with positive learning experiences [41]. One study demonstrated the value for students in using mobile technologies in their out-of-classroom learning [42]. Perceived usefulness was a significant mediating factor for student use of digital textbook on mobile devices, with self-efficacy and learning strategies influential factors [43].

The trend, however, was clear: students preferred printed books [44]; students "prefer print over electronic formats for learning purposes, but multiple factors such as accessibility, cost, complexity and importance of the reading to the course" affect student behaviours [45]; and, "the broad majority of students worldwide prefer to read academic course materials in print" [46]. In one study students found digital textbooks challenging "because of distractions on their device, eye strain, and a feeling of being overwhelmed with choices" [47]. Content is important to students, but one study found that "traditional books are still preferred over eBooks by a three to one margin" [48]. Even where there was evidence of an increase in usage of digital texts, students reported challenges with interface designs and "the ability to easily control and manipulate their own copies" [49]. Where there was evidence of student willingness to engage in using digital textbooks, one study showed "a drop in enthusiasm for e-textbooks from the beginning to the end of the pilot" [50]. Perceived usefulness and text satisfaction were found to have a positive and significant association with acceptance of e-book devices [51].

If digital resources were to be adopted, there was a critical role for the library, such as in South Korea, where most users discovered and access digital content through the library web site [52] or to overcoming a lack of student awareness through library led teaching focused on collections and distinctive features of digital content [53]. One study found that the student of digital textbook features, such as glossary, audio, quizzes, notes, highlighter, and video, increased after library instruction [54].

There was some evidence that the quality of digital content was improving and this was essential for faculty acceptance [55]. One study indicated that student engagement with digital texts improved performance [56], while another concluded that graduate students prefer using e-books to printed texts [57]. One exception to the trend is a study indicating the success of the Kindle when used by students and faculty for recreational reading [58]. The emerging technologies were criticised for creating something that bears a resemblance to print but doesn't do much else besides [59], while innovations included tangible experiences for paper like e-paper [60]. Wiesinger [61] argued people don't read, they skim; they are not readers, but users, "with an entirely different behaviour pattern" (p.149). Students may be losing the habit of reading except for required texts, and deep reading skills may be eroded by habits of interrupted and partial attention [62]. One study found academic users search digital books for discrete bits of information and described this behaviour as "use rather than read" [63]. A complexity to the behaviour was identified because "learning to read in a digital world is not a single process, but rather a multidimensional problem space of learner, reading goals and digital context" [64].

Nevertheless, as the coronavirus emerged, research had a new context for investigations. Bibliometric mapping and analysis research highlighted a lack of research on the effects of the pandemic on research, teaching and education [65]. Research focussed on online teaching in many specific disciplines, including chemistry [66], chemical crystallography courses [67], biochemistry [68], biology [69], and language education [70]. Many universities adopted textbooks as part of their response, including the University of Edinburgh [71]; vendors of digital textbook resources, including Gale, ProQuest, Sage Publishing, and Oxford University Press, for example, shifted through "evolution and acceleration" in response to the pandemic [72], or provided free access to digital textbooks until the end of May 2020 [73]; and, as part of the "collective sense-making" in academia, many publishers extended trial periods of their digital textbooks to help professors and students reduce the anxiety of sudden moves online and allowed them free access to online features [74]. Research investigated students use of digital textbooks in specific disciplines: engineering students and their attitudes and strategies when forced to adopt digital books [75]; mathematics students and digital textbook engagement [76]. Some evidence indicates students engage with technologies for learning, find them easy to use, and beneficial for their learning [77]. There are examples of innovation in asynchronous discussion and the use of web based tools to post a reading or link to an digital textbook and invite students to post comments and questions [78] or student support for textbook reading and post-lecture exercise assignments [69]. Student acceptance and adoption of digital textbooks is influenced by perceptions of ease of use and usefulness [79].

There are, however, distinct problems and challenges in digital 'transformation'. Research has identified normalising "master narratives of Ed-Tech speak" as an academic issue [80]. Some students, however, avoid buying textbooks and rarely read them, indicating they may be a waste of education resources [81]. There are identified equity issues because

some students "may not have access to basics like their textbook" [70], and the costs of digital books are "hobbling university teaching" [82], with open educational resources offering a possible solution [83], especially when the library has a leading role in developing alternative to textbook models that deliver financial savings for students [84]. When students used digital textbooks results show they "skimmed, scanned and flipped" [85]. University managers tend to be "techno-optimists, attaching an incantary magic to the word digital" [86]. There is, however, a need for educators to engage in critical conversations that go beyond what digital tools and platforms are effective in meeting narrow definitions of reading and writing, and go beyond digital literacy in a post-pandemic world [87]. Another perspective has emerged in recent years through a renewed articulation of contemplative studies [88]. Newman [89] identifies multitasking as "the deliberate refusal of mindfulness," when "there is nothing so effective or so strangely joyful as focussed attention" (p.34). The forthcoming book by Naomi Wolf [90] will argue we need to rethink how to help learners to use digital texts and platforms. This paper examines engineering student behaviours using a digital reader for reading specific digital academic texts in a post-coronavirus environment.

## III. Research Methodology

This study focused on engineering students on two different optional module programmes of study: BEng electrical engineering and electronic engineering; and, BEng mechatronics engineering. Students were informed about the project at the beginning of semester, and digital readers were distributed. Students were asked to use the digital reader for the module readings, and encouraged to use it for other academic and non-academic reading.

This study used three engineering digital academic texts in the PDF format: *Microcontroller Theory and Applications with the PIC18F* by Rafiquzzaman [91] ; the *PIC18fxx8 Data Sheet* (402 pages) [92]; and, the *MPASM Assembler, MPLINK Object Linker MPLIB Object Librarian User's Guide* [93] (274 pages).

All of the digital texts were available to students in a PDF format. The module readings were delivered to all students through the virtual learning environment (Moodle), with basic guidelines on how to add the digital texts to the digital reader.

The Amazon Kindle was the e-reader selected for the study to allow students to read PDF files.

A survey used Microsoft Forms, and was distributed to students at the end of the first semester. The responses were analysed using simple statistics together with the student responses from the open question fields to derive meaning from the results. This paper presents selected data from the study.

A focus group was conducted after students had completed their final exams. A focus group with engineering students in a post-pandemic context in China was conducted. One practical guide [94] described how focus groups bring participants who share certain characteristics in common related to a topic together to share perceptions for systematic analysis (p.2). This paper presents the qualitative results and analysis.

## IV. Results

### A. Quantitative Survey Results

Students were asked: to what extent they find academic texts easy to read on the reader? The majority (72%) said it was neither easy nor difficult (Figure 1). The students were asked how easy it was to transfer documents onto the reader, with 72% saying it was very easy or relatively easy (Figure 2).


Fig. 1. To what extent do you find the Module material on the e-book reader easy to read?

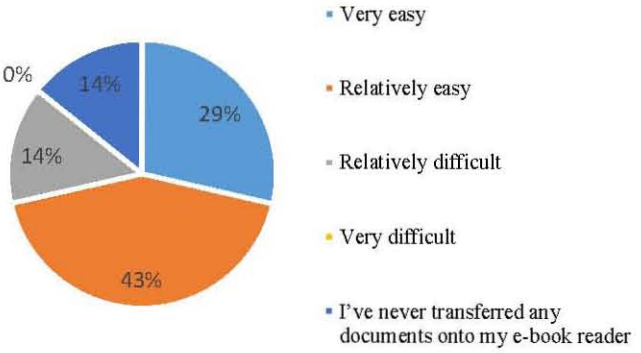


Fig. 2. How easy it is to transfer documents onto the e-book reader?

Students were asked an open question to explain why they found the course material on the reader difficult to use:

- "Since the e-book reader is of a smaller screen size that would be the only drawback using it."
- "Since the e-book reader is of a smaller screen size, it was quite challenging to read."
- "The font size for the reading material are small."
- "It's inconvenient for me to study with the kindle reader for longer hours at a time."
- "The device is a new and fairly easy to manage though."
- "Slow refresh rate and hard to search for specific results."
- "The search function is not as convenient as that on the computer."
- "The Refresh rate, colour, inconvenient sometimes can't do notes."

Students also said: "Lack of pencil to write down some notes not enough size"; and "it was difficult to read than in computer or i-pad." The lack of notetaking was another reason why the reader was considered challenging for course

readings. Students need to write their own notes to develop understanding and knowledge retention for examination.

### B. Qualitative Focus Group Results

#### 1) Pandemic and Post-Pandemic Contexts

When the coronavirus emerged in China, the students in the study group were in different places. The students on campus needed to "adapt quickly." One student living on campus "decided to stay against a better judgment, and described "the immediate reaction" from the university, where there "was a concern for the students," saying: "I'd actually have to appreciate that they did the very best to make sure of the well-being of the students on campus. Another student explained a specific experience of support, when a platform was created "for us to go out to shop; "the support was really, very good." One student was in Thailand when everything changed, and returned to Shanghai. A different student was in her "hometown in the countryside," near Taizhou in the South East of Zhejiang, and how, in the neighbourhood, three people were infected by the coronavirus, so she moved to here grandpa in the countryside.

The students described the move to online teaching. Students reacted to online teaching, with one student saying: "recording is a good way to do some review and grasp the knowledge." The student stranded in Thailand described challenges with downloading files "because the internet is so slow in Thailand that I will not be able to get access to any video." Students discussed how in some locations it can be "very difficult" to watch videos, with access and internet speed being "a very crucial factor." On campus "it was better," because the "Library was available for us to use," meaning "we actually prefer to have stayed to leaving, because at some point, it was very crucial thinking of going back home." For engineering students, not having "access to the lab resource" was a big issue.

#### 2) Digital Reader

Students talked about their initial reactions to being given a digital reader to support online teaching and learning. One student explained that: "I had my own Kindle since I was about 12 years old and I usually read some novels." A different student explained: "in principle I was in favour for the idea of having a digital reader in place of a textbook because my biggest challenge is that I major rely of text books for all my studies"; "I actually have to carry a lot of stuff everywhere I go. I soon learned that in practice, when I started using the reader and got all my digital copies of the books." Students also described issues with the Kindle: "it's not very useful for me to read the material on kindle because I think the screen is too small"; "I cannot make some notes on it"; "the font was very small"; with the Kindle being preferred to "read novels."

Students described how they used other devices compared to the Kindle: for example, I "check the meaning on another application on the laptop or on the iPad. I can't do this on the kindle." One student had a different digital reader, which was preferred to the Kindle: "It's big so it's very convenient to read. The text is really big." Students were "more in favour of some device that could actually be more general purpose"; "the Kindle reader is more of a one purpose." One student said: "It's nothing, but a reader. Just enable me to read something. But when I have to make notes, when I have to search I'll turn to other kind of a tablet or uh some, other devices. We want to use one stone to kill so many bits. We want the book as a reader, we still want to do search. So, it's like we want one thing to solve a lot of problem."

The students agreed that the Kindle had one major advantage. Because of the lack of functionality for search and social media, "you will not get distracted." One student said: "It has a strength of nothing, not allowing us to just get distracted." A laptop or iPad "has more to offer, and that can sometimes be distracting, especially if I want to study the book alone."

#### 3) Digital Reading

Students described how digital reading in an academic environment was not just about reading. It was about reading, writing, and research. For instance, one student said "academic reading, particularly for study," "is a different type of reading experience." A different student said: "there's a difference between a novel and class materials because we always want to go back to class materials to search something. Yeah, to search for a specific topic. And that is a problem." Another student said: "I wouldn't be able to, say, search online. If I found a certain vocabulary or something I didn't understand in the reading material that was limiting for me." A different student said: "you're not just reading when it comes to academic work. There's other activities you'll do as well." For one student, "there's more that you can do with these all the technologies that are available now." "But then for academic work, we have to do research. So you may come across certain things you don't understand, and then you would want to make a reference."

#### 4) Student Learning

The students explained that the move to online learning and teaching in response to the coronavirus pandemic was not the major change for them. One student said: "Not really for me. Since I started study at university, it is all basically electronic. Like I make notes on my laptop, and the information," "and also I update notes to cloud, so I can access to any devices. It's good." A different student said: "I wouldn't even have had access to digital devices for study, no laptop, no videos or even mobile phone." Students make specific and individual personal choices about which digital technologies to invest in when they move to university: "I have to buy them myself" and "You make a commitment there to invest in these different devices." A different student said: "Actually. Yeah, before I enter the college, I had never used any digital device to at my learning. I purchased my laptop here. When I enter the school, and in the next year I purchased the ipad with my scholarship. No, I think it's necessary for us to change ourselves to the new technologies." The technology becomes essential to the student experience: "Every student relies on the laptops when the laptop breaks down, I think that's when option two comes into play." Students identified the need for preparation before moving to higher education: "I think we can change people's orientation before they get here by making them aware of what they're coming to," describing how "It's like a psychological adaption."

Some students expressed a preference for a digital only environment. For example: "I don't think there's a difference. That's why I said I did not pick both. I would prefer just digital. Since it's already a substitution to the physical and it doesn't make a difference. It has the same text, everything, the same content, everything you can do, everything with physical work in the digital reading, I don't think there is a difference in there."

This might be a particular preference of some engineering students because: "Most of our study and research work, we usually depend on online materials. We prefer having something that's accessible to the internet, because most of the technical stuff that we want to learn about or would find ourselves required to study about might not be a free available in hard copy in the library or even in a digital format through the library."

Even when presented with a future scenario where all digital texts where made available on a digital device to support student learning, some students described how they would still want to use physical books: "Yeah, yeah. I think I will go to the physical. You'll still want the physical books. So it's not about access to material. You've got access, you got the device. You will still want physical books. We need to still be in mind that people are coming from all works of life. They're trying to adapt. There are some countries that this is new to them."

However, one student observed: if "it's still everything from my devices and it's easy to access and very portable compared to books, which I would like to take one day, turn everything to e books." Either way, "we cannot just stay out of the circle of reading," concluded a student.

## V. Discussion

### A. Digital Reading

The purpose of this paper was to evaluate a digital reader device for reading digital texts in a post-coronavirus academic teaching environment. Engineering students in this study compared the dedicated digital reader with other devices, such as the iPad, with one student saying in the focus group: "It's just a reader!" However, unlike some previous studies [49, 50], students are not finding the transition to digital reading challenging. Unreliability and learning [23] were not issues for students in this study, as some already had their own device; one student had a reader for 12 years. Students were given the reader, so price was not an issue [28]. As some previous students have concluded [32], digital readers are suited to student learning because students understand the need to have access to academic texts. They can benefit student learning, especially during educational disruption [77]. Students in this study would prefer a digital device that gave access to all the digital texts they needed. However, it was clear in this study that engineering students were rarely just reading; in academic contexts they were reading, writing and finding. Significant limitations of a digital reader include not being able to take notes or find word meanings; but this is also the strength because it limits distraction and is suited to focussed attention [89].

### B. Digital Academic Texts

While there may be negative experiences reported in some disciplines [40, 41], the engineering texts selected for this study were all available in the PDF format and accessible on the digital reader. As in some previous studies [44-46], engineering students expressed a continuing preference for print, even when encourage to use digital texts. While some studies have found textbooks are a waste of educational resources [81], this study showed students were using and appreciated the value of academic works. Moreover, students also explained the need to access inter-related academic texts, such as to find word meanings as part of their research. Scholarship is the outcome students are working towards; they need to create their own academic texts. One revealing feature of this study about digital reading is that post-pandemic teaching and student learning will be about more than academic texts. Reading was not the main concern for some students in this study; in some instances, they struggled to access video of lecture captured content. Students will learn through video and deliver presentations as a key component of current and emerging pedagogical practice in higher education. Perhaps like the graduate students in one study [57], the final year engineering students in this study were committed to reading academic texts because of their academic ambition.

### C. Post-pandemic Teaching and Student Learning

The pandemic may have been the biggest crisis of our generation [11], with Sino-foreign universities at the front in providing new models four course delivery [12]. This study shows how one group of engineering students managed the crisis as people and learners through a variety of experiences in different places. They adapted, sometimes supported by the University or making individual accommodations by moving to the countryside. Furthermore, it was clear in this study that students have already developed knowledge and understanding about how to work in a digital learning environment. They had already invested in digital devices before coming to university. In some cases, students expressed a preference for digital, especially when the academic content is the same as the print alternative. Other students would still prefer print, even in a future scenario where everything was made available on a digital device to support learning.

### D. Research Limitations and Future Considerations

The study used three specific engineering digital texts, which were all the texts students needed for learning on the module. However, students work across modules, with different texts and reading requirements; not all the academic texts needed by students on all their modules were available on the digital reader. Students used different devices for related research tasks, particularly finding information and writing. The texts in this study were available on the digital reader in the PDF format, but one study, for example, found people read EPUB files faster than PDF files, with dedicated digital reader and tablet participants having higher average reading comprehension when reading EPUB files [95]. Moreover, one identified challenge to pedagogy is the many different characteristics of digital texts made available to students [3]; research is needed to compare student reading behaviours and learning across different modes, devices, and variations in network connectivity. The evidence indicates that student transitions from School or College to University is more significant and needs to be considered in terms of academic reading, writing and research.

### E. Practical Implications

The findings are useful for informing online teaching environments and student transitions to university.

- **Transition**. Students enter a new learning environment when they move to a University, including: digital devices and digital texts; a wider range of print and digital reading materials; and, new expectations for research, learning, and finding information. Students need to be supported in the transition to the digital university. Orientation needs to begin before students arrive at University to better

enable a blended learning approach to be adopted in a post-pandemic era.

- **Practice**. Universities need to consider teaching and student learning practices in higher education. More digital academic texts are being provided in higher education. But are the digital materials being read by students? What is the quality of the student reading in developing knowledge and understanding? Directors of teaching and learning need to consider how digital academic texts are used and assess the measurable impact on student learning.
- **Complexity**. Digital reading is not just different from reading print; it is complex and changing. There are a variety of formats and pedagogical approaches. Video, in particular is becoming important to teaching and student learning. At the same time, some students prefer printed texts. University leaders need to better understand the impact of blended approaches on student learning as they develop new strategies for digital leaning environments.
- **Technology**. Students need digital technologies that support a wide range of inter-related academic and research practices, including, reading, writing, and finding information. Students make personal choices about investments in technology before they arrive at university. University leaders need to consider choices already made by students when developing new approaches or spaces for teaching and learning.
- **Disciplines**. There is a continuing need to investigate disciplinary differences in reading behaviours. Engineering students in this study may have a distinct approach to reading, learning, and technology. Universities need to investigate the extent and quality of digital reading across disciplines, to assess the impact on student learning. Decisions must be based on pedagogical evidence, focused on studies with teachers and students in different disciplines.

## VI. Conclusion

Research has shown a pattern of student and faculty dissatisfaction with digital texts as a teaching technology in higher education. Universities have continued the increased adoption of digital texts. Strategies and tactics are not aligned with teaching and learning pedagogies or the evidence recorded in research and scholarship. This paper outlines new understandings that have emerged after the pandemic prompted a sudden move to online teaching and the return to a new normal at a University. Engineering student attitudes to digital reading were investigated during a semester when they returned to study after a period of pandemic and online teaching. The findings suggest that engineering students have individual preferences in the devices they choose for digital reading, with a preference for devices that support a range of inter-related research processes, including reading, writing, and finding information. Students want to use both physical and digital texts. Students are engaging in interconnected reading, writing, and finding activities using multiple devices. There are times when reading is a focus and a digital reader has benefits. Students, however, describe, reading, writing, and finding activities happening together. Moreover, the research indicates that the move to online teaching was not the major change on student learning practices; students described the transition to University as more significant in their individual adoption of digital devices and adaptations to new learning processes in reading, writing, and research.


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