Digital literacy practices of engineering students and lecturers using e-textbooks at a university of technology in South Africa

Ekaterina Rzyankina

Student number: RZYEKA001

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Department of Electrical Engineering

Faculty of Engineering and the Built Environment

University of Cape Town

Supervisors: Dr Renee Smit

Assoc. Prof. Zachary Simpson

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Declaration

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Abstract

Higher education in South Africa has experienced significant transformation and restructuring, presenting unique challenges for both students and lecturers. Amidst these changes, the advent of new technologies is introducing novel learning opportunities, yet their effective utilisation often demands the development of new digital practices. In the context of engineering education, where digital technology is increasingly prevalent, understanding how students' digital literacy practices influence their engagement is crucial. Despite the growing use of e-textbooks in engineering courses, not all South African students are comfortable with this shift. Engaging with online texts featuring embedded resources like hyperlinks, audio clips, graphs, or charts requires specific skills and practices. Given that Engineering Education research is a relatively new field, there is a dearth of studies specifically addressing the use of engineering e-textbooks.

This study aims to explore how students and lecturers engage with engineering e-textbooks at a University of Technology in South Africa. Focusing on first-year students and lecturers from the departments of Maritime Studies and Chemical Engineering, the study delves into their interaction with e-textbooks. Data were gathered through individual and focus group interviews, observations, and a think-aloud protocol for students, alongside individual interviews with lecturers. This study draws upon Cultural-Historical Activity Theory (CHAT) and Mediated Discourse Analysis (MDA) to understand the socio-cultural and historical factors influencing e-textbook engagement, interaction order, and the usage of affordances of e-textbooks.

The study identified four distinct patterns in how students interact with e-textbooks, noting that the majority favoured a blend of multimedia and other digital features over traditional text-based reading practices. A few students expressed a positive disposition towards using e-textbooks for study purposes, provided they received adequate support. However, in most cases, the findings showed that first-year students struggle with the transition to university-level reading and learning, particularly due to their limited prior exposure to digital devices and experiences. Some students found e-textbooks confusing and had a negative attitude towards them due to lack of familiarity and operational knowledge.

Furthermore, in introducing e-textbooks as part of the curriculum, the following contradictions were revealed in students' activity system, namely limited knowledge of how to operate e-textbooks, limited use and restricted access. Thus, the study underscores the necessity for additional support to help students who are less comfortable with e-textbooks, as demonstrated through the analysis of students' activity system. A parallel examination of lecturers' activity system highlighted their own challenges, such as adapting to a changed teaching role, presenting content effectively through e-textbooks, and facilitating students' access to these resources. The findings emphasise the importance of lecturers recognising and addressing the varying levels of students' digital literacy, offering guidance for the effective utilisation of e-textbooks in their academic pursuits.

The study contributes to existing knowledge by conceptualising digital literacy practices and pedagogy within an activity system of CHAT. The combination of CHAT and MDA offers a methodological and theoretical contribution that could be employed in future research in order to surface the literacy practices within complex activity systems in higher education. Moreover, the study offers insight into the digital literacy practices of engineering students and lecturers in the context of e-textbook use for the acquisition of engineering concepts, highlighting the nuanced challenges and opportunities inherent in this digital transition. It recommends involvement of various university stakeholders in order to ensure that this transition promotes social and epistemic access in an unequal South African higher education landscape.

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This doctoral research focuses on engineering education and is presented as a comprehensive single-case study, adhering to the University of Cape Town's requirements.

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The data collected during this study was also shared at a conference and published in the IEEE database under the title "Digital Literacy Practices of Engineering Students Using E-Textbooks at a university of technology In South Africa" (Rzyankina &

Simpson, 2022). It is important to note that the content of this thesis does not duplicate any previously published data; rather, any relevant empirical findings are appropriately cited and referenced.

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Chapter 1
Introduction

The enduring impact of historical inequality in South Africa is evident in its higher education sector (Bozalek & Boughey, 2012; Elliott-Cooper, 2017; Fataar, 2018). Students from previously disadvantaged and under-resourced backgrounds still encounter obstacles in accessing and succeeding in higher education. A considerable number of disadvantaged communities, particularly in the global South, reside in remote rural areas where educational resources are scarce or unavailable (Dalvit, 2023). Moreover, low participation and completion rates can be attributed, in part, to the limited accessibility of educational resources, a concern that has been on the South African government's radar since the #FeesMustFall student protests during the 2015 and 2016 elections (Winberg et al., 2018).

Furthermore, the higher education system in South Africa is presently undergoing significant transformation and restructuring, posing additional challenges for students (Jansen, 2019). This transformation is primarily driven by the digital revolution, which emphasises the integration of technology in the classroom, necessitating that both students and educators become "digitally literate" and adept with technology.

The disparity between individuals who have access to and knowledge of technology and those who do not, is commonly known as the digital divide (Faloye et al., 2020; Norris, 2001). In South Africa, the digital divide within the educational system has exacerbated the inequalities that originated from the apartheid era. During that time, access to educational resources in institutions was racially biased, placing certain groups of students at a disadvantage (Makhado & Tshisikhawe, 2021; Nyahodza & Higgs, 2017). Regrettably, this educational divide has persisted, even into the democratic era (Lembani et al., 2020), now with an emphasis on access to the use of technology in education.

The integration of technology into academic institutions' teaching and learning processes has ushered in a series of challenges. A significant number of students in South Africa lack prior experience with computers and digital devices for educational purposes. This unfamiliarity creates barriers to their learning, and South African

universities struggle to offer adequate support and training to bridge this technological gap (Bond et al., 2020; Buzzetto-Hollywood et al., 2018). As technological advancements introduce new learning methods, they further highlight the prevailing digital divide among students. Such disparities can have profound implications for their educational experiences and outcomes.

In March 2020, the whole world was affected by the COVID-19 pandemic and the digital divide became even more evident. According to the Department of Basic Education (DBE), COVID-19 had a substantial impact on higher education institutions worldwide, as they faced the abrupt challenge of transitioning to online teaching and learning (DBE, 2020a). For some, the pandemic represented both a blessing and a curse, compelling institutions to utilise the opportunities presented by online teaching and learning (Simpson et al., 2020). For these observers, COVID-19 created opportunities for the transformation of the delivery of knowledge from face-to-face to online or remote teaching and learning modes. However, it soon became apparent that not every university could easily shift to online teaching and learning (Mhlanga et al., 2022). Traditional and comprehensive universities[1] in South Africa adjusted reasonably well to COVID-19, but the universities of technology (UoTs)[2] faced major challenges (the complexities of UoTs are discussed in depth in Section 1.1 of this chapter) (Gumede & Badriparsad, 2022; Woldegiorgis, 2022). The challenges for UoTs are clear evidence that COVID-19 has laid bare the inequalities of access to and participation in higher education (Simpson et al., 2020).

In South Africa, most students at UoTs come from marginalised communities and “previously and currently disadvantaged backgrounds” with limited resources (Hammond et al., 2009). A common problem that most South African higher education institutions face is that many students enter higher education and are unable to fund their studies at university (Edgcomb & Vahid, 2014). The "Higher Education and Skills in South Africa" report, which Statistics South Africa released in 2020, found that more

[1] In South Africa, there are a total of 26 public universities. Among them, twelve are classified as traditional universities, focusing on providing theoretically oriented university degrees. Additionally, eight universities are categorised as universities of technology, offering vocationally oriented diplomas and degrees. Lastly, there are six comprehensive universities that provide a blend of both types of qualifications, catering to a diverse range of academic and vocational pursuits (Frith & Prince, 2018).

[2] Universities of technology (UoTs) place their emphasis on technology innovation and transfer, providing educational programmes that are specifically geared towards careers. These UoTs collaborate with industry for work-integrated learning which is a significant part of the programmes offered.

than half (or 51%) of youth (aged 18–24) claimed that they did not have the financial means to pay for their tuition (StatsSA, 2020; DBE, 2020a).

The COVID-19 pandemic presented unprecedented challenges to the education sector, especially in the realm of accessing academic resources. With university libraries closed and delays in deliveries from global online retailers like Amazon, students faced significant hurdles in acquiring textbooks. This was particularly problematic for engineering students given the high costs associated with their textbooks (Gyllen et al., 2018). The shift towards e-textbooks emerged as a practical and economical solution. Not only are e-textbooks more affordable (Daniel & Woody, 2013; Dlodlo & Foko, 2012), but they also offer immediate access to the content (Daniel & Woody, 2013), addressing the delays associated with physical deliveries. Recognising the gravity of the situation and the need to sustain the academic project, the management at the UoT where research data was gathered for this study, took the progressive step to provide students with e-textbook access across all engineering disciplines.

In South Africa, a country faced with numerous challenges yet brimming with resilience, smartphones have become a significant source of hope. Their ubiquity has transformed them from mere communication devices to potentially potent learning tools (Dlodlo & Foko, 2012; Embong et al., 2012; Hwang et al., 2018). This trend is not confined to South Africa alone; research indicates that smartphones have become indispensable in countries grappling with similar challenges (Uden, 2007). Thus, as the educational landscape continues to evolve, the pivot towards digital resources like e-textbooks, especially accessed via smartphones, is both timely and imperative.

Moving from face-to-face teaching and learning to online learning during the pandemic, opened new opportunities for investigation of digital literacy practices for reading science, technology, engineering and mathematics (STEM) subjects, discussed in the next section of this thesis.

1.1 Rationale and context

This research study aims to contribute a better understanding of the digital literacy practices students employ when they are involved in reading e-textbooks in an engineering context. The research is located within the field of engineering education and draws on the socio-cultural concepts of cultural-historical activity theory (Vygotsky, 1978a, 1986, 1997) and mediated discourse analysis (Jones & Norris, 2005; Scollon & Scollon, 2003). The research project seeks to understand how first-year engineering students engage and interact with e-textbooks for learning purposes. In particular, I was interested in seeing what digital literacy practices novice engineering students employ and how they engage with e-textbooks, since digital literacy goes beyond the traditional literacy practices of reading and writing. My emphasis in this project is on the nature of digital literacy practices when students read e-textbooks to gain engineering knowledge. I also investigated lecturers' practices regarding the use of e-textbooks in order to discover whether and how e-textbooks change teaching practices.

South African UoTs have recognised the need to provide engineering students with epistemic and technological access to digital learning tools. However, we know very little about how students interact with e-textbooks. The increasing complexity of engineering content necessitates that engineering students receive additional instruction and in-class support to better comprehend these texts. In these circumstances, engineering e-textbooks should provide students with adaptable support as they engage with complex concepts (Roberts et al., 2021).

Several researchers, including Daniel and Woody (2013), Embong et al. (2012), and Katsarou and Sipitanos (2019), have explored the use of e-textbooks as educational aids. Their studies reveal that e-textbooks offer advantages in higher education such as flexibility, accessibility, interactivity, and cost-effectiveness compared with traditional paper books. Additionally, research conducted by Fike et al. (2016), Lim and Hew (2014), and Martin-Beltrán et al. (2017) suggests that e-textbooks have the potential to enhance student learning.

Despite these potential benefits, some individuals still hesitate to embrace e-textbooks in education. Numerous university educators, as found by Dlodlo and Foko (2012), Eicker-Nel and Matthee (2014), and Liebenberg (2010), view e-textbooks as a novelty, particularly in the field of engineering. Moreover, not all South African students possess the necessary skills to navigate and utilise e-textbooks effectively. This is because, when students encounter online texts with embedded resources like hyperlinks, audio clips, graphs, or charts requiring decision-making, specific skills become essential (Leu et al., 2015).

Research on reading e-textbooks for learning purposes is moving beyond reading in the classroom or other environments. There is a growing awareness that digital literacy practices take place in increasingly complex and interconnected ways (Dooly, 2017). Digital technologies potentially lead to exciting new teaching and learning opportunities, but their effective use often demands of students and lecturers a new set of skills. Traditional practices that previously dominated education may not be enough in the face of new digital technologies. However, as mentioned in the previous section, there is a digital literacy gap in South Africa (Teferra & Altbachl, 2004). This digital literacy gap exists among students as well as educators, and suggests an urgent need for students and educators to develop “new” digital literacy practices, not only for use in their social life but also for the academic purpose of teaching and learning.

Although e-textbooks have the potential to transform students' learning experiences, their availability alone is inadequate to address educational inequality. While some students have consistent access to digital resources, others do not, making it difficult for them to engage with e-textbooks (Edmondson & Ward, 2017). Additionally, students who have never used a digital device for learning may find e-textbooks difficult to use (Al-Qatawneh et al., 2019). While lowering the cost of e-textbooks may assist some students in overcoming financial barriers, it is important to note that reading e-textbooks does not automatically make students digitally literate. Students instead need to develop critical thinking skills in the digital age. As a result, while e-textbooks may give students more flexibility and access to resources, more support and interventions are required to address the broader issue of educational inequality in South Africa, even when e-textbooks are used.

Furthermore, the transition to technology-enhanced learning in South Africa presents a unique set of challenges, particularly for first-year engineering students. Many of these students hail from the country's rural regions, where access to technology is limited. In fact, a significant portion only encounters computers for the first time upon entering tertiary education. Yet, the advent of the COVID-19 pandemic accelerated the shift towards online learning across all South African universities. This shift highlighted the affordability and accessibility of digital resources, such as e-textbooks. The transition, however, was not seamless for all educators. While lecturers seasoned in face-to-face teaching grappled with the digital transition, often facing the arduous task of converting traditional lectures to online formats, those with prior exposure to technology-integrated teaching recognised the enhanced opportunities online platforms offered. This study explores these varied experiences, specifically examining lecturers' pedagogical approaches and interactions with e-textbooks.

During the COVID-19 pandemic, engineering lecturers at South African higher education institutions (HEIs) faced significant challenges in transitioning course content online. Moreover, they grappled with devising and implementing new strategies to cater to a diverse student body. Within South Africa's higher education landscape, there are three distinct types of universities: traditional universities, comprehensive universities, and UoTs. UoTs, which evolved from institutions akin to technical colleges, and formerly known as technikons, generally do not enjoy the same research-intensive status as their traditional counterparts. Historically, these UoTs were established from technical colleges, primarily hiring faculty with technical expertise from professional sectors. As a result, they often lack staff with advanced, research-oriented degrees, reflecting their vocational roots (Garraway & Winberg, 2019).

This research project is situated within a faculty of engineering and the built environment (FEBE) at a UoT. The FEBE generally adopts a student-centred approach that incorporates appropriate digital technologies (Faloye & Ajayi, 2022). For this study, I worked with first-year students from the Extended Curriculum Programme (ECP). The ECP is designed to provide students with greater academic support. These ECPs play a significant role in providing access to and retention of students in higher

education in South Africa (Shay, 2016). This choice of selecting ECPs was made because ECP students require more support and interventions to improve their academic performance than typical mainstream students. One of the interventions in the engineering faculty at the UoT, was to implement e-textbooks because of the high failure rate in the first year at university (Ramnarain & Molefe, 2012) in UoTs, comprehensives, as well as traditional universities in South Africa. Another challenge is the complexity of the subject content. Physics e-textbooks include chapters covering foundational engineering knowledge of mechanics, fluid mechanics, thermodynamics, electricity, and electronics. These sections lay the foundation for many engineering disciplines and require students to have good conceptual understanding.

1.2 Research questions, aim and objectives

The focal research problem in this study is to investigate the digital literacy practices of students at a university of technology in South Africa, exploring how they use e-textbooks for engineering subjects.

Primary research question: *How do students and lecturers engage with engineering e-textbooks?*

Secondary research questions:

- *What digital literacy practices do students employ while using engineering e-textbooks? (RQ1)*
- *How do lecturers deploy engineering e-textbooks in the classroom? (RQ2)*

This research aims to contribute to the existing body of knowledge on the utilisation of e-textbooks as tools for teaching and learning. By focusing on engineering students, this study seeks to gain insight into how students engage with e-textbooks, which could potentially explain digital literacy practices associated with e-textbooks. The first objective of this study is to discover which “new” reading practices (digital literacy practices) students use for academic purposes. The second objective of this study is to investigate how engineering lecturers deploy engineering e-textbooks in the classroom.

1.3 Combining CHAT and MDA to investigate digital literacy practices

The theoretical framework in a research project can be likened to a "blueprint" that lays the foundation for the entire investigation (Grant & Osanloo, 2014). It acts as a guiding principle, offering direction and support to the study, and outlines the philosophical, epistemological, methodological, and analytical approaches that will be employed in the study. This framework serves as a solid grounding base, akin to an anchor, for conducting the literature review, as well as for shaping the methods and analysis in the research.

This study adopts an interpretive framework, drawing upon two key approaches: cultural-historical activity theory (CHAT) and mediated discourse analysis (MDA). By using these methodologies, the research gains insight into students' behaviours within their real classroom environments, enabling a comprehensive understanding of human activities and agency within them (Johnson & Johnson, 2009, p. 365). CHAT is defined as an interdisciplinary approach to studying human learning and development (Cole, 2010, p. 463; 1998). On the other hand, MDA delves into discourse beyond the text and explores students' social actions and their cultural tools. MDA enables scholars to analyse the multimodal aspects of communication, such as text, images, and video. The combination of CHAT and MDA allows for examination of digital literacy practices in their social, cultural, and historical contexts. By combining both frameworks, I can conduct a comprehensive analysis of digital literacy practices that considers both the social context of this study and the multimodal aspects of e-textbooks.

Cole (1996) extensively researched cultural-historical perspectives and activity theory, which he referred to as cultural-historical activity theory to encompass both the cultural-history perspective and the activity practice. In this study, I aim to follow Michael Cole's suggestion by exploring how cultural history is evident in the activity system. According to Cole (1998, p. 143), culture is viewed as a system of artefacts, and the mind mediates behaviour through these artefacts. By using both CHAT and MDA as interpretive frameworks, the focus is on analysing the overall activity system of a group of students reading e-textbooks (Engeström, 2001).

A significant number of educational studies conducted within CHAT and MDA are focused on the integration of emerging technologies into existing instructional frameworks (see, e.g., Hardman, 2007; Schuh et al., 2018; Wohlwend, 2009). One of the difficulties associated with integrating new tools into the system is the possibility that the tool will change the object or perhaps transform the object itself. A “tool object reversal” is the term used to describe this phenomenon (Virkkunen et al., 2013). For example, according to the research of Schuh et al. (2018), “students' e-textbook use may be limited if they consider it as a mere object with no special function”, which means that students may not see the value in using an electronic textbook. To put it another way, if the technology is too distracting or too complicated, and it ends up being the focus of the action rather than the instrument, then it will not be successful in achieving the goal that it was designed to achieve.

I was also able to recognise the tensions and contradictions that arose when a new tool (the e-textbook) was introduced. Through the lenses of CHAT and MDA, I analysed students' digital literacy practices, viewing them as an integral part of the cultural history within the activity system. The participants in the study were introduced to digital artefacts such as e-textbooks developed in the digital space. As participants collectively adopted these tools, however haltingly, they brought their beliefs into their practices, which were influenced by cultural tools developed over time, as proposed by Cole: "Culture comes into being wherever people engage in joint activity over a period of time" (Cole, 1996, p. 301). These cultural tools possess the capacity to either mediate or constrain human behaviour (Vygotsky, 1986). To fully grasp the existence and impact of social and cultural tools, it is crucial to consider the entire activity system as the unit of analysis (Yamagata-Lynch, 2010). By integrating CHAT and MDA, researchers can attain a deeper understanding of this complexity, including how digital literacy practices are shaped by broader social and cultural influences, as well as how they are enacted and negotiated in everyday interactions.

Lastly, combining CHAT and MDA can have further practical applications, such as informing the design of digital literacy interventions or assisting educators in better understanding how to support the digital literacy development of their students. Researchers can therefore contribute to the development of effective strategies for

supporting digital literacy in a variety of contexts by gaining a more comprehensive and nuanced understanding of digital literacy practices.

1.4 Research design

Because this study involved investigating behaviour of engineering students and lecturers in naturalistic settings, a qualitative paradigm was selected (Denzin and Lincoln, 2005; Lincoln & Guba, 1985). The selection of a qualitative research paradigm was driven by the need to understand real-life experiences and events, specifically concerning engineering students' usage of e-textbooks. Given the continuously evolving nature of the digital literacy practices related to reading e-textbooks, a naturalistic approach employing qualitative case study methods and techniques was considered the most beneficial in documenting in-depth engagement of both students and lecturers with e-textbooks.

The research design was one case study, with a focus on two embedded units of two engineering departments at a UoT in South Africa. The research sought to comprehend the various relationships between a specific phenomenon and the context and variables within a specific bounded system (Yamagata-Lynch, 2010). This study began with interviews with lecturers and progressed to interviews with students. The study focused on exploring how engineering students utilised e-textbooks for their physics courses at the selected UoT. Operating within an interpretive paradigm, the case study sought to gain preliminary insights into the methods students used to incorporate e-textbooks into their learning process. The investigation concentrated on twelve individual students and four engineering lecturers, forming an embedded case study (Merriam, 1998; Stake, 1995; Yin, 2009).

Unlike traditional quantitative inquiries seeking positivistic generalisation (Yin, 2018), this study did not aim for broad generalisations. Instead, its objective was to provide a descriptive account of the phenomenon, specifically digital literacy practices concerning e-textbook reading, to enhance current and future academics' understanding of student engagement with e-textbooks. By gaining a deeper insight into these experiences, some analytical generalisation could be established, serving as a foundation for comprehending and informing the applications of e-textbooks in

higher education in a similar context (Yin, 2018, p. 63). Consequently, this knowledge could shed more light on the interaction between e-textbooks and engineering students, informing future research into e-textbooks and student learning in higher education.

1.5 Significance of the study

South African universities are preparing for increasingly digitalised workplaces. Access to technology creates an opportunity to incorporate technology into the classroom to improve the teaching and learning process. However, some argue that pedagogy should be the driving force and technology should be merely an accelerator (Fullan & Langworthy, 2014). In South Africa, technology has not been fully integrated into the learning process, and many students still struggle to study partially or entirely online. Following the dilemma of digital technology and access, digital technologies play a significant role in how our daily lives are now markedly different from what they were 20 years ago. Learning on and through the World Wide Web introduces a slew of new practices that both extend and challenge traditional notions of universities and literate practice (Lea & Goodfellow, 2009).

This study contributes to engineering education research, which is a relatively new field of study, particularly in South Africa. A substantial amount of literature on e-textbooks in education (Fike et al., 2016) and business has been published. However, very few studies on the use of e-textbooks in engineering education have been conducted (Gyllen et al., 2018). Although research seems to be increasingly supportive of the benefits of using e-textbooks, there is a notable scarcity of studies focusing on how students actually interact with these digital resources. Additionally, with the availability of interactive e-textbooks and other e-textbook features, there is the possibility of achieving even greater learning outcomes. In this study, my aim was to explore the various affordances offered by e-textbooks and to understand how students actually utilised them in practice in their reading and engagement with the e-textbooks. Moreover, this research should contribute to the existing knowledge on the utilisation of e-textbooks as tools for teaching and learning. By focusing on engineering students, this study seeks to gain insight into how students use e-textbooks, which could potentially help explain the inconsistency in learning gains associated with their

use. Additionally, the objective of this study is to discover which “new” reading practices (digital literacy practices) students use for academic purposes. I examine how engineering lecturers use e-textbooks as an educational tool and demonstrate the impact this has on the lecturers' pedagogical activity. It is critical to examine how lecturers use e-textbooks for teaching and assessment, as well as how e-textbooks are used as a means of mediation to improve understanding of complex engineering concepts.

My objective is to benefit engineering students and lecturers in a very practical way. Understanding and knowing the affordances of e-textbooks, I believe, can improve learning and facilitate teaching for engineering problem-solving where students must apply theoretical knowledge to solve complex practical, real-world problems. It is hoped that this research will benefit engineering students and lecturers, particularly in terms of pedagogy and policy.

This study augments the existing body of knowledge, particularly within the realms of CHAT and MDA. From the outset, I was inclined to employ socio-cultural concepts theory as a lens for data analysis. The primary focus was to decipher how engineering students engage with digital texts. This entailed a deep dive into digital literacy practices, examining specific interactions and engagements pivotal to the study process. The research further explored literacy practices tailored for teaching engineering subjects in classrooms and the use of e-textbooks as mediational tools for both assessment and curriculum practices.

Recent arguments in favour of new media have also expanded to systematically examining e-textbooks and digital literacy practices (ICTs information communication technology). As a result, it is clear that more research into digital literacy, specifically for engineering students, and how they engage with e-textbooks for learning purposes, is required. As an engineering lecturer, I take my role in researching digital literacy practices seriously. My intention is thus to use e-textbooks to bridge the knowledge gap and to reimagine digital literacy practices around the digital text. At this point, I have only started to explore these potential contributions, but further contextual development and positioning are needed for a comprehensive understanding, as revealed in the subsequent chapters of this thesis. Ultimately, this research on digital

literacy practices is anticipated to aid the design of curricula and pedagogy that align better with the specific requirements of engineering education in the twenty-first century.

1.6 Outline

As a researcher, my primary focus is to investigate the digital literacy practices employed by students when reading physics e-textbooks. To address these research questions, the thesis is structured into eight chapters, which will provide a comprehensive examination of the topic. In the first chapter, I have introduced the aim, research questions, objectives and rationale for this study, as well as how I collected and analysed the data. This is an introductory chapter, outlining the landscape of this study.

Chapter 2 situates the research in the broader contextual framework and draws on available literature to present aspects of digital literacy practices as well as exploring reading in engineering education. It then discusses studies on using e-textbooks in general and for engineering subjects specifically.

Chapter 3 introduces cultural-historical activity theory (CHAT) and mediated discourse analysis (MDA), and presents the key concepts of each theoretical and analytical lens. In this chapter, I provide a discussion of why two theoretical frameworks were selected for this study and what each of these theories contributes to this study.

Chapter 4 introduces the research design for this study. I start this chapter with an explanation of interpretivism and the qualitative paradigm for this research and case study. I then introduce the pilot study, which was done one year prior to the main data collection for this study. After that, I discuss the participants and selection strategy employed. Next, I detail the methods of data collection and data analysis. In the last section, I discuss the trustworthiness and rigour of the study.

There are three data analysis chapters. Each chapter presents detailed analysis of the two embedded units of a single case study.

Chapter 5 introduces the two groups of students and the four lecturers' responsibilities, roles and experiences.

In Chapter 6, students' engagement with e-textbooks is addressed, where I discuss the different affordances that students employed. I then discuss patterns of interaction and possible opportunities for collaborative reading among students. Additionally, in Chapter 6, I investigate the four lecturers' understandings of e-textbooks and their interaction with e-textbooks in terms of the affordances utilised by the lecturers.

In Chapter 7, I provide contradiction analysis of students' and lecturers' activity, drawing on the second and third generation of CHAT. In this chapter, I focus on the learning and pedagogical practices of the participants.

Finally, Chapter 8 summarises the findings, and discusses potential limitations and implications for curriculum and pedagogy. This chapter also concludes the thesis with suggestions for further research.

Chapter 2
Understanding the digital literacy practices associated with e-textbooks

"We must form our minds by reading deep rather than wide" – Marcus Fabius Quintilianus

The previous chapter provided an overview of this research. It also discussed the rationale and motivation for this research, the research questions, as well as the theoretical framework and research design. This chapter provides an extensive literature review on e-textbooks and digital literacy practices and how students interact with digital texts in higher education. In this chapter, I explore various issues and debates related to literacy practices and reading. After that, I discuss changing literacy practices for reading e-textbooks with a specific focus on engineering studies. I then look at the advantages of using e-textbooks for teaching and learning, as well as the challenges of incorporating them into the curriculum. Lastly, I discuss the affordances of e-textbooks and the research gaps in the current literature.

2.1 Reading as literacy practice

The concept of literacy as a social practice, as developed by Street (1984), Gee (1999), and Barton and Hamilton (1998), emphasises the significance of social relationships within institutions. In this study, literacy is specifically examined through the act of reading for study purposes. Literacy practices encompass the cultural ways in which individuals use language in their everyday lives. Essentially, literacy practices encompass what people do with literacy in specific contexts. The term “practice” acknowledges the dynamic and interconnected nature of contemporary information and communications technologies (ICTs) (Lea & Goodfellow, 2009). Practices extend beyond mere observable behaviours; they also encompass values, attitudes, emotions, and social interactions (Street, 2001; Pahl & Rowsell, 2020).

Furthermore, practices encompass individuals' literacy awareness, literacy constructions, and literacy discourses, which encompass how people talk about and make sense of literacy. These processes are internal to individuals, but they also form the social processes that connect people with one another. For instance, reading in

an educational setting involves social relationships among individuals, such as those between lecturers and students, among students, and between authors and readers. These social relationships establish groups and ways of interacting with others, influence one's social status and position, and contribute to acquiring culturally appropriate ways of thinking, problem-solving, valuing, and feeling (Julian, 2018).

The study of literacy involves more than just language; it includes social and situated interaction among people that is set in a social activity or event. This alerts us to the fact that literacy cannot be viewed as a separate event, and consideration should be given to what people are doing and how, what types of practices they engage in and under what conditions, as well as with whom they are doing it. Simply put, literacy should be considered as a complex, social and situated process which goes beyond traditional notions of reading, writing and numeracy (Pantaleo, 2010; Smagorinsky, 2011a).

The New Literacy Studies (NLS) framework has established a tradition of investigating informal and everyday literacy practices (Goodfellow & Lea, 2013; Lee & Goodfellow, 2009). It highlights the importance of studying language and literacy within their natural social context, while taking cognisance of different cultural groups' meanings. NLS emphasises the need for educators, curriculum designers, and evaluators to recognise how students bring meaning and practices from their home communities to formal learning settings, such as university classrooms.

NLS views academic literacy as a social practice, focusing on the social aspects within academic texts. Individuals' cognitive and social development is connected to the socio-cultural environment through social practices (Bloome, 1985; Smagorinsky, 2011b). The social context of reading events cannot be described broadly or statically. Instead, it depends on how people interact with each other, with differences arising in the selection of readers or speakers, the material being read, when and where reading occurs, and the various ways reading is performed.

Literacy is inherently linked to the historical context of a society (Barton & Hamilton, 2000). It is situated within a specific historical background, and the understanding of this history plays a crucial role in conceptualising literacy practices. Furthermore,

literacy practices are purposeful and deeply embedded in social goals and cultural practices. For the full implications of this statement to be realised, it is necessary to situate “social goals” in the constructed future and “cultural practices” as having been constructed through recurrent events in the past and emergent in the present (Barton & Hamilton, 2000). This will be seen later in my analysis of the literacy practices associated with students’ reading and interaction with digital texts (in Chapters 5 and 6), where literacy plays a key part in academic activities to achieve shared social goals.

When examining various literacy events, it becomes evident that literacy is not uniform across all contexts; instead, there exist different literacies. Different literacies can be defined in various ways. For instance, practices involving different media or symbolic systems, such as film or computer, can be considered distinct literacies, like film production literacy and computer literacy. Another perspective is that different cultures and languages entail different literacies. In this context, we primarily use the term to refer to literacies as coherent configurations of literacy practices. These sets of practices are often identifiable and named, such as academic literacy or workplace literacy, and they are linked to specific aspects of cultural life (Baker et al., 2019). This understanding acknowledges that literacy can take on different forms and be shaped by the specific contexts and purposes it serves in society.

2.2 “New” digital reading practices

Understanding the distinction between digital and traditional literacy practices is pivotal. Traditional literacy encompasses reading textbooks, engaging with novels, discussing cultural values, and using writing as a tool for expression (Singer & Alexander, 2017, p.1023). In contrast, digital literacy, as described by Bawden (2008), denotes one's ability to adeptly navigate digital platforms, curate and assess information, and employ methods such as typing and tapping. This necessitates a foundational understanding of computer skills and the ability to engage with multimedia content like video calls and messaging. While the basic competencies of reading and comprehension underpin both literacies, digital literacy demands an additional layer of technical proficiency. By “technical skills” I refer to mastering e-reader navigation, digital text traversal, and digital annotation.

The reading paradigm has evolved with digital books, sparking diverse perspectives among educators and researchers. The medium of reading, whether it is traditional paper or digital, does influence readers' reactions. However, the purpose behind reading also significantly shapes these responses (Katsarou & Sipitanos, 2019). A competent reader not only knows which reading strategies to apply, but also discerns their appropriate contexts. The debate on comprehension levels across print and digital texts remains ongoing, with some research suggesting differences (Edgcomb & Vahid, 2014; Eicker-Nel & Matthee, 2014), and others finding consistent metacognitive learning across both mediums (Cardullo et al., 2012; Junco & Clem, 2015).

Literacy transcends individual skills, reflecting broader social practices. As literacy transitions from traditional to digital, students employ varied strategies, whether they're navigating digital content like text, graphs, or videos (Gilliot et al., 2010) which impact learning. This dynamic landscape underscores the need for ongoing research and pedagogical adaptation. Reading in the digital age extends beyond just text. Websites might offer content in bite-sized segments, interspersed with hyperlinks, images, and videos. Conversely, storybook apps typically maintain a linear format, akin to printed text, but often incorporate audio aids and interactive elements (Bearne, 2009; Bearne & Kress, 2001).

While both e-textbooks and traditional textbooks are multimodal, e-textbooks offer readers a diverse range of affordances, enabling them to better grasp concepts (Eicker-Nel & Matthee, 2014). E-textbooks present various media, including videos and simulations, and tools like note-taking features (Smagorinsky & Coppock, 1995). The act of reading is transformed with multimodal practices such as touching, tapping, and clicking (McLean et al., 2018). Beyond consumption, students also become content producers (McLean et al., 2018), emphasising the need to understand the semiotics of images, colours, sounds, and layouts in digital spaces (Kress, 2003).

Digital literacies, as defined by Dudeney et al. (2013, p.2) and others, encompass skills essential for interpreting, managing, and sharing digital content. More than just individual competencies, these literacies allow students to actively participate in societal actions (Scollon, 1999). This study views digital literacy as not just about

reading and writing in digital spaces, but also about interactive engagements within specific educational contexts. Such interactions might encompass searching, zooming, and annotating. These specific digital literacy operations within e-textbooks are termed “e-textbook affordances” (Martin-Beltrán et al., 2017).

The digital realm presents a multitude of text types, each with its unique purposes. The National Assessment of Educational Progress (NAEP) emphasises this diversity, suggesting that different texts might necessitate varied reading behaviours (National Assessment Governing Board, 2013). With digital texts increasingly infiltrating academic spheres, it is imperative to explore how students engage with them and the literacy practices they adopt in such digital landscapes.

2.3 Challenges and opportunities associated with digital reading

Digital technology changes the literacy practices in which we participate in our daily lives. Hence, different skills, strategies, and dispositions are needed to engage in these practices (Martin & Mulvihill, 2017). Accordingly, these practices should be reflected in the university curriculum, and opportunities to develop these new skills, strategies, and dispositions should be provided (Martin & Mulvihill, 2017). When reading moves into a digital space, the term “reading” takes on new meanings and may begin to carry different implications for reading comprehension.

Digital reading requires skills that are different from traditional reading. Even a simple reading device such as an Amazon Kindle comes with embedded features such as a dictionary and highlighting features that create a different reading experience. Digital reading, or the act of consuming texts on a digital device (i.e., e-reader, tablet) or platform (i.e., blog, wiki, website), utilises traditional reading skills, such as decoding and fluency, but also often requires students to use other skills, such as navigating texts, listening to audio, or viewing video (Kiili, 2012).

In digital reading environments, our traditional understanding of reading comprehension is being challenged. Many adolescents, adept at conventional reading, may struggle with the distinct comprehension demands posed by navigating search engines (Eagleton & Guinee, 2002), deciphering search outcomes (Coiro,

2011), and critically assessing information tinged with social, commercial, or political biases (Julian, 2018). In today's digital writer–reader landscape, communication thrives on interconnectedness. Readers and writers forge connections through a vast reservoir of instantly available information, allowing for swift creation and distribution of content. This profusion and immediacy of data reshape the dynamics of reader–writer interactions in the digital realm (Coiro, 2011; Dobler, 2015; McLean et al., 2018). For instance, the way people seek information is evolving. E-textbooks are addressing user needs (JISC, 2003) with greater efficiency and convenience compared with traditional books. Reading is increasingly becoming a collaborative activity, bridging global gaps and necessitating the acquisition of novel digital proficiencies.

For example, the latest licensed Adobe Acrobat Pro DC software, a renowned PDF reader, offers numerous interactive features that enhance the reading experience, facilitate text modification, and enable seamless collaboration with colleagues through file sharing and document merging. However, it is essential to recognise that while PDF files were originally designed for printing purposes, their usage has significantly evolved over time. Traditionally, PDF files primarily served as a means of preserving document formatting and ensuring accurate printing results. However, in today's digital era, PDFs have become a widely adopted format for reading and sharing content, particularly in academic and research domains. Many researchers rely on PDF files as a standard format for accessing scholarly articles and books.

Moreover, modern research databases have adapted to user preferences by providing a variety of reading options, including the widely used PDF and ePub[3] formats. This adaptability ostensibly facilitates a tailored reading experience, allowing for choice based on individual reading needs. However, this flexibility is not without its challenges. For instance, not all devices are primed to seamlessly display both PDF and ePub formats. While PDFs generally offer consistent rendering across platforms, ePub files can sometimes introduce formatting inconsistencies. Moreover, accessibility enhancements during format conversions don't always cater to users with disabilities, potentially hampering their reading experience. The dynamic nature of

[3] ePub is an e-book file format that uses the “ePub” file extension. ePub is supported by many e-readers, and compatible software is available for most smartphones, tablets, and computers.

ePub may also be incompatible with older devices, whereas PDFs, particularly graphic-rich ones, can be cumbersome in size. Transformations between these formats can inadvertently alter the original content's layout or text. Furthermore, the spectre of Digital Rights Management (DRM) restrictions looms over these formats, possibly constraining sharing, printing, or even basic reading on certain devices. And while the digital nature of these formats might suggest advanced interactivity, both PDF and ePub can sometimes fall short, lacking elements like embedded videos. Lastly, utilising these formats often mandates specific, sometimes costly, software, presenting another hurdle for readers Despite the benefits of content adaptability within PDF and ePub as highlighted by Julian (2018), it's imperative for users to navigate their inherent challenges judiciously.

In current research on e-textbooks, many scholars focus on student voices and their perceptions of a technology. In their review, Singer and Alexander (2017) found that the length of the text made a difference in the comprehension of undergraduate students. Specifically, Singer and Alexander (2017) conclude that students process digital texts more effectively if they are able to break them into shorter sections. Other studies that investigated reading speed and comprehension revealed no notable distinctions between print textbooks and e-textbooks. For instance, Sackstein et al. (2015) observed that students read faster on iPads compared with print, yet comprehension levels showed no significant difference between the two platforms (Chmiliar, 2015). Additionally, another study on e-textbooks (Julian, 2018) found that digital texts encourage behaviours such as skimming and keyword seeking. Perhaps this can explain why students read digital text faster. One of the key digital literacies skills that needs to be developed is the self-control required when reading digital text in order to manage the distractions of online reading (McLean et al., 2018). However, in addition to all these studies, there is an evident gap in that digital readers also need to develop new literacy practices aimed at collaboration, information-sharing, curation of content and advanced annotation (Schuh et al., 2018).

As has been mentioned earlier in Chapter 1, students in higher education in South Africa may not all be digitally literate and do not necessarily all have the same digital capability levels or skills (White & Le Cornu, 2011; White & Le Cornu, 2017). Despite being “native” to the digital world, students may still require instruction on how to

effectively utilise online tools for educational purposes. When it comes to reading digital text, educators need to impart new literacy practices to students so they can engage with digital content for academic study. These practices might involve employing tools like flashcards, digital notetaking, highlighting text, conducting searches, and utilising virtual bookmarks and glossaries. Digital texts provide readers with the ability to customise, manipulate, and navigate content through various features such as hypertext, screen resolution, page orientation, text size, and read-aloud capabilities. Certain students can find advantage in e-textbook features such as auditory pronunciation of words and instant word definition lookup by clicking on a word in the text (Hyman et al., 2014). It is evident that reading online differs from offline reading, demanding the implementation of additional reading strategies (McLean et al., 2018).

E-textbooks have unlocked the potential for collaboration, not just among peers, but also between students and lecturers. Such collaboration transforms both parties into engaged, critical readers (Julian, 2018). The landscape of digital academic texts is evolving towards greater interactivity and collaborative learning, allowing students to benefit from collective insights. Yet, there's a pressing need for deeper research into fostering collaborative digital literacy, encompassing interactions not only among students but also between students and lecturers. As digital technology continually reshapes our literacy practices, traditional teaching methods fall short in equipping students for future literacies. The modern student must be adept as a navigator, collaborator, digital communicator, problem solver, critical consumer, and beyond. Nonetheless, there's a challenge: educators sometimes grapple with integrating digital technologies into their teaching (Hutchison & Reinking, 2011). Therefore, a synergy between lecturers and publishers is imperative to ensure students are well equipped for their digital reading environments.

2.4 Digital textbooks, higher education and engineering study

In academia, reading and writing are closely interconnected, as readers develop their thoughts and ideas through the act of writing (Frankel et al., 2016). Both reading and writing represent literacy events, which are manifestations of literacy practices – social practices where individuals employ reading and/or writing to comprehend information

and achieve social objectives (Baker et al., 2019). This perspective on literacy encourages researchers to move beyond the text itself and investigate how people use literacy in various contexts (Goodfellow & Lea, 2013; Lee & Goodfellow, 2009). Reading is an active and strategic process, where readers deliberately and consciously apply reading strategies to construct meaning from the text (Bikowski & Casal, 2018). In this section, I shall discuss how the reading process aligns with broader academic literacy practices.

Reading skills serve as the foundation for both academic and personal development. Yet, the mode and method of reading have undergone significant transformation; the rise of the digital age means that the confines of classrooms or workplaces no longer limit learning. Contrary to the belief that modern students have moved away from reading, they are, in fact, increasingly engaging with digital texts, often accessed through smartphones, though there's also a growing inclination towards visual content like videos.

Navigating the digital landscape introduces new challenges. Reading from screens involves considerations like contrast, resolution, luminance, fonts, letter size, and potential eye fatigue (Sackstein et al., 2015). Beyond the mere act of reading, digital platforms demand skills like navigating hyperlinks and hypermedia, skimming, scanning, curating, searching, and more (Brown et al., 2016; Coiro, 2011; Dobler, 2015; Julian, 2018; O'Bannon et al., 2017; Rockinson-Szapkiw et al., 2013).

South Africa's rich linguistic tapestry encompasses eleven officially recognised languages. While historically, only English and Afrikaans held official status, today, nine African languages, including Sepedi (also known as Sesotho sa Leboa), Sesotho, Setswana, siSwati, Tshivenda, Xitsonga, isiNdebele, isiXhosa and isiZulu, share this distinction. For learners in South Africa for whom English is a second or foreign language, the educational journey presents distinct challenges (Webb, 2002). In mastering English, self-regulation emerges as a pivotal attribute. Students proficient in self-regulation can adeptly merge diverse skill components, from attention and working memory to inhibitory control. Typically, those with robust self-regulation capacities outperform peers with lesser self-regulation skills in academic contexts (Corno & Mandinach, 1983; Pintrich, 1995).

The utilisation of e-textbooks extends the boundaries of mere digital reading. Such tools can foster adaptive, self-regulated learning (Ahn, 2014; Ryu, 2017). As a consequence, e-textbooks might unlock novel avenues for students to delve deeper into texts, enhancing comprehension of intricate concepts and potentially broadening learning horizons for a diverse student populace (Singer & Alexander, 2017). This may be particularly important for engineering students. Traditionally, students who select engineering careers are expected to be highly digitally literate as a result of working with technology and electronics. Engineering students need access to technology from their first day at university because most engineering courses have practical and experimental work in virtual or physical labs. Access to virtual labs for engineering subjects can be provided through e-textbooks. However, to access and use these e-textbook features, engineering students require advanced digital literacy practices (Prensky, 2001). Engineering students must possess digital literacy as a crucial skill to actively engage in the world outside the classroom, while also benefiting their learning experiences within the classroom.

Digital literacy practices diverge from those employed while reading a paper book, as students have the ability to customise font sizes, utilise features to enhance reading comfort, and they are not bound by the constraints of printed paper or book size. However, students have to rely on the quality of their device and the quality of their access to the material. Additionally, students may be expected to create and collaborate using digital text (Chung et al., 2018). However, not all students are digital natives and they do not necessarily have the same capability levels (White & Le Cornu, 2017). Even though students have grown up in the digital world, some still need to be taught how to use online tools (such as how to navigate an e-textbook) for learning purposes.

Over recent decades, our rapidly evolving digital world has expanded and refined the definition of digital literacy. It now encompasses the localisation, evaluation, and utilisation of information within digital contexts, marking these as indispensable competencies. Such competencies align with a host of personal, professional, and interpersonal skills that are integral to the engineering curriculum. This skill set includes knowledge discovery, critical thinking, an innate curiosity, a penchant for lifelong learning, and effective communication (Gilliot et al., 2010).

However, it is crucial to differentiate between digital familiarity and true digital literacy. Being adept at sending texts or posting on social media does not automatically equate to digital literacy. True literacy transcends the basic ability to read and produce text, demanding mastery over an array of intertwined skills, with digital literacy being paramount among them. Recognising this, universities have the opportunity to resonate with the contemporary generation of engineering students by integrating and valuing their digital experiences (Wohlwend, 2009).

Literacy practices evolve over time, and individuals frequently acquire new practices through informal learning, sense-making, as well as formal education and training. This learning process occurs within specific social contexts, and it involves the internalisation of social interactions. Understanding informal and vernacular learning strategies, as well as the concept of situated cognition (linked to the research of Lev Vygotsky-influenced scholars such as Sylvia Scribner, Jean Lave, and colleagues: Lave & Wenger, 1991; Scribner 1984), becomes crucial. These aspects are further explored in Chapter 3, where the theoretical framework of this study is elucidated.

In general, the prescribed textbook holds significant importance as a primary teaching and learning tool. In engineering courses, it plays a crucial role in class discourse (Rockinson-Szapkiw et al., 2013; Schuh et al., 2018; Van Horne et al., 2017) and serves as a primary knowledge source for students. Many lecturers in engineering and science courses rely on textbooks (Donnell et al., 2014). However, the nature of the textbook is changing dramatically. Universities have moved to digital modes of teaching and learning. The utilisation of tablets, smartphones, electronic devices, and e-textbooks has grown significantly in recent times. Publishers are also providing an increasing number of e-textbooks (Van Horne et al., 2017). These digital texts can be accessed via the internet through learning management systems (LMS) and can be downloaded onto tablets, e-readers, smartphones, and laptops. However, as with many technological innovations, there's a discernible gap; while e-textbooks are rapidly being integrated, there is still a paucity of educational research exploring their efficacy.

In engineering, specifically, e-textbooks provide simulation of complex concepts and include visualisations to better explain concepts to students. E-textbooks do not only

present concepts in print and media format; they also include simulations that promote deep understanding of complex engineering concepts (Chung et al., 2018; Donnell et al., 2014; Gyllen et al., 2018; Richards, 2013). E-textbooks can be combined with virtual experiments to practise learning content, allowing students to engage with engineering experiments, watch learning videos, and solidify their knowledge. The capacity of experiments is limited by the constraints of space and access, hazards of handling tools and materials, and a lack of proper safety education. Virtual platforms adeptly navigate around these impediments. Yet, this evolution prompts a critical inquiry: To what extent does the knowledge assimilated from virtual environments translate effectively to real-world applications? Such queries underscore the imperative for continued research in this domain.

E-textbooks have evolved into platforms that seamlessly blend e-learning and e-publishing technologies. They present interactive reading materials, serving as a conduit for learning activities among learners and their communities. Engineering students and professionals rely on photographs, diagrams and video simulations to understand engineering concepts. Text, graphs, figures, and mathematical equations are commonly used in engineering textbooks to communicate ideas (Case & Light, 2011; Richards, 2013). E-textbooks can provide powerful video demonstrations for improving student engagement with scientific topics (Donnell et al., 2014). However, while these advancements offer a modern approach to learning, there are concerns. The heavy reliance on technology might overshadow the fundamental essence of traditional learning, potentially diminishing critical thinking and analytical skills. Moreover, the interface, though interactive, might not cater to all learning styles, potentially leaving some students behind. It is essential to strike a balance between leveraging technology and preserving the core tenets of holistic education.

2.5 Reading in the South African context

The main focus of critical research on e-textbooks has predominantly centred on “First-World” countries like the United Kingdom, the United States, France, and various Asian nations. China, Japan, Korea, Malaysia, and Singapore were among the pioneering countries in using e-textbooks in schools and higher education (Gu et al., 2015; Jang et al., 2016). In Korea, for instance, e-textbooks were developed as

supplementary material for paper textbooks within multimedia learning packages as part of courseware solutions.

Since 1994, the South African government has undertaken several initiatives to enhance literacy levels in the country, including literacy and reading campaigns, school upgrades, and teacher training (Bharuthram, 2012). However, despite these efforts, there are still reports of low literacy rates among South African school learners. For instance, the DBE reported a decline in literacy scores from the 2014 Annual National Assessment compared with those in 2013. In 2013, Grade 3 learners scored on average 57%, with a minimum of at least 50% in literacy, which increased to 66% in 2014. Similarly, a comparison of the 2013 Grade 3 results and the 2014 Grade 6 results indicated poor performance, with 42% of Grade 6 students scoring at least 50% (DBE, 2014). Recognising the importance of reading literacy in education, the South African Department of Education (DoE) made it a priority in 2004. The Revised National Curriculum Statement (RNCS) placed increased emphasis on reading. However, as pointed out by Howie et al. (2008), the reading outcome was incorporated alongside other language outcomes in the foundation and intermediate schooling phases, related to overall language competency (DoE, 2003).

Research on e-textbook use in Africa, particularly in South African schools and higher education institutions, remains limited (Dlodlo & Foko, 2012; Eicker-Nel & Matthee, 2014; Liebenberg, 2010; Sackstein et al., 2015). Focusing on higher education, Bharuthram (2012) examines the intricacies of teaching reading in South African universities. Given that university students are often more independent and perhaps more digitally adept, their e-textbook adoption patterns might differ from those of their high school counterparts. Moving to the high school context, Eicker-Nel and Matthee (2014) offer a perspective of studying e-textbook adoption starting from Grade 10. As students in this phase transition to advanced academic endeavours, understanding their digital resource needs becomes paramount. The diverse socio-economic backdrop of South Africa further accentuates the significance of discerning the unique challenges and advantages they encounter.

Liebenberg's study (2010) provides an earlier glimpse into this context, focusing on secondary school students. Given its timing, Liebenberg's study (2010) could

potentially offer insights into the nascent stages of e-textbook adoption and the initial hurdles faced by educators and students alike. It is evident that the topic is gaining traction within the academic community. Lastly, a broader study by Sackstein et al. (2015) encompasses both university and senior high school students across two distinct South African institutions. This comparative approach promises valuable insights into the differential adoption of e-textbooks among varied educational levels. Furthermore, the contrasting school environments could highlight potential disparities in e-textbook access, user experience, and their overall educational impact.

However, there remains a clear gap in the research literature. Very little research has been done on the use of e-textbooks in higher education within the South African context, with no studies that exclusively focus on engineering subjects. One of the possible reasons for the lack of research on e-textbooks in the South African context could be that many South African students have limited resources and in some cases fully depend on government and private scholarships to study (including fees and expenses such as residence, stationery and books) at university. Another reason for the lack of research could be that e-textbooks are still a new technology for students as well as educators. Additionally, not all engineering textbooks are available as e-textbooks.

The 2016 Progress in International Reading Literacy (PIRLS) study, which evaluated the reading comprehension abilities of fourth-year primary school learners, placed South Africa at the bottom of the list of 50 participating nations. Alarmingly, the study showed that an overwhelming 78% of these South African learners faced difficulties in reading for comprehension. This data underscores a profound reading crisis in the nation. Reading, being a cornerstone for academic achievement, not only shapes individual futures but also has broad societal implications. In an era where digitalisation has permeated every corner of the globe, it is worth pondering if integrating technology-based innovative teaching techniques could address this literacy gap. Indeed, digital technologies might offer solutions that could positively influence the reading literacy of first-year students, as suggested by Oyedemi and Mogano (2018).

The drive towards digitalisation has significantly influenced university management in South Africa, a trend that became starkly evident during the COVID-19 pandemic when traditional teaching methods were no longer viable. In today's digital era, technology permeates every aspect of life, including education, health, communication, and work, profoundly impacting these sectors (Batiibwe, 2019). For educators, technology serves as more than a mere tool; it acts as a bridge, enabling lecturers to present content more dynamically and engage students effectively with learning outcomes. The goal is to leverage technology to promote inclusive education, a mission particularly critical in developing nations like South Africa. Yet, transitioning to a fully digital educational paradigm poses challenges. Not every first-year South African student enjoys the privilege of reliable internet access or possesses a personal digital device. This issue is starkly evident among students in universities of technology (UoTs). A significant portion of these students hail from economically constrained backgrounds, often with limited exposure to computer use during their formative schooling years.

In the last decade, there has been a surge in innovative e-textbooks, offering both promising opportunities and distinct challenges for engineering education. These digital texts introduce new possibilities for studying engineering subjects. However, e-textbooks have been available for two decades, but there is still a need to investigate how students interact with and respond to e-textbooks. The literature suggests that there are few studies on reading engineering e-textbooks, particularly in contexts such as South Africa.

2.6 The evolution of the concept of e-textbooks

The development of e-textbooks intensified from 2004 onwards (Kapaniaris et al., 2013). Initially, these e-textbooks were merely multimedia resources supplementing traditional printed textbooks. They were often delivered with CDs or DVDs, enhancing the teaching and learning experience while also serving as tools for assessing students' comprehension of concepts (Daniel & Woody, 2013; Larson, 2010).

Over time, as technology evolved, so did the nature of e-textbooks. They transitioned from being mere digital replicas of paper books to becoming highly interactive learning

platforms. Renowned educational publishers like McGraw-Hill, Pearson, John Wiley & Sons, and Cengage now offer e-textbooks that promise rich interactivity, allowing users to navigate through diverse content ranging from text and graphics to audio and video (Laurillard, 1999). This multifaceted approach goes beyond the simplicity of PDF versions of textbooks, promoting a higher level of engagement.

The notion of the ‘e-textbook’, however, remains fluid. Various authors have provided diverse interpretations (Anagnos et al., 2018; Chen, 2019; Gueudet et al., 2016; Gueudet et al., 2018; Vassiliou & Rowley 2008). While some view e-textbooks merely as "paper behind the screen" (Gu et al., 2015; Hyman et al., 2014; Mangen & Van der Weel, 2016), others recognise them as comprehensive digital texts, accessible across a myriad of devices from e-readers to mobile phones (Embong et al., 2012; Jang et al., 2016). This evolution of e-textbooks has given rise to a spectrum of designs, each dictating a unique student–text interaction. From basic digital replicas of paper versions to complex interactive platforms laden with multimedia and self-testing features, the diversity is vast (Rockinson-Szapkiw et al., 2013).

When comparing e-textbooks with their traditional counterparts, research paints a mixed picture. Some studies suggest students lean towards e-textbooks, while others prefer paper (Brunet et al., 2011; Jao et al., 2005). Interestingly, while e-textbooks often come at a cost advantage, students' inclination to use them is largely influenced by their past experiences and perceived usefulness (Baker-Eveleth & Stone, 2015; Stone & Baker-Eveleth, 2013). Initiatives in South Africa, like the Siyavula project, offer free e-textbooks, making them a more cost-effective solution than traditional ones (Dlodlo & Foko, 2012).

Exploring the potential of e-textbooks extends beyond their interactive and multimodal features (Felvégi & Matthew, 2012; Hutchison et al., 2012). To truly harness their benefits, educators must mentor students in maximising these tools for language and literacy growth (Hardman, 2007). Additionally, the analytical capabilities of e-textbooks provide a data-driven approach to refine teaching methodologies (Mouri et al., 2019; Ogata et al., 2015; Viberg et al., 2018).

Recent studies have delved into the multifaceted realm of e-textbooks, highlighting their interactive features and the challenges and benefits that come with their multimodal nature (Felvégi & Matthew, 2012; Hutchison et al., 2012; Martin-Beltrán et al., 2017). While these studies shed light on the potential of e-textbooks, it is evident that their integration into educational settings involves more than simply adopting new technological tools. Instead, a comprehensive approach is necessary, where educators play a pivotal role in mentoring students on harnessing these features, particularly to bolster their language and literacy skills (Hardman, 2007; 2019).

A distinct advantage of e-textbooks lies in their capacity for learning analytics. These analytics, deeply integrated within the digital platform, offer data-driven insights that can be instrumental in refining teaching methodologies (Mouri et al., 2019; Ogata et al., 2015; Viberg et al., 2018). Recognising this potential, South African higher education institutions are now venturing into leveraging these analytics, aiming to elevate the quality and efficiency of both teaching and learning processes (Van Barneveld et al., 2012). This integration promises not only to inform curriculum design but also to provide timely assessment and feedback, further enhancing the learning experience.

To provide a clearer perspective on the evolution from traditional print to the current state of e-textbooks, Table 2.1 offers a comprehensive overview of the e-textbook's developmental timeline and its emerging affordances.

Table 2.1 Evolution of e-textbooks for academic purposes

Name	Content aspect: Element and Form	Interface aspect: Layout and Hardware	Communication mode: Inside and outside	Level of interactivity	Development of media technology
Print format or text format - static					
Conventional book (print)	**Text, image, diagrams, graphs**	**Codex, paper**	**Reader – Reader (to themselves)** **Reader - Text**	**Not interactive** **(open, close, scroll down and up)**	**Gutenberg Bible (1455)** **First printed book (1461) Germany**
Digital format - dynamic					
Multimedia book	**Sound, videos,** **Software, Webpage**	**Static** **CD, DVD** **Hypertext structure**	**Reader – Writer/publisher** (Direct forms within the book that allow readers to send feedback or questions).	**Low** **(annotation, notes, comments, feedback)**	**Development of storage technology (1900s)**
			Student - Computer (e-material)	**Intermediate** **(learning reading and practising (activity))**	**Inventing internet 1971**
Digital format – page fidelity[4]					
Interactive PDF book The primary purpose of the PDF format is mainly for printing	**Digital text**	**Static images, graphs and diagrams** **Hypertext structure**	**Reader – Writer/publisher via comments bar** **Reader – Instructor** **Student - Computer (e-material)** **Reader - World (External Links**: Hyperlinks that lead to related articles, papers, or forums outside the pdf)	**Low** **(annotation, highlighted, notes, comments)**	**Version 1.0 of Adobe Acrobat, (1993)**
Digital format – reflowable e-textbooks[5]					
E-textbook (interactive)[6]	**Video, 3-D drawings, simulation, electronic charts. E-textbook include:** **Textbook (acquisition of new knowledge)** **Workbook / Learning tool (for individual and collaborative practising in real-time and assessment of knowledge** **Reference book** **Instructional manual**	**Multimodal and interactive text (simulation element and virtual lab experience)** **Any digital devices for eLearning and mLearning (mobile learning)**	**Real-time collaboration** **Student as a developer of the content – e-text + e-textbook software + LMS** **Student as practitioner and** **Student – assessor** **Student – publisher Autor** **Student -Instructor**	**High** **(disseminate and develop new knowledge).** **Multiply interaction between user/developer and the system** **Overall, a high level of interaction**	**Development of Smart Technology (AI) (2000s).** **Gamification.** **Customization of e-textbook and personalization of the learning process** **Technology for inclusive education (audio files and transcripts)**

[4] According to Rockinson-Szapkiw et al. (2013), page fidelity e-textbooks are simply scanned pictures of the print version of the book. An example of this is a PDF file with no dynamic media, no active web links, and no capability to manipulate fonts or pictures.

[5] The page-flexible format system of this e-textbook allows users to customise the layout and interactive features according to their display medium. It includes dynamic media and offers greater flexibility for user modification.

[6] A segment of a digital textbook that engages students with content through various interactive activities such as reading, writing, exercises, simulations, educational games, virtual labs, art animations, and other interactive elements.

Conventional books are traditional print formats that have been in use since the invention of the printing press. They are primarily composed of text, images, diagrams, and graphs, printed on paper and bound into a codex form. These books contain static elements such as text, images, diagrams, and graphs. The content is fixed and cannot be altered unless a new edition is printed. The interface here refers to the physical paper and the codex (book) form. The book is tangible and requires physical storage space. The primary mode of communication is one way: from the author to the reader. The reader may also engage in self-dialogue while reading, but doesn't have a direct way to interact with the text or the author. Interactivity is almost non-existent. The reader can open the book, close it, scroll through pages, but there's no way to interact with the content in a dynamic manner. The printing of the Gutenberg Bible was done in 1455.

Second are multimedia books. They are a digital evolution of the traditional book, incorporating various forms of media such as sound, videos, software, and webpages. These books can contain dynamic elements like videos and interactive software, enriching the learning experience. The interface is digital and can be accessed via diverse hardware such as CDs, DVDs, or online platforms. These books often have a hypertext structure, allowing for non-linear navigation. Readers can communicate directly with the writer or publisher through built-in feedback forms. There is also an interface for student-to-computer interaction for e-materials. The level of interactivity is low to intermediate, featuring options like annotations, notes, comments, and feedback forms. The development of storage technology in the 1900s and the invention of the internet in 1971 enabled the creation of multimedia books.

Interactive PDF books are designed to mimic the look and feel of a print book but are primarily digital. Their main purpose is often for printing, but they offer limited interactivity. These PDFs contain digital text and static images, graphs, and diagrams, closely resembling the print layout. The interface is similar to a hypertext structure, and it allows for some digital advantages like clickable links and easy navigation. Readers can leave comments or interact with the instructor via a comments bar. Hyperlinks may lead to external articles, papers, or forums. Interactivity is limited but includes features like annotations, highlights, notes, and comments. The launch of Adobe Acrobat's Version 1.0 in 1993 made interactive PDFs possible.

Interactive e-textbooks are the most advanced form of textbooks, designed for high levels of interactivity and enriched learning experiences. These textbooks can include a variety of dynamic elements like videos, 3-D drawings, simulations, and electronic charts. They serve multiple purposes, acting as textbooks, workbooks, reference books, and instructional manuals. The interface is highly interactive and multimodal, often incorporating simulations and virtual lab experiences. These textbooks are accessible on a variety of digital devices. These books enable real-time collaboration and allow the student to act as a developer, practitioner, assessor, publisher, and even an instructor. The level of interactivity is high, offering multiple ways to engage with the content and even contribute to it. The development of Smart Technology, AI, and gamification technologies in the 2000s have enabled this high level of interactivity. Additionally, features for inclusive education, like audio files and transcripts, are often included. Each of these formats represents a step in the evolution of textbooks, offering varying levels of interactivity, complexity, and user engagement.

E-textbooks are more than mere replacements for printed textbooks (Chung et al., 2018; Lau et al., 2018; Martin-Beltrán et al., 2017). Apart from the text, they provide a platform where students can take notes, make highlights and summaries, and to which teachers can push content. This study aims to show how technology as a mediator provides several advantages but also causes new obstacles to carry out the tasks of teaching and learning. Many of these obstacles can be ascribed to the different affordances of old (print) and new (e-textbook) technology (Eicker-Nel & Matthee, 2014).

While considerable research has investigated students' overall comprehension of e-textbooks, there has been limited exploration of their utilisation of specific features within e-textbooks. Currently, there is inadequate evidence regarding the digital literacy practices employed by students when reading e-textbooks.

2.7 Affordances of e-textbooks

The concept of “affordance” has become increasingly prevalent in various academic fields, including educational design and human–computer interaction, as noted by Scarlett and Zeilinger (2019). This term was first introduced by J.J. Gibson, a cognitive

and ecological psychologist. Gibson's perspective (1966, 1979, 1982) on affordance pertained to the ways in which entities navigate, understand, and generally interact with their surroundings. Notably, Norman (1988) expanded on this concept, applying the theory of affordances to digital artefacts and environments. As Leonardi (2013) posited, viewing affordances relationally deepens our understanding of human–technology interactions.

Norman (1999) categorised affordances as either real or perceived. Real affordances are inherent functions of an object – the potential actions it can facilitate. In contrast, perceived affordances are those that are immediately apparent to users, as discussed by Davis et al. (2017) and Davis and Chouinard (2016). This study examines the digital literacy practices within e-textbooks and the real affordances shaped by their design. Beyond real and perceived affordances, there is also a need to explore hidden affordances. These are not deliberately obscured by e-textbook design, but stem from users' lack of awareness or reluctance to engage with certain features. Some readers, for instance, remain unaware of e-textbooks' interactive capabilities simply because they've never used them.

This discussion now shifts to navigational affordances in e-textbooks. These features enable readers to effortlessly sift through content or switch between chapters to quickly locate information or definitions. For instance, the search function can expedite the retrieval of specific terms (Letchumanan & Tarmizi, 2010; Singer & Alexander, 2017). E-textbooks also excel in flexibility and portability which refer to temporal (the ability to access the e-textbook at any time and from any location) and spatial (the capacity to adjust elements within the interface, enabling users to resize or modify the layout) affordances. They do not require physical storage, can be readily revised, and even offer multilingual options to bolster vocabulary acquisition (Chiu et al., 2017; Mouri et al., 2019).

E-textbooks are characterised by an array of interactive features specifically designed to cater to the needs of both students and lecturers. These features range from basic to advanced. At a fundamental level, they offer customisation tools akin to PDF reading, like note-taking functions, built-in dictionaries, and web links (Dobler, 2015; Rockinson-Szapkiw et al., 2013). More advanced features promote engagement with

digital texts, encompassing interactive diagrams, live hyperlinks, social networking capabilities, and multimedia content. Such tools empower readers with diverse learning preferences to engage with content in ways most suited to them.

E-textbooks can also be personalised with various adjuncts, including workbooks, exercise books, and instructional guides (Mangen & Van der Weel, 2016). Such elements enrich the reading experience, making it more immersive and engaging (Larson, 2010; Ryu, 2017; Zmazek et al., 2012). Research by Weng et al. (2018) further classified e-textbook interactivity into low, medium, and high levels. The most advanced interactivity levels offer dynamic apps, games, and exercises, enhancing the learning and teaching journey. In essence, e-textbooks can be tailored to individual learners, making education more adaptive and personalised.

2.8 Open Educational Resources (OER) and Digital Literacy Practices

The concept “Open Educational Resources” (OER) was first coined during a UNESCO forum discussing open courseware in 2002. As the concept evolved, UNESCO further refined and expanded the definition through online deliberations. According to UNESCO (2019):

Open Educational Resources (OER) refer to teaching, learning, and research materials, irrespective of their medium, that are either in the public domain or released under an open license. This permits free access, use, modification, and redistribution by others, subject to minimal or no limitations.

While OERs are primarily tools for teachers and educational institutions in curriculum development, they are also directly accessible to students. The breadth of OER includes a wide variety of educational materials: lecture notes, references, readings, simulations, experiments, demonstrations, as well as broader educational frameworks like syllabi, curricula, and teaching guides.

However, a common misconception often emerges when discussing OERs, especially in the context of e-textbooks. While many OERs are disseminated digitally, it is essential to understand that an OER might manifest as an e-textbook, but not every

e-textbook is an OER. Numerous publishers offer e-textbooks for purchase, often at prices more economical than physical copies.

The momentum for adopting open-access textbooks in higher education has been steadily building. A significant driving force behind this surge is the push for equitable access to essential textbooks for all students. In contexts such as South Africa, open-access textbooks have the potential to be a game-changer, especially for marginalised groups, addressing the prohibitive costs that can burden students, their families, and sponsors. By providing open access, the challenges associated with resource limitations and distribution can be mitigated.

Yet, the shift towards open-access textbooks is not without its challenges. Concerns arise around plagiarism (as pointed out by Dienlin et al., 2021; McKenna & Hughes, 2013) and the potential reduction in interactivity, especially between students and their e-textbooks (Zmazek et al., 2012). Simply resolving the accessibility and distribution hurdles associated with textbooks doesn't address the core challenge of enhancing interaction with content and deepening understanding of intricate subjects. The transition to digital and open-access resources necessitates a parallel focus on digital literacy. As educational materials become more interactive and digital, there is a heightened need to ensure students can effectively engage with these resources (Gilliot et al., 2010). This study aims to explore digital literacy practices, with a particular focus on engagement with interactive e-textbooks for academic purposes.

2.9 Conclusion

This chapter has explored literature spanning four pivotal themes. It commenced with an examination of reading as a literacy practice. This was followed by an exploration of digital reading practices, where both their nuances and inherent challenges were discussed. The discourse then transitioned to the realm of higher education and the specific context of engineering study and reading in the South African context. Then the discussion moved to understanding of what an e-textbook is by discussing the evolution of e-textbooks and the opportunities they present. Finally, the chapter discussed open educational resources and digital literacy practices in the current body of research. The overarching objective was to contextualise e-textbooks within the

broader landscape of digital literacy practices. To genuinely grasp the implications of literacy practices for both teaching and learning, it is imperative to delve deeper, seeking a richer understanding from the vantage points of students and educators. In the ensuing chapter, I shall articulate the theoretical framework that underpins and guides the research study.

Chapter 3
Theorising changing digital literacy practices

"The more you read, the more things you will know. The more you learn, the more places you will go." – Dr Seuss

3.1 Introduction to CHAT and MDA

In the previous chapter, I discussed the literature on digital literacy practices and e-textbooks. In this chapter, I outline how two theoretical frameworks, cultural-historical activity theory CHAT)[7] and mediated discourse analysis (MDA),[8] along with their analytical concepts, can be utilised to analyse the digital literacy practices associated with reading e-textbooks within the context of university-level education. I prefer to use the term 'cultural-historical activity theory (CHAT)' instead of activity theory (AT) as, like Cole (1996), I believe that both cultural history and activity are essential aspects to understanding human behaviour. Cole emphasises the significance of studying the history of behaviour to gain insights into behaviour itself (p. 335). In fact, Cole advocated for the term “CHAT” to describe his approach to studying culture in human development, rather than using the term “sociocultural theory” (Cole, 1996; 2005; 2010). CHAT revolves around the notion that individuals engage in human activity, which is mediated by cultural tools and deeply embedded within a social context. These interactions occur within an activity system, and for this study, we focus on e-textbooks as tools within the engineering teaching and learning activity system.

In this study, I employed MDA to explore students' social actions. MDA's primary focus is not limited to individual linguistic elements such as words, paragraphs, texts, images, gestures, or sounds. Instead, it centres on the actions that involve the use of these elements. Words and other modes carry little significance or meaning unless they are part of some action. At the same time, actions cannot be fully understood without the involvement of words, sentences, texts, images, gestures, or sounds. In essence, all actions are mediated through cultural tools. Therefore, MDA's

[7] Cultural-historical activity theory (CHAT) originated from the work of Russian socio-cognitive theorists Vygotsky (1980) and Leont’ev (1974), and was later expanded upon by Engeström (1999, 2001).
[8] Mediated discourse analysis was developed by Scollon in the late 1990s.

fundamental unit of analysis is not just the action itself, but rather the mediated action (Dooly, 2017), leading to the term “mediated discourse analysis”. Originating from linguistics, MDA goes beyond analysing discourse merely as words, sentences, and texts, but also emphasises the social aspect of discourse as a form of action.

The choice to combine elements of CHAT and MDA was made based on the research topic and the relative affordances of each as a theoretical and analytical framework for answering the research question for this study: *How do students and lecturers engage with engineering e-textbooks?* CHAT and MDA were used as an interpretive framework because they informed the researcher's understanding of digital literacy and the implementation of new tools such as e-textbooks within educational activity (Jones & Norris, 2005).

3.2 Origins of CHAT and MDA

Both CHAT and MDA have theoretical foundations in three key sources: Marx and Vygotsky (Engeström, 1999). CHAT's foundational concepts are deeply rooted in Karl Marx's ideas of transformative practices, which suggest that actions have the dual effect of shaping individuals and altering their surrounding environment. Leveraging these foundational ideas, Vygotsky further expanded upon them, paving the way for subsequent theorists to develop and refine what we now recognise as CHAT, MDA, and other related theoretical frameworks.

MDA and CHAT were selected as the theoretical and analytical framework for this study for several reasons. Firstly, CHAT and MDA share the same key elements or concepts: action, subject, object, tool, agency; these concepts are expanded upon later in the chapter. In addition, they share the goal of studying human social practices. It is important to mention that the same key elements can be found in both theories, albeit that they are termed differently; for example, what are called tools in CHAT, might be called mediated artefacts in MDA. It is important to mention that, in the original model proposed by Engeström (1987, p. 78), the uppermost mediating element was originally termed an instrument, due to its instrumental role in expansivity, but this was subsequently annotated and discussed as a mediating artefact, which can be both a tool and a sign (Kaptelinin and Nardi, 2006).

Secondly, both these theories make visible how everyday actions realise power relations and identify those actions that have the potential for remaking actions, mediational means, discourses and institutions (Medina & Wohlwend, 2014). In this research study, I use concepts from CHAT and MDA to analyse how students read e-textbooks and what digital literacy practices they employ in reading as well as how lecturers deploy e-textbooks within their pedagogical practices. I focus on the relationship between practices, mediated action, agent-participants, community, and Vygotsky's *zone of proximal development* (ZPD) for this research (Batiibwe, 2019). The ZPD concept and other concepts are explained in detail in Section 3.3 of this chapter.

Thirdly, both CHAT and MDA offer theoretical and methodological frameworks to comprehend how students engage with and utilise e-textbooks. The objective of the activity is dynamic and subject to change over time. E-textbook publishers, for instance, assert that their products, which facilitate communication between students and instructors within the e-textbook, are designed to enhance teaching and learning. Nevertheless, there is limited research on how students and educators adapt and effectively utilise these mediating tools in educational environments. By employing CHAT and MDA, it becomes feasible to examine student interactions with e-textbooks and their influence on the broader student activity system.

Finally, digital literacy practices are emergent, and there has been little research on engineering e-textbooks, as shown in the previous chapter. CHAT and MDA enable researchers to identify and understand the multidimensional complexities of how contradictions within the activity system transform and shape the activity. The analysis of contradictions (or tensions) assists in identifying the need for transformation (or change) and the development of new reading practices for e-textbooks, as well as for reimagining pedagogy. CHAT and MDA are both concerned with social action or activity, an example of which is teaching and learning. E-textbooks have the potential to transform teaching and learning. To understand the adoption of e-textbooks, we need a theory that not only describes an individual student or group of students, but also provides a framework to discuss these aspects from a social, organisational, and cultural perspective, as CHAT and MDA do (Gueudet et al., 2016). In the next section,

I provide a detailed comparison of the principles of CHAT and MDA and how and where they overlap and are different from one another.

3.3 CHAT and MDA: Theory and principles

Lev Vygotsky, a Russian psychologist known for his work during and after the 1917 Russian revolution, is closely associated with sociocultural theory, which explores learning activities in three dimensions: personal, interpersonal, and institutional/community. Each of these dimensions allows for the examination of complex human activity at the individual, group, and organisational (institutional) levels (Kaptelinin & Nardi, 2009). In the context of my study, students engage in various collaborative activities and internalise the effects of online collaboration when using e-textbooks, acquiring new literacy practices and knowledge of the digital world and culture.

Another significant sociocultural theme, identified by Wertsch (1991), is the role of mediation in human action at both the social and individual levels through instruments and signs, or semiotics. These semiotic means encompass various forms, including language, counting systems, mnemonic techniques, algebraic symbol systems, works of art, writing, schemes, diagrams, maps, mechanical drawings, and various conventional signs, among others (Vygotsky, 1981). Digital adaptive learning platforms, such as e-textbooks, used in the current study are additional semiotic tools that are useful for representational activity. These semiotic means play a dual role, serving as tools for collaborative knowledge co-construction and as internalised resources that aid independent problem-solving in the future. For example, a physics e-textbook is a tool for facilitating learning and teaching; at the same time, through reading the e-textbook, students construct knowledge through their own meanings in order to solve real-world problems. Additionally, Vygotsky's concept of mediated action emphasises a semiotic process that involves three components: the subject or individuals, the mediating means or artefacts or tools, and the object or goal of an activity. This process plays a crucial role in guiding and influencing how individuals understand and interact with the world, and it is considered the fundamental structure underlying mediated action within sociocultural theory (Cole, 1996; Cole & Engeström, 1993; Wertsch et al., 1993; Sannino, 2008a; Sannino, 2008b).

Wertsch (1991) explains that mediated action does not primarily focus on language in isolation but rather on how language and other semiotic and material tools are utilised to mediate action. The central interest of MDA is not solely on discourse itself, but on the intersection of social practices, within which discourse plays a role. It explores how discourse functions as a tool for making claims and emphasises the actions carried out with these tools. In Gee and Hayes' (2011) perspective, Discourse (with a capital D) refers to the ways in which individuals perceive themselves and their identity within the world, akin to an identity kit. Gee and Hayes (2011) further posit that individuals are apprenticed early in life to primary Discourses, which serve as the primary source of socialisation through family and sociocultural contexts. Secondary Discourses, on the other hand, are those to which people become apprenticed through socialisation, such as through involvement with religious institutions or schools (Gee & Hayes, 2011). In other words, Discourses are associated with a person (as identity and as member, e.g., engineers, academics), while the general term *discourse* (with a small 'd') is a category where all Discourses in some sense "belong".

Drawing from this foundational understanding of mediated action and discourse, it becomes pertinent to introduce the theoretical lens of CHAT for this study. CHAT, as expounded by Engeström (2009), is based on five underlying principles which are instrumental in defining the activity system (Sannino, 2010). These principles emphasise the dynamism and multi-dimensional nature of social interactions, bridging the gap between individual actions and broader societal systems.

The first principle highlights the significance of the mediating artefact, as briefly discussed in Section 3.2. According to this principle, human psychological processes developed in conjunction with a new form of behaviour, where humans started modifying material objects to regulate their interactions with the world and each other (Cole, 1996). In this study, the mediating artefact is the e-textbooks within the activity system of teaching and learning.

The second principle underscores the central role of culture in human life (Cole 2010), where material and ideal artefacts are accumulated over time, shaping the culture of a particular group of people. It highlights the importance of acknowledging multiple perspectives, interests, and traditions within an activity system. Since members of an

activity system come from diverse backgrounds and the system itself comprises multiple layers, its artefacts, rules, and conventions are inevitably shaped by historical influences, and multi-voicedness can be a source of conflict and transformation. In the context of this study, culture is also central to the academic and disciplinary literacy practices of students and lecturers in South Africa. These practices have developed over time and are influenced by a range of cultural artefacts, such as textbooks and other resources that support teaching and learning. Understanding the role of culture in this study of digital literacy practices is important because it can help lecturers and instructional designers develop more effective strategies for teaching and learning. By examining the cultural artefacts and practices of students in South Africa, this study can provide insights into how these artefacts are used to support academic learning and research in this context.

The third principle highlights the role of history, emphasising that humans not only use and modify tools but also rediscover existing tools that were created by previous generations (Cole, 1996). This implies that human actions and behaviours are influenced by the achievements and activities of previous generations. CHAT considers the historical development of activity systems, recognising that practices and conventions in education have deep roots and are slow to change to accommodate new elements such as objects, subjects, tools, rules, communities, and divisions of labour (Edwards, 2007). CHAT warns that the introduction of a new tool, such as e-textbooks, could cause disruptions in the system. Such disruptions are not necessarily negative, as activity systems are not static; they are constantly changing the ways they operate and the resources and tools they use, orienting themselves towards different purposes (Sannino, Daniels & Gutiérrez, 2009).

The fourth principle relates to systemic contradictions. Interactions between the components of the activity system can result in tensions that can hinder or aid achievement of the goal (Cole & Engeström, 1993; Engeström, 1987, 1993; Yamagata-Lynch, 2003; Stetsenko, 2021). These contradictions, tensions[9] or disruptions do not arise accidentally or arbitrarily; rather, they are inherent to human activity (Engeström, 1996). For example, tensions emerge in activity systems when

[9] In scholarly works, the terms "contradiction" and "tension" are often used interchangeably.

one or more elements distract individuals from the activity's intended purpose. These tensions can lead to the collapse of an activity or be the catalyst for change (Engeström, 1993). Therefore, systemic contradictions can either facilitate or impede human activity (Yamagata-Lynch, 2003).

In CHAT, contradictions are seen as fundamental elements (Gedera, 2016). They play a vital role in driving the development of the system (Fleer, 2016). Contradictions are described as historical tensions that accumulate within and between activity systems (Engeström, 2009). They do not necessarily refer to problems and conflicts. According to Sannino and Engeström (2018), the various terms used by scholars to describe contradictions (such as "paradox", "tensions", "inconsistencies", "conflict", "disturbances" and "dilemma") all refer to the same concept. It is important to note that tensions arise and affect the subjects' (in this study, subjects are the students and lecturers) ability to attain the object (goal of the activity) by taking a role as obstacle, making it difficult for the subjects to attain the object, or by taking a role as an enabling influence for the subject to attain the object of the activity (Yamagata-Lynch, 2003).

The subjects' interpretations of the object/motive should be seen as dialogical, involving interaction with one another and with the historically accumulated meanings within the activity. CHAT is a dialectic theory, and the dialectic concept of "contradiction" is essential to its understanding. Contradictions transform an object into a "moving, motivated, and future-generating target" (Engeström, 2010, p. 115). Finding contradictions or "sticking points" in an activity system reveals opportunities for system-wide improvement. In a CHAT analysis, these misalignments, contradictions, and other disturbances contain the potential for the collective to search for new ways of doing and achieving "what is not yet there" (Engeström, 2018; Engeström et al., 2010; Foot, 2014).

Engeström and Sannino (2011) assert that contradictions cannot be directly observed; rather, they are discerned through their manifestations. These contradictions are historical and systemic phenomena that are beyond our direct control. Researchers can only engage with them through their articulation and construction, which is manifested through words and actions. In essence, an activity system is constantly navigating tensions and contradictions within and between its components, and these

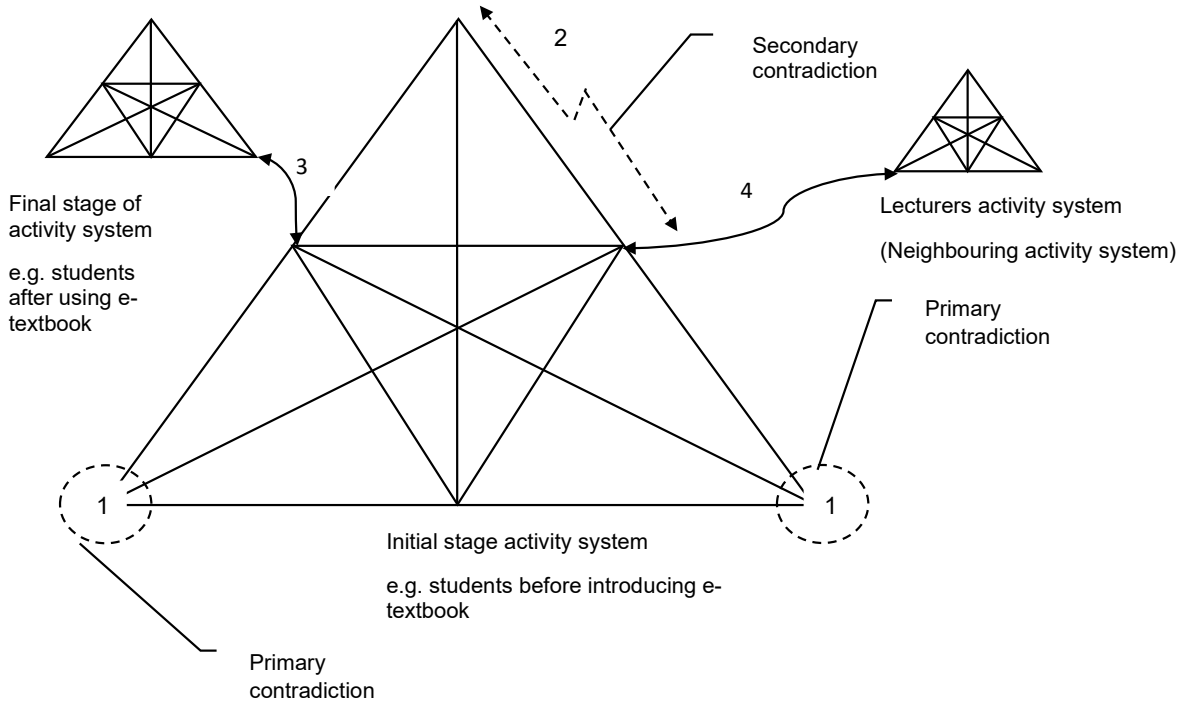
contradictions manifest as disruptions and opportunities for novel solutions (Agherdien & Petersen2016). Contradictions/tensions can be primary, secondary, tertiary, or quaternary based on their location within an activity system (Cole & Engeström, 1993; Roth, 2003). In the following paragraphs, these types of tensions are examined in detail.

According to Roth and Lee (2007), a fundamental aspect of educational change is that it is riddled with contradictions. A primary contradiction (see Figure 3.1) may exist inside of specific elements of CHAT (see Figures 3.2 – 3.4) such as the mediational means (the e-textbook in this study). It is worth noting that primary contradictions have the tendency to give rise to secondary contradictions that are specific to the particular conditions of the activity (Giddens, 1984). Primary contradiction in CHAT is a reflection of the fundamental tensions inherent in capitalist societies. These contradictions arise from the opposition between use value and exchange value (Foot, 2014). According to Foot (2014), there is a direct tension in capitalist economics between use (for societal benefit) and exchange (trade for another commodity, such as increased wage). The primary contradiction, pivotal in CHAT, keeps the activity system in a state of constant flux. It emerges in everyday contexts, taking various forms and influencing other levels of contradiction (Foot, 2014). The persistence of the primary contradiction is crucial; it not only remains a continual presence but also forms the basis for subsequent levels of contradiction. Even if resolutions are found for secondary contradictions, the underlying primary contradiction continues to exert its influence, perpetuating the dynamic nature of the activity system (Engeström, 2001).

While primary contradictions occur in the element or concept within CHAT (as depicted in Figure 3.1) (Roth & Lee, 2007), a secondary contradiction arises between two elements of CHAT when a new external element, like a novel technology, is introduced into an activity system. The integration of this new technology often clashes with traditional elements, such as established rules or division of labour. Consequently, these contradictions lead to disturbances, conflicts, and also novel attempts to modify the activity, turning it into an imperceptible battleground.

As an example of the contradiction, consider the interaction between mediational means like physics e-textbooks and their corresponding academic communities. The

e-textbook, being a written and static medium, contradicts the community's value of oral and dynamic knowledge transfer. For example, in South Africa many first-year students still experience limited access to devices. This can be especially problematic if the community doesn't have the resources or skills to maintain or update the technology. For a visual representation and closer inspection of this dynamic, one could conceptualise it within the activity system triangle, placing each stakeholder and tool within the relevant sections of the CHAT triangle (the CHAT triangle is discussed in greater detail later in this chapter).



Symbol	Description
1 Primary contradiction	This contradiction appears within the elements of the activity system, e.g., contradiction inside of one of CHAT element such as rules, division of labour.
2 Secondary contradiction	This contradiction appears between elements of the system, e.g., contradiction between two elements of CHAT such as mediational tool (e-textbooks) and object of the activity.
3 Tertiary contradiction	This contradiction is between different versions of the same activity system. e.g., before and after or an old and new model of teaching.
4 Quaternary contradiction	This contradiction is between neighbouring activity systems, e.g., students and parents, or students in their first year and students in their second year.

Figure 3.1: Graphical illustration and explanation of contradictions: primary, secondary, tertiary and quaternary (Engeström, 1999)

At the tertiary level, contradictions arise between an activity system and its potential forms in more advanced stages or when the object of the older activity system clashes with the object of what is considered a more advanced activity system. Additionally, Roth and Lee (2007) suggest that tertiary contradictions can also occur between the object (motive) of the dominant activity and the object of a culturally advanced version of that activity. Lastly, at the quaternary level, contradictions emerge when elements

of the central activity conflict with elements of any neighbouring activity systems (Engeström, 2005; Mukute, 2010; Roth & Lee, 2004; 2007).

Contradictions can act as a dynamic force for change and development, as participants become aware of them within the activity (Roth & Lee, 2007), leading to transformations in the activity itself (Engeström & Sannino, 2010). The concept of contradictions proves valuable in this study to analyse the individual and collective activity systems of the students and lecturers, as it helps to comprehend the tensions arising from the introduction of a relatively new technology, such as e-textbooks in the context of South African higher education. A more detailed examination of contradiction analysis is presented in Chapter 7 during the analysis of the data collected in this study.

The fifth principle of CHAT relates to transformation of the activity system. Depending on the subject's innate structure and learning history, activity in CHAT is interpreted either within a materialistic or naturalistic framework, as the response of a passive subject to an external influence (Leont'ev, 1974). For example, the onset of COVID-19 catalysed a transformative shift to online pedagogy in higher education. While the merits of a student-centred approach had been debated for years as a progressive alternative to the conventional teacher-centred model, the integration of technology into classrooms had been more of a theoretical discussion than widespread practice. The sudden need for online learning, encompassing both asynchronous and synchronous methods, led to a sporadic and uneven transition among educators. The mandates of social distancing rendered traditional, including student-centred, face-to-face teaching methods untenable. In a physical classroom, educators already grappled with limited control over their students, a challenge which became even more pronounced in the virtual realm. Consequently, this rapid pivot to online education demanded significant adjustments from both instructors and students. One way to understand the full cycle of transformation of activity system is via the ZPD.

Vygotsky's (1978a) concept of the ZPD was introduced as a critique of psychometric-based testing in Russian schools, which only assessed learners' current level of achievement, neglecting their potential for future development. The ZPD highlights the potential for emerging behaviour and the "future of development" (Vygotsky, 1978a).

According to Vygotsky (1978a), the ZPD is the gap between the learner's current level of development, as demonstrated through independent problem-solving, and the potential level of development achieved through problem-solving with adult guidance or collaboration with a more capable peer. The ZPD represents the learner's present abilities and the next level that can be reached through the use of mediating tools, such as language and environmental support, along with the guidance of a capable adult or peer. Effective learning occurs when individuals collaborate with others, as it is through such collaboration with more skilled individuals that learners acquire and internalise new concepts, psychological tools, and skills. In this study, e-textbooks were used as a form of mediation. The researcher was interested in how an e-textbook helped students engage with learning materials and what digital literacy practices they used while reading, as well as the potential for further development as they interacted with peers in small groups.

The concept of agency is also important to both CHAT and MDA. Different perspectives conceptualise the concept of agency in various ways (Feryok, 2012). However, in this study, I consider agency through the eyes of CHAT and MDA. Human agency is emphasised in CHAT because the individual can choose the best course of action within the culturally and contextually constrained norms of a specific location (Johnson & Johnson, 2009). Within a CHAT perspective, human agency is perceived as existing along a continuum with society, as articulated by Feryok (2012). This viewpoint suggests that both the individual agent and society are seen as constantly evolving through daily practices (Stetsenko, 2005; Stetsenko & Arievitch, 2010). Students' agency can result in the emergence of novel forms of activity (Stetsenko & Arievitch, 2010).

MDA perceives agency as dispersed among human actors, mediational means, and the circulating discourses that intertwine them (Al Zidjaly, 2014; Scollon & Scollon, 2003). The concept of agency, within MDA, is viewed as a negotiable process between individuals and their social environments. Furthermore, MDA aims to comprehend the social, cultural, and historical distribution of agency. Actions are situated at the crossroads of a historical embodiment, a social interaction order, and contextual discourses (Scollon, 1998, 2004, 2014; Scollon & Scollon, 2003; 2007). Scollon (1999;

2004) have been pioneers in the analysis of MDA, also known as nexus analysis, which constitutes a theoretical framework encompassing discourse and social action.

MDA consists of five key components: mediated action, mediated means/cultural tools, social practices, site of engagement, and agency. While agency has already been mentioned, the remaining elements now are discussed. MDA emphasises social practice (a repeated action recognised as socially meaningful) as the foundation for understanding social issues. Working outwards from the nexus of practice (the specific time and place where and when the action occurs), one seeks the components that influence the action as well as the impact that the action has on subsequent iterations of that same action. MDA characterises “practices” as actions or “chains of action” that have become deeply ingrained and assimilated into the “historical bodies” of social actors. The notion of “practice” connects a specific action to an individual's extensive history of learning and past experiences. Additionally, it establishes a connection between the individual action and other actions, as practised actions are seldom carried out in isolation but are intertwined with broader social practices. Individual actions are interrelated with groups of individuals, societies, and cultures that engage in similar actions, thereby identifying themselves as members based on their shared practices. This thesis, for example, employs cultural-historical activity theory (Engeström et al.,1990; Leont'ev, 1978) and analyses discourse through digital reading to reconceptualise reading an e-textbook as a nexus of practice.

Every human action involves mediation, where interactions between individuals and mediating artefacts/tools, as well as semiotic signs, lead to mediated action. Within this process, the subject, object, and instrument share a dialectical relationship, influencing one another and the overall activity (Stetsenko, 2005). Mediated action serves as the focal point for MDA. The concept of mediated action, initially proposed by Wertsch (1991) within Vygotskyian psychology, remains widely utilised today. Ron Scollon further explores mediated action, considering its timing, occurrence, and context. Scollon emphasises that all mediated actions coexist on various timescales, each having its unique rhythm. Analysing the intricate sequencing of actions within an activity, such as digital reading practices, can provide insights into the process (Blommaert, 2004).

A mediated action involves two key elements: the social actor or agent and the mediational means or tools (Wertsch, 1991; 2003). The mediational means refer to cultural tools utilised by individuals (social actors) to engage in various social practices, such as reading, writing, or online communication, with the aid of material instruments (e.g., digital pen, digital device) and surfaces (e.g., touch screen of a laptop, tablet, phone) in the context of this study. As social practices often intersect and intertwine (Scollon, 2001), a given activity typically incorporates multiple mediated actions.

In MDA, sites of engagement are not “objective” times or locations; rather, they are the result of the participants' orientation towards time and space when they interact (Jones, 2005). Individuals, according to Jones (2005), construct sites of engagement by focusing on specific mediated acts for a variety of reasons, and this is how he claims that people construct sites of interaction. Scollon (2001, 2008) further elaborates how these various mediated actions occur in “sites of engagement”, which are real-time social spaces in which the action is the focus of the actors. In these real-time social spaces, mediated actions coalesce as "historical outcomes of social actors' practices and habits" (Scollon, 2008, p. 16). There is an emphasis on interaction at this site, rather than within it, which is a "unique moment in history" (Scollon, 2001, p. 144).

Because they focus on development and change in activity systems, which are frequently the result of historically derived tensions in older activity systems (Sannino & Engeström, 2017), CHAT and MDA are particularly relevant to this study on implementing new educational tools (e-textbooks). As such, CHAT and MDA, in combination, are useful for investigating and comprehending the implementation of e-textbooks in higher education in South Africa, as well as for investigating the cultural history of novice users, such as first-year engineering students, in this context. According to Kuutti (1995), CHAT emphasises the importance of incorporating the context of individual actions into the fundamental unit of analysis – the activity (Engeström, 2001).

3.4 Operationalising CHAT

CHAT has three distinct generations of development, as identified in the literature. These are outlined in the sections below.

3.4.1 First-generation CHAT

Drawing from the initial concepts of Vygotsky's mediated action, the first generation of activity theory is often described as a process. However, human activity is more accurately conceptualised as a series of processes that are encompassed within an activity, forming a bounded system. Vygotsky's well-known triangle model (first generation of CHAT) encapsulates this idea, highlighting the direct link between the subject, object, and mediational means or tools. The unit of analysis of the first generation of CHAT is a “mediated act” (Vygotsky, 1978, p. 40). The subject refers to the participant or participants in an activity. The mediational means or artefact include both physical artefacts and prior knowledge that play a role in shaping the subject's mediated action during the activity (refer to Figure 3.2). The subject acts in the activity through mediation (mediation artefacts). The object refers to the motive of the activity. It is important to note that signs, which are intangible, are considered to be by-products of the mediated action process and are not explicitly represented in the basic triangle model. Signs emerge from the interaction between a person and a mediating object (Yamagata-Lynch, 2010). This suggests that subjects are influenced by the tools available to them, but they are also capable of transforming these tools as they engage in the activity.

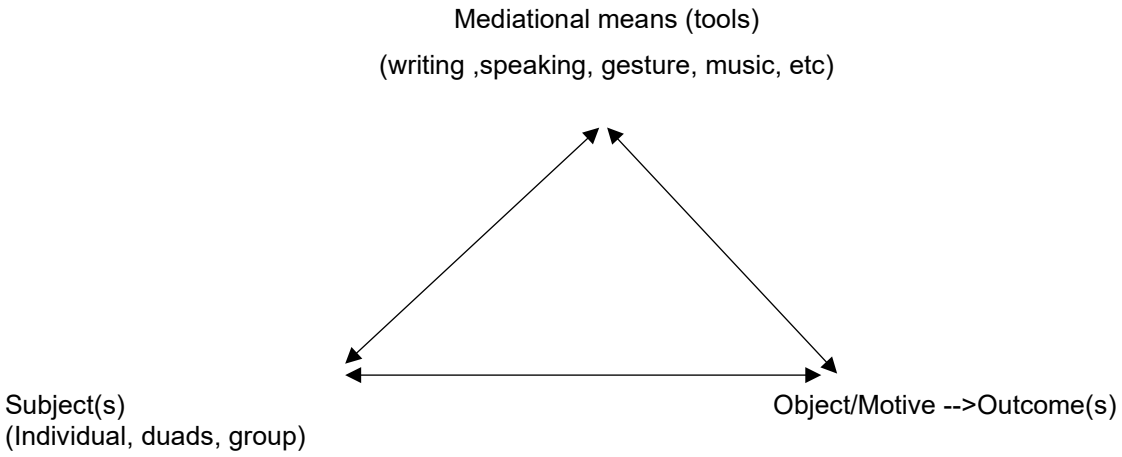


Figure 3.2: First-generation activity theory (Vygotsky,1978a)

The subject in an activity refers to the person or persons who are actively engaged in the activity (Igira & Gregory, 2009, p.436; Yamagata-Lynch, 2010, p.16). Both physical tools (e.g., technical instruments) and mental tools (e.g., logical thinking or categorisation) play a role as mediational means or artefacts, contributing to the mediated action (Gedera & Williams, 2016, p.154). Mediated action, facilitated by these tools, enables the subject to achieve the objective or goal of the activity within their limitations (Igira & Gregory, 2009, p.436). The object of the activity not only holds together the various components of the activity but also represents the motivation or purpose that drives individuals or groups to engage in the activity (Yamagata-Lynch, 2010, p.17).

Various types of tools can mediate the relationship between the individual (subject) and the goal they seek to achieve. For instance, an e-textbook can serve as a tool that facilitates learning for students who are receptive to the benefits it provides. This mediated relationship is visually represented in the form of a triangle, as illustrated in Figure 3.3. Consequently, the activity system proves to be an effective unit of analysis for understanding how students and lecturers utilise a new tool like an e-textbook in a learning context. It is worth noting that Vygotsky's interest extended beyond the interaction between individuals and tools. He was also interested in the contributions of more knowledgeable others, the student's own input, and the broader cultural and historical context that shapes the interaction (Tudge & Scrimsher, 2003). Students' literacy practices in South Africa are influenced by the cultural and historical contexts from which they originate.

3.4.2 Second-generation CHAT

Leont'ev (1974, 1978, 1981) and other representatives of the Soviet cultural school built on Vygotsky's thesis, extending the theory which was previously limited by a focus on individual activity. This was extended in the second generation of activity theory, which centred around Leont'ev's contribution. Leont'ev articulated the crucial difference between individual action and collective activity. The activity system of the second generation of CHAT is depicted in Figure 3.3. The unit of analysis of the second generation is described as collective activity rather than individual action (Leont'ev 1974).

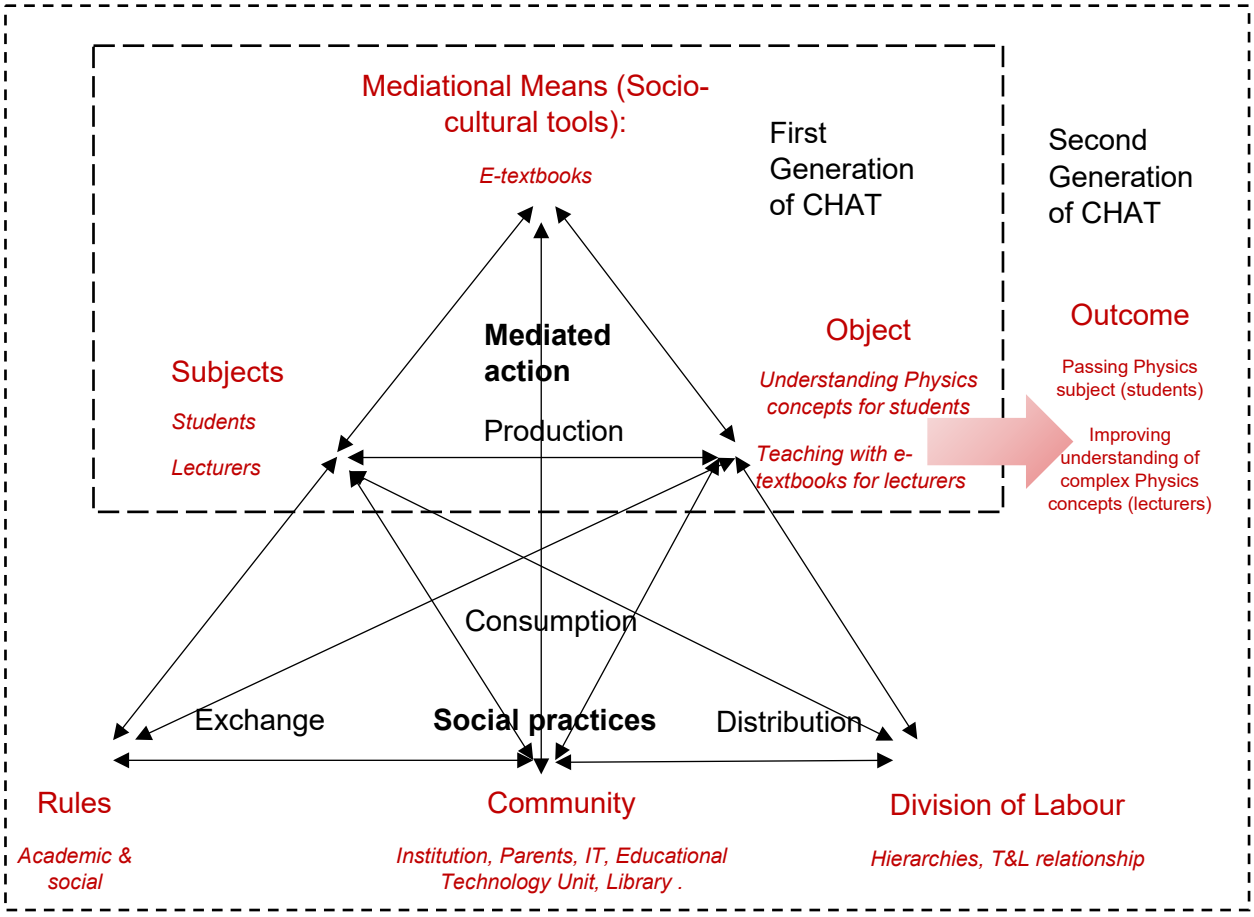


Figure 3.3: Second generation CHAT: A teaching and learning activity system (Engeström, 1999)

The second generation represents a significant advancement in the paradigm as it shifts the focus towards the intricate interrelations between individual subjects (actors) and their communities. CHAT directs our attention to the connections between subjects and the objects of their activities, the role of tools and mediation, and the contextual aspects of the activity (Engeström, 1999). An activity system is depicted in a triangular model, as illustrated in Figure 3.3, encompassing six core components and four zones of production, exchange, consumption, and distribution, which carry cultural and historical dimensions. The zone of production includes the subjects, their tools, and the object of their activity. In this model, the first element of CHAT is the subject (agent or actor), represented by an individual or a group of individuals participating in the activity. In educational settings, such as in this study, the subjects are the students, whose objective is to learn (Roth, 2004). Additionally, we can identify people of interest within the system. In the context of this study, the subjects are the

students who are in the process of understanding the engineering knowledge presented in e-textbooks.

The second element of CHAT emphasises the significance of the *object* in driving the activity (Engeström, 2001). The *object* refers to the motive of the activity. CHAT makes a distinction between the object and the outcome of a system. The object represents what the subjects perceive as the purpose or intention of the activity; it is the driving force that motivates them to act (Engeström, 2018). In this study, the *object* is the acquisition of engineering content knowledge, more specifically, that which is contained in engineering e-textbooks. The outcome is that which results or flows from the focus on the object. In CHAT, it is important not to conflate the object and the outcome (Engeström, 2008). An effective activity system must be driven by the object and not the outcome. The outcome flows from the activity as a whole. CHAT tells us that outcomes can only be attained if the participants do not lose sight of the object. The *outcome* in this study is moving to the next level/year of the study and successful graduating at the end.

In an activity system, *tools* can take various forms, including human, physical, cultural, or conceptual. CHAT also emphasises the importance of considering the socio-cultural-economic context in which the activity takes place. The mediated artefacts/tool(s)/mediational means[10] are utilised, adapted, or created by the *subject/s* to engage with the central object or pursue the desired outcome of the activity. These tools can be physical (material), cultural, or conceptual in nature. Language, protocols, scientific methods, models, and in the context of this study, e-textbooks, are all considered tools, just like hammers, computers, and phones. CHAT recognises tools as products of human craftsmanship at a particular point in time, subject to adaptation and evolution over time.

There are other socio-material and culturally mediated tools, such as curricula, facilities, equipment, internet-based and library-based resources, a learning management system (LMS), and so on, that are also directed at the object. There is a sense in which teachers/lecturers could be understood as a “tool” that supports

[10] The researcher uses these terms interchangeably.

(mediates) student learning (Roth, 2004), or as a co-subject focused on the object of learning and knowledge acquisition (Leont'ev, 1992; Winberg & Garraway, 2016; Rogoff, 1995, 1998). In order to work successfully on the object, human and other resources are needed – and these may or may not be sufficient for the attainment of the object (Hardman, 2019). The top part of the triangle in Figure 3.3 is identical to Vygotsky's basic structure of mediated action (shown in Figure 3.2).

The fourth element in CHAT is the *community*, which comprises individuals who share a common interest in and engagement with the same object. The consumption zone is influenced by the community or the broader social context in which the activity system operates. Interactions between the subject and the community, involving a shared object, can be considered as the "communicative relations" of the activity (Engeström, 1999, p. 32). These interactions play a crucial role in shaping the activity and its outcomes within the given community or social context.

The community of an activity system are those who are affected by the system (parents, professional bodies, etc.), but are not directly involved in the work of achieving the object (Uden, 2007). The community can be beneficiaries of the activity but also stakeholders in the activity. In the case of this study, important community participants include an institution's IT department which maintains the LMS and internet connectivity. Also important are educational technologists, who play a role in training staff in the use of e-textbooks, and library staff who provide support to students.

The last two elements facilitate relations between the subject and the community: firstly, *rules* govern the subject's actions towards the object and encompass formal and informal regulations and interactions with other participants in the activity. Moreover, rules outline the accepted procedures and interactions for engaging with other members of the community (Engeström, 1993). The exchange zone is constrained by tacit and explicit rules, shaped by historical and social processes, which dictate the actions of the subjects (academics and managers). These rules originate from academic traditions and might be slow to adjust to new contexts. In this study, academic and social rules refer to both formal university policies and informal regulations or norms.

Lastly, the *division of labour* refers to how tasks are allocated among community members in relation to the object, including both the horizontal distribution of tasks and the vertical allocation of power, positions, and access to resources (Engeström, 1987, Engeström et al., 1990). In this study, the division of labour pertains to how tasks are shared among community members within the activity (see Figure 3.3). The zone of distribution pertains to the organisational arrangements for the division of labour, encompassing hierarchical structures and task distribution within the larger university activity system. The study explores division of labour hierarchies and roles of lecturers and students in the teaching and learning activity.

The inclusion of the rules, community, and division of labour components enriches the mediated action with a socio-historical perspective. For instance, within the context of a university, teachers and students operate as part of a larger institutional culture governed by rules and hierarchies of decision-making or task distribution. These rules and division of labour can either facilitate or impede students' and teachers' progress in acquiring engineering knowledge. The availability of necessary tools and resources, along with a well-guided system that outlines appropriate tasks for students and lecturers, plays a crucial role in achieving the activity's object.

The four zones encompass the subjects, tools, objects, rules, and communities, as well as the manner in which work is carried out (Engeström, 1999). By comprehensively examining the entire system, researchers can uncover the interactions and tensions that subjects must navigate. Identifying these “sticking points” offers valuable insights and opportunities for enhancing the practices within the activity system. Understanding the interplay of these components and their influence on one another allows for the identification of potential areas for improvement and innovation.

3.4.3 Third-generation CHAT

The third generation of activity theory provides conceptual tools for understanding the interconnectedness of activity systems (Engeström, 2001). Engeström (1987) expanded the theory to encompass the broader sociocultural contexts that influence the second generation of activity. He argued that the world had become more intricate than that which the second- generation model had depicted. The third generation is

visually represented by a basic model involving at least two interacting activity systems (refer to Figure 3.4). The unit of analysis of the third generation focuses on relations between multiple activities (e.g. students' activity system and lecturers' activity system). The third generation was introduced to facilitate dialogue and interactions between diverse traditions, cultures, and perspectives.

Engeström (2009) started to represent this interaction as a triangle, illustrating the relationship between different components. In this context, two activities share similar objectives. Object 1 evolves from an initial state of unreflected and situationally given "raw material" to a collectively meaningful Object 2 constructed by the activity system, and eventually to a potentially shared or jointly constructed Object 3. The object of activity is a dynamic concept, not limited to conscious short-term goals, but rather subject to continuous change and development.

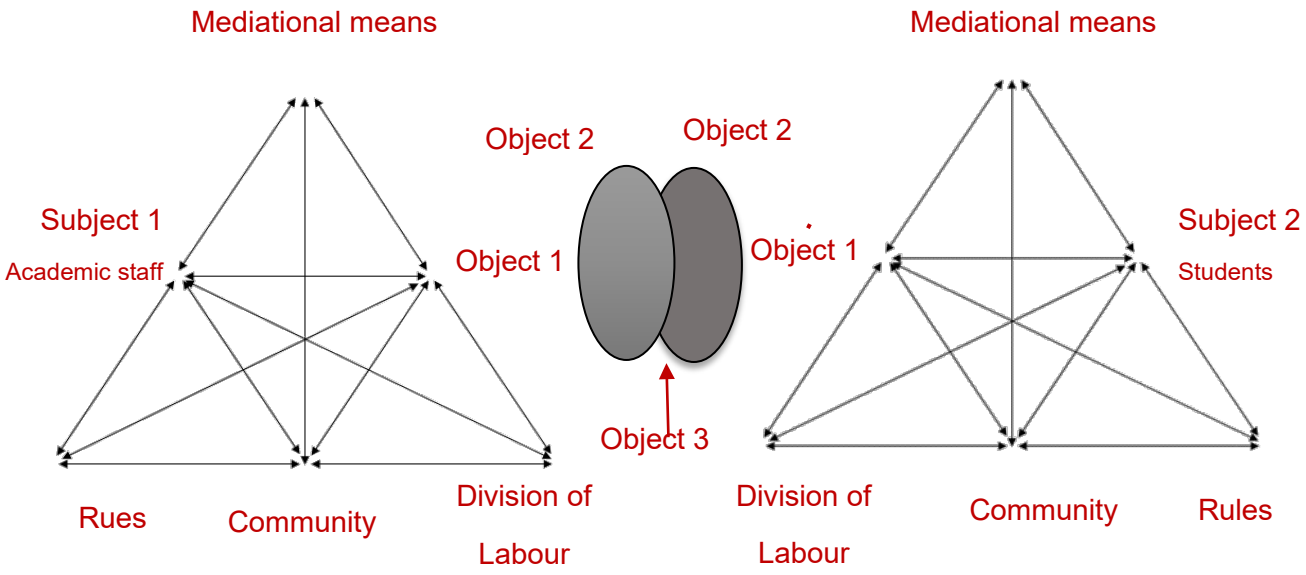


Figure 3.4: Two interacting activity systems in the third generation of activity theory (Engeström et al., 1999)

According to Engeström and his colleagues (1999), the internal tensions and contradictions among these elements serve as the driving force for the development of what they refer to as "expansive learning". This model goes beyond merely analysing individual actions and expands to encompass a broader analysis of the activity context and vice versa. It highlights the dynamic interplay between the individual's actions and the broader activity system, recognising how tensions and

contradictions within the system can lead to transformative learning and development. This study employs the second and third generations of CHAT. For example, when I look at students and lecturers' activity systems separately then I employ a second-generation activity system. When I discuss these activity systems in combination, I use a third-generation activity system. In the subsequent section, I delve deeper into the components of MDA. I elucidate the specific concepts of MDA that underpin my data analysis and discussion chapters. Moreover, I outline their practical application and operationalisation within the context of this study.

3.4.4 Fourth-generation CHAT

The fourth generation of CHAT is distinguished by its focus on long-term, expansive cycles, supplementing rather than replacing the previous three generations (Stetsenko, 2021). Rooted in the need to comprehend and analyse the dynamics of interconnected and rapidly changing global systems, this generation of the theory specifically addresses contemporary challenges such as climate change, digitalization, poverty, multicultural interactions, and broad societal issues, which earlier generations might not have fully addressed (Engeström & Sannino, 2020).

In the fourth generation, the unit of analysis is expanded to encompass multiple transformative cycles of expansive learning. These cycles occur within and across various activities, characterised by both independent dynamics and interdependencies. This comprehensive unit of analysis is vital for understanding complex global phenomena, where actions and interactions extend beyond local or individual activity systems and are influenced by broader global trends and networks (Engeström and Sannino, 2020).

This generation marks a significant shift in the study of social relations, emphasising the need for dialogue, trust, and collaboration across a wide array of diverse activity systems. These systems span various professional, functional, and administrative boundaries, both horizontally and vertically. Such an approach fosters a more holistic and interconnected understanding of global and digital phenomena, aligning with the complexities of our increasingly interconnected world.

While the fourth generation offers an expansive framework suitable for global-scale analysis, this research, centered on the engagement of students and lecturers with engineering e-textbooks, and required the more focused framework offered by earlier generations of CHAT.

3.5 Operationalising MDA

Mediated discourse theory serves as the overall theoretical perspective that is utilised in this thesis (Scollon, 2001). Mediated discourse theory serves as the foundation for the field of study known as MDA, which was primarily established by Ron and Suzie Wong Scollon (e.g., Scollon 1998, 2001, 2004; Scollon & Scollon, 2003). MDA is tightly connected to nexus analysis (Lane, 2014; Scollon & Scollon, 2007)[11]. Nexus analysis is considered the methodological operationalisation of mediated discourse theory. Mediated discourse theory is positioned as a "theoretical position within critical discourse analysis", focusing on social action rather than solely on texts or genres (Fairclough, 2013; Scollon 2008, p.35). As an interdisciplinary framework, the Scollons, being linguists with diverse research interests, draw from various sources within linguistics. Notably, they incorporate ideas from scholars in Soviet psychology (Vygotsky, 1978b, 1981) and literary sciences (Bakhtin, 1981, 1986) to shape mediated discourse theory. The contributions of Vygotsky, Bakhtin, and Wertsch (who further developed Vygotsky's thinking) are crucial to the overall development of mediated discourse theory, particularly in the context of its interest in social action and mediation (Jones, 2016, p.44; Jones & Norris, 2005, p.30; Scollon, 2001, p.142). As mentioned in Section 3.3, Scollon and Scollon (2003) assert that *all action is mediated*, all actors participating in action are socialised, and interactions are embodied practices. In other words, social practices (such as reading, in this study), are composed of mediated acts, and the actions themselves constitute an interaction site within which repeated social practices form a practice nexus.

MDA, also known as nexus analysis (Scollon, 2004), takes into account past, present and future action by “providing a theoretical account of how participants, context,

[11] Nexus analysis was introduced as a methodological approach to study and analyse social action by Scollon (2004), building on Scollon's previous writings (e.g., 1998, 2001) and collaborative works (e.g., 2003). Subsequently, Scollon and Scollon (2007:615) proposed that nexus analysis should replace the term MDA. However, MDA continued to be acknowledged as primarily a theoretical framework (Scollon, 2008:65).

discourses, and objects (artefacts) reciprocally facilitate action and social change" (Scollon, 2004; Scollon & Scollon, 2003). MDA enables researchers to analyse complex social action by taking into account three convergent aspects. The first is the historical body or habitus (Bourdieu, 1977), which is the historical accumulation of experiences a social actor has had over time. These experiences lead to the social actor exhibiting observable social behaviours such as, for example, reading from a digital screen. In this study, I shall discuss students' previous experiences before entering university and during the first year of reading e-textbooks (see Chapter 5). A second aspect is interaction order, which refers to the social practices of interaction that individuals employ to organise themselves. In this study, I shall look at students' interaction order when reading and engaging with the affordances of e-textbooks. The third aspect is known as "discourses in location", and it includes both verbal and visual discourses that are recognisable to the participants of the encounter. When taken as a whole, these three elements can be woven together to produce a comprehensive analysis of a particular site of engagement.

In the context of engineering education, MDA can be useful as discourse encompasses not only written text, but also mathematical equations, graphs, figures, and other such means of communication and representation. Engineering discourse centres on the implementation of design strategies to address issues that are prevalent in the real world. Collecting and analysing data, making use of empirical laws and correlations, carrying out mathematical calculations and modelling, and presenting one's results to a range of audiences are all required steps in this process. In this study, mediated discourse theory was used to gain a better understanding of the characteristics and implications of new digital literacy practices and engagement with e-textbooks.

Digital literacy practices have taken on a substantially broader meaning in recent years because of the proliferation of rapidly evolving technologies and the growth of online communities (Davis et al., 2021). I use mediated discourse theory to outline a complementary relationship between a New Literacy Studies (NLS) understanding of literacy as a social practice (Barton & Hamilton, 1998; Barton et al., 2000; Street, 1984, 2003, 2011) and the CHAT focus on mediated action (Engeström, 1987; Leont'ev, 1978). Mediated discourse theory (Scollon, 2001) investigates the connection

between literacy (in this study, by literacy I refer to reading) and action. More specifically, the theory examines how the use of language is an action in and of itself, and how it is related to other types of human action. Mediated discourse theory examines the ways in which related chains of mediated acts across contexts and through time produce social practices (Scollon, 2001), as well as the ways in which related social practices are linked to form a nexus of practice. Mediated discourse theory provides a framework for making inferences about literacy practices (Street, 1984; 2001;2011) that are brought to bear on and constructed within and across literacy events (Heath, 1983; Street, 2011).

The concept of mediational means is a fundamental aspect of mediated discourse theory. As described by Wertsch (2007, p.178), mediation implies that individuals interact indirectly with the social world through various mediating artefacts. Vygotsky (1981, p.140) distinguished between two types of mediational means: signs and tools. Signs encompass examples like spoken language, while technical tools, like computers, exemplify the latter category. In the evolution of Vygotsky's ideas, Wertsch (1991, p.28) further elaborates on these concepts by referring to them as signs and technical tools. Both spoken language and a computer are examples of tools that have been culturally produced and are used by social actors within social groups; as a result, both can be categorised as examples of cultural tools, despite the fact that they are examples of different types of tools (Wertsch 1998, p.17). In this study, e-textbooks are seen as technico-semiotic tools, because they straddle the line between sign (semiotics) and technical tool.

The mediated discourse theory heuristic of sites of engagement can be operationalised in analysis of literacy events to understand, for example, how students' reading histories, their social interaction with one another, and the discourses, material conditions and available mediational means converge to shape the mediated action that constitutes reading with e-textbooks. The NLS term, literacy practice, refers to the use of reading, writing and related semiotic systems as embedded in, and ideologically framed by, social practices. People engage in literacy in particular ways for particular purposes in particular social settings; literacy practices are “social models of literacy” that participants bring to bear on and construct within literacy events (Street, 1984, 2003). Investigating literacy practices involves considering not just what they

accomplish with literacy, but also the meaning they give to their accomplishments, how they conceptualise the value of literacy, and the ideologies that surround its situated use (Baynham, 1995).

The use of mediated discourse theory in this study of the digital literacy practices associated with e-textbooks represents a contribution to sociocultural studies of reading and literacy. Mediated discourse theory (Scollon, 2001) analyses the relationship between language and action; the theory considers how language use is an action itself and relates to other forms of human action.

3.6 Conclusion

This chapter discussed the two conceptual and theoretical concepts employed in this study. CHAT and MDA were identified as fruitful interpretive frameworks. The chapter began with a definition of the theories, followed by a discussion of each of the theories' concepts. Because this study used two theoretical frameworks, the researcher first discussed the operationalisation of CHAT before discussing the operationalisation of MDA in this research. CHAT and MDA both focus on change and provide new ways of thinking about e-textbooks. Many engineering educators rely heavily on textbooks. Together, these two theories allowed me to analyse e-textbooks as part of a system of teaching and learning. Although e-textbooks have been on the market for some time, we still need to understand the full potential of e-textbooks. CHAT and MDA can assist with this.

Chapter 4
A research design for understanding digital reading practices

When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it – this is knowledge.
(Confucius, Chinese teacher and philosopher (551–479 BCE))

4.1 Introduction

This study aims to understand engineering students' digital literacy practices as they interact with e-textbooks. In this chapter, I investigate the methodologies and techniques employed to collect and manage data, as well as to analyse and present the findings. As discussed in the previous chapter, I draw on mediated discourse analysis (Norris, 2016) and activity system analysis or contradiction analysis (Engeström, 1987, 1996, 2001; Leont'ev, 1974; Vygotsky, 1978a, 1980) which are used as analytical frameworks (Yamagata-Lynch, 2010). Furthermore, this chapter provides a description of and rationale for the chosen research methods and instruments employed to address the primary research question of this study: *How do students and lecturers engage with engineering e-textbooks?*

In addition to the primary research question stated above, the following secondary questions have guided this study:

1. *What digital literacy practices do engineering students employ while using e-textbooks?*
2. *How do engineering lecturers deploy e-textbooks as a learning aid in the classroom?*

The research approach selected for this study is designed to deepen and enrich the findings. Methodology extends beyond mere data collection and analysis methods; it encompasses the theoretical underpinnings that justify their use and the nature of knowledge they yield. This research primarily aims to explore the processes participants employ to derive meaning from their interactions with e-textbooks. It is essential to understand that the relationship between the research questions and the

chosen methodology is not linear, but rather "dialectical" in nature, as emphasised by Case and Light (2011). To put it succinctly, this study seeks to understand the digital literacy practices of engineering students when engaging with e-textbooks for academic pursuits.

The research questions determine the choice of methodology that the researcher wishes to employ in the study (Creswell & Creswell, 2017). Firstly, in this chapter, I discuss my selection of an interpretive, qualitative, case study research design. My rationale and justification for this selection are described in addition to methodological criteria such as trustworthiness, reliability and transferability. Secondly, I discuss sample selection and the unit of analysis in this study, as well as the data-collection process, which includes focus group interviews, individual interviews, think-aloud protocols, and an online questionnaire. Thirdly, I discuss the data analysis process, which involves bringing together findings and forming themes. I also describe in detail how I used qualitative software for the analysis.

4.2 Interpretivist paradigm

This study can be classified into interpretivist and (critical) constructionist approaches (Hennink et al., 2020). These approaches each represent a distinct paradigm of inquiry, and each offers researchers a unique approach to generating and legitimising knowledge. In this study, I use an interpretivist approach. In the interpretivist approach, the primary focus is on understanding particular people of interest and events in specific cultural-historical circumstances (Bevir & Rhodes, 2012). Moreover, to achieve such understanding, the researcher draws upon participants' own experiences rather than seeking to achieve procedural objectivity (Creswell & Creswell, 2017). In this study, the participants were students and lecturers who discussed their experience with e-textbooks. The interpretive paradigm enables researchers to perceive the world from the perspectives and experiences of the participants (Thanh & Thanh, 2015). When investigating research questions, interpretive researchers rely on these experiences to construct and interpret their understanding from the data collected. In essence, interpretivism facilitates exploring the world by interpreting the perspectives and insights of individuals (Thanh & Thanh, 2015).

Moreover, interpretivism, using an ethnographic methodological approach, involves describing, understanding and explaining human action, perceptions and behaviour in a lived cultural or social context. One of the earliest and strongest proponents of the interpretive tradition, Clifford Geertz (1973), argued that the interpretivist task is to clarify the intersubjective meanings that form the foundation of social reality in the everyday life experiences of people. However, Leeds-Hurwitz (2015) argues that simply expressing meanings is not enough and that we need to go beyond reproducing what we observe to abstract the information that can help answer research questions. Additionally, Leeds-Hurwitz (2015) takes issue with Geertz's notion of "thick description" and the related argument that the interpretivist's job is to articulate the experiences of participants.

In essence, interpretivism has several implications for research. Firstly, it calls for the researcher to adopt an exploratory approach and strive to understand the unique perspectives of the individuals involved. Secondly, it requires researchers to observe how participants' actions and behaviours unfold within specific contexts. It is crucial to avoid dismissing people's attitudes or behaviours as irrational or objectionable, and instead, research should be conducted with the assumption that their attitudes and behaviours are reasonable and justifiable from their viewpoint, with the researcher suspending any personal evaluation. The aim is to uncover the “logic” or rationality behind what might appear unfamiliar, unknown, or even illogical, which necessitates in-depth exploration of people's experiences and perspectives (Cohen et al., 2017). This approach is essential for explaining and describing people's behaviours and practices and the contexts in which they occur and are sustained. Methodologically and conceptually, this research is grounded in human behaviour and practices that are fundamentally interpretive. This implies the use of various “tools, techniques, or procedures used to gather the evidence” (Onwuegbuzie & Leech, 2005, p. 280).

4.3 Qualitative research

This study employs a qualitative research paradigm with case study methodology and ethnographic methods. It is essential to note at the outset that a full ethnographic study was not conducted. Instead, I collected data through ethnographic techniques such as observation and in-depth interviews.

Qualitative methods are often inductive in approach, implying a naturalistic design (Lincoln & Guba, 1985) and a small, in-depth study of relatively few cases. In qualitative research, the researcher does not test hypotheses, which are generally applied in quantitative research (Cohen et al., 2017). Qualitative research seeks to illuminate and understand a social phenomenon from participants' perspectives.

The qualitative research paradigm finds its origins in cultural anthropology and American sociology (Kirk & Miller, 1986). It aims to comprehend a specific social situation, event, role, group, or interaction (Locke et al., 2009). It involves an investigative process where the researcher gradually makes sense of a social phenomenon by contrasting, comparing, replicating, cataloguing, and classifying the subject of study (Miles & Huberman, 1984). Marshall and Rossman (1989) suggest that this entails immersing oneself in the everyday life of the chosen research setting, where the researcher enters the world of the informants and, through ongoing interaction, seeks to understand their perspectives and meanings (Creswell & Creswell, 2017).

Qualitative research can be characterised as intense, deeply engaging, challenging and contextualised (Cohen et al., 2017). Qualitative data provides a deep understanding of the research questions where the situation is measured not by statistics and variables, but by personal experience, beliefs and values. Data coming from observation and interviews provide a descriptive summary connected with participants' voices (in the form of quotations). This allows the researcher to examine the research question and extend current knowledge through new recommendations and contributions. My role as the primary researcher is integral in interacting with participants' practices, values and biases that affect the data that I describe in the following chapters.

In qualitative research, researchers immerse themselves in the study, becoming the primary data-collection instrument. It is essential for researchers to identify their personal values, assumptions, and biases from the outset of the study. The researcher's involvement in the research setting can have a valuable and positive impact rather than a detrimental one (Johri et al., 2013; Ramos, 1989). For instance, in my case, my experiences as a lecturer at a university of technology (UoT) from 2016

to 2021 have shaped my perceptions of higher education and UoTs. In this research, I approach the study topic through my understanding of reality, which is influenced by the perspectives of CHAT and MDA. I have selected specific aspects of CHAT and MDA to guide my research questions, focusing on exploring the digital literacy practices employed by first-year engineering students and lecturers when using e-textbooks.

4.4 Case study research design

A case study is a research design that aims to derive meaning from a specific instance of a phenomenon, where related variables cannot be separated from the context (Merriam, 2009; Yin, 2009). The primary objective of a case study is to gain an understanding of a single case rather than comparing multiple cases to draw general conclusions (Yamagata-Lynch, 2010). This research finds its methodological foundation in the work of Yamagata-Lynch (2010, pp. 78-79), who compellingly argues for the commensurability and established efficacy of case study methodology within the realm of CHAT. Yamagata-Lynch's insights illuminate how case study approaches, with their intrinsic focus on the complexity and contextual richness of specific instances, are uniquely suited to unpacking the nuanced dynamics inherent in CHAT.

Each case study presents a unique narrative, and the expected outcome is to provide specific insights and findings rather than making generalisations (Stake, 1995). However, in the past, there were divergent opinions regarding the validity and significance of the information obtained from a case study. Today, the role of the case study procedure in engineering education is generally acknowledged. Some authors (Cohen et al., 2017) believe that the results of case studies could very well be transferable to other phenomena. Case studies are regarded as valuable supplements to other research techniques.

The case study design was chosen for this research because it is well suited to addressing descriptive questions such as "how" and "why" in an empirical investigation that explores a current phenomenon within its real-life setting (Baxter & Jack, 2008; Yin, 2009). This study focused on a single case with embedded units, which involved examining multiple units or objects of analysis within that single case. Selecting the

case and setting up the breadth and depth (boundaries) of the case study was done using the following criteria as presented in Figure 4.1.

The organisation, location and place (context)	One University of Technology (UoT) Faculty of Engineering and the Built Environment (FEBE)
Two Units	Department of Chemical Engineering Department of Maritime Studies
Program	Extended Curriculum Programme
Participants	First-year engineering students registered in 2021 and four lecturers from these two departments
Course or subject	Physics
Study phenomenon	Digital literacy practices associated with e-textbooks

Figure 4.1: Selection and setting up the boundaries for the case study

In this single case study with embedded units of the Chemical Engineering and Maritime Studies departments, I selected first-year engineering students from the Extended Curriculum Programme (ECP) who registered to study in 2021 at a UoT in South Africa. The ECP supports students who do not meet minimum entrance requirements to nonetheless enrol in an engineering programme. In this way, the Department of Higher Education and Training (DHET) provides previously and currently disadvantaged students access to university. The main difference between ECP and mainstream programmes is that students will have one additional year to complete the qualification. Another difference is that more support is provided to scaffold students' transition into Higher Education (HE). In most models, the subjects from the first-year mainstream programme are divided into two years. The DHET funds ECP programmes, encouraging lecturers to include innovative pedagogical

interventions focused on improving students' learning and understanding of a course and discipline.

The course or subject of this study was physics for first-year students. Physics is one of the high failure rate subjects and, often, a gatekeeper subject for all engineering disciplines at universities in South Africa (DBE, 2020b). Physics is not simply a collection of facts and formulas, although many students see it that way. The knowledge structure of physics is highly hierarchical (Bernstein, 1980), with more advanced knowledge concepts building on more fundamental knowledge. Students must also comprehend its logic and discipline-specific philosophy in order to successfully study it. Applied physics is a branch of physics that focuses on the application of physics principles to solve engineering problems. This interdisciplinary field integrates physics with engineering, mathematics, and other scientific disciplines to design, develop, and optimise technological systems and processes. Physics also can be described as a mode of human thought, action and human activity. Physics involves real human problems and requires students to engage with theoretical concepts and apply them to practical problem-solving examples.

The first embedded unit of the case study is the chemical engineering department at the selected UoT. The participants in chemical engineering were first-year students from the ECP and three lecturers who teach engineering subjects with e-textbooks. The second unit of the embedded case study was the ECP programme in nautical science in the Maritime Studies department. The participants were registered first-year students in the nautical science programme, and one physics lecturer.

4.5 Pilot study

This research study consisted of two phases: a pilot study conducted as a preliminary step before the main research, and the main study itself. The pilot study, which took place in July and August 2020, was a small-scale initial investigation. The data collection for the pilot study was undertaken with first-year students enrolled in the Bachelor of Marine Engineering programme at the Department of Maritime Studies at the selected UoT. All data collection for the pilot study was done exclusively using online platforms: LimeSurvey for the questionnaire phase and Zoom for the individual

and group activities and individual and group interviews. For the pilot study, I opted for a face-to-face data-collection method because of the pandemic. During the interviews and observations, I took field notes on what the students were discussing about their experiences with reading the e-textbook and the digital literacy practices they used. I was interested in what digital literacy practices students associated with reading and how they enacted these practices with e-textbooks.

The pilot study was undertaken for a few reasons. Firstly, it was important to test the instruments before conducting the main study, which provided an opportunity to reflect on what was working and what not, and to revise the instruments accordingly. The findings from the pilot study were utilised to shape the research design, leading to the development of comprehensive instruments to guide and steer the main data-collection stages, including reading, observation, interviews, and think-aloud protocols. Secondly, the pilot study showed where the research was lacking in triangulation and trustworthiness. Thirdly, the pilot study was used for justification of the research methods and instruments. The pilot study allowed me to prepare for any possible challenges working with the participants. I learned from the pilot study and from other scholars that the researcher must be able to understand group dynamics and be able to coordinate them to further the purpose of the discussion. The outcomes and learnt skills from the pilot study research were implemented in the main study. After completing the pilot study, the researcher implemented minor adjustments to the interview and questionnaire questions. These alterations were primarily focused on enhancing clarity for the participants, ensuring that the questions were more comprehensible and straightforward. This step was essential in refining the research tools to better suit the needs of the study and facilitate more effective communication with the participants.

4.6 Research participants and selection strategies

Purposive sampling involves intentionally selecting particular participants or settings based on their ability to offer vital information that may not be as effectively obtained through other means (Campbell et al., 2020). I drew on the participation of students and lecturers from the ECP, since these programmes already had implemented the use of e-textbooks in the physics subject. As Patton (2015) suggests, the strength of

purposive sampling lies in the selection of information-rich cases for in-depth study. These cases, whether individuals, events, or settings, provide researchers with extensive insights into the issues being investigated, which is why the term “purposeful sampling” is used (Miles et al., 2019; Seale, 2004).

A purposive sampling strategy was employed, using the following eligibility criteria: the students needed to: 1) be registered in the Departments of Maritime Studies or Chemical Engineering at the selected UoT; 2) be in their first year of study in an ECP; and 3) use e-textbooks for the subject physics. The lecturers needed to: 1) be employed in the Departments of Maritime Studies or Chemical Engineering at the selected UoT; 2) lecture physics to ECP first-year students; and 3) have a minimum of two years’ experience in the use of e-textbooks.

4.7 Data-collection methods

Methods are tools to collect data, while methodologies are understood more broadly as involving the theoretical underpinning, data collection, analysis and interpretation employed (Silverman, 2020). Research questions dictate the researcher's choice of methods, and research questions are guided by a theoretical framework. This study focuses on the social practices associated with reading and draws on theorists such as Vygotsky, Engeström and Scollon. The study uses methods such as observation, and individual and focus group interviews that take into account the views and behaviours of social agents (in this case ECP first-year engineering students and lecturers) and the environment(s) in which they interact (specifically, their use of e-textbooks).

The study included four phases of data collection: questionnaires, interviews, think-aloud protocol, and observation. Data collection took place over a 12-month period spanning 2020 and 2021. Each of the four phases was preceded by a pilot study. I negotiated and discussed all arrangements with participants in advance and followed health and safety protocols (required owing to the COVID-19 pandemic) for data collection. The four phases are listed below.

- Phase 1: Online questionnaire

- Phase 2: Individual digital reading activity with think-aloud protocol and follow-up individual interview
- Phase 3: Digital group reading activity with follow-up focus-group interviews
- Phase 4: Interviews with engineering lecturers

In the discussion that follows, these four phases are discussed in greater detail before further information is provided regarding each of the specific data-collection instruments used.

Phase 1

The first phase of this research aimed to understand students' e-textbook usage and identify students who could participate in the subsequent phases of this research. This phase also sought to comprehend some of the students' practices related to the use of e-textbooks. Participants indicated whether or not they had previously used e-textbooks in the questionnaire. I forwarded the link to the online questionnaire via WhatsApp messaging and student emails. The questionnaire was accessible for about five weeks. Appendix E contains the online questionnaire. The two engineering departments collected a total of 73 fully completed questionnaires. A total of 25 students agreed to participate in the subsequent phases of the research. The questionnaire responses were entered into an Excel spreadsheet and recorded.

Phase 2

Following the completion of the questionnaire, 25 students voluntarily agreed to participate in the study. Their consent was obtained through electronic invitations via email, WhatsApp messaging, or phone calls for participation in Phases 2 and 3 of the study. From these, I handpicked seven volunteers from each department and invited them for in-depth follow-up interviews. Each of these interviews spanned approximately 90 minutes. The data-collection process was conducted face to face on campus. Participants were provided with a specific digital text to read, either on a laptop or desktop, in a computer laboratory setting. As they read, they were encouraged to use think-aloud protocols, verbalising their thoughts and reactions. During this phase, I observed each student individually, documenting key observations on dedicated sheets (Appendix H). For a comprehensive data collection, I audio-recorded the students as they read aloud, simultaneously addressing any questions

or ambiguities they had. This approach yielded two distinct forms of data: the audio-recorded digital reading (capturing the think-aloud protocol) and a digital activity grid formed from the observational notes (refer to Appendix H). After the observation, I conducted immediate interviews with the participants to delve deeper into their reading experiences.

Phase 3

After completing phase two, the individual reading activity and follow-up interviews, the same students were invited to participate in phase three. Phase three involved reading the physics e-textbook while working as a group. One participant from the chemical engineering department could not participate owing to logistical problems regarding transport issues due to not living on campus. Therefore, six students from the Chemical Engineering department and seven students from the Maritime Studies department participated in this phase.

In collaboration with the relevant lecturers, I chose a section from the physics e-textbook that hadn't been addressed in the physics course yet. This decision was made to allow students to showcase their digital literacy practices when studying the e-textbook. Specifically, the objective was to explore the collaborative study methods participants employed while using the e-textbook. The choice of the physics topic was influenced by its relevance to engineering disciplines, particularly thermodynamics. While each participant utilised their own computer screen, they actively communicated with their peers, especially when they had enquiries about the chapter's content. I observed their engagement with the e-textbook, documenting my observations on a dedicated sheet (Appendix H). These notes later played a pivotal role in the data-analysis process.

After completing the reading activity, I provided each participant with a pen and paper to perform an ice-breaking activity; this involved drawing an emoji representing their experience with the e-textbook that expressed their feelings about e-textbooks at that time and overall. The ice-breaking activity was implemented to help participants feel comfortable answering the interview questions in front of their classmates. The emoji drawing activity was done after the reading in the group and before the focus-group interview, which allowed students to relax and naturally transition into the focus-group

interview questions. In addition to the observation notes, I audio-recorded and took observational notes during the group activity and focus-group interviews.

Phase 4

In phase four, I conducted interviews with four lecturers who were using e-textbooks for their engineering subjects, in order to determine their experiences and engagement levels. These one-on-one interviews were conducted with lecturers at the selected UoT. Lecturers were invited via email to participate in the study. After signing the consent form (Appendix D), the researcher contacted each lecturer individually for setting up an interview. Two lecturers agreed to meet in person, and three lecturer interviews were done online via Zoom. All interviews were audio-recorded and transcribed.

In the sections below, I discuss the main methods/research techniques used to document and understand the digital literacy practices associated with e-textbooks: online questionnaires, observation, interviews, think-aloud protocol, and focus-group discussions. I highlight the use of multiple research tools that can serve, when analysed separately and in combination, to strengthen the validity of the findings.

4.7.1 Online questionnaire

The first data-collection instrument was an online questionnaire using a paid version of LimeSurvey which allows researchers to have a high level of confidentiality. The aim of employing a questionnaire is to transform a defined purpose into tangible fields through which actual data can be collected (Cohen et al., 2017). In this study, the questionnaire method had a dual purpose: obtaining an overview of the digital literacy practices of a larger cohort of students, and identifying participants for further investigation.

This study was done during the COVID-19 pandemic, and I collected the data via an online questionnaire. The main advantage of the online questionnaire was that it was easy to access and distribute to participants. Additionally, I could monitor response rates by checking and reminding students, and data could be exported/imported into software for further analysis. However, the online questionnaire had some limitations,

such as participants requiring stable internet and data access to complete the questionnaire, which potentially involved inherent costs to the students, albeit minimal.

I first designed and tested the online questionnaire in a pilot study with 33 participants. The purpose of the pilot study was to test the questionnaire instrument and make necessary changes to the main study. The primary purpose of a small feasibility study (pilot study) is not to answer the research question, but to prevent one from launching a main study without adequate knowledge of the methods used and to prevent errors during the main study. I also tested the presentation of the questions on different devices to check readability, presentability and compatibility.

The final structure of the online questionnaire had five main themes and 19 questions. The five main themes of the questionnaire were: background; use of technology before the student came to the UoT; digital literacy skills; general reading; and reading from the screen for study purposes. The final questionnaire is shown as Appendix E. The number of participants who completed all questions in the online questionnaire for the main study was 73. Partial and blank attempts at the questionnaire were not included in the analysis.

4.7.2 Think-aloud protocol

The roots of think-aloud techniques can be traced to cognitive psychology. Understanding the relationship between thought and words involves revisiting Vygotsky's (1962) concept of "inner speech" in his work, *Thought and Language*. In this research, the goal of using the think-aloud protocol was to gain insight into the processes of working memory. However, researchers need to be cautious of certain difficulties when using think-aloud techniques, as they can potentially over-influence participants' natural thought processes (Charters, 2003).

To address these potential problems, I anticipated and addressed issues during the pilot study before conducting the main study. One of the challenges was clarifying the think-aloud study to the participants, as some confused it with reading aloud. To overcome this, the researcher explained the purpose of the think-aloud study and allowed participants to conduct a short test using one paragraph of the e-textbook, both reading and thinking aloud. In this study, a combination of reading digital text

from the monitor and think-aloud protocols was employed to investigate the processes utilised by 14 participants during their reading of a physics e-textbook (refer to Appendix G, the digital activity grid).

4.7.3 Observation

Observation is a systematic technique that involves carefully selecting, observing, and recording the behaviours and characteristics of social practices or phenomena (Stake, 1995). In this study, I played the role of observer. I observed the students' behaviour and practices through the participant observation data-collection technique (Cohen et al., 2017). I observed the participants read and interact with the digital text and with each other (during the group activity in phase three), silently making notes on the observation sheet (Appendix H). My position was that of an observer, seeking to remain silent while observing, making notes and audio-recording the activity of the participants.

It was anticipated that the students might find the researcher's presence “strange”, which could potentially influence their behaviour. It was difficult for me to avoid possible reactivity on the part of the participants. As such, efforts were made to minimise the influence of reactivity during the data-collection process as far as possible. When I entered the classroom, I kept reminding myself that I was no longer a lecturer in that environment. I was only a researcher and observer seeking to gain knowledge and understanding of the digital literacy practices of each participant. I showed respect and appreciation to each participant. I did not provide answers, and I was not an expert on the topic covered in the selected sections of the e-textbook. During phases two and three of the observation, I captured several photographs of the participants, using a camera. For ethical reasons, these photographs were later converted into line drawings (see Figures 6.2 – 6.5) and utilised in Chapter 6 to graphically present patterns of interaction with e-textbooks and opportunities for collaborative reading.

4.7.4 Interviews

In qualitative studies, researchers often seek to understand human actions, experiences and practices (Kvale, 1996). In this study, I used interviews, one of the most common qualitative data-collection methods in engineering education research.

Interviews offer a relatively easy way to collect data (Appendices F, I and J). This feasibility can also lead to problems, as interview studies are often seen as straightforward, and novices may begin interviewing participants without a broader understanding of what constitutes valid qualitative research data (Bearman, 2019). The selection of the interview as a data-collection instrument was based on this study's research aim to understand the digital literacy practices employed when reading e-textbooks. The interview aims to interpret the research problem through the respondent's eyes and values.

The focus of the interview was on individual participants' practices that I observed during the think-aloud protocol. In the interview, I followed up with participants to garner explanations regarding participants' practices. The typical interview guide and protocol are available as Appendix F, though it should be noted that this was tailored to each participant based on what was observed during the think-aloud protocol.

4.7.5 Focus-group discussions

Focus groups provide a rich, collective view of data. The strength of focus groups, according to Cohen et al. (2017), is that they encourage groups to talk about their practices. Cohen et al. (2017) also point out that when participants are “relative strangers” to each other, focus- group data becomes richer. This was the case in this research study because the focus groups were formed primarily based on the availability of students.

As part of phase three of the research study, I created what Street (2001) and Barton and Hamilton (1998) refer to as a literacy event. Following that, the focus group questions (Appendix I) were designed so that I could determine students' digital literacy practices as well as the cultural-historical factors influencing these practices in the study of physics for engineering. The focus-group interview is an effective tool for gathering diverse opinions and experiences.

As such, this study made use of focus-group discussions. The focus-group activities consisted of two parts: studying a chapter of the physics module as a group, and a focus-group interview where students discussed their experiences of the activity. I asked students to do what they do when they read a new chapter – to read for meaning

from the digital screen. I made it clear that I was not interested in “testing” them on their subject matter knowledge or scoring them on their understanding of physics. Rather, my goal was to know how they engage with the e-textbook, what digital literacy practices they applied when they read, and what they thought worked and what they thought did not work. After the reading activity, I asked students what they noticed/remembered from the reading activity, and each group member had at least one speaking turn. In general, the discussion in the focus groups moved quickly and efficiently in the one hour allotted.

The focus-group interview for this study aimed to understand how students apply and interpret digital literacy practices for reading e-textbooks for study purposes. The focus group size was two groups of either six or seven students. The researcher intended to have an open, non-judgemental and fruitful discussion. I was unfamiliar with the students, I did not teach them, and I saw them only twice – for the individual activity in phase two and the group activity in phase three.

An atmosphere was created to encourage freedom of expression and stimulate conversation in general. Therefore, group members felt relaxed, but at the same time, anxious to participate in the discussions. In this regard, the role of humour should not be underestimated. When I saw that conversation became difficult, I tried to make it easy and used some humour where I could.

4.8 Data-analysis procedures

In Phase 1 of this study, I used the Statistical Package for the Social Sciences (IBM ® SPSS ®) to analyse the data from the questionnaires and sought to understand the participants' background before they entered the UoT and other information regarding their experiences with technology. After the participants completed the LimeSurvey questionnaire, all data was stored in the SPSS software. I exported the LimeSurvey questionnaire data into SPSS. In analysing the quantitative data, I used descriptive statistics.

Analysis in this study was undertaken deductively using the theoretical framework which guides this study, as described in Chapter 3. The process of analysis involves

drawing together multiple insights and patterns across complementary data sources. Computer-aided qualitative data analysis (CAQDAS) involves several phases, which can be broadly categorised as follows: preparing data and setting up a project file, coding the data, utilising the software to organise and structure the data, and querying the data to identify patterns and relationships. Once the audio interview recordings were transcribed into text, edited and checked for mistakes and clarity, the next step was reduction and analysis. I started with the coding process by assigning comments to each deductively generated code. Comments were provided for each code to guide the researcher as to the exact meaning of the code and avoid bias in the coding process.

All data was coded, and this process assigned data to categories and identified informal and formal connections. This step of classification of the data is essential in the analysis. Without this step, the researcher would lose track of the analysis and not provide a meaningful conceptual foundation for interpretations, and would not be able to make it meaningful to others. Once the data was classified, regularities and variations were investigated, and patterns identified.

In this study, I worked with a large amount of unstructured textual data – interviews, transcripts and online questionnaires. All collected data were transferred to ATLAS.ti 23, where the researcher used quotations, coding schemes and memos, which assist with the inductive and deductive coding categorisation strategy (Friese, 2019). In this study, I employed two modes of data analysis using ATLAS.ti 23: the textual level and the conceptual level. At the textual level, the focus was primarily on the raw data, involving tasks such as text segmentation, open coding, and memo writing. On the other hand, the conceptual level involved framework-building activities.

One of the valuable advantages of implementing the CAQDAS tool is that it provides access to the data and coding (Appendices K and L) so that others can see the units of meaning and the relationships within the data analysis. A second advantage is that it allows the researcher to quickly and comprehensively search within the data. This is because the software can handle multiple and overlapping codes without losing the context of analysis. Additionally, codes can be combined using the filter function, which is useful for identifying more detailed connections and relationships. ATLAS.ti 23 offers

functionalities that support qualitative researchers in theory building. These features allow for the establishment of connections between codes, which aids in developing higher-order classifications and categories. Furthermore, the software facilitates the formulation of propositions that imply a conceptual structure that aligns with the data (Woolf & Silver, 2017).

The main reason for the selection of mediated discourse analysis (MDA) and cultural-historical activity theory (CHAT) (see more information about the theoretical frameworks in Chapter 3) was to understand the social activity of reading when engineering students engage with digital text, and what digital literacy practices students and lecturers apply. Both theoretical frameworks focus on instances of socially situated communication and seek to link these to the underlying ideas they represent. In this study, the social practice is reading a physics e-textbook and interaction with that e-textbook. I had a specific interest in the digital literacy practices of participants as they read and interacted with the e-textbook.

The integration of these two theoretical lenses in my analysis has proved to be mutually complementary, despite their slightly different emphases. For instance, while they employ distinct terminologies, their combined application has enriched the analysis and discussion of the data. Notably, the use of MDA was particularly prominent in examining the interaction order (see Section 6.3).

In Table 4.1, I present the steps involved in the analysis of the interviews and observations. This table enables one to describe digital literacy practices and pedagogy in terms of the various CHAT and MDA concepts which were identified and discussed in Chapter 3. The process of data analysis is illustrated in Table 4.1. I started from the inspection cycle, which included developing the analytical framework, transferring data into ATLAS.ti, and inductively coding the data (Kalpokaite & Radivojevic, 2019). During this process, I created memos (later in this section) and reflected on the process of data analysis. This allowed me to keep track of the process of data analysis and ensure trustworthiness. For example, using various sources of data (multi-voicedness is the first principle of CHAT – see discussion in Chapter 3), various data-collection methods allowed me to understand the systemic contradictions and tensions of this activity system. After the inspection cycle, I moved to the data-

coding process using deductive coding of the data. The coding process also included categorisation and organising the code in folders, categories, and sub-codes. After completing the coding process, I started analysing and writing the narratives, linking the codes to the theory, and presenting the findings in the chapters that follow.

Table 4.1: Steps of data analysis

1.	**Inspection cycle**
1.1	The researcher developed an analytical framework for coding (see Appendix L and K) and exported this to ATLAS.ti.
1.2	The researcher identified codes by using an open coding strategy and the initial phase of auto-coding (in vivo coding) by examining the entire data set.
1.3	The researcher applied coding and identified families of codes and possible themes.
2.	**Ensure the trustworthiness of coding process**
2.1	Memo writing: research diary, methodological memos, and analytical memos
3.	**Coding cycle**
3.1	Coding the data set multiple times, merging and splitting codes, and writing memos
4.	**Categorisation cycle**
4.1	Revising and grouping codes to elaborate possible categories
4.2	Selective coding: researcher coded data from a theoretical perspective of CHAT and MDA.
4.3	Displaying networks[12] of codes and displaying relations among categories. An example of a network can be found in Appendix N.
5.	**Developing a thick description of data in narrative format**
5.1	The researcher examined data and identified stories within the data, using the search button for linguistic cues as described in Table 4.2 for further analysis of discursive manifestation contradictions.
5.2	Writing narratives
6.	**Conducting activity system analysis**
6.1	Draft activity systems based on narratives
6.2	Identifying and reporting the final findings

The primary benefits of integrating CHAT and MDA in qualitative research and data analysis are that these approaches offer a robust framework that serves as a reliable guide for constructing valid interpretations of the data. The interviews, observation and read-aloud protocol were used to triangulate findings as well as provide a “thick

[12] A network refers to a visual representation of data consisting of nodes or points interconnected by links or lines. These networks are used to display participant actions, events, and processes in a coherent and connected manner.

description" (Denzin, 1989) of students' digital literacy practices and lecturers' practices. Together these data sources enabled the researcher to develop a picture of the students' subject position in terms of the knowledge of what and how students use digital literacy practices when they engage with physics e-textbooks.

In this research, the coding process is divided into two phases. The initial phase focuses on describing the data and establishing a coding system. The primary goal of this descriptive-level analysis is to thoroughly explore the data, reading through transcripts and field notes, and listening to audio files to identify noteworthy patterns and trends. This phase involves generating word clouds, word lists, conducting searches based on CHAT and MDA concepts, and coding the data. These activities serve as a starting point, especially considering the substantial volume of data that was generated. Interesting aspects that I noticed were written down in memos, marking the segments that were found to be of interest.

The data were organised and coded using ATLAS.ti 23. This ensured that data was treated systematically, following a consistent coding process, and allowed for a large amount of qualitative data to be produced, handled and analysed. In this study, I worked with 18 documents in ATLAS.ti 23, highlighting 1185 quotations, which yielded 200 codes. The number of codes is because, at the beginning, I was coding at a descriptive level. Then, after more detailed analysis and merging the codes, the number of codes was reduced to 130 (categories and sub-codes), which showed the conceptual level of analysis. All these codes were grouped into five families (see CodeBook, Appendix K and L). At the beginning of the analysis, I used inductive coding.

The first coding phase aimed to establish a comprehensive code list that described the various issues, aspects, phenomena, and themes present in the data. Through this process, these elements were named and examined for similarities and differences, resulting in a structured code list that subsequently could be applied to the remaining data during the second-stage coding. However, further refinement of the code list was necessary, and additional cycles of observation and data collection were conducted to ensure comprehensive coding and the development of a complete coding schema.

In the second coding phase, the focus shifted towards querying the data to find answers and identify relationships aligning with the research questions. I began by using CAQDAS tools to query the data based on the previous coding. These queries yielded results that could be presented in numerical form, coded quotations, or visualisations. However, the actual analysis process occurred during the writing stage, where I summarised and interpreted the outcomes. To facilitate this process, I utilised the memo function. Through writing comments and memos, I advanced the analysis step by step, delving deeper into the data, examining details, and gaining a better understanding of how all the elements interconnected. This process allowed me to explore and uncover the intricate relationships within the data. After familiarising myself with the data, I created an analytical framework for deductive code analysis (see Appendices K and L). During the second step of deductive coding, I created many links to the data and various networks to visualise the data.

In deductive coding, the concept of contradiction was explored, and its discursive manifestation was examined. Engeström and Sannino (2011) argue that the term "contradiction" is broad and vague, encompassing various tensions and disturbances within the activity system. This broadness and vagueness make it challenging to analyse contradictions in data analysis, as the concept itself is unclear and the ways in which contradictions can be personalised are not well defined. Contradictions are manifested through tensions, problems, failures, and errors, which are observable owing to their historical and systemic nature.

To address the complexity of contradictions and their discursive phenomena, Engeström and Sannino (2011) developed an analytical framework, also known as the discursive manifestation of contradictions. This framework helps researchers understand the practices associated with contradictions, how to deal with them, and how to resolve them. Within this framework, the authors identified four types of contradictions: dilemmas, conflicts, critical conflicts, and double binds. These different types of contradictions provide researchers with a structured approach to analysing and interpreting the discursive manifestations observed during interviews and discussions with participants. Table 4.2, which follows, summarises the discursive manifestations of contradictions as adopted by Engeström and Sannino (2011). It is

worth noting that creating a codebook for this study greatly aided my contradiction analysis, which is elaborated upon in Chapter 7.

Table 4.2: Discursive manifestation of contradictions adopted from Engeström and Sannino, (2011, p. 375).

Manifestation of contradiction	Features	Resolution	Linguistic Cues
Dilemma	Expression or exchange of incompatible evaluations.	Denial	"on the one hand [ ] on the other hand", "yes, but", "I didn't mean that", "I actually meant"
Conflict	Arguing, criticising	Finding a compromise, submitting to authority or majority	"no", "I disagree", "this is not true", "yes", "this I can accept"
Critical Conflict	Facing contradictory motives in social interaction, feeling violated or guilty	Finding new personal sense and negotiating a new meaning	Personal, emotional, moral accounts, narrative structure, vivid metaphors "I now realise that [ ]"
Double bind	Facing pressing and equally unacceptable alternatives in an activity system	Practical transformation (going beyond words)	"we", "us", "we must", "we have to" pressing rhetorical questions, expressions of helplessness "let us do that", "we will make it"

Afterwards, the data was analysed to comprehend its coherence, and visual tools like the network function in ATLAS.ti were utilised for this purpose. Working with networks stimulated a distinct thought process and facilitated further exploration. Networks were also used as a means of communication to discuss findings and develop ideas collaboratively with my doctoral supervisors.

During this stage, the main objective was to integrate all the research findings and establish a unified understanding of the studied phenomenon. The use of network representations helped present a theoretical model (see Appendix N). Theoretical models offer an organised and coherent depiction of the relationships and connections within the data, resulting in a clearer and more comprehensive comprehension of the

research subject. Utilising network visualisations contributed to a more profound and meaningful interpretation of the data, promoting effective communication and discussion of the research outcomes.

I used three types of memos: research diary, methodological memo, and analytical memo. The research diary memo was used to write notes and feelings on each research day. These could deal with articles and noticing of exciting facts that needed to be investigated later or simple explanations of phenomena after reading. The methodological memo refers to conducting data collection, selecting research instruments, and writing about the methodology. I used a group of documents related to methodology, and memos were used to reflect on these. The last memo was an analytical memo, which is slightly different from methodological memos because it includes analysis of the transcripts and other collected data, and theorising and making arguments. In these memos, I reported on data by visualising (creating networks) and linking codes, quotations and memos together.

4.9 Ethical considerations

The ethical application for this research was reviewed and approved by the Ethics Research Committee (ERC) of the Faculty of Engineering and the Built Environment (FEBE) at the University of Cape Town (UCT). A second ethics approval was obtained from the Faculty Research Committee (FRC) at the relevant UoT at which this research was carried out (see Appendix N). In addition, the two heads of the Department of Chemical Engineering and the Department of Maritime Studies and staff members within the departments were informed of the nature of the study, and permission was obtained from them, even though they (the departmental heads) were not identified as participants in the research (see Appendices A, B, C and D for ethics clearance documents). This study involved human participants, and the research design was designed to ensure that the research did not pose any risks to any of the participants (engineering students and lecturers), the researcher, the department or the institution. The entire ECP first-year student cohort of these two departments were also apprised of the purpose of the research project. All volunteer student participants were required to give written informed consent (for all phases of this study). A letter of invitation was given to all registered students in the Maritime Studies and Chemical

Engineering departments, explaining the process of data collection and the purpose of the research study. Those students who volunteered to be part of this study signed an informed consent form and returned it to me for record-keeping purposes. I indicated to participants that there were no correct answers to the questions that were asked during the interviews. It was made clear to participants that they were allowed to withdraw consent freely and discontinue participation in the study without prejudice to the participant. The participants were assigned pseudonyms (e.g., Student 1 or Lecturer 1) to ensure confidentiality and limit bias. Confidentiality for each phase of data collection and data analysis was maintained throughout.

During the interviews, I only asked questions and made notes about the participants' digital reading practices. I did not collect demographic data from the participants since the goal of this study was only to investigate the digital literacy practices of the engineering students. All interviews were transcribed, and the audio files were kept in a safe place and locked in the researcher's office. The electronic data were saved as password-protected files on iCloud and backed up on Microsoft OneDrive. This research project is on the digital literacy practices of a diverse group of engineering participants, not their individual academic performance. As a result, no conclusions were reached that could be applied to the individual performance of the participants in this study.

4.10 Trustworthiness and rigour

Lincoln and Guba (1985) advocated data collection from multiple sources. Multiple data resources were used in this study to ensure internal validity and to ensure data saturation. I chose methodological triangulation as a data-collection technique, employing in-depth interviews, observation, the think-aloud protocol, and questionnaires.

Sample access was made possible through consultation with an academic contact who acted as a gatekeeper, connecting with lecturers and heads of departments. As the researcher, I had no prior relationship with the participants; this was vital to prevent potential biases. This strategy ensured that no facets of academic life were overlooked or assumed based on familiarity. During the interviews, an open and accepting

approach was adopted. This allowed the researcher's preconceptions to contribute to the data-collection process without interfering with it. The emphasis was on creating a comfortable and unbiased environment for gathering information.

Reliability and validity are quantitative research-derived methodological principles later adopted in qualitative research. In quantitative research, reliability focuses on ensuring consistent results across multiple researchers and projects using the same methodology. On the other hand, qualitative research emphasises validity, which involves the use of specific procedures to verify the accuracy and credibility of the findings (Creswell & Creswell, 2017). In qualitative research, “validity” is measured by “credibility” and “transferability”, as described by Lincoln and Guba (1985); it is an indicator of internal validity, and is determined by the degree of respondent agreement with the findings.

“Reliability” in qualitative research is measured by “dependability” and “confirmability” (Lincoln & Guba, 1985). In terms of credibility, the reading activities of the students were used to triangulate their individual and focus-group interviews. Furthermore, to reduce bias, interview data findings are reported using verbatim transcripts of respondents (Maxwell, 2009). According to Maxwell (2009), verbatim transcripts of interviews contain more information than digital researcher journals and notes on what a researcher deemed significant and necessary to record for future research. In terms of transferability, the findings of this study, which was conducted with a specific sample of first-year students at a university of technology in South Africa, may be applicable to a similar setting. The concept of dependability is related to the concepts of duplicability and dependability (Guba & Lincoln, 1982). In this study, I used a “step wise replication” (Guba & Lincoln, 1982) methodology to collect data on students' from two engineering programmes digital literacy practices and how they read e-textbooks. The data collection and analysis methods used in this study were documented, and the data-collection instruments are included in the appendices for convenience.

According to Rolfe (2006), rigour is socially constructed and thus has different meanings depending on the discourse in which it is used. I looked into engineering students' practices, which are built in and out of human-environment interaction and developed and transmitted in a social context. In this study, multiple methods, such as

observation, interviews, and recordings, result in more valid, reliable, and diverse interpretations of reality.

Triangulation serves a pivotal role in qualitative research, acting as a mechanism to bolster its credibility. By leveraging multiple data sources and diverse collection techniques, researchers can ensure a more robust and comprehensive understanding of their subject (Creswell & Creswell, 2017). Triangulation can be broadly categorised into three types: data triangulation, theory triangulation, and methodological triangulation.

Data Triangulation: This approach entails gathering information from various sources across different timeframes and settings. In the study at hand, the data didn't solely originate from textual content or oral discourse. Instead, it extended to wider social practices associated with e-textbook interactions, offering a richer picture of engagement beyond mere text or interviews.

Theory Triangulation: This process demands that collected data be viewed through the lens of multiple theoretical frameworks. For this study, both the cultural-historical activity theory (CHAT) and multimodal discourse analysis (MDA) were employed as guiding frameworks. By integrating insights from both theories, a more comprehensive understanding of students' engagement with e-textbooks was achieved.

Methodological Triangulation: Here, the emphasis is on using varied strategies for data collection. A prime example from the study is the utilisation of ATLAS.ti software for code list organisation. This method presented dual advantages: it facilitated easy data navigation and introduced a layer of transparency to the research procedure. Such transparency ensures that the research's findings and methodologies remain accessible and comprehensible to peers and stakeholders alike.

In interpretivist research, a significant challenge encountered in any study is the potential influence of personal biases due to prior experiences working with lecturers from the departments involved. Despite making every effort to maintain objectivity, these biases could still impact the researcher's perceptions and understanding of the collected data and the interpretation of the experiences.

4.11 Conclusion

As stated earlier in this chapter, the aim of this study is to understand the digital literacy practices of first-year engineering students registered at a UoT and how engineering lecturers employ e-textbooks in their teaching practice. This study uses qualitative data. I discussed the qualitative paradigm in engineering education research. The rationale for the chosen methodology, and justification for this study's epistemological, ontological and methodological dimensions, were presented. The debate regarding methodological criteria to ensure trustworthiness and rigour was discussed in parallel. I described in this chapter the data collection undertaken for this study and further analysis procedures. Additionally, I elaborated on the computer-aided qualitative analysis software process employed. Ethical measures, rigour and trustworthiness were also discussed. In the next chapter, various themes and subthemes that emerged from the empirical data are discussed and interpreted.

Chapter 5
Participants' digital literacy access, experience and practice

5.1 Introduction

In the previous chapter, I discussed the research design and procedures for conducting data analysis. The purpose of this chapter is to introduce the participants of the study. The participants were first-year students (*n* = 73) from the Chemical Engineering and Maritime Studies departments in the Faculty of Engineering and the Built Environment at the selected university of technology (UoT). Notably, these students were enrolled in the Extended Curriculum Program (ECP) (more information about the research context is discussed in Chapter 1, Section 1.1). Secondly, the participants included four engineering lecturers from the same departments, teaching physics to engineering students at the UoT. Since this study focuses on the digital literacy and pedagogical practices associated with e-textbooks, it was important to understand the participants' previous experiences before they entered the university as well as the lecturers' roles, experiences and responsibilities.

The research design consisted of one case study with two embedded units. One unit was the chemical engineering students, and the other one the nautical science students.[13]. The findings in this chapter are drawn from an online student questionnaire and interviews with students and lecturers (see Appendices E and J). The data from the questionnaire are organised into six themes, including participants' background, their use of technology, their knowledge and experience with e-textbooks prior to enrolling at the UoT, their preference for reading (time and format) for study purposes, and their engagement with traditional textbooks for study purposes. In this study, the questionnaire served three primary purposes. Firstly, it was used to collect information about participants before they entered the UoT. Secondly, the data collection for this study was conducted in 2021, when COVID-19 impacted all aspects of personal and professional life, and it was important to understand participants and their experiences with digital learning devices and tools such as e-textbooks. Thirdly, the questionnaire was used to identify and invite participants for the subsequent

[13] In the second embedded unit, from the Department of Maritime Studies, my participants were students enrolled in the nautical science programme (see more information about the case study design in Chapter 4).

phases of data collection, which are discussed in the following chapters of this thesis. In this chapter, I also discuss the student participants' prior experiences, choices and challenges with reading and technology, as collected in the interviews. In the last section of this chapter, I introduce the four lecturer participants in terms of their roles, responsibilities, and experiences.

5.2 Background of the student participants before entering university

In this section, I discuss the background and previous school experiences of students in relation to computers and digital devices. The total number of students who completed the questionnaire was 73 (*n* = 34 from Chemical Engineering and *n* = 39 from Maritime Studies: Nautical Science). It was important to have a clear understanding of participants' prior digital literacy experience before enrolling at the UoT because, in South Africa, many learners entering higher education from rural areas have limited access to the internet and other forms of technology.

Figure 5.1 reveals that the majority of participants entered higher education for the first time in 2021. As can be seen in Figure 5.1, 41 first-year students graduated from high school in 2020 and immediately enrolled at the UoT in 2021, while nine students had previously attended other universities or changed their qualifications. Nineteen students reported staying at home for a variety of reasons, such as undecided majors, universities, and/or programmes. Several students (19 participants) selected the "Other" option, of whom seven from this group indicated they were busy upgrading their matric results[14] in the year prior to registration.

[14] Matric results in South Africa refer to the National Senior Certificate examination for Grade 12 at school.

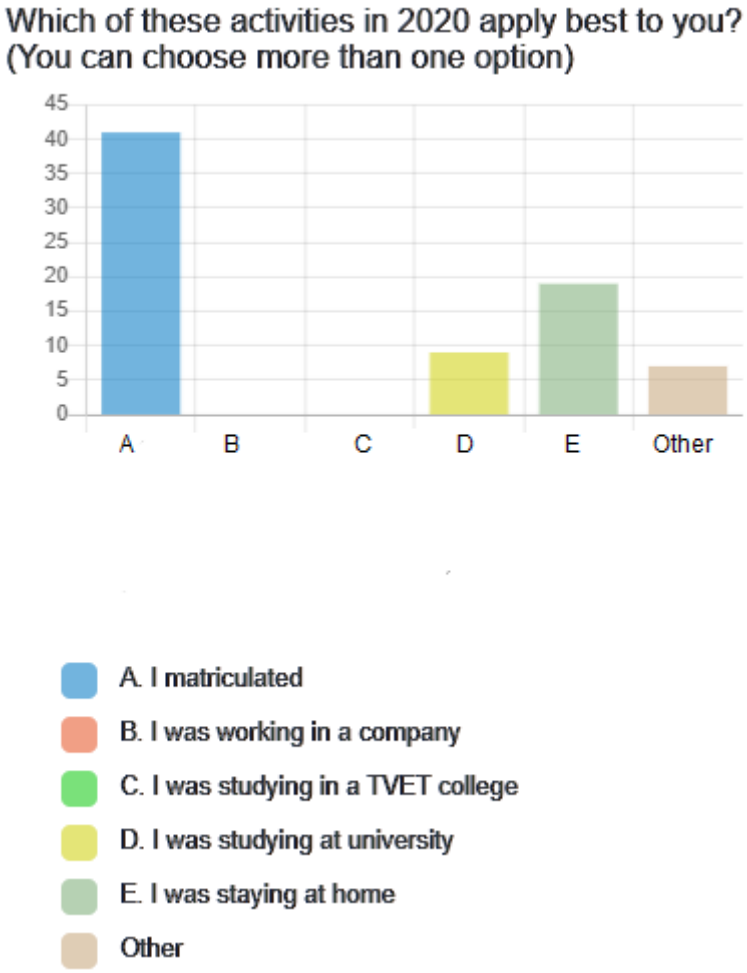


Figure 5.1: Students' activity before they entered the UoT in 2021

The COVID-19 pandemic affected all school learners in South Africa, but the effect was particularly severe in schools located in rural areas, where access to physical and digital resources has historically been limited. Figure 5.2. shows the extent to which students may have had limited computer and digital literacy skills. As can be seen, of the 73 participants, 16 only had access to the internet and related technologies at home, 11 only had access at school, and 17 had access both at home and at school. However, 29 participants reported that they lacked access to these technologies at both home and school, including computers, the internet, and Wi-Fi.

If students do not have access to computers, the internet, and Wi-Fi, they are unlikely to have any computer-related classes at school (as shown in Figure 5.2). Figure 5.2 shows that only 17 high school students were enrolled in a computer-related course. This reveals that the distribution of technology and access to technology on the part

of first-year students into higher education in general, and engineering education in particular, is of concern. The transition is not always smooth. Students 7 and 4 recounted stressful experiences navigating the intersection of reading and technology, as two students argued during their respective interviews:

> *I'm not used to a computer … since I'm new at university … I'm frustrated, confused… I am new to computers as these things are irritating me … But I'm trying to get to there.* [Student 7].

> *And at school … I never had anything with computers, the only thing I'd [do with] computers is going to Word in taking down my assignment [and] printing it out. So, it's different, that it's a new way of learning. And it's hard to adapt to it because it's new…* [Student 4]

Students at UoTs historically come from educationally disadvantaged communities where they do not always have access to Wi-Fi and internet or other types of technology. South Africa is a country with diverse population groups that are economically, culturally, and socially stratified. Access to digital devices and internet connectivity (which requires both knowledge of and the ability to connect to technology) is crucial for the development of students' digital literacy skills. The engineering curriculum of the first year is designed for students to learn programming, coding, and mathematical modelling. This means that a student needs to have basic and intermediate knowledge of computers. However, according to the survey, nearly half the students did not have access to technology and the internet at home or at school, or exposure to computer-related subjects at school.

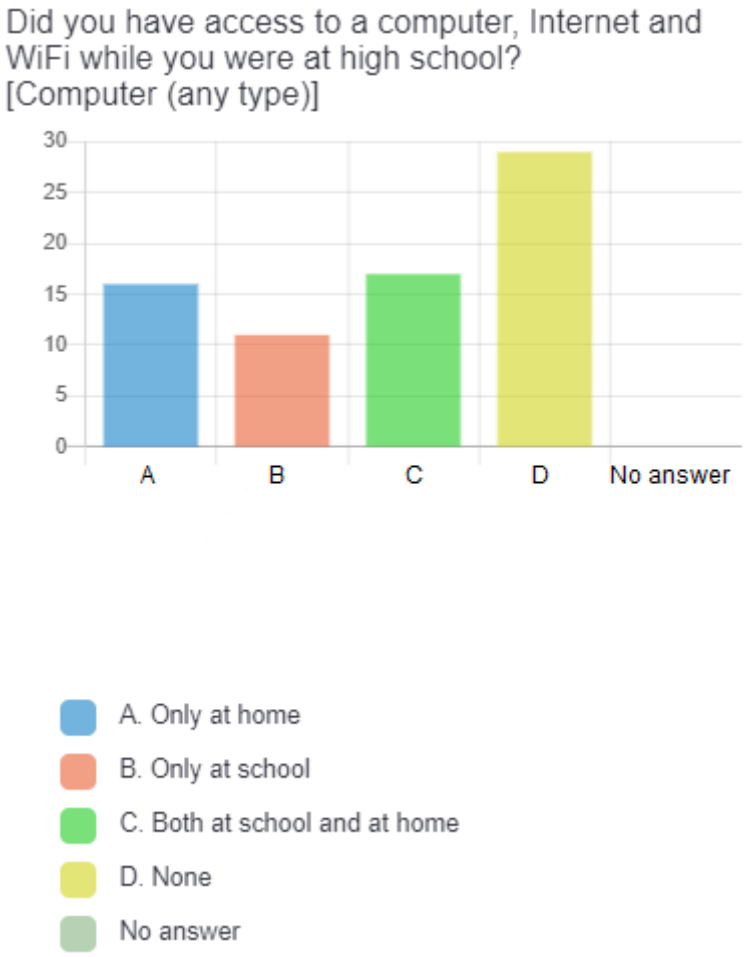


Figure 5.2: Access to technology

In addition to understanding students' access to technology and the internet at home and school, the survey also aimed to understand the participants' prior digital technology experiences. In Figure 5.3, participants' school exposure to computer-related activities is depicted. Figure 5.3 reveals that the majority of participants (56 out of 73) conducted online search activities for school-related learning, while 12 participants used technology to search electronic library catalogues for books and materials and 14 participants reported using technology to submit assignments via email. Eleven participants shared files through cloud storage, 15 collaborated with other peers online, and 13 stated that they had never used technology for learning in high school. The data presented in Figure 5.2 warrants careful consideration, especially in light of the finding that nearly 50% of the participants reported lacking access to technology both at home and in school. Despite this apparent lack of access, it is noteworthy that 56 of the 73 participants had engaged in online activities previously. This suggests that these activities were likely conducted in settings other

than home or school, highlighting an intriguing aspect of technology usage patterns among the respondents.

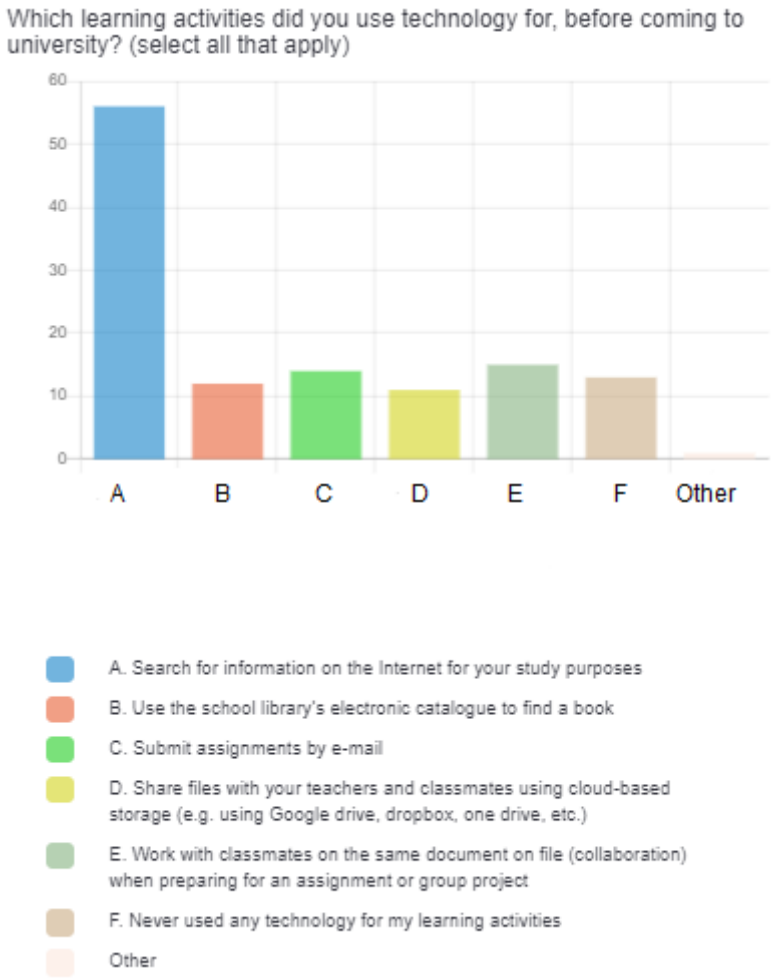


Figure 5.3: Learning activities and usage of technology before entering UoT

Despite the fact that a notable portion of the participants reported limited access to computers (27 in total at home and school out of 73, as shown in Figure 5.2), the majority had never enrolled in any computer-related courses in school (56 out of 73, see Figure 5.4). It is important to mention here even through some participants had never taken any computer-related courses, a variety of digital and computer literacy practices were used, demonstrating that the students possessed some general digital literacy skills (Figure 5.3). Even where students do have access to technology, this does not mean they know how to study with technology. It is also important to note that receiving technological devices through a bursary (as is often the case in South

Africa) does not guarantee that students have adequate skills to effectively use these devices.

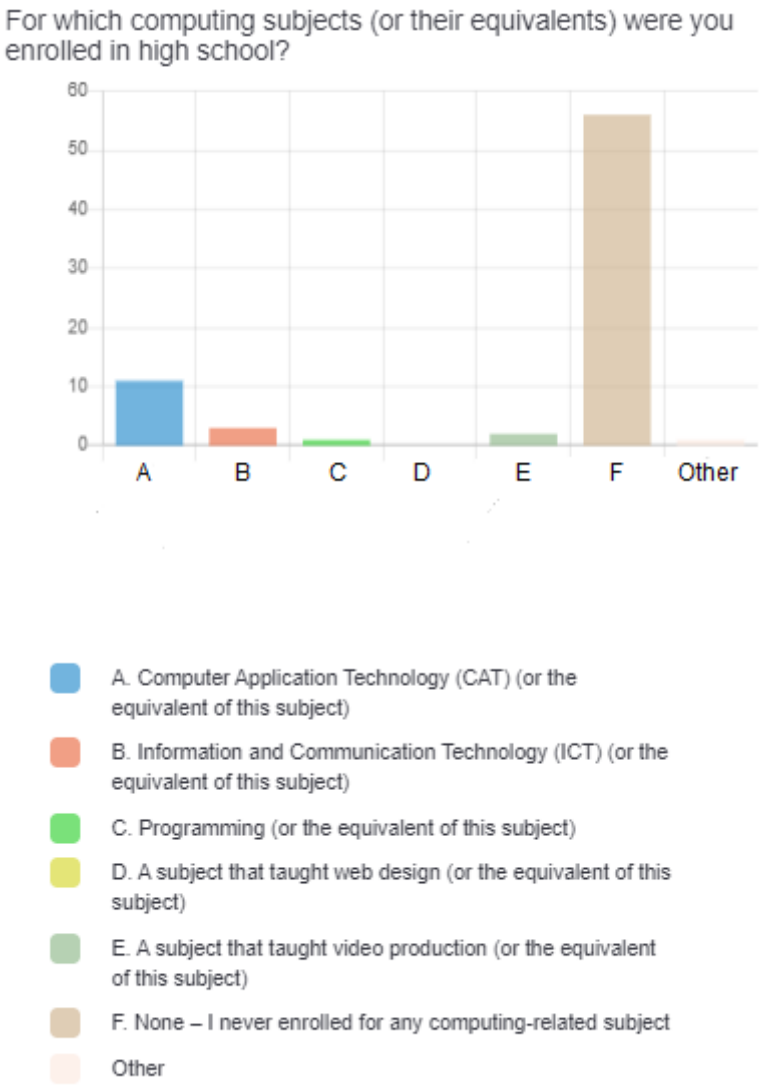


Figure 5.4: Participation in computer-related subjects at school

Participants were asked what other leisure activities they used technology for aside from school learning. Figure 5.5 depicts the responses received. Most notable is a relatively large number of responses (55 out of 73) on the use of chat technology (e.g., WhatsApp). This is to be expected as students primarily use mobile or computer devices for social interaction on social media platforms. The second most popular response was to share files, apps, and games with friends (46 responses), followed by access to email (43 responses). The subsequent response was to capture and edit images and videos using a mobile device (38 responses), followed by playing online

games, and recording stories and live streaming (21 and 13 responses, respectively). The data indicate that participants use technology and devices in their free time for a variety of purposes, but primarily for social media.

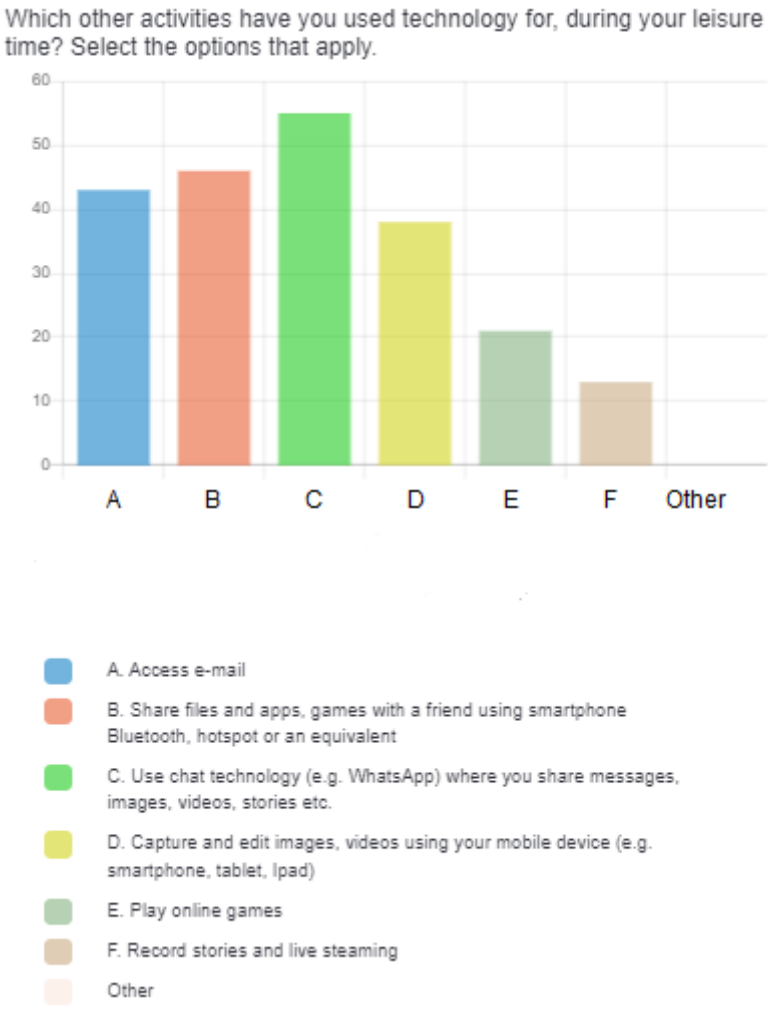


Figure 5.5: Usage of technology during leisure time

First-year university students use their mobile phones extensively for social media communication and other social activities (Díaz-Sainz et al., 2021), despite the fact, as shown in Figures 5.2 to 5.4, that many of the students did not have easy access to technology, Wi-Fi, or the internet, nor did they take any computer-related courses in high school. However, they were nonetheless able to use their mobile phones, as shown in Figure 5.6. For example, 70 students indicated that they used their mobile phones for communicating with friends and family; 58 reported using them for studying; 54 respondents used them for watching videos on YouTube (which could be for either study or leisure purposes); 45 respondents used their mobile phones for

reading the news; 43 used them for taking photographs; and the last two answers, playing games and recording and editing videos, received 31 and 26 responses, respectively. For instance, students may have used a WhatsApp study group in which they interact with classmates. Additionally, students may access learning outside of the classroom such as browsing and reading news which could indirectly be for academic purposes.

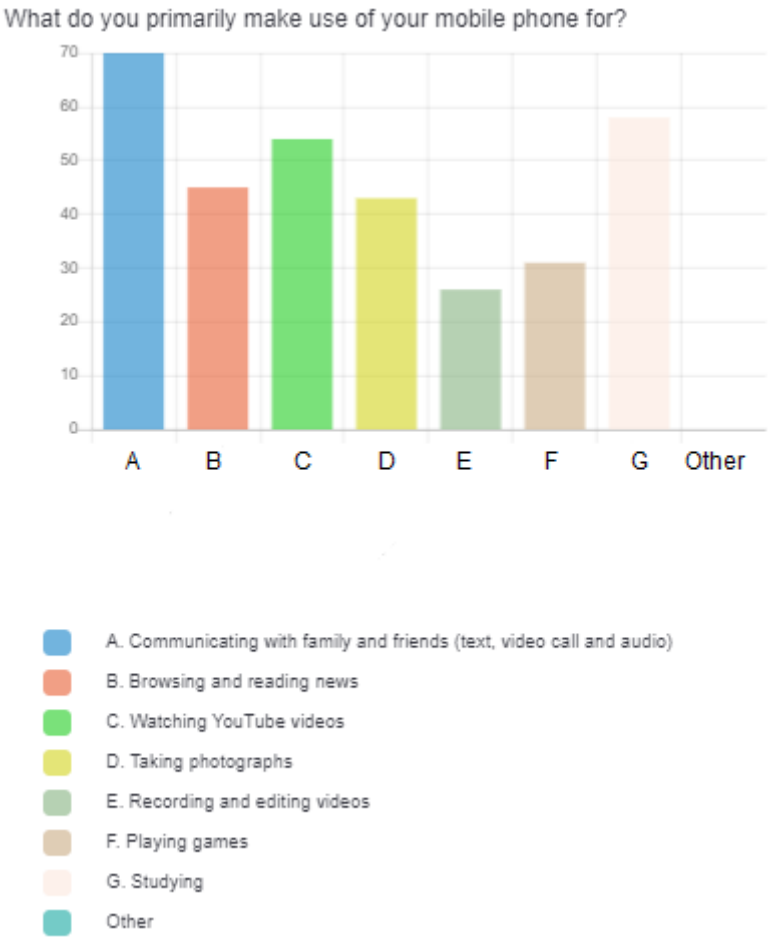


Figure 5.6: Usage of mobile phone

Since this study investigates the digital literacy practices associated with reading e-textbooks, it was important to understand participants' prior e-textbook experiences, as well as their preferences regarding reading format, time spent reading and digital literacy practices associated with traditional textbooks before enrolling at university. The interviews with participants were done in April and May of 2021, and the academic year started in March 2021; therefore, participants had limited experience utilising e-textbooks for reading. At the beginning of the semester the physics lecturers arranged

for students to meet with a representative of the publisher for a demonstration session on how to study with e-textbooks and what functions and affordances e-textbooks have for academic reading (such as displaying media and audio elements in e-textbooks, collaboration, and online group work). Although students were exposed to some demonstration of the functionality of the e-textbook, based on the observations made in this study, it is unlikely that the demonstration was in-depth and moved beyond a superficial showcasing of some of the tool's features. The presenter, who may not have possessed an educational background or experience in teaching students, merely showcased the tool. There was a lack of depth in explaining how e-textbooks can enhance the understanding of complex engineering concepts. More detailed discussion on this is provided in Chapter 7, Section 7.2.

5.3 Students' prior experiences, choices and challenges with reading

In this section, I discuss students' prior experiences, choices and challenges associated with reading. Figure 5.7 shows the level of knowledge students possess in relation to e-textbooks. As can be seen, 44 participants stated that they understood what an e-textbook was, while three participants said they did not. Twenty-six participants responded that they were unsure. However, knowing what an e-textbook is does not imply that participants knew how to study with and benefit from e-textbooks. Despite the data presented in Figure 5.7, students are occasionally unaware of the distinction between a PDF file and an electronic textbook (more discussion is provided in Chapter 7).

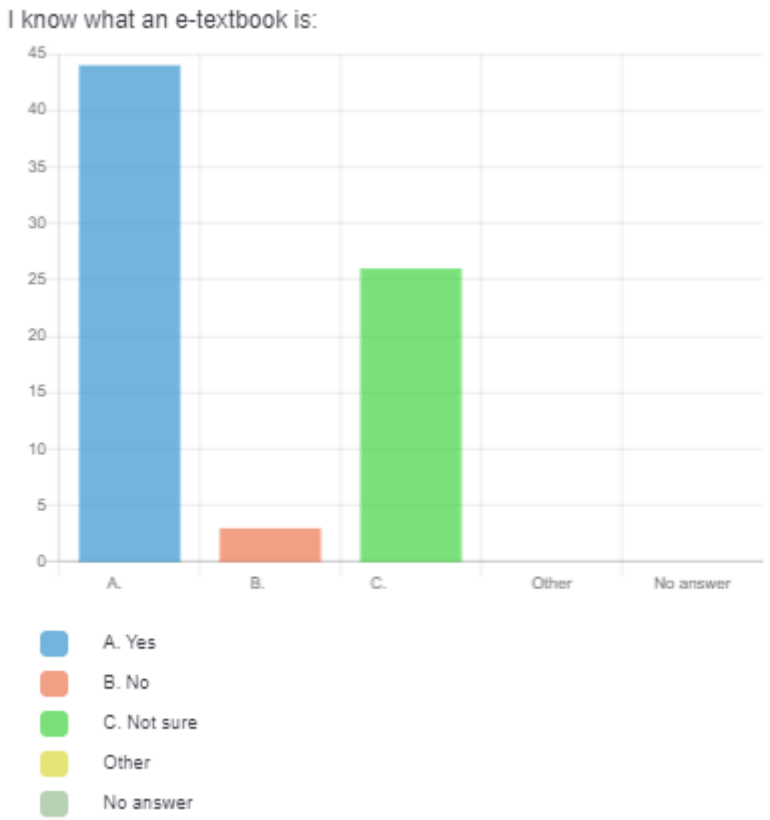


Figure 5.7: Knowledge of e-textbooks

The next question, illustrated in Figure 5.8, is related to usage of e-textbooks. Figure 5.8 demonstrates that participants entered the UoT with limited knowledge of and experience with e-textbooks. Seventeen participants stated that they had never used an e-textbook, while 6 participants reported using them one once. Thirty participants reported using e-textbooks a couple of times, and 14 participants stated they used them frequently. One respondent who selected the "other" response from the question in the questionnaire also indicated in the comment area: "*Maybe I have used it.*" However, upon later investigation during interviews with selected participants, it emerged that the students confused e-textbooks with PDF copies of textbooks, as discussed in Chapter 7. Evidently, few students had experience with the use of e-textbooks prior to entry into higher education.

Figure 5.8: Students' experience of studying with e-textbooks

Figure 5.9 displays the weekly usage of the physics e-textbook in hours, as reported by the students. Based on Figure 5.9, the number of hours per week that students used the e-textbook was relatively low. Most students' use of e-textbooks was between two and four hours per week. During the individual interviews, one student expressed concern over their lack of understanding and study skills, particularly in theoretical courses where students need to read a great deal of text.

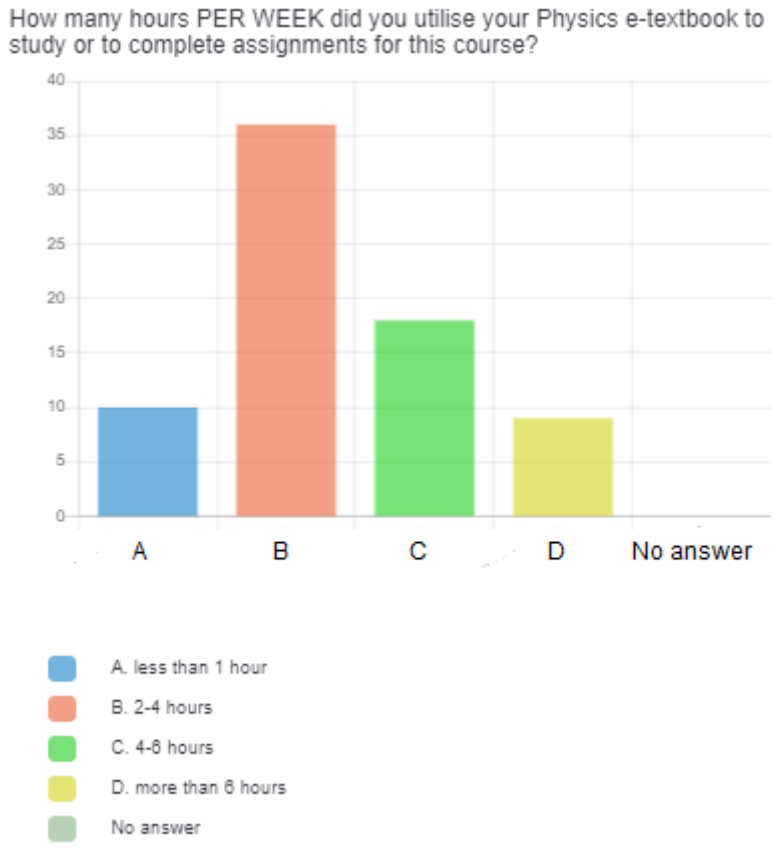


Figure 5.9: Usage of physics e-textbook per week

Earlier, I addressed students' familiarity with e-textbooks, their experiences using them, and their weekly usage of physics e-textbooks. To further understand their preferences, I examined whether students favoured studying with a hard copy or a digital copy. Figure 5.10 indicates that of the participants, 56 preferred hardcopy textbooks, while 17 opted for digital versions. This trend suggests a preference among students for traditional books. Merely having access to technology and e-textbooks does not ensure that students will engage with these tools. Despite having access, some students still gravitate towards hard copies, possibly due to limited experience with e-textbooks or not having used them in the past.

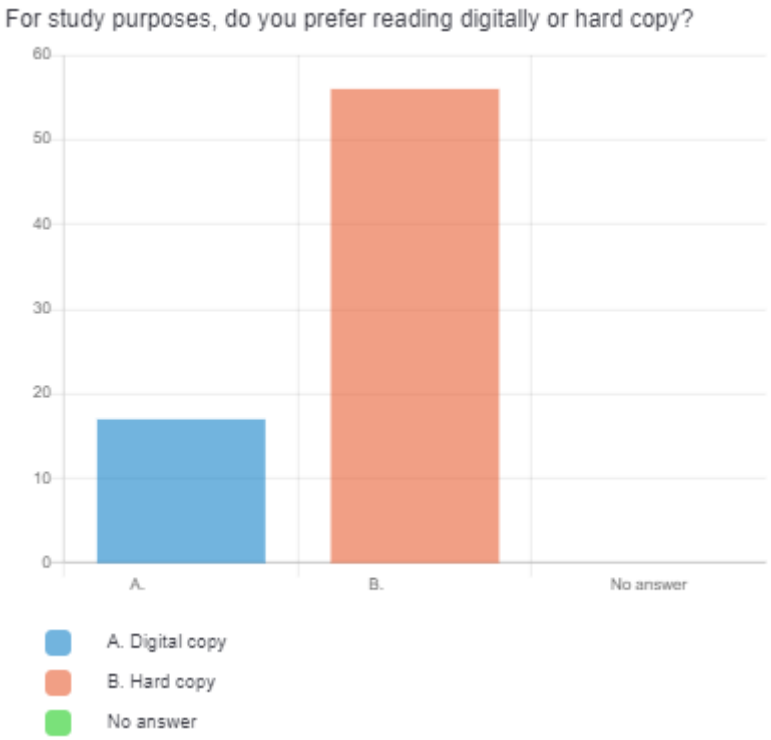


Figure 5.10: Students' preference for book format

During the interview discussions, students' preferences for hard copy formats were also pronounced, with students explaining why they chose hard copy formats. This related to the context of limited resources and access to computer-related subjects in schools in rural areas of South Africa. As one student states:

> *Sometimes … if I want to use digital notes,* [it] *is hard … because …* [there] *may be load shedding,*[15]*, if you want to study* [for a] *test, you might not be able to do it. But if it's a paper book, you might* [study]… [Student 3]

Another reason for preferring the hard copy format is that many students in South Africa revert to studying on their mobile phones. Studying with a mobile phone, particularly reading, is difficult owing to the small screen size, although students could use the read-aloud option. In addition, students experience challenges regarding mobile data, and not many e-textbook publishers support doing calculations on mobile phones. As the same student notes:

[15] South Africa experiences load shedding due to an electricity generation shortage. During this time, the electricity supplier turns off electricity to users in different parts of the country on a rotational basis to help prevent longer, larger outages.

> *…if you use mobile data and you busy* [reading] *an e-textbook. … I'm not sure if you can have access to the e-textbook if mobile data is off*. [And also, if your mobile data is on] *then you might be getting messages.* [I] *lose focus; maybe a text comes through your phone.* [But if] *I am using hardcopy* [I] *just switch off my phone and focus* [on reading] *…* [Student 3]

Another student agreed with the previous point:

> *For me … it is easier to do with hard copy of the book, because it's hard to first understand everything that's going on, So I never had the privilege at school* [to] *learn with computer. I had to learn it on my own. So, I prefer the hardcopy.* [Student 4]

As depicted in Figure 5.10, participants indicated that they prefer to study from a hard copy textbook. Nonetheless, it was crucial to comprehend the types of literacy practices they employ when reading a print textbook. Figure 5.11 shows these practices. Participants were most likely to make notes and highlight or underline the text (51 and 41 responses, respectively), and then use the margins for comments (7 responses). However, 24 students reported doing all of these activities. These are fundamental and standard reading practices and represent what students can do with textbooks if they own the print book (otherwise, they are restricted to making notes outside the textbook). Before students can benefit from studying with an e-textbook, they need to be introduced to this technology in a meaningful way and fully instructed on how to utilise it (Jang et al., 2021) so that they can engage in the same kinds of learning practices while reading.

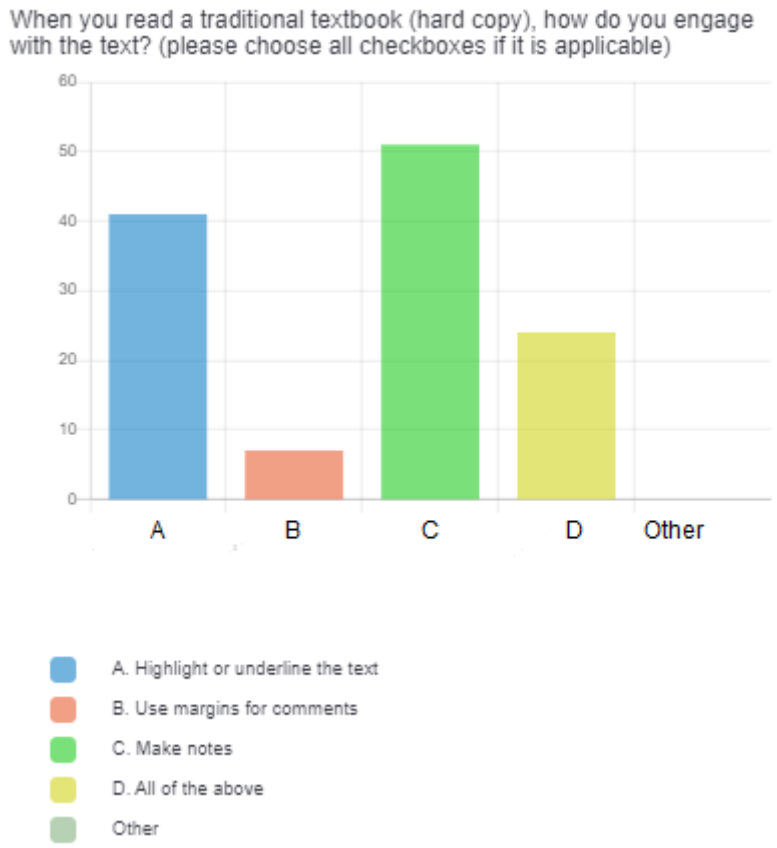


Figure 5.11: Literacy practices associated with reading a hardcopy book

One of the fundamental components of learning at university is reading with understanding. Students read texts to acquire new knowledge and put previously learned concepts into practice. However, because of the rise of digitalisation and the accessibility of resources online, reading online required additional literacy practices (digital notetaking, hyperlink use, and so on) (Schneps et al., 2013). Some students have a difficult time managing large amounts of reading and engaging with the subject matter by employing digital reading strategies such as taking notes to summarise important information. In the context of e-textbooks, students are expected to possess digital literacy, which encompasses a set of skills, attitudes, and behaviours. As they navigate through different formats, such as switching between print and digital text or engaging with media and hyperlinks within an e-textbook, readers must adapt their reading strategies to effectively utilise the information. Having a strong grasp of digital technology enables students to leverage various reading affordances and aids to enhance their learning experience (Coiro, 2011).

As illustrated in Figure 5.10, 56 out of 73 students indicated a preference for reading hard copy textbooks. Such a mode of reading often entails fundamental activities like highlighting and note-taking. The theoretical foundations of both hard copy and digital reading were previously explored in Chapter 2, specifically in Sections 2.1 and 2.2.

The previous section, 5.2, highlighted a significant finding: many first-year students lack awareness of digital reading practices. This is largely attributed to their limited exposure to digital devices. In fact, as detailed in Figure 5.2, 28 students reported having no access to such technology, while 27 students indicated only limited access. This limited familiarity with technology underscores the challenges associated with the broader adoption of digital reading practices.

From the individual interviews with students, it was observed that some students find studying by reading and the activities that come after it quite challenging, as Student 11 said:

> *… I'm confused, too... I find I see everything important. I don't know what's not important. And like when I tried to summarise like this paragraph …"Why did you leave that out?" It's not important. How do you know it's not important? Because I feel like everything that's written there was written for a purpose. So, it is important.* [Student 11]

This student expresses the challenge of navigating a new subject. Students struggle to distinguish between elaborations on an idea and the central tenets of a particular concept. This student's struggles to identify key points in reading are indicative of a broader literacy gap. This gap is further exacerbated by the challenges inherent in South Africa's educational context, where, according to the DBE (2020b), students often grapple with comprehending discipline-specific content in e-textbooks and other digital sources. The COVID-19 pandemic further highlighted these literacy challenges (Ali, 2020). The second part of this quote described the workload which this student faced during the first-year study: *It's really hard for me to study because now I have so many subjects to read that I can't keep track of some of these subjects* [sic]. [Student 11]

I asked participants to describe their digital learning practices in Grade 12 prior to joining university in order to better understand students' readiness for literacy practices at university.

> *No, school last year was hard for me. There was no teaching for the exam. So last year, I lived on videos. YouTube videos. Every section had all I needed to know. It was something hard for me because I had to, like, know everything. So, it was kind of easier for me because I preferred it. I watched the videos, did the experiments, because everybody will be willing to experiment. So, I had to do the experiment.* [Student 7]

According to the student, the main method of exam preparation in school was watching videos. This suggests that the participant primarily relied on YouTube videos as a learning tool, indicating some degree of learning from this medium. The participant's perspective is that, due to the absence of formal teaching for the exam, YouTube videos effectively took on the role of the lecturer. However, at the university level, lecturers play an active role in facilitating learning. They engage directly with students, introduce them to the various technological tools available for learning, and supplement their teaching with digital content, such as e-textbooks.

In summary, students face challenges with reading, irrespective of the medium. While some prefer traditional textbooks, others recognise the value of e-textbooks but admit to not utilising them owing to issues like limited technology exposure or access.

5.4 Lecturer-participants' roles, responsibilities and experiences

Research on the effects of e-learning on the roles of lecturers in digital spaces remains limited (Dhawan, 2020). While some studies focus on understanding and accommodating individual responses to change, there is a lack of emphasis on the practical challenges and lived experiences of academics during the transition to digital pedagogy. In contrast to the increasing body of research exploring the student experience in e-learning, where student perspectives are prioritised (Creanor et al., 2006), the voice of lecturers is often overlooked. As such, I outline four reasons as to why it is crucial to include lecturers in this study.

First, lecturers serve a variety of functions within the department, faculty and university, including content delivery, facilitating learning, and assessing learning. Given that lecturers have a variety of roles and responsibilities, it is crucial to understand how they conceptualise these roles and responsibilities in order to influence their pedagogical practices with regard to e-textbooks.

Second, lecturers are pivotal to the educational process, signifying their central role in delivering education, shaping its content, and influencing student outcomes. Additionally, they are integral components of the teaching activity system, which means they collaborate and interact with various elements such as tools, students, and curricula within the broader educational landscape. Despite this, relatively little attention is given to what they do in the classroom, how teaching takes place, and what mediation tools lecturers use to facilitate learning. Lecturers play an important role in the teaching process, particularly in developing course curricula and activities, prescribing subject resources, and teaching with e-textbooks. This means that lecturers should be considered for analysis in the activity system surrounding the use of e-textbooks.

Based on the analysis that follows, the third point delves into the broader teaching philosophy of lecturers. It seeks to determine how their beliefs about effective teaching shape their approach to education, especially concerning e-textbook resources.

The fourth point is the need to understand the specific pedagogical practices surrounding e-textbooks adopted by the lecturers. This includes identifying strategies and methodologies they employ when integrating e-textbooks into their teaching, and how these practices align with or diverge from their overarching teaching philosophy.

As can be seen in Table 5.1, Lecturers 1, 2 and 3 fulfil multiple roles in their departments. These include not only teaching and research, but also administrative support for the extended curriculum programme in their department. The participants hold the following positions: one is a junior lecturer, one a lecturer, and two are senior lecturers. Before being appointed as lecturers, all participants started their careers at the current university.

Within the CHAT framework, the roles of lecturers are understood through the concept of division of labour, where different members of the academic community engage in various roles with distinct purposes and objectives (mediated action). The division of labour involves the negotiation of responsibilities, tasks, and power dynamics within a classroom setting, whether it be face to face or online, and extends throughout the university structure. In this chapter, division of labour refers to the manifestation of participants' roles in their teaching. Leont'ev's emphasis on division of labour underscores its influence on our thought processes, as he argues that object-oriented activity is mediated by tools and occurs within specific conditions (Edwards, 2007).

Table 5.1: Lecturer-participant characteristics

Pseudonym	***Role***	***Rank***	***Responsibilities***	***Years of teaching***
Lecturer 1	Lecturing staff and outgoing ECP Coordinator in Chemical Engineering department	Dr, Senior Lecturer	Teaching, administration, managing the ECP programme, research	More than ten years
Lecturer 2	ECP Lecturing staff in Chemical Engineering	Lecturer	Teaching, administration, support the ECP programme, research	Three years
Lecturer 3	Lecturing staff and newly appointed ECP coordinator in the Chemical Engineering department	Dr, Senior lecturer	Teaching, administration, managing the ECP programme, Teaching and Learning Representative for the department, research	More than ten years
Lecturer 4	ECP lecturing staff in the Department of Maritime Studies, Nautical Science programme	Junior Lecturer	Teaching and studying towards a master's degree	Two years

As part of the interview, the lecturers discussed their visions and ideas about their own teaching. All the lecturers interviewed claimed to incorporate a significant amount of interactivity into their classrooms. Lecturers 2 and 3 mentioned interactive teaching styles as an example:

> *I tried to promote an open atmosphere, I want students to interact. So, I tried to keep things a little bit light. … my teaching style is interactive by supporting students with understanding concepts. For example, if a student asks a question that you would consider ridiculous to some extent, I try not to just say "yes, it's wrong, or yes, it's right." I tried to dig a little bit deeper, even if a question was completely wrong, and maybe the whole class could see it. However, I try to dig deeper into where the misconception might have led the students to that conclusion for that type of question. just to try and make it seem like it's open for conversation. It's free. They can ask whatever comes to their mind. They can ask, and without feeling too much of a judgement.* [Lecturer 2]

Lecturer 3 also described their teaching style as "*interactive. And I am not somebody that wants to stand in the front of the class and speak the whole time, and when I'm done, I leave".*

However, each lecturer seems to draw on different underpinning philosophies on interaction. For example, Lecturer 4 seems to draw on the idea of facilitation:

> *The lecturer's role is to facilitate the learning to guide and help a student gain some skills based on specific subjects. Students are coming to the classroom to acquire knowledge and skills for their future fields.*

Lecturer 1 explicitly draws on the conversational framework proposed by Laurillard (1999), and clickers to improve the participation of the students:

> *When I started asking myself the question, how can my students be active participants in the conversation or dialogue that is happening between the students and me?... I adopted the clickers to improve the dialogue in the classroom. So on the conversational framework, Laurillard also talked about another secondphase of it, which is called the interactive side. When you bring in a system, the interactive side becomes more apparent... make sure that what you've taught in the classroom now is the reinforcement to test the student's understanding or to gain that level of understanding.*

Lecturer 2 appears to conflate interactivity with the use of humour*:*

> *I try to insert jokes here and there and try to lighten up the mood so that because I feel like they are learning, it makes it easy for the students to ask and request for clarity on something they don't understand if they feel like the classroom is a safer space. …my teaching style of physics as it's kind of an involved subject. So you … and there's a lot of content, so you do that, but you can't do that all the time.*

Nonetheless, all four engineering lecturers agreed that lecturing should be interactive and dialogical. Interactive communication between lecturers and students is part of their pedagogical practice. According to Smagorinsky (2011a:69), teaching involves mediation, primarily through scaffolding, guidance, and assessment. The terms "scaffolding" and "providing guidance" refer to the use of mediation techniques that involve students in problem-solving activities using cultural tools. In this perspective on teaching, a teacher who expects students to use tools that are unfamiliar to them for tasks that do not build upon their previous problem-solving experiences is not truly teaching but merely assigning and testing. This does not imply that teachers should only ask students to do what they already know, as that would negate the purpose of education. However, it does emphasise the importance of aligning formal instruction with students' prior culturally fostered tool use. When there is little or no congruence between instruction and students' existing knowledge, and when teachers do not establish a reciprocal relationship with students to support appropriate tool use, the instructional process is likely to be ineffective.

The main idea of teaching practices is that to be a successful teacher, a conversation between lecturer and students is laid out in a dialogical manner. Vygotsky's concept of the ZPD (see Chapter 3, Section 3.3) implies that students need assistance from more capable (or more knowledgeable) others. Such mediation occurs through social interaction. Vygotsky explains the ZPD (1978, 1987, p.113) as follows:

> The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These

> functions could be termed the 'buds' or 'flowers' of development rather than the 'fruits' of development. The actual developmental level characterises mental development retrospectively, while the zone of proximal development characterises mental development prospectively.

Based on this, the ZPD is when the more knowledgeable one assists the less knowledgeable one. This can be done by other students, for example, when working in groups, as Lecturer 3 mentions:

> *So, you kind of teach them that you don't only have to think one way… you can think outside the box as well. I like group work. So, I'll explain something on the board. And then I'll give them a question. And they can work in groups. I don't mind if they're working in groups because sometimes it's easier when a student explains to another student what they are doing wrong or what they do not understand because they sometimes speak the same language versus me, not the same language thing.*

Many scholars, such as Smagorinsky (1995, 2011a) and Hardman (2020), agree on the crucial role lectures play; up to now, the debate on assisting students and mediation in online spaces is still present. Scholars are still trying to understand how much assistance should be provided to students to make them independent learners and promote self-regulated learning. Sociocultural constructivist views of teaching and learning emphasise the significant agency and active role of learners-as-teachers in the educational process. In constructivist approaches, teachers follow the ZPD concept to move students from an unknown area of knowledge and concepts by using teacher mediation as part of scaffolding tasks.

In comparison with the other lecturers discussed above, Lecturers 2 and 4 described their teaching philosophy as interactive by making the lecturing space informal and less serious. Setting up rules (whether formal or informal) in the classroom allows these lecturers to promote space for learning by making mistakes. The effect of making informal classroom rules is to promote a student-centred approach, as mentioned by Lecturer 2:

> *So, I mean, the lecturer can be serious all the time. So students know that they need to be able to focus on something when they need to do something, but they can also relax a little bit when time allows.*

Students develop an understanding of engineering concepts in different ways, as Lecturer 2 discusses:

> *Students have different ways of learning; some people are visual people, some are kinesthetics and some are whatever. So, some people learn best with experience, some people learn best by thinking, and some people learn best by just looking. So, for people who are visual, they just want to see the words and whatever.*

Lecturer 2 further explains how e-textbooks allow students to learn in these different ways.:

> *E-textbook is the best because the student can actually have all these ways of learning. Depending on the software you have, you can actually have someone reach out the thing for you, which is wonderful. With* [a] *paper textbook you really can't have all these options of learning.*

As demonstrated, all the lecturers mentioned that their teaching style is interactive and they all expressed their view on teaching with e-textbooks. This links the teaching approach directly to the adoption of e-textbooks. However, it was noticed that at the beginning of the interviews, the lecturers did not have a clear understanding of the differences between an e-textbook and a paper book; however, by the end of the interviews, the lecturers showed greater appreciation for the affordances of e-textbooks. More specific discussion of the lecturers' practices around the use of e-textbooks is provided in the chapters that follow.

5.5 Conclusion

In this chapter, LimeSurvey questionnaire responses from 73 participants and interviews with lecturers and students were analysed. The responses to the questionnaire provided an overview of and introduction to the student participants before they entered university. The chapter shows that many first-year students have had limited access to technology (digital devices and the internet), not only at home but also at school. This creates a digital gap for students in relation to digital literacy and is a source of inequity among students. Many participants further indicated that they did not have any computer-related subjects in school, and only a few students had leisure time experiences with technology. This means that not all students have access to technology, and many may use it only for leisure purposes rather than for academic purposes. In addition, many students are unfamiliar with or have not previously worked with technology for study purposes. Only a few students had used e-textbooks for their studies. Based on these findings, it is evident that first-year students may face a lengthy transition to university life and encounter academic challenges during their initial year of study. These findings support the debate on inequality in the Higher Education landscape in South Africa and other developing countries. Beetham's (2015) proposal to recognise diverse types of learning and learners, which can involve independent study or guided and supported learning, provides a valuable perspective for understanding and facilitating teaching and learning processes.

According to student responses from the interviews, first-year students struggle with reading and adjusting to university because of previous limited access to digital devices and experiences. Some students explained that reading from a screen confused them, and others had a completely negative attitude towards reading from a screen or mentioned that they prefer to read from hard copy text. There was a small number, however, who expressed a more open positive attitude towards reading and engaging with an e-textbook for study purposes, provided they were given more support on how to use e-textbooks.

In the last section of this chapter, I introduced four lecturers and discussed their roles, prior experiences, and familiarity with e-textbooks. All engineering lecturers, according

to the findings, value the availability and presentation of e-textbooks for teaching and learning. All of the interviewees shared their perspectives on teaching physics as an interactive and engaging manner in their classes.

In the following chapters, Chapters 6 and 7, I expand on the findings from the perspectives of both students and lecturers. In Chapter 6 I observed a think-aloud activity where students demonstrate their interactions with e-textbooks and showcase the digital literacy practices they employ during reading. This observation is complemented by individual interviews. Furthermore, I present data gathered from two focus-group discussions. In Chapter 6 I also discuss how lecturers interact with e-textbooks and how they use the affordances of e-textbooks. In the final chapter of data analysis, Chapter 7, I discuss the contradictions in digital literacy practices through the lens of CHAT, using data from students and lecturers.

Chapter 6
Students' and lecturers' interaction with e-textbooks

"I have learned that people will forget what you said, people will forget what you did, ***but people will never forget how you made them feel"*** *–*
Maya Angelou

6.1 Introduction

In the previous chapter, I discussed students' and lecturers' prior experience with digital literacy and e-textbooks in the context of teaching and learning. In this chapter, I present the results of the investigation into how 12 students participated in an individual activity with a think-aloud study that was followed up by semi-structured individual interviews. After that, these same students took part in a group reading activity and attended follow-up focus-group interviews. In this chapter, I also discuss the interviews held with four engineering lecturers.

The first part of this chapter presents this discussion according to the themes that emerged during data analysis, guided by the research sub-questions: *What digital literacy practices do students employ while using engineering e-textbooks?* In this part of the chapter, I discuss how students harnessed the affordances of e-textbooks and the patterns of interaction students followed when engaging with e-textbooks for study purpose. I also discuss students' views on reading for study and the opportunities for online collaborative reading that may be opened up by e-textbooks.

In the second part of the chapter, I focus on four engineering lecturers and discuss their interaction with e-textbooks. This aspect of the research sought to answer the specific research question: *How do lecturers deploy engineering e-textbooks in the classroom?* Moreover, the chapter examines how engineering lecturers articulate their views on and apply e-textbooks in their pedagogy from collected data from interviews.

An interpretive framework combining cultural-historical activity theory (CHAT) and mediated discourse analysis (MDA) was used in this research. CHAT and MDA provide concepts that offer insight into the complexity of digital literacy practices

(Engeström, 1987, 2001). Engeström's (1987, 2001) activity system allows researchers to visualise how activity development takes place in social interaction between the individual and their environment (site of engagement) and how the many factors in the context mutually affect one another. Mediated discourse analysis allowed the researcher to interrogate the interaction order followed by students as they engaged with reading tasks.

6.2 Students' engagement with e-textbooks

The term "affordances", originally conceptualised by Gibson (1979) and later developed by Norman (1999) in the context of designing calculators and typewriters, refers to the actions or activities enabled by a cultural tool within a specific environment. In this research, the e-textbook offers various affordances, including navigation, emphasis, media, spatial, and temporal affordances (refer to Chapter 2, Section 2.7 for a detailed discussion on these different types of affordances). The affordances provided by the e-textbook can vary based on the users' (or readers') preferences and the context, as they can be influenced by the user's expertise, background, and cultural context (Jeong & Hmelo-Silver, 2016). In this section, I discuss the five main affordances available in e-textbooks and whether and how students engaged with them.

6.2.1 Navigation affordances

In this study, the e-textbooks offered navigational affordances (Bower, 2008), or the ability to browse through sections of the e-textbook, move between chapters, and conduct a search within the e-textbook. It is not surprising that students utilise affordances for navigation, as this requires simple chapter, page and section navigation. However, I observed that navigational affordances were not utilised to their full potential by all students because students did not always know how to locate information quickly in other chapters. They tended to scroll down and up only (see more evidence in Section 6.3). For example, even the search button was only used by a few students, such as Student 1, who reported using it while "*looking for resources inside of the e-textbook*". However, Student 2 stated: "*At first I used Google to search. I was not aware that there was an option of just searching by definition, so it's a helpful function when you do not have enough time.*" In this statement, Student 2 describes

choosing to move away the e-textbook and rather use Google to search for the meaning of a word, despite the fact that the e-textbook provided a function to obtain the definition within the e-textbook itself. Student 2 was aware of the e-textbook's features, including the option to watch a video explaining the concept, but at that moment, students were less familiar with these functions, so they opted for strategies they were more comfortable with.

The navigation affordances allow readers of e-textbooks to have the option to click on a link that leads away from the e-textbook and onto the internet for further exploration of a topic. For example, Student 11 mentioned: "*a hyperlink … redirects you in the book"*, and Student 5 noted: "*Yeah, and the hyperlinks as well – to be able to search."* Students demonstrated knowledge about the functions of hyperlinks and their affordance. For example, Student 9 commented, while reading: "*I am going to use hyperlinks because it can take me for* [to] *the information"*, and Student 13 added: "*I use a hyperlink. Yeah, sometimes for reference. I do click on it and see if it helps."* Students thus demonstrate knowledge of the functions of hyperlinks and their affordances. However, many other students did not use the hyperlinks provided in the e-textbook. During discussion with me, a number of participants demonstrated little or no understanding of the purpose and functionality of hyperlinks: *"I was not aware about a blue text* [hyperlink]" [Student 1], despite the fact that these can be advantageous for students as they enable them to be redirected to new and old concepts across the chapters.

Nonetheless, both groups demonstrated appreciation and enjoyment of navigational affordances in comparison with standard paper textbooks. Some students found that having e-textbooks and using their affordances present advantages for learning as all resources are in one place. As Student 1 stated:

> *I wanted to mention the different resources and everything in one place. And it's a prescribed book, which is provided for study purposes. The videos are very helpful. …* [the] *searching function and access to a dictionary. Now you do not have to go to other books, you just keep everything here.*

At the beginning of the discussion and meeting with students, it become clear that some students had not used e-textbooks prior to university (Chapter 5, Section 5.3), and it was their first time studying with an e-textbook. As such, the students reported benefiting from having participated in this research study; Student 14 mentioned: *"It is no longer confusing anymore. Now I can easily navigate the e-textbook"* and Student 7 noted*: "No, now the thing* [e-textbook] *is like it is new for me. So, like I don't know everything about it. Okay, but I think I'm getting there."*

The rise of digital reading and e-textbooks underscores the need for coherent curriculum provision in the university system. Access to e-textbooks as well as how to operate e-textbooks as educational tools should not be taken for granted, since students need to know how to use e-textbooks and instruction in this regard should be built into the curriculum.

6.2.2 Emphasis affordances

Another set of affordances is emphasis affordances (Bower, 2008), where the student has the opportunity to highlight digital text and explicitly direct their own attention to important concepts and information. Emphasis affordances are dynamic in that they emerge from the interaction between the student and the digital text to promote reading for understanding (Kannengeisser & Gero, 2012). The keywords or concepts of digital text can be highlighted using the digital text's emphasis affordances, such as the highlighter function. Student 5 mentioned this function as an advantage to understanding reading:

> *I need now to understand properly, that's when I do my highlighting. And then, after the highlights, now I sit down {and] just break it down for myself. I wrote it down on paper...* [Student 5]

Student 5 reads the e-textbook on the computer and then writes it down. What is notable here is that this student reverts to a non-digital format of processing the affordance; instead of copying and pasting the sentences into a word processing document file, which potentially could save time and allow them to more quickly take notes, they move to a paper and pen activity. For some students, the act of physically writing presents certain advantages for reading for understanding even though it could

be argued that this presents a less efficient way. Each student has a personal preference for interacting with an e-textbook. For example, Student 4 stated: "*I prefer doing highlights in my notes."* I observed during the reading activities how, while some of the students used the highlighting function, most of them took notes on paper and then proceeded to highlight and underline the text in hand-written notes. It is important to recognise that individual preferences and learning styles may vary, and some students may still find value in the tactile experience of manual writing and highlighting.

An example of how the digital reading text can improve the reading process is to look at where participants used a highlighter to select different highlighting colours to emphasise different concepts or reading strategies for the memorisation process. An example of emphasis affordance was mentioned by Student 12: "*Maybe you just don't understand that whole paragraph. So, you had to go back there and look at it and understand it and try to answer it. … It has many sections where you can highlight or add..."* Here, this student argues that they can easily revisit the highlighted portions to refresh their memory or quickly find relevant information.

E-textbooks allow students to highlight text with just a few clicks or taps. This convenience potentially saves time and effort compared with manual writing and highlighting, which can be slower and more tedious. This can be seen in the fact that Student 6 argues that: "*Highlighting is saving time."* Additionally, the highlighting allows students to customise their highlighting based on their preferences or specific study needs. For instance, they can potentially use different colours to signify different types of information (e.g., main ideas, supporting details, definitions) or use highlighting styles to differentiate between important and less important content. However, Student 11 pointed out that "…*highlighting, that is my favourite. Because it makes it colourful, so I usually use it"*. This student quote can be understood in two ways: first, their reason for using the highlighter is to make it colourful which can be used in assisting with reading through a colour-coding technique or mind map, or possibly colourful highlighting can be used for aesthetic reasons.

A relatively new way of emphasising important concepts and quick notes for students to come back to can be made with the emoji function in the e-textbook: "…*if I understand the reading text I use* [an] *emoji for text"* [Student 3]. Emojis are here used

by Student 3 to evoke emotional responses, for example, helping connect the participant's feelings or emotions to reading text (Scheffler at al., 2022). For example, a happy face or excited emoji can be used to emphasise positive outcomes, while a sad or confused emoji can draw attention to challenges or areas requiring further understanding. The use of emojis in e-textbooks can provide emphasis affordances through visual representation and emotional engagement. Even though the emoji function was used by only a few participants, I believe this affordance has potential in the future for students to make quick expressions regarding text and possible revision for tests and exams. It is important to reiterate that the effectiveness of highlighting and the use of emojis in e-textbooks may vary depending on individual learning preferences and instructional contexts.

6.2.3 Media affordances

The next set of affordances is media affordances (Bower, 2008). Every day, students interact with digital text using various digital devices, which significantly impacts their learning process, including tasks like learning new words specific to engineering and applying theoretical knowledge to practical situations (Hmelo-Silver et al., 2015; Van Joolingen et al., 2005). Certain learning concepts are more effectively presented through multimedia formats. Digital media has the potential to offer more comprehensive and authentic representations, preserving the accuracy and quality of the learning materials (Ritchie & Hoffman, 1997). The concept of media affordances in e-textbooks presents opportunities for both enhancing content understanding and increasing accessibility. This section aims to scrutinise the significance of these distinctions, particularly perhaps in relation to accommodating the needs of students with disabilities and ensuring equitable access to educational resources. From the findings of this study, I noticed that media affordances can be categorised into two levels: those focused on enhancing content understanding and those aimed at increasing accessibility. Within e-texts, various multimedia modes and opportunities exist for engaging with content. Students have highlighted features such as read-aloud functionality, adjustable speed, options for different accents, and gender choices. These features offer diverse ways of engaging with the content, providing alternative methods of content engagement.

The first level of media affordance is *engaging with content*.

Multimedia presentations, such as the video function, can facilitate a deeper comprehension of intricate engineering concepts, particularly for first-year students, some of whom may come from previously or currently disadvantaged communities. The participants from both groups of chemical engineering and the nautical science programme appreciated the video embedded in e-textbooks. For example, Student 1 said: "*The videos is* [sic] *very helpful for understanding."* Student 1 indicated that the media afforded by e-textbooks, such as videos, helped them, particularly in relation to understanding concepts. In the following excerpt from the focus group with the chemical engineering students, one participant commented: "*When I didn't understand this 'diffusion', I am looking for a video to explain it* [to] *me … for the video, so you can listen to and watch how he or she explained the concept*" [Student 3]. A similar view was expressed in the focus group interview with nautical science: "[When I did not understand] *I tried to find out in another resource* [video]."

Using an e-textbook with media affordances such as video gave students the feeling of being taught:

> *Because it's like a teacher, he or she is teaching you. So, I guess we have to understand everything that they say. Unlike when you're alone, sometimes the certain knowledge that you aren't, maybe on that level. So maybe if someone does it for you, and then you understand.* [Student 3]

Some students preferred video with animation:

> *I prefer videos, but not the videos with the presence of someone just looking at you and talking and talking everywhere, and I prefer videos with animation. Yeah, animation video …* [Student 12]

An animated video demonstrating an engineering concept can enhance students' understanding by allowing them to visualise the phenomena and dynamic relationships more effectively than static images (Hmelo-Silver et al., 2015; Van Joolingen et al., 2005).

The explanation of engineering concepts, for some students, works better with video than with other media affordances such as images and graphs, as highlighted by Student 3:

> *So, it's something special about videos. And the particular videos in the fact that they use diagrams, they explain everything. That which is something but it's not in the normal book.*

Videos within e-textbooks also play a vital role in supporting comprehension, as they provide elaborated explanations of concepts. Animation videos further enhance the learning experience by allowing students to visualise dynamic relationships and phenomena. Diagrams and graphs in e-textbooks provide visual representations and the possibility to zoom in and out to see the illustrated process in detail.

In summary, the first set of media affordances focuses on enhancing content understanding. For example, the videos within e-textbooks also play a vital role in supporting comprehension, as they provide explicit explanations of concepts. Animation videos further enhance the learning experience by allowing students to visualise dynamic relationships and phenomena. Diagrams and graphs in e-textbooks provide visual representations that go beyond traditional textbooks, aiding in the explanation of engineering concepts.

The second level of media affordances is *accessibility* of e-text.

Features such as read-aloud functionality cater to students with different learning preferences and abilities. For students who prefer listening to reading, the audio component of e-textbooks proves crucial in understanding complex topics. Additionally, offering choices between print literacy and multimodal literacy allows students to switch between reading text and engaging with videos, images, and graphs. This flexibility caters to different learning styles and helps students grasp concepts more effectively. The integration of various modes of presentation, including static and dynamic representations, aids in connecting theoretical knowledge to real-life applications and problem-solving scenarios.

For example, Student 5 mentioned listening:

> *I don't think necessarily about the e-textbook. I just love listening. And then I get to the problems. I mean, studying. I must listen. That's like what's in the videos first. I must listen. And the other things that just refer me to your formulas on the extra information to understand what increases, what happens, all those things.…*

Some students find it difficult to process information by reading text only, even when actively attempting to do so; as such, the audio component in the e-textbook for explaining a concept is important. As Student 12 argues: "*… I prefer reading aloud. It helps me."*

> *If someone talks to me about it, because normally I live with* [Student 15], *and so every time we have a test, we study, I always say, "Please tell me what's happening." Read my book. Tell me your understanding. That's how I learned by testing everything.* [Student 12]

Additionally, accessibility of media affordances allows students to learn new technical language pronunciations. For example, the read-aloud function in e-textbooks assists students with pronunciation of unfamiliar engineering concepts; for example, Student 14 states: "*If I come across a word that I cannot read and understand its meaning, I can just choose that read-aloud option and get to know the new word* [technical language pronunciation]."

Another example of accessibility of media affordances is to cater to student choices for reading, such as moving between print literacy (reading text) to multimodal literacy (videos, images and graphs). For example, Student 13 explains how digital e-textbooks assist with understanding and verification: "*If the text was not clear I verify by watching a video,"* and Student 4*:*

> *I always start with the e-textbook. And then when I get lost* [I] *go to videos to kinda* [sic] *have a verbal explanation like more into kind of interactive,*

> *although you're not gonna* [sic] *talk anything for it. So, I first go* [to the] *book and then I listen to videos and then additional information afterwards.*

Physics books represent knowledge in different modes. One mode of engineering physics is the symbolic mode which includes mathematical symbols, formulae and graphs. Some students become highly skilled in symbolic representation because it is expected of them to transfer symbolic or abstract knowledge to conceptual understanding of this knowledge and further application of this knowledge for the problem-solving operation of calculations. Having different modes of presentation of knowledge in e-textbooks helps students to understand how things relate to one another. To improve the understanding of concepts and be able to apply this symbolic knowledge to real-life applications and problems, students should have a variety of educational presentations of media in e-textbooks (static and dynamic presentation of concepts).

By recognising and exploring the diverse dimensions of media affordances within e-texts, we can further emphasise their importance. These affordances play a significant role in accommodating the needs of students with disabilities and ensuring equitable access to educational resources. The multimedia elements in e-textbooks offer unique opportunities for scaffolding conceptual learning and facilitating comprehension. Publishers and educators should consider these affordances when designing and implementing digital learning materials, ensuring that students can engage with content in multiple ways and access resources that meet their individual needs.

Media affordances in e-textbooks therefore have the potential to enhance understanding and improve accessibility. By incorporating features that enhance content understanding and provide accessibility options, e-textbooks have the potential to provide equitable access to educational resources for all students. The integration of multimedia elements allows for diverse modes of engagement with content, catering to different learning styles and preferences.

6.2.4 Temporal affordances

Temporal affordances include the ability to access the e-textbook at any time and from any location, as well as the ability to adjust the playback. I discussed participant engagement with e-textbooks in Section 6.2.1, and all participants appreciated the fact that they could study at any time of day, in any location, and at any time. Student 12 said: "*The person* [in the video] *can talk really fast, so I have to listen to what they say. I pause the video* [or adjust speed of the video] *and take notes … try to remember what they say."* Students study with e-textbooks by watching videos and taking notes from these. The ability to adjust the speed of the video and pause it allows students to take notes while the presenter is speaking and to repeat the information.

6.2.5 Spatial affordances

Spatial affordances, as identified by Bower (2008), refer to the capacity to adjust elements within the interface, enabling users to resize or modify the layout according to their preferences. An example of this is the option to adjust the settings in an e-textbook for comfortable night-time reading or to configure a dyslexia-friendly format of the text. As Student 12 stated, they use the: "*Read at night function* [for changing background]", while according to Student 5*: "I liked the particular drawing in the e-textbook because it's kind of colourful and you can enlarge the image. If it was a normal book in black and white, well, sometimes it is not even properly showing what is happening."* Student 9 added: *"Yes, sometimes I click on formulas, graphs and images to enlarge or check the information."* Student 4 commented: "*I only know and use enlarge size of the images."* This function empowers readers to have greater control over their reading experience, allowing them to manage and tailor the process according to their individual preferences, thus ensuring a more comfortable and personalised reading experience.

The ability to resize the text font of the interface and setting up the size of the letters and background of the interface of e-textbooks was used by participants for comfortable reading and visual issues. Student 5 states that: "*I think because of issues of vision* [I change the size and background]*."* Student 12 added that they like to use the *"read at night* [function]. *… My eyes are sometimes tired to see things like that, and I prefer a black background"* [Student 12]. Student 13 agreed that they use the *"reading-at- night features for comfortable reading".*

Several categories of young people with disabilities are still largely excluded from society. This makes it difficult for these types of students to study in the same ways and at the same pace as their peers. Furthermore, because of resource limitations, these disabilities are often under-diagnosed in countries such as South Africa. Reading digital text in which space, contrast, letter size, background, and spacing can be used to make reading and notetaking easier to read again for preparation and review, minimises confusion or fatigue. The text can be easily changed (in terms of font, size, and background), copied, dismantled, and reassembled for creating student notes (McKenna & Hughes, 2013).

E-textbooks, based on the provided affordances, can potentially support students with disabilities:

> *Okay, with a normal book, I will give an example already. I've got eye issues and now with highlighting and adding content, it's hard. In an e-textbook, I can choose to read at night, adjust the brightness of the screen, or even activate the read-aloud function.* [Student 14]

6.2.6 Analysis of affordances used by students

A graphical presentation of affordances of e-textbooks used by participants is presented in Figure 6.1. Figure 6.1 includes a table and Sankey diagram[16] which show the distribution of affordances of e-textbooks mentioned in the two focus groups. The table shows the frequency of quotations (groundedness) relating to each type of affordance mentioned by participants, and the Sankey diagram represents this information graphically, where the thinner the line, the fewer number of times an affordance was mentioned during the interview.

In Figure 6.1, it can be seen that emphasis affordances were mentioned three times in discussion with the nautical science students and only once in the focus group discussion with chemical engineering students. Navigational affordances were the most frequently cited affordance (9 and 8 citations, respectively), while media

[16] A Sankey diagram is a visualisation used to depict a flow from one set of values to another.

affordances also had a high number of mentions (5 and 6 citations, respectively), and for spatial affordances, the number of citations across the two focus group interviews was 5 and 5 citations, respectively. Temporal affordances were only mentioned once in each focus-group discussion.

	94: Focus group interview: DMS Nautical Sci... 135		95: Focus group interview: Chem Engineerin... 172		Totals	
Affordances of e-textbook: Emphasis affordances 8	3	75,00%	1	25,00%	4	100,00%
Affordances of e-textbook: Media affordances – 37	5	45,45%	6	54,55%	11	100,00%
Affordances of e-textbook: Navigation affordanc... 29	8	47,06%	9	52,94%	17	100,00%
Affordances of e-textbook: Spatial affordances (r... 26	5	50,00%	5	50,00%	10	100,00%
Affordances of e-textbook: Temporal affordances 10	1	50,00%	1	50,00%	2	100,00%
Totals	22	50,00%	22	50,00%	44	100,00%

Sankey Diagram

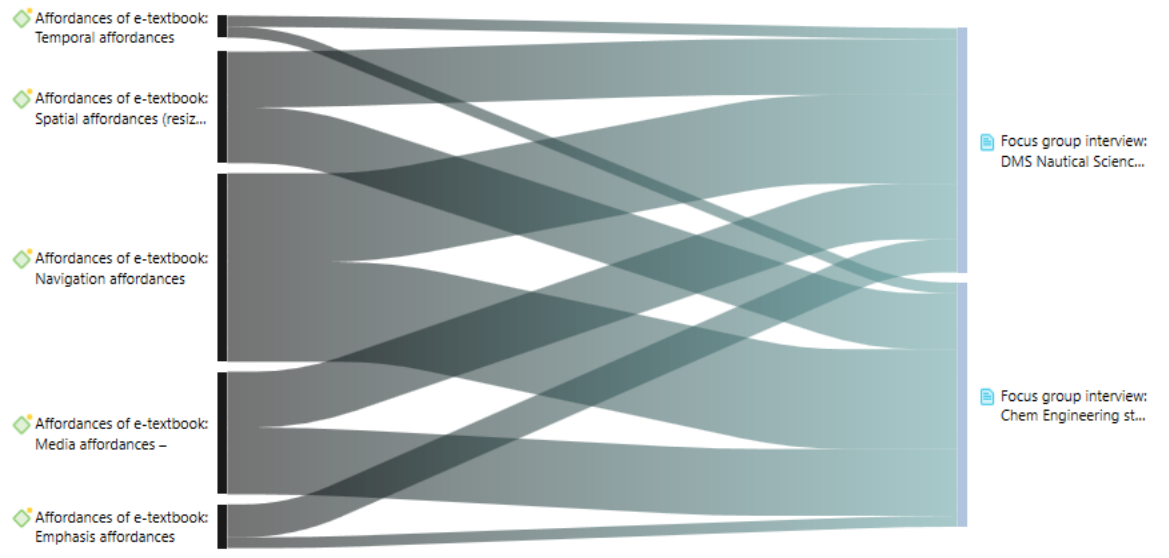


Figure 6.1: Analysis of affordances of the focus-group discussion: Chemical engineering and nautical science students. (Table of affordances and Sankey diagram)

Evidently, the participants valued and utilised the media and search functions of the e-textbook the most. Nonetheless, through discussion, I identified some tensions regarding the use and affordances of e-textbooks, which will be the focus of Chapter 7.

In this section, I argued that e-textbooks introduce a different set of affordances for digital literacy practices on the part of students. The affordances of e-textbooks are important to investigate as this speaks to what they permit students to do to achieve learning outcomes. In the next section, I discuss the patterns of interaction observed as evident in the think-aloud study and during interviews and focus-group interviews with the students.

6.3 Patterns of interaction with e-textbooks

From the think-aloud protocol (see Section 4.7.2) which I conducted with students during the reading activities and then followed up with interviews, I noted that different students engage with e-textbooks using different orders of interaction[17] (and different linkages of practices), which reframe how the e-textbook is taken up as a mediational tool. In this section, I report on the literacy practices students employ and their interaction order when they were observed in the computer laboratory. For a better understanding of how students read the e-textbook, I analysed the interaction order where I categorised the ways in which students interacted with the e-textbooks. These interaction orders are categorised into four main categories (conventional practice, preference for multimedia, navigating and engaging with multimedia texts, and participating in practical exercises) according to their engagement with the affordances of the e-textbook (see discussion on affordances in Section 6.2). Prior to the interviews, students participated in a reading activity in which they engaged with an e-textbook to demonstrate how they read an e-textbook for learning purposes. It is important to note that the purpose of this activity was to observe what digital literacy practices they employ while reading from an e-textbook, not to evaluate their performance or understanding of the concepts.

Additionally, this section does not categorise the students, but rather the forms of interaction, which means that different students may exhibit different types of interaction when reading individually and working in groups. In this section, I describe the four types of student interaction. These interaction order patterns are sorted

[17] As per Goffman's (1983) perspective, the interaction order serves as the space where individuals shape their self-concept and identity through various unspoken routines, performances, and rituals during social interactions with other members of society.

hierarchically in terms of their levels of engagement with the affordances of the e-textbooks (e.g., Category 4 is more engaged than Category 1).

It is important to note that during the think-aloud protocol, students demonstrated certain patterns of practices of reading and engaging with e-textbooks that were limited or less interactive, but after the individual interviews, group reading, and follow-up focus-group interviews, some students explained a different interaction order that was more interactive. For this reason, some participants can be present in more than one category. As mentioned, data in this section came from different research instruments such as the think-aloud protocol (represented by line drawings and textboxes); and the individual and focus-group interviewers (presented via quotations from the student participants' responses).

6.3.1 Category 1: Mimicking conventional reading practices for digital texts

The first category includes moments where students read the text and made handwritten notes, but did not demonstrate usage of the additional affordances of e-textbooks. In these moments, students mainly used conventional ways of reading, that is, the reading practices associated with hard copy texts, as shown in Figure 6.1 and the two textboxes that follow (6.1 and 6.2), and neglected features of the e-textbook. In this category, participants showed traditional or conventional reading and interacting with e-textbooks.

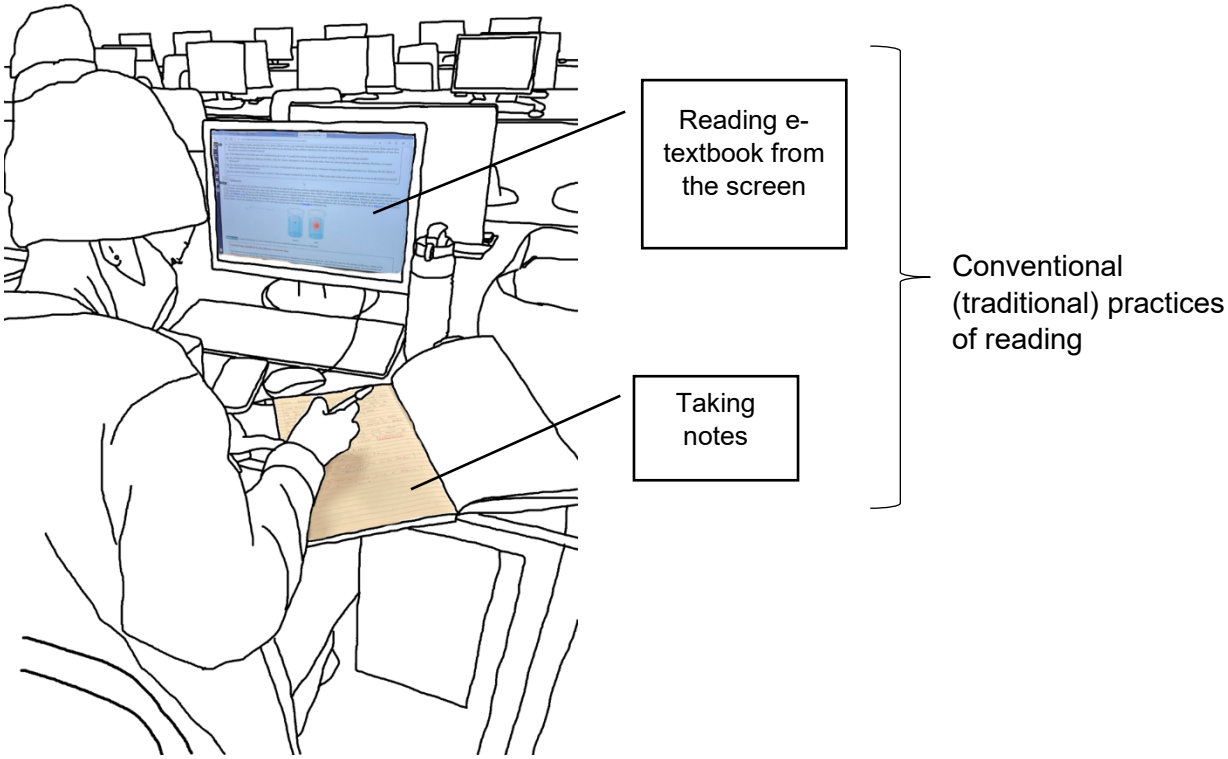


Figure 6.2: Line drawing of digital reading of the student participant from this category

Textbox 6.1: Description of Student 1's interaction during think-aloud protocol

Student 1 attempted to open an e-textbook by logging into the LMS, but he spent three minutes looking for the e-textbook tab and opening the requested chapter and topic. The student read the section for ten minutes. When the text in an e-textbook referred to a figure, the student scrolled down for one minute to examine the figure before continuing reading for three minutes. The next portion of text in the e-textbook referred to the same figure; the student scrolled down to look at the figure for one minute and continued reading for two minutes. The cycle of reading and looking at figures continued for another round, during which the student spent another three minutes. The student then read the text for another five minutes, focusing on formulas and symbols in the formulas. The important formulas and symbols were noted in the student's hard copy notebook for four minutes.

Textbox 6.2: Description of Student 13's interaction during think-aloud protocol

Student 13 opened his e-textbook in the LMS and scrolled manually down until he reached the requested chapter and topic (Chapter 13, Section 13.3), which took around two minutes. The student then began reading the digital text for eight minutes, and at the same time, the student was taking notes in his personal notebook. When the text referred to the same figure, he scrolled down to look at the figure (one minute). After that, he continued reading at that point before he went to look at the figure. The student read the digital text for another six minutes. When the student read the text and the text referred to the graph, the student scrolled down and looked at the graph to examine cycles of thermodynamics processes, and then drew the graph in his notebook for three minutes.

These students did not fully engage with all the facilities offered in the e-text: Students 1 and 13 could potentially have used the navigation function to move to the relevant sections in the e-textbook without using only scrolling down and up. They could have interacted with media files such as images and videos. They could have highlighted important information and used the comment or flashcard option to annotate the text digitally.

Another example of the Category 1 interaction order came from a focus-group interview with the nautical science students. Student 12 exhibited the following interaction pattern: "*When I started with the chapter, I just scanned the whole chapter to check the amount of work… then I read the whole chapter."* This participant scanned the chapter; this was done in order to understand the amount of work and time needed for this task. Student 9 had the same traditional approach to reading: "*I tried to read the whole chapter and from the beginning and so I would then go back and just figure out if I understood."* In interacting with only digital text in this way, this student demonstrates conventional reading practices. This is likely because students' interaction order is influenced by their cultural and historical practices before they enter university. These students showed a strong preference for reading texts as they would a hard copy text and avoided using the features of e-textbooks (hence their classification into Category 1 – conventional practice).

6.3.2 Category 2: Preference for multimedia over text

In this category, I focus on participants who showed a preference for watching videos over reading the text or students who explained in the interviews that they start studying using videos. Students from this category did not engage completely with digital text; instead they went straight to watch videos inside the e-textbooks or opened a browser to do a manual search of videos available on YouTube and other websites.

In the textboxes below, Students 5 and 10 went immediately to watch videos outside of the e-textbook on YouTube and sometimes completely ignored the written text.

Textbox 6.3: Description of Student 5's interaction during think-aloud protocol

Student 5 opened the e-textbook in LMS and went to the folder of the e-textbook for watching videos provided by the publisher for this particular topic for six minutes. After that, this student watched the same video for another three minutes, then paused it and took notes in a hard copy notebook for another four minutes. Following that, the student went to Google and searched for more videos on the same topic, which he watched for five minutes. During the watching of videos, this student continued taking notes by writing in his notebook for four minutes.

Textbox 6.4: Description of Student 10's interaction during think-aloud protocol

Student 10 first opened Google browser and searched for thermodynamics concepts, then opened the first video from the list and watched videos for seven minutes. At the same time, Student 10 paused and played back the video to write down notes. After this, the student opened the e-textbook and looked at the titles of the sections and subsections for three minutes. In order to find the requested topic, the student scrolled down to page 105. Then the student looked at the figure and clicked on the figure to enlarge the size. After that, Student 10 went on to look at the notes for three minutes.

Neither Student 5 nor Student 10 spent time reading the text in the e-textbook; instead, they spent their time watching videos. However, at the end of the reading activity, Student 10 opened the e-textbook and looked at a figure in the e-textbook, to possibly clarify his notes on the information presented in the image. The interactions of these

students showed a preference for multimedia modes such as videos and looking at figures. They did not utilise the navigation and emphasis affordances.

Some students, during the interviews, discussed their choice of watching videos as opposed to reading the digital text. For example, Student 14 stated*: "I chose to watch the first video, yeah. I think videos for me, it is mostly listening to videos"* and Student 5 explained his choice of preference for videos over reading*:* "*I want to listen to someone tell me about what I'm about to do before I actually go to the e-textbook and try to work it out myself."* These students preferred to start by watching videos then read the digital text. In this category of student interaction, other possibilities for engagement that were not taken up by this group include highlighting and annotating the written text in the e-textbook to support their understanding of the content and how it relates to the videos they were watching. The written text could potentially have introduced them to the discipline-specific concepts, with the videos supplementing that content with examples.

Additionally, the students explained how video can "save their life" to understand the topic. For example, Student 9 explained*: "YouTube might save your life. My first instinct on understanding Khan academy[18] is video."* Other students explained how video can assist them with learning new concepts in terms of understanding, as articulated by Student 10:

> *I watch videos with the subtitles; some of the videos don't have the subtitles. I usually watch the ones that have subtitles because sometimes they* [presenters] *go fast, and then you can't hear what they're saying so I read the subtitles. And then I watch it over and over again until I understand… Then, I'll write everything that is important.*

Another example of video helping with harnessing understanding was indicated where the video is foregrounded in the interaction order: "*I needed to understand the constant concept, if it's constant, maybe the energy I don't understand, then I usually go to*

[18] Khan Academy: A nonprofit educational platform offering free online resources in a variety of subjects, founded by Salman Khan in 2008.

YouTube and watch certain videos until I understand" [Student 3]. In this quotation, the interaction order is combined with external resources in the form of YouTube videos. The student moves beyond the affordances of the e-textbook to check their understanding of concepts using YouTube. This student does not click on the video examples/links in the e-textbooks, but goes "outside" the e-textbook for additional information, possibly because this student is familiar with finding information on YouTube and does not realise that multimedia files are available in the e-textbook.

In summary, the participants of this category used a particular set of practices (and particular linkages of practices) that reframes how the e-textbook, as a mediational means, is employed within the particular social action of reading.

6.3.3 Category 3: Navigating and engaging with multimedia texts

The third category of students' interaction order patterns occurred where students read the text in the e-textbook and also watched videos. In this category, a combination of the two previous categories was shown, namely, reading the digital text and watching videos. Also, when the students read the digital text, they also used some of the affordances such as read-aloud and navigation affordance (searching), and the highlighting function (see Figure 6.3). The detailed interaction order for this category is presented in the Textboxes 6.5 – 6.7.

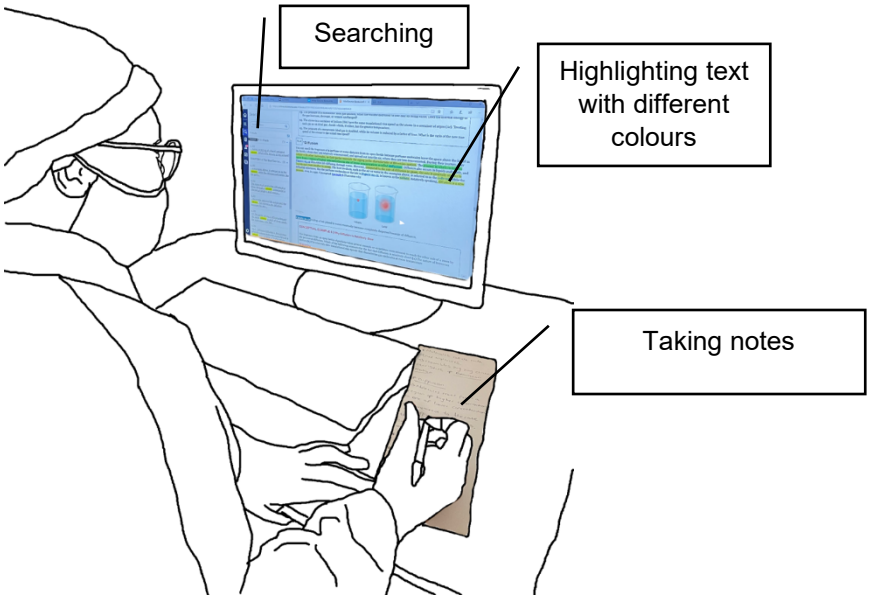


Figure 6.3: Line drawing of digital reading from student participant (searching, highlighting (green and yellow)) and taking notes

Textbox 6.5: Description of Student 9's interaction during think-aloud protocol

Student 9 opened the LMS and then used the search function to find the chapter and topic. After that, the student started reading for four minutes and at the same time made notes by writing formulas in the notebook. Then, the student continued reading text in the e-textbook for another ten minutes. At some point, the student went outside the e-textbook and opened Google to search for the meaning of the physical concept *diffusion* for two minutes. Following that, the student searched for videos on the same topic and watched them for three minutes.

Textbox 6.6: Description of Student 11's interaction during think-aloud protocol

Student 11 used the search function to open the relevant chapter and topic, scrolled down to the section of the requested chapter, and then read the text for ten minutes. After reading, this student started watching videos related to the topic for ten minutes inside of the e-textbook. During the watching of videos, the student stopped the video and made notes from the video. This student spent approximately the same time on reading and watching videos.

Textbox 6.7: Description of Student 12's interaction during think-aloud protocol

Student 12 accessed the LMS and scrolled down to find the chapter and topic. Then this student began reading for six minutes and after that student started watching videos in the e-textbook for four minutes. After finishing reading, the student opened their internet browser and opened YouTube. In the search panel, they typed the topic of the chapter and started to watch more videos for another three minutes. While watching videos, Student 12 paused the video and made notes in the notebook.

Students 9, 11 and 12 read the text in the e-textbooks and then watched the videos related to the topic. Some of them watched the video within the e-textbook, and others accessed it using Google and YouTube.

From the focus group interview with nautical science, Student 10 explained his interaction order which is related to this category: "*I highlighted some of the things that seem to be important then I watched the videos to understand the definition that is represented there."* Similar interaction order saw Student 13 state: "*When I use an e-textbook, I note things down* [while reading] *... I watched the videos and then moved out after I combined the information from what I had learned and interacted with the equations."* As an example of interaction order for reading e-textbooks, this can include movement or navigation of the text, watching videos and simulations, listening to the read-aloud voice and making notes. Another example of interaction order of this category, with specific focus on generating questions, was noted by Student 11:

> *Since I use the e-textbook, I usually draw it down and then just interpret how they plotted the graph in the paragraph, trying to get an understanding of the paragraph. What does this paragraph mean? Like the context for this paragraph? I ask many questions. Why are they saying this? And then, since I have this basic knowledge, I should be able to answer my "Why" questions. And even if the paragraph doesn't answer my questions, I will still be curious. I'll ask many people* [classmates or lecturer], *"Why do they say this?"*

This student's interaction begins with visual actions and noting the graph, but it continues with trying to find answers to questions generated by the student while reading the text. As learning/literacy goes, this is high-level engagement, evident in the asking of "'why' questions" as mentioned by this student. The student seeks assistance from others in order to comprehend the graphic representation. Goffman (1959) argues that the dynamics of how participants in the same social space interact form a significant aspect of the physical world in which we live. The manner in which students engage with specific cultural tools, e-textbooks, and the types of actions they undertake are determined by their individual level of familiarity with these tools and the practices they are accustomed to employing.

In contrast to the two previous quotations, some students prefer different patterns of interaction with e-textbooks. Student 5 states that they "*go to diagrams, then read the tips there. So, in order for me to know what to read ... I have to take things from tips, and then use Google to make notes"*. This participant went through a different interaction order where engagement started not from the text but from the visual modes of communication (diagrams) and a short summary (tips). The participant did not engage with the whole chapter but only looked at tips where the authors summarise the main idea of the chapter and then went to Google to watch videos and make notes.

6.3.4 Category 4: Engaging with practical examples

The last category of students not only read and watched videos, but also attempted to do calculations and even check their understanding by completing a short quiz after the calculation. The main difference with this category compared with the previous categories was that students did calculations, solved practical examples, and attempted short quizzes. The steps in the interaction order of this category were similar to one another.

Textbox 6.8: Description of Students 2, 3, 4, 7, 8 and 14's interaction during think-aloud protocol

Students 2, 3, 4, 7, 8, and 14 opened their e-textbook on Blackboard, scrolled down to the chapter, and read for about seven minutes. Students 3, 4, 7, and 8 started writing notes. Students 8 and 2 also highlighted the text in the e-textbook, and students 2 and 3 looked at animated videos for three minutes. Some students (2, 4, and 14) read the text in the e-textbook for the second time for seven minutes. After that, all the students went to solve practical examples. After calculating the questions, Students 4 and 7 decided to go to Google to watch more videos.

In this last category, students not only read the text in the e-textbook, highlighted text, and watched videos inside and outside the e-textbook, but also went on to solve examples/problems related to the topic and even attempted to answer the quiz. The difference was that by engaging in all these literacy practices, students in this group used more affordances and showed more engagement with the e-textbooks and their affordances.

The example of interaction order that emerged from the focus-group discussion with the nautical science students was mentioned by Student 3: "*So, first I read the text and took notes. I also tried to find some questions. I was up for activities. If it was offered, I didn't go outside the subsection* [because] *first I want to find my understanding,"* while Student 8 adds*: "I'll find some quizzes, then I'll access examples. So now I'll start writing answers for the questions. After that I see where do I understand or not ..."* These students check their understanding by attempting the practical exercises or answering quizzes after reading a section.

Other students also explained their interaction order and engagement with the digital text during the interview discussions. For example, Student 7 explained:

> *I'm going to start a new chapter. I will read it maybe three or four times. If I don't understand, I will always read a few times and then try to attempt the questions and see where I didn't understand.*

Student 7 continued:

> *What I usually do when I read for an example, I'm trying to understand what is going on when I look at this diagram to remember what I did. Then, I'm trying to make some notes ... Firstly, I tried to interpret the graph or the diagram. Before attempting the question, I will write notes on anything that I see that is important to me. When I'm solving* [problems], *for example, I will write down the given data and the formulas.*

In this example, the interaction order involved in the social practice of reading includes reading the text for understanding a few times, viewing the diagram and making notes, and then moving to practical examples. These practical examples begin with writing down the provided data and formulae.

The interaction order involved when engaging with e-textbooks includes engaging with the different modes of presentation afforded by the digital text, as Student 4 states: "*Text, picture, question* [practical example], *videos, only if I don't understand what's going on."* It is important to mention that the aim of the study was to investigate the students' interaction with e-textbooks for studying purposes. The reading material provided to the students was intentionally focused on thermodynamics, as this subject is only taught in the second year. In this category these students were moving beyond just reading, they were learning and assessing their understanding by attempting the practical problems from the e-textbooks.

These four categories show different interaction orders, as well as how some students are more comfortable and confident with e-textbooks than others. Students in Categories 3 and 4 were more comfortable using e-textbooks and their affordances for purposes of learning, whereas students in Categories 1 and 2 used fewer affordances, and less frequently.

6.4 Opportunities for collaborative reading

In addition to the existing affordances of e-textbooks and new literacy practices (interaction order patterns), discussed in Sections 6.2 and 6.3 of this chapter, e-

textbooks provide possible opportunities for collaborative reading, though these affordances were not harnessed by students. In this section, I firstly discuss students' preference for reading for study purposes, then, secondly, I discuss the students' views and their preference for studying in a group and students' views on how e-textbooks can open future opportunities for collaborative reading.

Participants were questioned about their ideal study preferences and reading environment. Some students expressed concerns related to where they lived, commenting on the lighting, time of day, and furnishings. The reading settings and preferences of the participants comprise what is here termed the reading environment. In order for readers to concentrate and pay attention to what they are reading, some participants said that the reading environment should be quiet, and Participant 8 preferred to study by himself: *"For me the study strategy, I think I'll just have to be alone, then when I'm alone, maybe just getting in a room and then locking the door."* However, not all students living in residences and sharing rooms have the option to study by themselves. Students occasionally wear earphones to reduce noise and distractions in their immediate environment: *"I usually study in the study room. I mean, if the people around me are making noise, I just put on my earphones"* [Student 3]. This participant emphasises the importance of privacy and a quiet setting for the intended reading comprehension. Other students offered further information regarding their study location, schedule, and motivations:

> *I like to study at night. I don't have time to study during the day. I can't study. Because I feel like there's a lot of distraction during the day … you cannot go outside. You just have to be indoors. So, I study at night most perfectly. Even if it's a day before* [exam or test], *I think I'm good with under-pressure studying better than having a long time to study … I like quiet environments.* [Student 4]

Another student expressed a similar preference to study at night:

> *Okay, I do it in the hall or the kitchen. Yeah, I start studying around 9, when people like quiet in the evening, and that's the way I use that, like, yeah,*

> *study far away from my room. I can focus on that … I leave my cell phone in my room.…* [Student 1]

Student 11 appreciated the portability and convenience by moving the laptop from the desk to their bed which provided this student with comfort and less distraction:

> *Okay, my space, it's just that I usually have a desk, but sometimes I prefer to sit on my bed because I find it distracting or when I really get tired I sit on my bed. And I have this book and then a laptop and all the materials that I'm going to use.*

Location, time and furniture were also mentioned by Students 2 and 5. Perhaps writing notes and focusing on reading while sitting at the table is key for these two students: "*I don't read early in the morning. I prefer to read at night, like maybe in the evening in my home, where I have the desk."* [Student 2] and Student 5: "*I have the table, but it's always there around midnight, in the early hours of the morning, from 12 until 6, because it's quiet then."*

As noted, Students 1 to 5 all prefer to study at night, and they have preferences for where and when to work. Participant 11 voiced the following issues concerning noise, lights, and windows:

> *My space… There has to be no noise when I study. I don't want any noise. So, I really have it. I usually switch everything off, I need to focus. I don't focus when it's like … I'll be like* [lights], *okay, … and I will look at the skies, and do other stuff so when I close everything* [windows, curtains], *I'm going to study that I can focus on.*

The participants' reading takes place in different physical spaces: residence, room, computer laboratory and even the kitchen; however, Student 7, mentioned studying outside: "*Sometimes I do study alone; sometimes. I'm studying physics in the open air. Even outside, it's fine."* All these quotations showed that most students find it difficult to study when there are many people around.

In the second part, I discuss how students view peer collaboration when they study in a group, as observed when they participated in the group reading activity. Figure 6.4 shows two participants from the Department of Chemical Engineering after they had completed part of the reading, and one of them had requested clarification on a particular concept. Figure 6.4 depicts the interactive features available in the e-textbook, such as highlighting text, taking notes, and searching within and outside the e-textbook. Figure 6.4 also illustrates how students interact with the digital text while seated next to their peers.

Figure 6.4: Line drawing of the chemical engineering participants. Discussion in the group after reading digital text.

During the focus-group process, students from both groups mentioned how e-textbooks could support their learning. As Student 11 confirms, the reading process is social and involves collective engagement with the text and with others: "*If I'm in a group study, I tend to ask. I tend to ask someone when I don't understand to help me to understand."* The collaboration here happened in the physical space with the e-textbook, but rather than online. It is important to mention here that e-textbook affordance of online collaboration was not used by students. Moreover, Student 8

added: "*I also talk to someone who understands and explains it to me."* From this transcript, students see collaboration in physical space as more familiar to them as they know how this works based on their previous experiences in high school.
An effective e-textbook design should enable sharing and collaboration among students. For example, in the focus-group interview with chemical engineering, Student 5 described student collaboration: "*Share the screen when it comes to doing the same thing."* Student 3 agreed: *"Yes, sharing the understanding after reading with other students and sharing the notes."*

In a quotation from the focus-group interview with nautical science students, one participant explains how e-textbooks could support students' understanding and learning process: "*I tried to read again and find out from other resources. I also talked to someone who understood and explained it to me.*" Also, "*I just write down and ask questions* [from other students]. *Indeed, … that's how I have no problem"* [Student 12]. The participant initially engaged with the e-textbook and other resources before collaborating with a peer. This approach demonstrates that students did not rely solely on the teacher as their primary source of learning. It is important to mention here that e-texts do not hinder such collaborative engagement activities. The key to improving education, according to Vygotsky, is to introduce interaction between the students and their peers. Vygotsky (1978b) and social constructivists would argue that learning is best done collaboratively, and e-textbooks can potentially facilitate such collaboration.

Figure 6.5: Line drawing of the DMS participants. Reading digital text in the group.

Depending on the tasks and instructional objectives, the precise activities students engage in around e-textbooks may vary. Joint activities could include sharing files and screens, and joint multimedia activities, or by students discussing what they are observing in a simulation or video. For instance, Participant 3 from the chemical engineering focus-group interview revealed that "*sharing the understanding after reading with other students and sharing notes* [with others] *was important".* A similar view was shared in the other focus-group interview with nautical science students, where a participant stated: "*Whenever I try to make up some questions that can help me to understand, I tend to ask someone when I don't understand to help me to understand."* In these quotations, it is clear that the participants demonstrate the practice of sharing understanding with peers and collaborating among themselves. Asking someone else for help and improving understanding is what Vygotsky relates as the zone of proximal development (ZPD) (see Section 3.3): the relationship between learning and development. The aim is to develop students' understanding. Learning here also refers to learning specific skills such as digital literacy practices for reading, interaction with digital text, and collaboration (working in a group) that lead to the holistic development of students.

Although the students were in the same physical room when they participated in the group reading activity, during focus-groups interviews students further discussed this kind of collaboration could be possible even if they were not in the same physical space. After completing the reading activities, I noticed that some participants used a variety of practices (for example, uploaded PowerPoint slides on Blackboard or watched videos in e-textbooks and on YouTube). However, as students discovered new tools and related practices, these practices quickly spread among all students. During the focus-group interview, I observed students collaborate and begin teaching each other new reading practices. The quotations below show students' views on how e-textbooks can potentially facilitate collaborative learning – even when they are not in the same physical space. For example, Student 6 argued:

> *The e-textbook should include interactive features for collaboration* [online], *such as studying in groups where everyone sees each other's highlights in different colours.*

What this student's statement above illustrates is that students engage in reading as an individual practice, even though e-textbooks have the potential to facilitate greater peer collaboration. Four students in the chemical engineering focus group agreed with Student 6 who highlighted support for learning could be offered by using an e-textbook through online collaboration. Potentially sharing tasks and discussions through virtual collaboration is also provided for by adaptive technology within e-textbook platforms. A main difference between e-textbooks compared with paper books is that they offer collaborative learning even if students are not in the same physical learning space. The participants from the chemical engineering focus group also expressed how they would like e-textbooks to be developed in future, and what would be beneficial for engineering students. For example, Student 5 suggested that "*access to the e-textbook. It must be an app like to read on any device".* They argued that access to e-textbooks should be made more comprehensive, with more interactive features for group work: *"Yes, by sharing the* [digital] *notes with other students"* [Student 3].

It is important to mention students might use e-textbooks in the same ways they use print textbooks, but the e-textbooks constitute a unique site of engagement that brings with it its own particularities and, possibly, its own practices. The findings of this

chapter indicate that students use features that make reading more comfortable, such as changing the background while reading at night and using the text's read-aloud option.

In this section, I discussed how the use of e-textbooks provides students with new opportunities. In the subsequent section, I explore the lecturers' understanding of e-textbooks, their interactions with them, and how they utilise their affordances for teaching.

6.5 Lecturers' understandings of and interactions with e-textbooks

The potential of e-textbooks to impact higher education is gaining attention, but it is also viewed as a possible factor contributing to the decline of traditional universities. Information and communication technologies (ICTs) are reshaping access to information in the "knowledge society", and their widespread use in everyday life has led students to expect engagement with e-learning both on and off campus. Despite the increasing adoption of institution-wide technologies such as virtual learning environments (VLEs) and e-textbooks in South African universities, there is still a challenge in effectively involving academic staff in e-learning initiatives (Baker et al., 2019; Salmon, 2005).

The interviewees in this study expressed different understandings of e-textbooks, and some had challenges differentiating between different types of e-books. This was not surprising, given the confusion around terminology as discussed in Section 2.6, due to the fact that there is no concrete definition and explanation of e-textbooks and the difference between different kinds of books such as e-books, electronic books, e-textbooks, zyBooks, and interactive books.

However, some lecturers at the beginning of the interviews did not seem to understand that e-textbooks have different affordances compared with any online or web or PDF version of a print textbook. Lecturer 4's view is limited, defining e-textbooks as merely digital versions of print textbooks that contain exercises and worked examples: "*It's just like a normal textbook with exercises, worked examples"* [Lecturer 4]. This

perspective overlooks the potential benefits of e-textbooks beyond their mere convenience and accessibility.

On the other hand, Lecturer 2, on the definition of e-textbooks, argues that:

> *…it's an online copy of a book. That's the basic explanation. If you want to take a deeper look and explain what they can do with a book that's online that they couldn't do, like highlight and copy and paste and search for definitions and all the interesting stuff you can do.* [Lecturer 2]

This statement suggests that some lecturers are uncertain about the distinction between a PDF version of a print textbook and an e-textbook. Lecturer 2 offers a broader definition of an e-textbook as an online version of a book that offers additional functionalities, such as highlighting, copying and pasting, searching for definitions, and other features that are unique to digital media. This definition implies that e-textbooks offer students more interactive and engaging learning experiences compared with traditional print textbooks.

Lecturer 4 and Lecturer 2 have similar views that e-textbooks are just PDFs or online copies of the book. However, as noted previously, it was argued that they sometimes confuse e-textbooks with PDFs. This can be explained that they may have initially, during the interviews, conflated the idea of e-textbooks and PDFs, but then, through engagement in the interview, came to see how the two are different and started to articulate the differences between the two more clearly. As such, they changed their opinions of e-textbooks and provided different information about e-textbooks (as will be shown in Sections 6.5.1 following).

As discussed in Chapter 3, the notion of agency is seen as important in both CHAT and MDA: lecturers conceived their own agency in relation to the use of e-textbooks in different ways. Lecturer 3 voiced her concern about the way some lecturers could use the e-text, thinking that the text could replace teaching by a lecturer:

> *It's a very easy method to fall into if you're not careful. Just because there's an e-textbook doesn't mean you can stop teaching and explaining what is*

> *happening within that topic. Or they have a disconnect. That's the word, "disconnect", between the students, the lecturer, and the e-textbook. So, you have to ensure everybody's working together. The e-textbook … contributes to your teaching. It doesn't take over your teaching. As a result, you cannot rely on it to do your work for you.*

This lecturer experienced agency concerns. This lecturer acknowledges that the e-textbook contributes to teaching, but is concerned that it should not remove the lecturer's agency and control in the teaching–learning interactions in a classroom. E-textbooks cannot replace the lecturer, but do have the potential to reframe the role of the lecturer. A completely negative approach, where the e-textbook is not used, even where it is available, is also problematic. E-textbooks should be looked at as additional support for greater understanding.

Furthermore, Lecturer 3 describes the navigational and emphasis affordances:

> *What I understand an e-textbook is, and that is literally instead of having a hardcopy, that textbook is now available on your computer, on your phone, or on any digital device. And if you normally, if you need to look something up, you go to the table of contents page, when you go look back at the index, and then go and look it up with the e-textbook, you can Ctrl F and find what you are looking for and all the different sections with that same way – that particular topic will then be highlighted.*

This lecturer is still essentially positioning an e-textbook as a PDF version of a print textbook. It is important to mention that this is not the kind of e-textbook that the students are using in this course. However, none of them seemed to have a complete grasp of the potential of e-textbooks to aid learning. This highlights the need for training – not just for students in how to effectively use e-textbooks, but also for the lecturers who guide them. Even though none of the lecturers mentioned how e-textbooks can offer a different engagement, Lecturer 2 suggested that e-textbooks can be different for students who are tactile learners and further explained the affordances of copying and pasting the text for creating notes:

> *But if you're someone who wants to touch and feel, then that's touching and feeling and highlighting certain ways and folding books and certainly feeling like that can actually help them grasp or remember or understand things a bit differently. So maybe the difference is that two different types of learners are affected differently. It's different because you can't fold it, you can't … the best you can do is scroll and highlight … being able to copy and paste it onto another document is wonderful.*

Lecturer 2 suggests that for those who prefer hands-on learning, physically interacting with a book by touching, feeling, and folding pages can help them remember and understand information better. On the other hand, for those who are comfortable with digital tools, e-textbooks provide the benefit of being able to copy and paste information easily to use elsewhere. Lecturer 2 acknowledges that it may be a matter of individual learning styles, and that different people may be affected differently by the two formats. However, there are certain limitations to e-textbooks that physical books do not have, such as the inability to physically interact with the text.

Furthermore, during the interview discussion, Lecturer 2 elaborated further on the difference between e-textbooks and their affordances compared with print textbooks:

> *An e-textbook is simple … If you're looking for a particular chapter, let's say you want to do electromagnetism, it's easy for you to put in the keyword or go into the content area and search for the chapter. In that chapter, you can look for a specific thing that you're looking for – it helps you with searching for these things … It requires a little bit more energy to look for that in a normal textbook versus an e-textbook.*

Here, Lecturer 2 is discussing the advantages they see of using an e-textbook over a physical textbook when it comes to searching for specific information. The lecturer notes that with an e-textbook, it is easy to search for a particular chapter or keyword, which can save time and effort. This can be particularly helpful when looking for specific information, such as when answering a question or finding a definition. In contrast, the lecturer suggests that searching for specific information in a physical

textbook requires more effort, as it may involve flipping through pages or scanning through the text manually.

Another difference between an e-textbook and print textbook, according to Lecturer 2, is the ability to reproduce (copy) and remix (rearrange or modify) content. Digital formats inherently offer a flexibility that printed copy ones do not:

> *... with textbooks, you can't really do anything. You can't copy and paste, you can't do anything, the pictures are static and black and white in* [a] *textbook. And yeah, it makes life a lot harder for learning.*

I noted that Lecturer 2 had an ambivalent relationship with e-textbooks. During the interview discussions, lecturers were unsure of what constitutes an e-textbook, and they had an appreciation for the tactile elements of a physical print textbook (Lecturer 2), but at the same time did acknowledge that an e-textbook opens up opportunities for new practices and new forms of engagement. For example, Lecturer 3 expressed the view: "*I've used the e-textbooks for myself, and you interact with it differently than what you interact with your paper version."* This lecturer did not specify exactly the difference she/he experienced; however, based on her quotation above, this lecturer refers to the affordances of e-textbooks such as navigation to search for a particular chapter or concept.

Lecturer 2 mentioned that to implement e-textbooks as part of the curriculum will have some challenges: "*So, it's that initial learning curve of getting comfortable with the whole thing and readjusting to using an online textbook compared to a physical one."* This indicates that textbook implementation was done in such a rush that lecturers were not prepared before the technology became part of the curriculum.

According to Wertsch (1998), the mediational function of a tool, such as e-textbooks, pertains to its "affordances" (Gibson, 1979) that facilitate problem-solving or aid in learning. In the absence of such affordances, grasping physical concepts, especially those requiring hands-on laboratory work, becomes challenging. However, e-textbooks, equipped with their dynamic features and interactive capabilities, serve as a bridge. They can emulate laboratory experiences or provide visual aids, thereby

rendering these concepts more comprehensible even outside traditional laboratory environments. Conversations with lecturer participants revealed a spectrum of understanding regarding e-textbook affordances. While some participants demonstrated a rudimentary grasp, others exhibited a deeper and more nuanced comprehension.

Lecturers 1 and 4 mentioned that, for teaching and learning, having an e-textbook is no longer optional. "*I do not think it is a matter of whether I will recommend it. It is a must"* [Lecturer 1]; Lecturer 4 adds*:* "*I mean, in the time that we're living in, capacities are constrained in terms of the classrooms and the campus and all that. So, it's definitely something that I would recommend. Yes, it is the future."*

The e-textbook is a tool that potentially enhances lecturers' pedagogy by providing affordances for teaching and learning rather than replacing lecturers' presence; as Lecturer 1 stated: "*The e-textbook* [is] *an enhancer."* There was also focus on how e-textbooks can be used as a teaching aid. Lecturer 2 discussed his/her experience with e-textbooks in terms of availability of questions and solution manuals:

> *With the question banks they* [the e-textbook] *have, you can even see the different types of questions on how questions can be phrased. Which is something you can't get from a textbook* [paper book]. *I mean, at the end of the chapter, all the questions, but it is a whole hassle if it's a normal textbook, you must get the manual solution … then you must look at all the questions and some of the answers you might not get.*

The lecturer notes that the platform includes question banks which can provide different types of questions and phrasing. This can be helpful for lecturers in creating assessments that are varied and effective for testing students' understanding of the material. Lecturer 2 contrasts this with a traditional textbook, which often only includes questions at the end of a chapter and may require a separate manual solution.

Lecturer 3 used visual representation while teaching to explain complex concepts and support student understanding*:*

> *I found out things like physics, you know, you need to see, … so those are the kinds of things that I really enjoyed while working with these e-textbooks. Because e-textbooks now you can download all these things to reinforce your teaching, so that really makes my life a bit easier.*

The quotation discusses the benefits of using e-textbooks, particularly when it comes to teaching subjects like physics. Lecturer 3 noted that in order to fully understand physics concepts, it can be helpful to see visual representations or demonstrations. He suggests that e-textbooks can provide these kinds of resources, allowing them to reinforce their teaching. With e-textbooks, it is possible to download visual materials to use in class or as part of course materials.

> *And then the other features where you can download this PowerPoint, you can download some animation for your teaching, and show them as a clip when you're teaching.*

This extract discusses some of the features of e-textbooks that can be useful for teaching. Specifically, the lecturer notes that it is possible to download PowerPoints and animations from the e-textbook platform. This lecturer suggests that these resources can be used as part of teaching, such as showing an animation clip during a lecture or presentation. This can help to reinforce the material being taught and make it more engaging for students.

The sub-sections that follow provide a deeper discussion of how lecturers used e-textbooks in their pedagogical practices.

6.5.1 Navigation and temporal affordances

The affordances mentioned by Lecturers 3 and 4 are access to e-texts on many digital devices (temporal affordance) and fast searching for information (navigation affordance)*:*

> *An e-textbook is now available on your computer, on your phone, or on any digital device … If you normally need to look something up, you go to the table of contents page. When you go back and look at the index, and then*

> *go and look it up with the e-textbook, you can Ctrl F and find what you are looking for, and all the different sections with that particular topic will be highlighted.* [Lecturer 3]

Lecturer 3 emphasises the accessibility of e-textbooks, which can be accessed on a variety of digital devices, such as computers, phones, and tablets. Furthermore, e-textbooks allow for fast searching for information, enabling students to quickly find the information they need through the use of digital tools like the "Ctrl F" function. This feature can save students time and increase their efficiency when looking for specific information. Lecturer 4 also highlights the accessibility of e-textbooks, which makes them more user friendly for students who prefer digital media to print media:

> *[An] e-textbook is an electronic version of a textbook, that is designed for accessibility other than the hard copies located in the library, or a book that is more user friendly with digital platforms in terms of cell phones and laptops, which can be accessed by students.* [Lecturer 4]

Lecturer 1 mentioned temporal affordance of e-textbooks, namely, that they can be read in any place:

> *… e-textbook, basically, the first thing is that students can have it in any place. You can even have it instead of having this big textbook. You could just have a laptop and continue reading this simple thing.*

In the extract above, Lecturer 1 refers to the temporal affordance of e-textbooks, which is the ability to have access anywhere and at any time. This affordance is valued by many students who appreciate the flexibility of learning as this is an important factor in their studies (see Section 6.2.5).

Lecturers 1 and 4 viewed e-textbooks as a resource for knowledge to learn in their own space and place. For instance, Lecturer 4 claimed*:*

> *An e-textbook is a resource which facilitates learning. It helps the student to learn in their own space. So, they don't need a lecturer to be in front of*

> *them. Because some of them will even have videos, PowerPoint presentations, and even questions for practice. You may even assess yourself to see how far you are when it comes to a specific concept.*

Lecturer 4 elaborated further on how he used e-textbooks in his teaching and what resources e-textbooks provided for instructors*:*

> *The resources that I use are from* [name of e-textbook publisher platform], *which is the e-textbook that I use for demonstration in the class, which comes with notes and methods and examples and a presentation of the concept to the students...*

Lecturer 4 explained that the publisher of the e-textbook provided an additional package of instructional resources to support the teaching approach and curriculum. Tools and technologies have functions that users (lecturers) expect to lead to certain kinds of learning. According to Lecturers 1 and 4, tools such as e-textbooks for engineering subjects can improve the teaching and learning process as mentioned: *E-textbook allows you to go back and reflect on the section. My students are battling with this section. It may be a must to go back and watch* [Lecturer 1]. However, Lecturer 1 emphasised that by giving access to the e-textbook, some students will find it challenging to work with the e-textbook because of a digital divide:

> *Everyone can have access to the e-textbook. However, to have access to an e-textbook, students still need the internet, you see, so the majority of my students live outside of campus. This can create a problem, which I could call the digital divide. It would be ideal for some students who have internet access, but for others who live off-campus, internet access will be a challenge.*

This point is revisited later in this chapter, and is just mentioned here to acknowledge the complexities associated with the temporal affordance of e-textbooks in a country such as South Africa.

The next section discusses the affordances of visualisation and simulation of engineering e-textbooks. Several participants agreed that engineering textbooks and content are not easy to understand on your own without guidance. By their nature, physics concepts are complex and not easy to understand for first-year students if they only read the text. It was thus essential to consider how engineering lecturers explain certain concepts using an e-textbook.

6.5.2 Media affordance – Visualisation and simulation affordances

Lecturers mentioned that e-textbooks help students with understanding through using visualisation of practical problems and looking at simulations. Lecturer 1 provided two practical examples of how engineering concepts can lead to misunderstandings if students only read the text and have a limited understanding of physical concepts.

Example 1: Bullet movement – visualisation

> *I used the example of the bullet's movement to show how physical concepts are complex and more than one solution ... students* [are expected] *to visualise this problem to use the correct physical law and then apply it for calculation. The bullet movement is complex because, if the student selects the wrong concept, then he/she fails the question. In this case of teaching complex concepts, it is almost impossible to teach students without a visual element.*

Example 2: Rotational motion of a person on a chair – simulation

> *If I do rotational motion on a chair, you don't see the rotation, but you imagine the motion, but with e-textbooks, you can replace this person doing simulation, and you can be able to see what's happening. So, you can formulate and understand the meaning differently in an e-textbook. And I think a student can formulate meaning through those kinds of things.*

All lecturers reported the visual presentation of physical concepts via video in e-textbooks as the main advantage compared with print textbooks. Lecturer 4 stated: "*E-textbook has got the feature of presenting the same concept that is written in words or graphics in the book so that you can have the option of actually watching that*

particular concept." Lecturer 2 described visualisation as part of their pedagogical practices and compared old, widely used tools such as writing on a blackboard and PowerPoint:

> *I integrated* [an] *e-textbook as part of my curriculum. I obviously used e-textbook examples. They have videos of explanations of things because even when writing on the board, or using a PowerPoint slide, some things, particularly in physics, you need to kind of visualise in 3D, and there's nothing better than having a video...*

It was interesting to see how Lecturer 2 experiences e-textbooks as assisting different students with understanding through available media resources:

> *With the subject I was teaching, because it's something that you need to be able to visualise in 3D, before we implemented e-textbook, it was quite difficult, particularly when you've got two chapters like vectors and you have to try and draw them to scale on the board, it was a mess ... The benefits you get from a e-textbook make a lot of difference because students are different. Some are visual learners, some are not visual, auditory, etc. But being able to see something* [visually] *you can reach more students...*

This lecturer discussed e-textbooks and the mathematics content of vectors where students need to visualise complex concepts in 3D which is very difficult to explain in 2D using traditional tools. Lecturer 4 pointed out the affordance of watching the video for improving understanding rather than only reading the text:

> *E-textbooks have the feature of presenting the same concept that is written in words or graphics in the book by watching the video. And then so that you can get an explanation of what the concept is about. So, the video concept kind of reinforces the learning step by step.*

Lecturer 4 highlighted the media affordance of e-textbooks in providing different modes of learning to enhance students' understanding of concepts beyond just reading the text, more specifically pointing out the benefit of videos that present the

same concepts in a more visual and interactive way, reinforcing the learning process step by step. This feature can help students who struggle with understanding concepts through written text alone, and can potentially enhance their comprehension and retention of the material.

A similar view on assisting diverse students was elaborated by Lecturer 4:

> When *you take into account the diversity of the students; some of them are not fluent with the concepts. So, their option of the audio component in the e-textbook is very useful, because they can take their time to actually adapt to what is being said. So, students can actually follow the presenter, which I find to be a positive result. It's a backup for me because in some cases, I might have gone fast on a particular concept which may have gone over their heads, and then the lesson was over, but because they've got that option, then they can always go back.*

Furthermore, Lecturer 4 noted the benefit of audio components in e-textbooks, which can provide a useful option for students who struggle with fluency or adapting to the spoken language. The audio component can also serve as a backup for students who may have missed a concept or may need to revisit a particular section of the lesson.

Further discussion of the importance of simulation was expressed by Lecturer 1: "*I think for me, if e-textbooks are there to provide a lot of simulation in such a way that learners are encouraged to formulate meaning from their own language first, that could really work".* For example, Lecturer 1 explained his view on the presentation of engineering concepts with different modes of e-textbooks:

> *So, e-textbooks now, that is the role they play in bringing this extra part of animated art that allows you to do this thing. I think that's one of the things you cannot get from the print medium. Some examples like this, or do some videos where they show you the things that you can never get anywhere else … it is to reinforce your learning.*

Another example of teaching engineering concepts when students use e-textbooks was also mentioned by Lecturer 3:

> *If you click on, for example, the atom, it gives you an entire explanation with extra questions at the end. Some students wanted extra questions and to be able to revise what they were studying. So, you can go to this question, you can answer the questions. If it's incorrect, it'll actually tell* [the] *student that and why it was wrong. And they'll give you a clue as to how to think about it and see how to answer it correctly next time.*

Furthermore, Lecturer 4 elaborated on the presentation of engineering concepts with different modes of e-textbook:

> *I say engineering concepts are very complex at times. It is not just reading a text. So, you're reading a text, and you have to interpret it mathematically. You also have to interpret it graphically in all three ways* [3D]. *So, with that, e-textbooks are a very strong tool when it comes to that. Because, as I said earlier, using the media component of it actually helps to elaborate furthermore on that concept itself.* [Lecturer 4]

Reading e-textbooks for study purposes is an active process that includes engagement of the reader with text and images as Lecturer 2 mentioned:

> *The pictures in a textbook can't move, but in an e-textbook you can get things like videos, simulations, etc.*

By providing students with hyperlinks in e-textbooks, students can move from basic to complex concepts which can promote self-regulated learning, as explained by Lecturer 2:

> *... there's a link from previous sections to direct and show how this thing can be solved. Or there's a link that can take you directly to the solution ... in the textbook, you have to page all the way to that page and try to find the solution. So, there are a lot of advantages to an e-textbook.*

That is to say, the engineering concepts of a specific discipline, such as in chemical engineering, are very challenging to understand. Enabling the acquisition of discipline-specific concepts is essential for engineering subjects when students read engineering texts. Engineering texts have specific disciplinary language related to a specific course. One of the aspects that the lecturers commented on with regard to the affordances of e-textbooks was problem-solving. Problem-solving is an important aspect of engineering study, and Lecturer 4 suggested that e-textbooks can assist with problem-solving: "*I think the e-textbook is also a book that has been written in modern times, so it brings the concept of the particular example as a strategy for problem-solving."*

6.5.3 Assessment affordances: learning analytics and feedback

Besides the previously discussed affordances – including temporal, spatial, media, navigational, and emphasis affordances – this analysis highlights that e-textbooks further provide assessment-related affordances, such as learning analytics and feedback. This affordance speaks more to pedagogy, and is therefore more important to the lecturers than the students.

Lecturers 1, 2 and 3 use e-textbooks for assessment purposes for efficiency of marking and timeous feedback made possible by elements of artificial intelligence (AI) within e-textbooks. Two lecturers, 1 and 3, elaborated on their point of using e-textbooks for formative assessment, or assessment for learning: "*When you're talking about assessment, there's this linkage to the e-textbook and the assessment, which is called formative"* [Lecturer 1]. Moreover, Lecturer 3 expressed an interest in trying to incorporate formative assessment from e-textbooks as part of the curriculum:

> *I'm planning on doing it this year, especially the formative assessments. If the formative assessments work well, I might even consider them for summative assessments. I know colleagues who have used it, and they say it is fantastic for both formative assessments and summative assessments.*

The formative assessment had several benefits: firstly, the questions linked to the course material to which students were exposed, as Lecturer 1 explained: "*That was*

so nice. If you give homework in an e-textbook, it automatically links to that specific homework question in the e-textbook."

Lecturer 2 pointed out that access to the practical bank of questions for students can assist students in becoming more confident:

> *So, for learning, it's wonderful, because now you've got a huge bank of questions where students can go and practise ... students start to see the trend of how certain questions are asked, what are the types of things that can confuse you ... They* [students] *kind of get used to the pitfalls they can fall into, and therefore they can prevent themselves from falling into those traps.*

Secondly, the provided questions allow the lecturer to apply different levels of difficulty and different graduate attributes, as mentioned by Lecturer 1:

> *You're not interested in possibly measuring what they've learned, but in getting them to learn. The platform is convenient in that you can create quizzes, homework tests, and other assessments, but it also has an important additional component known as an Orion. It's a competency test. And because this pool of questions is ranked into different categories, where the students are getting level one, if they make it, they move to level two and then they can move to the highest level.*

Thirdly, monitoring of students' performance and adjusting teaching can be done using the learning analytics provided by e-textbooks. The learning analytics embedded in e-textbooks provide information about students' learning, and allow lecturers to reflect on their teaching.

> *E-textbooks are the central part of adaptive learning technology. The computer itself responds to the learner as if they were working with another person. You get to a point where, like you, if the computer wanted your competency level on a certain topic, it would give you maybe six questions with a different variation on them. If the student is not on that level yet, the*

> *adaptive technology allows them to bring more questions so that the student can deal with them. And then if the student answers this question incorrectly, it automatically links the student to the e-textbook itself.*

Post-assessment analysis, which draws on data from these learning analytics, allowed lecturers to see how and where students did well, as was articulated by Lecturer 4:

> *The fact that you can actually view each student's performance, from assessment to chapter… you want to filter down and try and find the most difficult section. And there were, so you can check the section per student or you can get to that average student. So that means if, for example, I was teaching friction, that means there's an issue of friction. So, I may need to make some deliberate efforts to actually assist them to do much better on that particular concept.* [Lecturer 4]

> *[An] e-textbook allows you to go back and reflect on the section. My students are battling with this section. It may be a must to go back and watch. And* [for] *the record: those reports are helpful for lecturers to see how the students are working.* [Lecturer 1]

From the lecturers' transcripts, it is evident that learning analytics provide insights into student engagement with e-textbooks. This feature offers a novel function, enabling not only the monitoring of students but also providing lecturers with data on students' comprehension of the curriculum. Such analytics facilitate timely interventions during the semester and monitor student performance and engagement which was not previously available with paper textbooks.

Fourthly, e-textbooks enabled timeous feedback to improve understanding and adjusting of learning: "*Because the nicest thing for me, what happens to the bridging of the gap is that I'm able to respond to my students as fast as I can"* [Lecturer 4]. As well as timeous feedback, Lecturer 4 appreciated the automatic grading, which decreased their marking load:

> *Alright, so I've created the assignments for students as part of the assessment for the students. And the best part is that the book actually gives you, I mean, marks the assessment itself. So, there's the grading already, I mean, it's some work that has been taken away from me.*

With all the above-mentioned benefits of assessment and feedback in e-textbooks, some lecturers mentioned that assessment integrity can still be challenging. For example, Lecturer 4 stated: "*I think when it comes to assessment, it might be tricky unless you get to randomise questions and put them in a controlled environment."*

From the interviews, all lecturers mentioned that by implementing e-textbooks for teaching and learning, their teaching philosophy has changed from a traditional way of teaching to a more interactive way by using e-textbooks. They all indicated that they reduced some of their teaching and marking load by providing developed PowerPoint presentations for each chapter and giving access to banks of questions as well as feedback for each attempted question to see where students went wrong; the available hyperlink can easily redirect students to previous chapters or sections if they need revision. Despite this, several contradictions pertaining to content, role of lecturers and access to e-textbooks were identified regarding the lecturers' use of e-textbooks and are discussed in Chapter 7.

6.6 Conclusion

This chapter contributes to our understanding of the affordances of e-textbooks and the order of interaction with e-textbooks. The discussions in this chapter specifically focused on students' interactions when students read with e-textbooks, as well as the subsequent conversations with students regarding their literacy practices. The presentation and analysis of the data began with the identification of the affordances of e-textbooks in Section 6.2, examining which affordances students utilised. The discussion then progressed to the patterns of interaction order in Section 6.3, where an attempt was made to categorise the ways in which students interact with e-textbooks.

Students interact with e-textbooks based on their familiarity with the affordances of e-textbooks and their reading practices. Students were actively engaged in new digital literacy practices, such as watching videos, using emojis, and highlighting text, across the two e-textbooks. In Section 6.2, I discussed students' engagement with affordances such as navigation, emphasis, media, temporal, and spatial affordances. The analysis of all these affordances in e-textbooks revealed that the two groups of participants did not show significant differences in their use of these affordances, indicating that their preferences and familiarity played a role in their interactions.

Secondly, students interact with e-textbooks in varying ways, as discussed in Section 6.3, and it was found that some groups were more familiar with the affordances of e-textbooks than others. Further discussion regarding affordances is provided in Chapter 7. Thirdly, while students did not demonstrate online collaborative functions for digital reading of physics e-textbooks, they expressed a desire for online collaboration in higher education by utilising digital affordances such as sharing highlighted text and annotations. The incorporation of peer collaboration in e-textbooks should be considered, not only in the design of the e-textbooks themselves but also in the pedagogical practices surrounding their use, as shown in section 6.4.

Furthermore, this chapter also examined lecturers' interaction with e-textbooks as a teaching tool. Through discussions with lecturers, it was found that their understanding of e-textbooks varied. The main finding of this chapter emphasises the importance for lecturers to understand the affordances of the e-textbooks available to them and to use them meaningfully before prescribing them for their subjects. In this chapter, lecturers discussed affordances in relation to navigational, temporal, and spatial affordances, as well as visualisation and simulation affordances related to pedagogy, assessment, and feedback.

In the next chapter, the focus shifts towards exploring possible contradictions and their underlying causes that arise from students' literacy practices and lecturers' perspectives.

Chapter 7
Contradictions in students' and lecturers' digital literacy practices

We notice e-book readers, we do not notice books (Douglas Adams, 2000).

7.1 Introduction

In the previous chapter, I analysed focus-group discussions and individual interviews conducted with students and with four lecturers from two engineering departments at a university of technology (UoT) in South Africa. Students expressed the view that e-textbooks might assist in the development of an understanding of complex engineering concepts through the affordances of media and audio embedded in e-textbooks (see Section 6.2.3). Additionally, the findings suggest that there are possibilities for peer collaboration when engaging with e-textbooks beyond their physical class use. However, some students expressed concerns about access to e-textbooks and requested clear instructions on how to use e-textbooks in a meaningful and effective way. Also, the findings from Chapter 6 show that students engage in different literacy practices by using different interaction patterns when reading e-textbooks.

This chapter continues the discussion of the digital literacy practices involved in reading e-textbooks as surfaced in the focus-group discussions and individual student interviews. As such, the chapter continues to address the research question: *How do students and lecturers engage with engineering e-textbooks?* Even though this chapter uses the same data and answers the same question, in this chapter, I focus on the contradictions and/or tensions that arise in the activity system.

Before proceeding with the data analysis, it is important to re-examine the idea of contradictions as a catalyst for change and development, a key concept in cultural-historical activity theory (CHAT). The notion of tension is also significant in Engeström's theory of expansive learning and the methodology of activity system analysis. According to Karanasious et al. (2017), activity theory considers cultural-historical contradictions as fundamental analytical concepts that emerge within an activity or between interconnected activities, giving rise to dialectical transformation (Engeström, 2001; Igira & Gregory, 2009). The concept of contradictions in activity

theory was first introduced by Ilyenkov (1974), who identified these as dynamic tensions that historically accumulate between opposing forces within an activity system. Engeström (1987) further developed this concept in third-generation activity theory, emphasising that tensions act as drivers for change and development. Such tensions create opportunities and demand innovative solutions, which can ultimately lead to transformative shifts in activities (Engeström, 1987).

E-textbooks are used as a form of mediational tool (see the CHAT and MDA concept of mediational means discussed in Chapter 3, Section 3.3). Following the implementation of e-textbooks as part of the curriculum, contradictions and tensions cannot be directly observed, but are discerned through their manifestations (in words and actions of participants), such as whether students accept and adapt to the new digital literacy practices required or whether they resist and possibly avoid using e-textbooks. Identifying the contribution of this chapter, I shall undertake activity system analyses of the collected data. Using activity system analysis as an analytical framework allowed me to examine in greater detail how and why students use or do not use certain affordances and interaction orders in their digital literacy practices when they read e-textbooks. In this chapter, I examine students' digital literacy practices and I analyse interviews with lecturers to understand their experiences and roles after introducing e-textbooks, through the theoretical lens of CHAT (Engeström, 1987, 1999, 2001; Vygotsky, 1978b).

The chapter is structured as follows: first, I present an activity system analysis of particular contradictions which create *tensions* for all student participants from each of the two departments (Chemical Engineering and Maritime Studies). These analyses draw on the second generation of CHAT (see Chapter 3, Section 3.4.2). Second, I discuss tensions in relation to the role of the lecturer, e-textbook content and access to technology, as these arise in the lecturer interviews. Then I investigate the manifestation of these contradictions in terms of *dilemmas, conflicts, critical conflicts, and double binds* in order to understand these contradictions and their possible resolution (see chapter 3, section 3.3). Third, I analyse contradictions between students and lecturers using the third generation of CHAT (See Chapter 3, Section 3.4.3) and discuss the contradictions that underlie the tensions identified.

In this thesis, contradictions manifested through two processes. First, the inner contradictions of each activity system were identified. In this chapter, I note the elaboration of these contradictions by examining their interrelationships through activity system analysis. I particularly focus on the primary contradiction within the object of the student activity system. Additionally, secondary-level contradictions arise between various elements of the activity systems, often occurring between two constitutive moments (Roth & Lee, 2007). These secondary contradictions are typically evident when an external element, like a new technology, is introduced into the activity system. The incorporation of this new technology can lead to conflicts with existing elements, such as rules or the division of labour. These contradictions give rise to disruptions and tensions within the activity system, but they also stimulate innovative efforts to bring about changes and adaptations to the overall activity. I also focus on tertiary contradictions (these tensions are between different versions of an activity system such as learners before entering the UoT and first-year students). Tertiary contradictions also can be explained as contradictions within an activity system which arise when the object of a more "culturally advanced" activity (Engeström, 1987) is introduced into that system. Lastly, I shall look at contradictions between students' and lecturers' activities (quaternary tensions between neighbouring activities) arising from the data.

The focus in this study is on these tensions, because e-textbooks as mediational means affect the other elements of the activity system. This allowed me to see the change in the educational activity system and identify new challenges mentioned by the students. The primary, secondary, tertiary and quaternary contradictions occur between constituent parts of the activity triangle, different versions of the activity triangle, and neighbouring activity triangles, respectively. Identification and discussion of these tensions – and the possibilities for change and development they engender – is the particular focus and aim of this chapter.

7.2 Discursive manifestation of contradictions in students' usage of e-textbooks

This chapter's goal is to present and discuss the manifestation of contradictions (See Chapter 3, Section 3.3) by discussing all the tensions discernible across the data set

as a whole. Activity systems are represented in the form of an activity triangle. In the activity triangles developed and discussed in this chapter, the *subject* is the group of chemical engineering or nautical science students involved in the activity. The *mediational means* act as resources which the subject or subjects draws on during the activity. In this study, the mediational means of focus is the e-textbook, where the e-textbooks are incorporated into the learning management system (LMS).

The *object* is the motive of the activity. It is also the physical or mental product which needs to be transformed by the participant/s in the activity (Hardman, 2008). In this activity, the object is understanding the concepts presented in the e-textbooks. Depending on the purpose of reading, for some students the object might be understanding engineering concepts; for others, the object might be reading to memorise certain concepts and definitions and pass a test.

Rules refer to any formal policies or informal regulations and norms of the university. These rules affect how the activity takes place.

The *community* is the social group that the subject belongs to while engaging in the activity. In this activity system, the community includes the university IT system administrators, the librarians and educational technology unit professionals, as well as lecturers and peers, and the developers of the e-textbook; that is, all the people who share the common object.

Finally, *division of labour* refers to how tasks are shared among these members of the community. It is important to mention that power inheres in the space; there is asymmetrical power between lecturer and student.

Mediated action is located in the activity system's central triangle and refers to mediated action between the subject, mediational means and object. Leont'ev's (1981) emphasis on mediated action shifts the focus of analysis from the signs (words or symbols) produced by an action to the action itself, which is mediated by tools (physical and conceptual) (see more on this in Chapter 3). This shift requires a deeper examination of the cultural and historical context that has shaped and standardised social actions over time. It also necessitates an understanding of the specific tools

used in different settings and how they are employed. By considering the role of tools in mediating actions, researchers can gain insights into the ways in which social actions have become patterned and habitual within specific cultural and historical contexts. Reading, as a social practice, is incorporated into readers' lives, allowing them to form deep and personal connections with others and themselves, as well as to satisfy curiosity and learn by engaging with the text and reflecting. In the activity triangle, social practice is concerned with the CHAT elements at the bottom of the triangle: rules, community, and division of labour. Reading as a social practice is situated in human interaction and is socially and historically constructed, as well as framed by the context in which it is used.

In this section, firstly I present contradictions which create tensions between elements of the activity system. I discuss all the tensions that are visible across the data set as a whole (see Figure 7.1). These are the tensions that emerge from students' use of e-textbooks as well as from the interviews with lecturers, which will be discussed in Section 7.3. It is important to note that the goal of contradiction analysis in educational activities is to enable and/or promote the possibility of educational change. Even if this change occurs, it does not necessarily eliminate tensions. Because the system is not static and constantly changing, these specific tensions may persist or evolve into new tensions.

While contradictions cannot be directly observed and analysed through empirical means, their presence can be detected by examining how they manifest in practical situations (Karanasios et al., 2017). These contradictions are shown in Figure 7.1, using the letters (*a)–(e)* and dotted and solid lines between the relevant components of the activity triangle and other activity system. It is important to note that all contradictions arise from tensions and implicate various elements of the activity triangle. However, for analytical purposes, I highlight the ones most pertinently implicated in tension, those that most emphasise the digital literacy practices involved and which most clearly open up possibilities for bringing about changes in learning and teaching (see Section 7.3) through the use of e-textbooks.

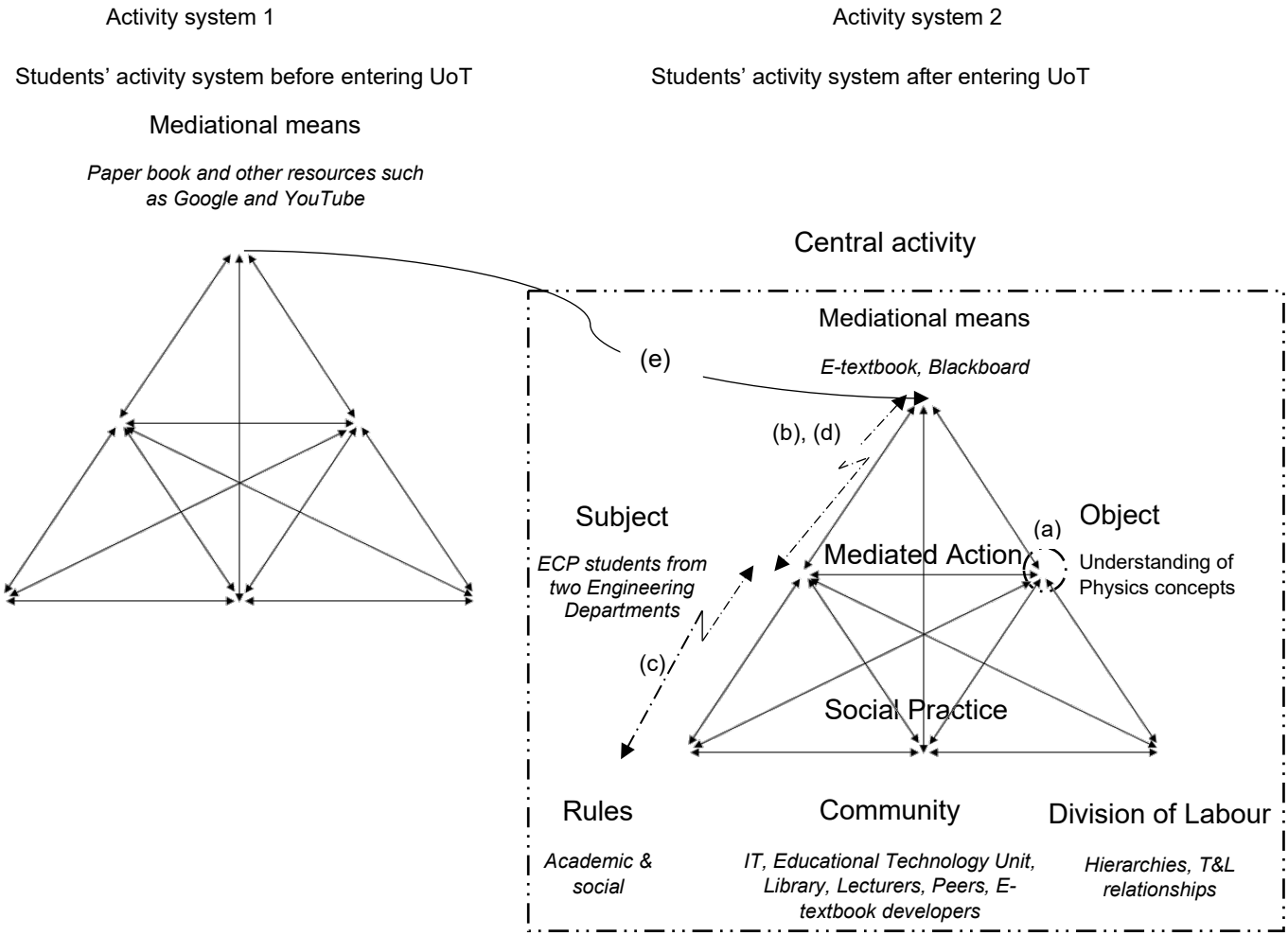
Secondly, since contradictions are not always obvious and often remain unclear, they emerge through people's articulation of activities (Engeström & Sannino, 2011). I

intend to use the analytical framework proposed by Engeström and Sannino (2011) in my discussion. This framework outlines four distinct manifestations of contradictions that can arise within various contexts: dilemmas, conflicts, critical conflicts, and double binds. Through the integration of these contradictions, my discussion will offer a nuanced perspective that showcases the multifaceted nature of e-textbooks and digital literacy practices, and contributes to a more thorough understanding of the underlying dynamics.

- *Dilemmas* are characterised by "expression of incompatible evaluation" and can be observed in discourse when contrary themes emerge (Engeström & Sannino, 2011). For example, e-textbooks offer the convenience of carrying an entire library on a single device, but they also raise concerns about eye strain and the tactile learning experience that physical books provide.
- *Conflicts* are often marked by resistance, disagreement, arguments, or criticism, and they are commonly expressed through negative expressions (Engeström & Sannino, 2011). For example, a conflict might arise in the classroom when students disagree about the use of e-textbooks' interactive features, with some arguing that the instant feedback on quizzes and multimedia enhance learning, while others believe they can be distracting and detract from focused reading.
- *Critical conflicts* encompass various types of experiences, including the sense of helplessness resulting from conflicting motives experienced by different individuals (Engeström & Sannino, 2011). As example, engineering lecturers can face a critical conflict regarding e-textbooks, being torn between concerns about unequal access for students without devices or reliable internet.
- *Double binds* refer to situations where participants repeatedly face equally unacceptable alternatives or impossible conditions, demanding urgent collective action for resolution (Engeström & Sannino, 2011). For instance, in South Africa, the adoption of e-textbooks in education can highlight a double bind for school learners. On the one hand, South African schools in economically disadvantaged areas, which would benefit most from the cost-saving aspect of e-textbooks, often lack the necessary infrastructure for

> digital integration, such as reliable electricity, internet connectivity, or digital devices for every student. On the other hand, reverting to traditional printed textbooks, while bypassing the need for technology, incurs higher long-term costs, lacks the dynamic updating capabilities of e-textbooks, and may not meet the evolving needs of the 21st-century learner.

Thirdly, I provide evidence of contradictions by discussing their types, which emerged from individual interviews with students and focus-group discussions. In order to identify these contradictions, I adopted and employed the concept of linguistic cues, as suggested by Engeström and Sannino (2011), during the preliminary data-analysis phase. However, the next stage of data analysis, specifically focusing on the student participants of this study, presented some challenges. These challenges were attributed to the diverse nature and backgrounds of the students, as outlined in Chapter 5, as well as their previous experiences with meta-languages. It was observed that not all manifestations of contradictions were consistently supported by linguistic cues. To conduct this analysis, I read the data from the transcripts and also listened to the think-aloud studies, allowing me to draw inferences from the information gathered.



Name of contradiction	Type [I]	Discussion section
(a) Learning physics with e-textbooks versus learning how to operate the e-textbooks	Primary contradiction in the object of the student activity system	Section 7.2.1
(b) Limited use of e-textbooks	Secondary contradiction brings about tension between mediational means and subject	Section 7.2.2
(c) Access to e-textbooks	Secondary contradiction between subject and rules	Section 7.2.3
(d) Study preferences: Isolation vs. collaboration	Secondary contradiction between subject and mediational means	Section 7.2.4
(e) Challenges of dependency: E-textbooks and the erosion of research curation skills	Tertiary contradiction between mediational means in the traditional or old activity and mediational means in the new activity	Section 7.2.5

Figure 7.1: Graphical presentation of the second generation of activity system for students and description of contradictions (Engeström, 1999).

E-textbooks are often seen as a solution to the challenges of paper textbooks, for example, by quickly finding required information and sharing this information.

However, e-textbooks present their own set of challenges (or tensions). Because the nature of these tensions can be student dependent, involving students' preferences and experiences, resolving a tension for one student may result in another tension or tensions for other students. In the following subsections, I discuss the contradictions presented in Figure 7.1 in greater detail.

To clarify, I believe it is important to establish that each contradiction within the activity system has implications for the system as a whole. However, the tension arises between two specific elements, which in turn affects the entire activity system. In the upcoming discussion, I address the contradictions in terms of specific elements within the activity system. It is important to note that these elements are interconnected and never exist in isolation. Consequently, the contradictions and resulting tension have implications that extend beyond the individual elements and affect the entire activity system. As previously mentioned, contradictions are pervasive throughout the entire system.

7.2.1 Learning physics with e-textbooks versus learning how to operate e-textbooks

The introduction of e-textbooks in the learning process has created a contradiction in the primary object of the activity system, which is the pursuit of understanding complex engineering concepts in physics. The intended goal of the students is to learn and improve their understanding through the use of e-textbooks. However, a contradiction arises as the students find themselves primarily focused on learning literacy skills associated with the e-textbooks rather than the actual physics content.

This primary contradiction, symbolised by *(a)* in Figure 7.1 in the *object* of the students' activity, manifests a dilemma where there are two conflicting options or choices that individuals or groups must navigate, leading to a sense of uncertainty. In this case, the dilemma arises from the conflicting demands placed on the students. On the one hand, they are expected to learn and understand complex engineering concepts in physics using e-textbooks. On the other hand, they are compelled to learn technology-related literacy skills associated with the e-textbooks, precisely in order to engage with understanding concepts. This contradiction is evident in the student activity system. The discussion of the primary contradiction will not only incorporate the perspectives

of students, but will also highlight the viewpoints of engineering lecturers who provide valuable insights into this matter. For example, Lecturer 2 emphasises the need for clear instructions and explanatory videos to help students navigate and utilise the features of e-textbooks effectively.

> *Students are supposed to learn physics, but now they must learn how to download and operate the e-textbook. And they must learn how to do this and other things. So, it's a learning curve of getting comfortable with the whole thing and readjusting to using an e-textbook compared to a physical one. [Lecturer 2]*

This creates a dilemma as the students must balance their focus and efforts between these two competing objectives.

It is important to mention that the primary contradiction focused on the tension between the intended goal of learning complex engineering concepts in physics and the actual focus on learning technology-related literacy skills associated with e-textbooks. It highlighted the dilemma faced by the students in balancing these competing motives. A dilemma, in essence, emerges when individuals face two conflicting paths, both of which are fraught with uncertainty. Here, students grapple with the dual responsibilities of mastering intricate physics concepts and simultaneously becoming adept at using e-textbooks. This dichotomy complicates their learning journey, pulling their focus in two directions.

Students, like Students 12 and 3, highlighted this contradiction, stating: "*On the first day, whenever we started the course, we couldn't open it. I didn't know when to open it or how to use it"* [Student 12]. Similarly, Student 3 observed: "*Students will end up quitting e-textbooks, even if it is a lot of opportunities for study. But because they don't even know how to use it and won't even try"* [Student 3]. Such statements underscore a fundamental issue: the introduction of e-textbooks has inadvertently shifted students' focus from pure physics comprehension to the acquisition of digital skills. This shift is exacerbated for those unfamiliar with the university's learning management system (LMS) or e-textbooks in general.

Furthermore, Student 12 expressed their initial experiences with no access to the e-textbook, explaining, "*I don't have the books that I am going to use. Like, just since every textbook that you're gonna use* [is] *a PDF* [sic]" [Student 12]. This excerpt describes what happened when students first arrived at the institution and were told they needed to use the e-textbook for physics. Students struggled at the beginning of the semester because they could not find the e-textbook in the LMS. Some students were unsure how to access the e-textbook, and because classes had already begun, they sought alternative access to the prescribed textbook in PDF format.

While some students may have had a limited understanding of what e-textbooks are, it does not necessarily mean they possess the necessary digital literacy skills to effectively study using e-textbooks. Another example is Student 14, who shares the same sentiment as Student 12: "[I never used before digital device for study] *it's actually my first time having this thought, so I don't know how to do so but I would love to know how* [to use e-textbooks]". The findings from Chapter 5, as illustrated in Figure 5.7, show that of the respondents, three students admitted they did not know what an e-textbook was, 26 were unsure, and 44 confirmed their familiarity with it. However, knowing what an e-textbook is does not mean that these students knew how to study with e-textbooks. This implies that there is a need for a digital literacy framework to better instruct students on how to use e-textbook resources. This is because of the fact that some students, or even a majority of students in a setting such as South Africa, may be unfamiliar with digital texts and tools, and may require assistance to access the digital text.

This primary contradiction in the object of the students' activity was also noticed from the lecturers' view that employing e-textbooks can raise some concerns about students learning with e-textbooks. As example, Lecturer 2 explained:

> *E-textbooks got some very nice things you can do there. However, I don't see any way to get instructions on how to access the videos. How do you select a particular chapter to practise on? What do you do if, like, there are a lot of features on there that are brilliant? But for someone who doesn't even know what the feature is, for instance, assuming there's a student who doesn't know how to use a highlighter, just having that highlighter thing on*

> *there without having something that explains what it does makes it kind of redundant. Many students won't use it because they don't know what it can do.* [Lecturer 2]

This shift in learning priorities is encapsulated by the concept of "tool-object reversal", as outlined by Virkkunen et al. (2013, p.18). Here, the tool, which is the e-textbook in this context, inadvertently becomes the primary focus or object, overshadowing the original object of the system, namely learning physics. Instead of being a facilitative mediational means, the e-textbook becomes an entity to be learned and mastered in itself, diverting attention from the core academic objective.

It is crucial to emphasise that the primary contradiction, as explored in section 3.3, stands out as the most enduring and resistant among all contradictions detailed in subsequent subsections of this chapter. This primary contradiction is central to understanding the dynamics of how and why students interact with e-textbooks, particularly when considering the concept of use value versus exchange value (Foot, 2014). The use value of an e-textbook is evident in the authentic epistemic growth of students, contrasting with its exchange value, which is exemplified in students' adherence to institutional norms and policies.

Additionally, this dichotomy extends to the values held by those engaging with Physics e-textbooks. The primary contradiction here lies between different forms of value: the practical utility of the e-textbook, its 'currency' or purchasing power, and the enjoyment derived from using the e-textbook in the learning process. This contradiction underpins the complex relationship students have with e-textbooks, influencing their engagement and the nature of their learning experience.

The focus on acquiring technology-related literacy skills and the challenges arising from students' limited experience and unfamiliarity with e-textbooks hinders the intended goal of learning complex engineering concepts in physics. Addressing these contradictions requires attention to both digital literacy support and a revaluation of the primary object to ensure a balance between technological proficiency and content mastery.

7.2.2 Limited use of e-textbooks

The secondary contradiction, symbolised by *(b)* in Figure 7.1, raises tensions between the *mediational means* and *subject* of the activity. The *mediational means* is the e-textbook as embedded in the LMS. The *subjects* of this activity are first-year students who registered in the chemical engineering and maritime studies departments in the Faculty of Engineering and the Built Environment (FEBE) at the selected university of technology. The type of contradiction that manifested in discussion with students is a dilemma and revolves around their limited knowledge and awareness of how to effectively use the affordances provided by e-textbooks. This lack of understanding leads to limited usage, and a perception that e-textbooks do not help students to acquire knowledge. The primary contradiction discussed above (where the object of the tool is learning to use the tool instead of learning physics, Section 7.2.1), leads to limited use of the tool such as an e-textbook. The primary contradiction is that students are becoming more focused on learning how to navigate e-textbooks rather than on learning the core subject matter, in this case, physics. This shift in focus detracts from their actual learning objectives. Furthermore, a secondary contradiction arises, that the more time and effort students must invest in mastering the functionalities of e-textbooks, the less inclined they are to use these digital resources.

As mentioned above, this contradiction is a dilemma, but it specifically addresses the limited knowledge and awareness of how to effectively use the affordances provided by e-textbooks. For instance, Student 3 stated: *"I was not aware* [of how to use e-textbook]", and Student 5 also had a similar view: "*You must know how to use* [e-textbooks]." The limited usage of e-textbooks can be attributed to limited knowledge of how to use e-textbook affordances. For example, Student 4 mentioned that not knowing or having limited knowledge of the functionalities of the e-textbooks might lead to limited usage of e-textbooks by students:

> *I don't think there's something wrong with the colour of hyperlinks or anything else, it's just that I was never informed that pressing there gives you additional information. So regardless of the colour green, blue, red, I would still leave it and continue reading the text. So, I just was not informed about it*.

In this case, the students' lack of understanding leads to minimum or limited usage of e-textbooks, and a perception that e-textbooks do not assist them in acquiring knowledge. The tension arises from the gap between the students' knowledge and their ability to effectively utilise the e-textbook as a mediational means. This dilemma is centred on the students' struggles with the affordances and functionalities of e-textbooks, which hinders their learning process. Another reason for limited usage of the e-textbooks is explained by Student 3: *I will be honest, I wasn't aware it had an index, and many things. I thought that maybe it's only for searching the chapters only, not any other searching things… Now, I know* [Student 3]. Student 14 responded:

> *[in the beginning], I …* [didn't] *know how to use a digital book. It's* [in fact] *much easier to use ... if I want to highlight something, I just highlight it. … if I could …* [be taught] *more about it, a digital book ... is much better.*

Another example of students having limited knowledge of the functionalities of e-textbooks was mentioned by Student 13:

> *The reason I use my book* [paper book] *is that I have eye problems. So, when I look at the screen for a long time, I tend to have tears coming up. So, like I make notes, and then watch videos, then turn off the screen, get to my book.* [Student 13]

In other words, students are unaware of the capabilities of e-texts. As a result, they default to a preference for what is more familiar. Student 13 mentions eye fatigue from digital screens or physiological issues that affect their reading. Some of these issues can be resolved by adjusting certain settings on the computer and e-textbook, such as the screen brightness, setting a black background, changing the font and size of the text, and using the read-aloud function for more comfortable reading.

This contradiction can be resolved as suggested by Student 7: "*If we have instructions on how to use an e-textbook, then it's acceptable because it's simple and straightforward*", with which Student 2 concurred*: "I agree."* Both these students contend that instruction on how to use e-textbooks was the main reason for not using e-textbooks.

The purpose of this study was not to evaluate the participants' level of text comprehension; however, based on their responses, the absence of clear and direct instruction on using e-textbooks for study purposes may imply a superficial and thus, simplistic use of digital literacy practices when using e-textbooks, which may lead to inappropriate use of e-textbooks and, in some cases, resistance to using e-textbooks.

In this section, I have shown that students were not aware of how to use the affordances of e-textbooks. Students mentioned that they need instruction on how to use the e-textbooks, and that they did not have enough time and experience to study with e-textbooks. Finally, some students had discomfort when they read digital text. This contradiction can be resolved and transformed into an advantage of e-textbooks by providing more detailed and explicit instruction and better embedding the e-textbook tool(s) into the course. It is evident that many students did not know how to use the e-textbooks and did not have enough time to practise studying with e-textbooks.

7.2.3 Access to e-textbooks

The continuum of knowledge dissemination follows a fascinating historical trajectory, beginning with the transmission of wisdom through ancient oral traditions which endured across centuries. The subsequent emergence of script introduced a pivotal transition, enabling the recording and preservation of knowledge. This evolution reached a seminal juncture with the advent of the printing press, an innovation that catalysed an unprecedented proliferation of information dissemination.

In our contemporary digital age, this continuum reached its zenith as we navigate a landscape characterised by the swift interconnectedness of information. The widespread accessibility of digital platforms has ushered in an era defined by the expeditious exchange of knowledge, transforming the dynamics of how information is shared and accessed. This aspect holds particular importance in developing countries like South Africa, where many first-year and first-generation students[19] face challenges accessing educational materials and resources.

[19] A first-generation university student refers to an individual whose parent(s) did not obtain any tertiary education qualification.

This contradiction has the nature of conflict because it arises from a tension between the subject, the engineering students, and the rules set by publishers regarding access (labelled as *(c)* in Figure 7.1). The subject would like to have easy access to the prescribed e-textbook by bypassing the LMS. The conflict is highlighted by students' statements expressing their preference for unrestricted access to e-textbooks on their digital devices, as opposed to limited access under a publisher's licence and through the official learning management system (LMS). This conflict is characterised by a disagreement between the desires of the students for unlimited access and the limitations imposed by copyright licences and restricted distribution.

During the interview, Student 5 suggested: "*Access to the e-textbook. It must be an app like to read on the device. Can we download* [publisher of the e-textbook] *on its own and we don't have to go to the* [LMS]*".* Student 1 added: "*Access to … e-textbooks available for everyone."* These statements by Students 5 and 1 indicate their preference for having unrestricted access to e-textbooks on their digital devices, as opposed to limited access under a publisher's licence and via the official learning management system (LMS). One apparent limitation in this context is the restriction on knowledge distribution outside of the university. This restriction reflects the traditional conceptions of ownership and distribution of knowledge. This conflict boils down to a clash between the desire for open and unrestricted access to knowledge and the limitations imposed by traditional models of knowledge distribution, copyright licences, and the interests of publishers. Despite efforts and investments in open education resources (OER), there is still limited evidence of the availability of engineering or STEM-related subjects and the widespread use of OERs.

7.2.4 Study preferences: isolation vs. collaboration

While e-textbooks hold the potential to foster student collaboration, as discussed in Chapter 6, an underlying secondary contradiction (secondary contradiction *(d),* Figure 7.1) surfaces, introducing a notable tension between the students (subjects) and the mediational means (e-textbook). This contradiction gives rise to conflicts, stemming from the disparity between the collaborative design possibility of e-textbooks and students' inclination towards solitary study. The preferences expressed by students underscore a fundamental conflict between the students (subjects) and the collaborative learning affordances offered by e-textbooks. This conflict further fuels

resistance among student participants, hindering their willingness to engage in collaborative efforts with peers.

During a focus-group activity, students were asked to read e-textbooks and engage in natural study behaviours, including studying with other students. Students 9 and 10 had similar preferences in that Student 9 stated that: "*I do not like studying in groups, so I'd rather study with myself,"* and Student 10 concurred that he also prefers to "*study alone".* These preferences indicate a tension between the subject (the students) and the affordances offered by e-textbooks for collaborative learning. Students may not be aware of how they can effectively engage in collaborative learning and overcome the limitations imposed by physical space.

Despite Students 9 and 10 expressing a preference for solitary study, it is important to acknowledge that their engagement in collaborative activities, particularly when assisting peers upon request, indicates a level of willingness to participate in shared learning experiences. It is worth noting that these actions occurred within the context that I, as the researcher, set up by requesting their collaboration. While I as researcher do not possess concrete evidence to assert that these students would have naturally initiated such collaborative interactions, their actions still underline their capacity to contribute to collective learning and support their peers' educational journey.

This observation underscores a critical point: although these students may lean towards studying individually based on their preferences, the coexistence of their collaborative actions within this controlled setup introduces a significant contradiction. The contradiction becomes more pronounced owing to the explicit opportunity for collaborative learning, which these students consciously choose not to fully embrace. This choice highlights a distinct tension between the collaborative potential embedded within e-textbooks and the students' inherent inclination towards independent study methods.

Such preferences could stem from individual perceptions of the advantages of collaborative learning. However, as they progress in their academic journey, the engineering curriculum and profession will provide ample opportunities for them to develop teamwork skills and recognise the value of collaborative learning.

Furthermore, the conflict is also evident in the students' potential lack of awareness of the benefits of collaborative learning and their limited understanding of how to effectively engage in collaborative activities using e-textbooks.

It is common for first-year students to be less accustomed to studying in groups for various reasons, such as individual preference, lack of prior experience with group assignments, or past dissatisfaction with teamwork. However, in the engineering curriculum and profession, teamwork skills are highly valued and necessary. As such, students will have more opportunities in their academic careers to develop collaborative skills and recognise the benefits of working in teams. According to Engeström (1999), knowledge creation and learning can become collaborative endeavours when individuals begin to question accepted practices and concepts. This is carried out through individually and collectively undertaking epistemic action, such as questioning prevalent practices and ideas, analysing and modelling systemic causes of problems, modelling the new object and form of the activity, and putting the new model into practice (Engeström, 1999).

7.2.5 Challenges of dependency: e-textbooks and the erosion of research curation skills

At this particular UoT, a notable shift in the mediational means used by students was observed. Prior to joining the UoT, students primarily relied on traditional tools and resources such as paper books, YouTube, and Google (refer to Figure 7.1 highlighting the tertiary level of contradiction *(e)*). However, upon entering the university, particularly for the purposes of this research study, there was a marked transition to e-textbooks and the learning management system (LMS) as the primary mediational means. This shift presents a type of conflict, characterised by a tension between students' former reliance on traditional tools like Google and YouTube, and the new digital literacy practices introduced at the UoT, including the use of e-textbooks and the LMS. This is especially evident in the first year of the engineering students' studies.

Engeström and Sannino (2011) posit that tertiary contradictions are historically rooted and must be traced through their historical development. According to Engeström (1987), such contradictions emerge within an activity system when a more "culturally advanced" activity becomes the focus. The introduction of a new mediational means

can also herald the onset of a new developmental phase, wherein the activity system undergoes redefinition and reconfiguration. In the context of this study, this redefining moment was propelled by the adoption of new digital literacy practices.

From a broader cultural and historical lens, it is important to note that many students in South Africa had limited or no prior access to e-textbooks, a finding demonstrated in Chapter 5. While diversifying resources can offer students clearer insights and a richer understanding of concepts, there is also a caveat. Not all online materials are reliable. In an age rife with fake news and an overwhelming influx of information, a pivotal literacy practice is the ability to discern, curate, and fact-check to identify the most pertinent and trustworthy information. For example, for study purposes, students rely on Google, YouTube, etc., to clarify concepts: "*I went to Google, and I found some concepts or something"* [Student 12]; "*So I'll use Google. YouTube is working for me. They explain the concepts*…" [Student 1] and "[I] *… search them in Google to help me to understand*" [Student 2].

> *… go to the Google and then Google explains the word and then sometimes Google gives you a play button whereby it says the word for you, and then that's how I know how to say* [it] [Student 4].

However, not all websites and information online are trustworthy, and some students do not seem to realise this: *"It's well-known that Google gives accurate answers*" [Student 7]. This raises concerns about this very important literacy skill of fact-checking and curating reliable information. Some students were surprised to learn that the e-textbooks give links to sites that give accurate and reliable extra information:

> *At first, I used Google to search. I was not aware that there was an option of just searching by definition, okay. So, it's a helpful function when you do not have enough time. That's great.* [Student 3]

Therefore, this is a mixed educational boon; on the one hand, the e-textbook curates reliable information; on the other hand, it decreases the need for students to develop this very important literacy skill. Additionally, these excerpts show that many students prefer searching on well-known and popular websites, such as Google or YouTube.

Because the students were unaware of the e-textbooks' functionality, they relied on a culturally and historically familiar method of searching for resources. However, while e-textbooks can provide curated information and resources, it is crucial for students to develop research curation skills. Over-reliance on e-textbooks for pre-curated information may hinder students' opportunities to develop these skills. Learning how to curate research is critical for students' future success, both academically and professionally. Therefore, e-textbooks should be viewed as complementary resources rather than substitutes for developing research curation skills. Educators play a vital role in helping students strike a balance between the use of e-textbooks and the development of research curation skills. This can be achieved by incorporating research curation assignments into the curriculum, guiding students in the selection and evaluation of resources, and promoting critical thinking and analysis. By doing so, students can benefit from the convenience of e-textbooks while still developing the skills necessary to succeed in their academic and professional lives.

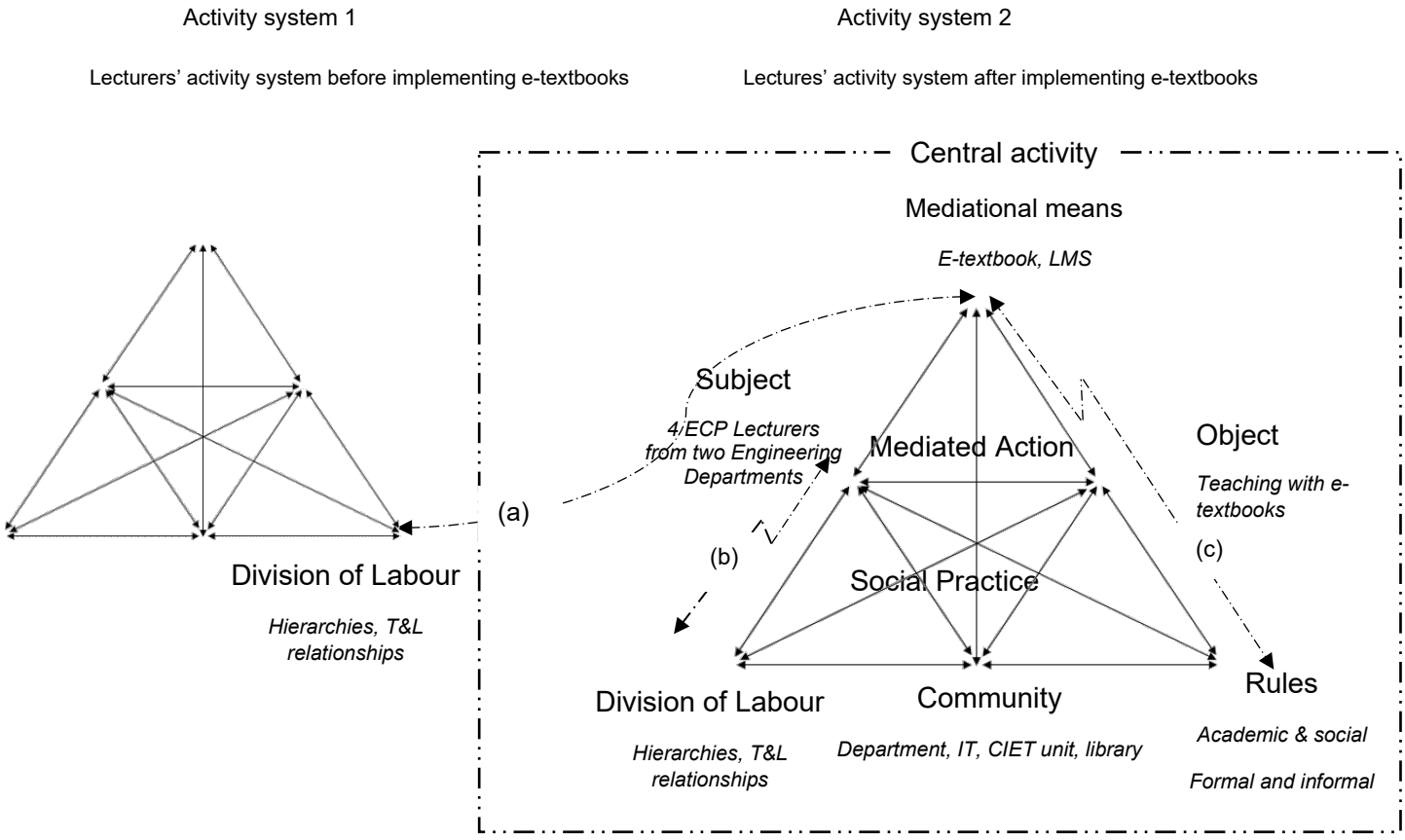
7.3 Discursive manifestation of contradictions in lecturers' usage of e-textbooks

In this section, I discuss the interviews conducted with four lecturers and present various contradictions that emerged, as shown in Figure 7.2. Figure 7.2 highlights several contradictions, labelled *(a) –(c)*. All the contradictions emerging in the lecturers' activity system analysis are secondary[20] and tertiary contradictions.[21] In the following subsections, I discuss these contradictions in detail.

It is important to mention that contradictions can drive activity systems and can possibly lead to change or improvement of the activity (see Chapter 3, Section 3.3) because not all changes will be implemented automatically and some will take time to settle into the educational activity system.

[20] Secondary contradictions occur between elements of the activity system, e.g., between "community" and "tool".

[21] Tertiary contradictions occur between an earlier version of an activity system and a current activity system, e.g., before and after implementing a new tool such as e-textbooks



Tensions for lecturer participants'

Name of contradiction	Type	Discussion section
(a) The role of the lecturer	*Tertiary contradiction:* Mediational Means (activity system 2) and Division of Labour (activity system 1)	Section 7.3.1
(b) E-textbook content	*Secondary contradiction:* Between Mediational Means and Rules	Section 7.3.2
(c) Access to technology	*Secondary contradiction:* Between Object (Lecturer motivation) and Rules (access to e-textbook)	Section 7.3.3

Figure 7.2: Graphical presentation of an activity system for lecturers and description of contradictions (Engeström, 1999) of teaching physics with e-textbooks.

7.3.1 The role of the lecturer

In this section, I examine the complexities introduced by the use of e-textbooks in academia, as depicted in Figure 7.2. A tertiary contradiction is symbolised by *(a)* in Figure 7.2 in the lecturers' activity, which arises from a tension between mediational means and division of labour. This contradiction underscores the transformative impact of the e-textbook on the conventional role of the lecturer. With the advent of the e-textbook, lecturers are no longer just content presenters (if, indeed, they ever were). They now face the challenge and opportunity to design and curate enriched

learning experiences. For example, Lecturer 2, capturing this sentiment of reliance on the e-text for grasp of the content, notes: "*E-textbook makes life so much easier in terms of understanding the content yourself, then being able to deliver the content, and then being able to pursue assessment. It's brilliant."* This statement suggests that while e-textbooks aid lecturers in grasping content, effective teaching extends beyond mere understanding. Although e-textbooks can bolster lecturers' comprehension, they still bear the responsibility of conveying content to students in a comprehensive manner, intertwining it with context, insights, and structure. This also raises concerns about diminishing lecturer–student interaction and potential loss of instructional control.

While the e-textbook offers a wealth of resources, the responsibility falls on the lecturer to harness it effectively, ensuring a holistic learning journey. This contradiction captures the evolution from a traditional teaching model to a more culturally advanced, student-centric approach facilitated by the e-textbook. Lecturer 3 further emphasises the need for balance:

> *I think e-textbooks can definitely assist you in your teaching ... It's there to support your teaching, not take over. Those lecturers who just use the e-textbook to teach on their behalf need to be cautious*. [Lecturer 3]

This underscores a risk at play: while e-textbooks offer undeniable advantages, relying solely on them could erode the lecturers' active involvement in teaching. Lecturer 3's comment illustrates the importance of maintaining agency and control over the instructional process. This contradiction arises from a clash between the capabilities of e-textbooks as intermediaries and the conventional beliefs and roles of lecturers. On the one hand, e-textbooks offer tools and resources that can simplify the teaching process, as articulated by Lecturer 2. On the other hand, there is a realisation, particularly from Lecturer 3, that relying solely on e-textbooks can diminish the active role of a lecturer. The disparity between the capabilities and potential of the e-textbook and the lecturers' actual utilisation of them creates this conflict. Effective teaching goes beyond content comprehension. It is a blend of pedagogical strategies, instructional design, student engagement, and clear communication. A pronounced conflict surfaces when lecturers primarily use e-textbooks for assessment, despite

acknowledging their benefits for scaffolded learning. This discord between stated belief and action accentuates the contradiction.

Moreover, Lecturer 1 brings another dimension, highlighting that "*using* [name of an e-textbook platform] *solely for assessment overlooks its potential for enhancing student learning*" [Lecturer 1]. This indicates that e-textbooks are not just assessment repositories; they should act as dynamic platforms aiding student performance, monitoring and facilitating various levels of lecturer–student engagement. This contradiction emerges from a double bind, because if lecturers use e-textbooks only for assessment, they miss out on their pedagogical benefits. However, if they lean too heavily on e-textbooks, they risk diminishing their active role and possibly the quality of student–lecturer interaction. This puts lecturers in a position where they seem trapped between two conflicting demands or constraints.

Additionally, this contradiction speaks to how the role of the lecturer has traditionally been conceived, and how the e-textbook has the potential to shift this role. Historically, the role of lecturer is understood in various ways -- from "sage-on-the-stage" to learning facilitator. However, as scholars like Ahn (2014), Gu et al. (2015), and others have argued, e-textbooks can foster self-regulated learning.[22] It is essential to understand that the objective is not to replace lecturers with e-textbooks, but to leverage them as supplementary tools to demystify intricate engineering concepts. For instance, Lecturer 2's initial response to the question of whether the e-textbook could replace the lecturer was initially affirmative: "*Obviously, I'm a teacher, I never want to agree with it that something can replace me, but the real answer is 'yes'."* Further discussion with Lecturer 2 elaborated and clarified their response:

> *It is also child* [student] *dependent because there are some students who will never be able to function in a classroom, but if you give them a laptop, you give them access to everything. And they still want to be in the classroom being taught something. Yes. So, I wouldn't say replaced, because I feel like some things can be supplemented.*

[22] Self-regulated learning refers to the process where learners personally initiate and manage their own learning processes. It is not just about the ability of students to study independently, but rather their ability to understand and control their own learning.

The lecturer later adds a nuance, suggesting that the situation is student dependent, with some learners thriving in a digital environment. Here, the emphasis isn't on replacing lecturers but supplementing their teachings. This mirrors a broader trend: students leveraging e-textbooks to foster independent learning.

Lecturer 4 identified the role of the e-textbook as a *facilitator* and his role as follows:

> *... lecturer comes in with more effort, especially to cover the background* [engineering problem] *for the students on what they've been exposed to help them use their imagination. So, e-textbook is linked to content and doesn't really stretch the minds of the students to a point where if you want to make an example about a particular concept, you want to make an example and you want to bring a typical application of that particular concept. So, an e-textbook won't do that for you. It was just purely to explain what is in the book.*

E-textbooks, while content rich and enhanced with visualisations and simulations, underscore the lecturer's role in providing contextual understanding and relevant application examples. A notable observation shared by multiple lecturers is the evolving nature of their role. With the advent of e-textbooks and supplementary resources provided by publishers, the primary responsibility of lecturers in content presentation seems to be supported, if not partially replaced. This evolution triggers two prominent concerns: firstly, the potential diminishment of the lecturer's unique role, and secondly, the prospective enhancement in teaching quality when e-textbooks are optimally utilised. From a cultural-historical activity theory (CHAT) perspective, it is crucial to consider the cultural and historical aspects of teaching. Certain lecturers perceive e-textbooks as a constraint, feeling a reduction in their agency and autonomy. This sentiment might stem from the sense of control they possess in traditional teaching contexts. Conversely, some lecturers view the incorporation of e-textbooks as a progressive step, leveraging technology to complement and enrich their instruction (Hanson, 2009).

For example, Lecturer 3 elaborate her view regarding e-textbooks and teaching:

> *Just because there's an e-textbook doesn't mean you can stop teaching, lecturing, and explaining what is happening within that topic. Otherwise, there is a disconnect between the students, the lecturer, and the e-textbook. So, you have to make sure that everybody's working together, and the e-textbook contributes to your teaching, but it doesn't take over your teaching.* [Lecturer 3]

Furthermore, Lecturer 2 sheds light on a nuanced challenge: students perceiving lecturers' e-textbook usage as a substitute for active teaching. This speaks to a broader discontent for some students between student expectations, rooted in traditional methodologies, and contemporary teaching objectives.

> *I found that even with my final year students, when you get to chapters that maybe have a lot of theory... And when you direct them to a resource, even if it's a video or something else, the perception that they feel like you're not teaching, you're trying to get away with teaching and you're being lazy, or it's not what they pay for, or those types of vibes, or reactions, or things like that. So I think that might be a disadvantage.* [Lecturer 2]

In the given instance, Lecturer 2 expressed frustration with her experiences. Historically, students were frequently directed on tasks without adequate guidance on effectively managing their individual study and learning routines. The pedagogical approaches adopted became particularly relevant during the challenges posed by COVID-19.

Teaching and learning under social distancing conditions, brought about by the global pandemic from 2020 onwards, brought the case for the use of technology for remote education into focus. The shift to remote teaching and learning made interest in e-textbooks more integral than ever. However, Lecturer 3 captures the essence of the prevailing sentiment:

> *You are kind of influenced by what is happening around you – for example, the fact that e-textbooks are becoming so popular and common. The pandemic where we couldn't teach face to face. So, it definitely changes*

the way you teach and your teaching philosophy because it makes you think about how to make your teaching methods better.

Lecturer 3 acknowledges the influence of external factors, such as the popularity and ubiquity of e-textbooks, as well as the shift to remote teaching during the pandemic. These factors prompted the lecturer to reconsider their teaching methods and philosophy, seeking ways to improve their instructional approaches. In this extract, Lecturer 3 also agreed that e-textbooks changed their teaching philosophy, but did not explain how and what functions e-textbooks fulfilled, or how it helped this lecturer.

This tertiary contradiction emerges from conflict regarding the lecturers' perspectives on the role of e-textbooks in their teaching. While some see e-textbooks as a supplementary tool, others fear the potential overshadowing of their traditional roles. Also, lecturers feel a tension between leveraging the e-textbook's capabilities and maintaining their authoritative and guiding role in the classroom.

Furthermore, this contradiction between the e-textbook and the subject (lecturers) is multi-layered, marked by both conflict and a double bind. While e-textbooks present challenges, they also usher in opportunities for pedagogical innovation. However, for optimal outcomes, it is essential to address student concerns about using the text and effectively communicate e-textbook benefits. The tertiary contradiction *(a)* between mediation means and division of labour focuses on the transformative role of the e-textbook, prompting lecturers to adopt a more active role in designing meaningful learning experiences. Recognising and addressing these tensions can foster a productive integration of e-textbooks within the educational landscape. To resolve this tension requires a balanced approach and professional development, and training programmes can equip lecturers with the necessary skills and strategies to effectively design and facilitate learning experiences that optimise the use of e-textbooks.

7.3.2 E-textbook content

In the following discussion, I explore a secondary contradiction, evident between the subject and the rules within the lecturing activity system. This contradiction manifests as a conflict stemming from the contrasting perspectives, disagreements, and criticisms voiced by the lecturers. The core of the disagreement revolves around the

cultural and contextual content of e-textbooks. Historically, many textbooks, whether digital or paper, have been centred around American and European contexts. As a result, students from diverse backgrounds, particularly from the global South countries[23] like South Africa, often find it challenging to relate to the content. For instance, Lecturer 2 points out:

> *Some of the examples in e-textbooks are American context examples. You need to come up with your own South African* [examples], *or ones that will be easily understood by people who are in our context. But it's a lifesaver because compared to subjects where you don't have an e-textbook, you have to go look for examples in the textbook.* [Lecturer 2]

Lecturer 1 further elaborates on the cultural disconnect:

> *The context in the e-textbook is written mainly for the European side, or they're from America. This might confuse a first-year student. For example, snow and sliding on the snow. I'm in South Africa ... we've never had snow … you've never seen it … if the context of an example is created in such a way that I relate to the context, I formulate meaning from my own language. To translate to English is not an issue, but to start it from there and bring it back to me. And if I cannot relate to those kinds of things, like snow. This will make it very difficult for* [a student] *to get these meanings.*

Such examples underscore the inherent tension within the lecturing activity system. Students are not only required to understand the technical content; they must also navigate unfamiliar cultural references, which adds to the pressure of academic performance.

This cultural misalignment brings up the broader issue of decolonising content. There is a strong push to make educational content more contextually relevant and inclusive. Lecturer 1 and Lecturer 2, although acknowledging the benefits of e-textbooks, emphasise the need for content that resonates with students' lived experiences. Their

[23] The global South countries refer to countries, primarily located in the southern hemisphere, that are characterised as having developing or less developed economies or cultures.

criticisms highlight the challenges e-textbooks present, particularly in their lack of relevance to the local context.

However, it is not just about content relevance. Lecturer 1 provides insights into the potential advantages and challenges of using e-textbooks in the context of teaching and learning:

> *… using an e-textbook, if learners are encouraged to formulate meaning from their own language first, that could really work. That's why our greatest challenge with this e-textbook is that any examples that are from one context can limit understanding.* [Lecturer 1]

While e-textbooks introduce new possibilities for teaching and learning, their current implementation falls short of addressing the embedded contradictions in the lecturing activity system. The challenges highlighted by the lecturers provide valuable insights. By integrating diverse examples and letting students derive meaning from their own language and experiences, e-textbooks have the potential to foster a more profound connection between students and content. Addressing these challenges can harness e-textbooks' potential to alleviate tensions in the system, promising a more inclusive and effective learning experience for all.

7.3.3 Access to technology

The next contradiction introduces tension between e-textbooks and rules (in terms of accessibility and socio-economic factors). The manifestation of this contradiction is a conflict which became particularly evident during the challenges presented by managing remote teaching during the lockdown period of the pandemic, when teaching and learning transitioned to an online activity. Lecturer 2 pointed out in an interview that this unveiled discrepancies in the students' readiness to adopt e-textbooks:

> *There's different levels of marginalisation… if you're looking at the level where some students they* [either] *come from a small town or a good public school or a moderate public school. And they get here, they know how to do basic things, like search on, they've got a smartphone, so they can kind*

> *of figure out from a smartphone to a computer, or they can learn it quickly, then access to an e-textbook is wonderful.*

Lecturer 2 highlights the different levels of marginalisation experienced by students. While some students have prior knowledge and access to technology, making e-textbooks beneficial for them:

> *there's a degree of marginalised students that … have never seen a computer,* [they have] *some smartphones that are considered smartphones, but don't have a PDF* [app], *or don't have space to download. So then giving them access to an e-textbook is not going to do much for them because they still can't access it at all.*

For these students, providing access to e-textbooks does not effectively bridge the gap: "*So in those cases, then making an e-textbook as a resource that they need to use, makes then the gap bigger"* [Lecturer 2], as they are unable to access the materials due to limitations associated with the technology.

Lecturer 1 expands on this narrative by reflecting on the socio-economic disparities among students at the university of technology (UoT):

> *… at* [the UoT] *we teach poor students. So, in that case, they don't have the text itself. So, what was nice about having access to* [publisher of e-textbook] *you have it inside of your device and you can read the text. But at that time, it will never be downloadable, but you have access to it on the system.* [Lecturer 1]

Lecturer 1 refers to the e-textbook which is only accessible within the learning management system of the university and cannot be directly downloaded to students' devices. Additionally, these two lecturers highlight the contradictory perspectives regarding access to e-textbooks and their impact on the socio-economic conditions of students.

A critical juncture in this debate is the introduction of e-textbooks to first-year extended curriculum programme (ECP) students at the institution. Lecturer 1 further elaborated on the challenges faced when e-textbooks were introduced to first-year ECP students. Lecturer 1 had originally believed that subsidising e-textbook costs would resolve accessibility issues, especially for students living off-campus who face challenges with internet access:

> *My motivation was to ensure that I was harmonising my students so that they were all on the same level. So, to be able to pay for that platform, and it is the e-textbook insight that they can read, that at least everyone could have access to the e-textbook.*

However, by resolving the contradiction of equity of access to e-textbooks, a new contradiction was created in the lack of device and internet access as the deeper socio-economic challenges faced by many became evident:

> *My thought was that if I cut the cost, but paid for them, I'd solved the problem. But, in the end, I realised that the impact of data if I had done that and give the student data to those who were staying off campus and were able to enter a small amount of data could have been different, but the fact that there were no laptops was discovered.*

Lecturer 4 resonated with this sentiment, emphasising the inherent challenges:

> *While many students staying in townships, they did not have internet access... They could say, "Sir, we don't have the internet at home, and we don't have this and that we can't use it* [e-textbook]".

Merely providing e-textbooks does not resolve all the underlying issues of technological and socio-economic disparities for South African students: access to digital devices such as smartphones and laptops, as well as the internet and data, pose significant challenges for many students, hindering their epistemological access to knowledge: "*As we mentioned about access, not having access to digital devices*

means not having access to knowledge. As we can see for students previously, this was a major issue." [Lecturer 1]

Despite these challenges, Lecturer 1 made efforts to bridge the gap:

> *I tried to address this when I went to the head of ECP at the time and asked if we could give students in the ECP laptops, and I got a lot of resistance; he said: "We don't want an ECP to be a place where people come in and get what they want."*

However, during the pandemic other institutions started providing computers, and Lecturer 1's foresight and empathy were validated. The lecturer emphasises the existence of resources that were previously refused to be utilised for students.

> *When COVID-19 came through, I looked around and saw that everyone had started giving them computers. I said I'd seen this and I have great empathy. I saw the future before it arrived. We will, as I said, arrive, because I was told that resources existed but people refused to use them.*

Lecturer 1 noted while efforts were made during the COVID-19 pandemic to provide laptops and data, not all students were equally equipped. The provision of necessary tools such as laptops and data helped alleviate some access issues, but significant disparities still exist. A reflection from Lecturer 1 elaborates on this point:

> *I mean,* [during] *COVID time* [moving teaching from the traditional classroom to online teaching and learning] *was the smoothest thing* [because] … *they* [students] *got laptops and data. So, the complaints that I heard at the time were that not everyone has it, so why can't we use* [name of the publisher platform of e-textbook] *for other subjects? Everyone wanted this technology, which meant that the biggest issue … to implement this technology was providing laptops for students.*

Lecturer 4 reiterated:

> *Students were happy to practise with it because they had the institution's data and laptops. So, there were no complaints … Since they* [students] *have been equipped with all the necessary tools like data, laptops, I did not have any complaints.*

Lecturer 2 acknowledged the widespread availability of cell phones and laptops among students, even if they had to rely on internet cafes for internet access:

> *I think, especially in the current times we are in, it affects everybody. Most people have access to a cell phone or a laptop. Some of my students have to go to an internet cafe, but they have access to a laptop or computer to be able to access the e-textbooks, whereas if they didn't have access to e-textbooks, they wouldn't have access to that information.*

A similar view was explained by lecturer 4: "*I'll say an e-textbook ... which is designed for accessibility other than the hard copies located in the library, or a book that is more friendly with digital platforms in terms of cell phones and laptops which can be accessed by students."* They argued that access to e-textbooks indirectly provides access to valuable information that students would otherwise be unable to obtain.

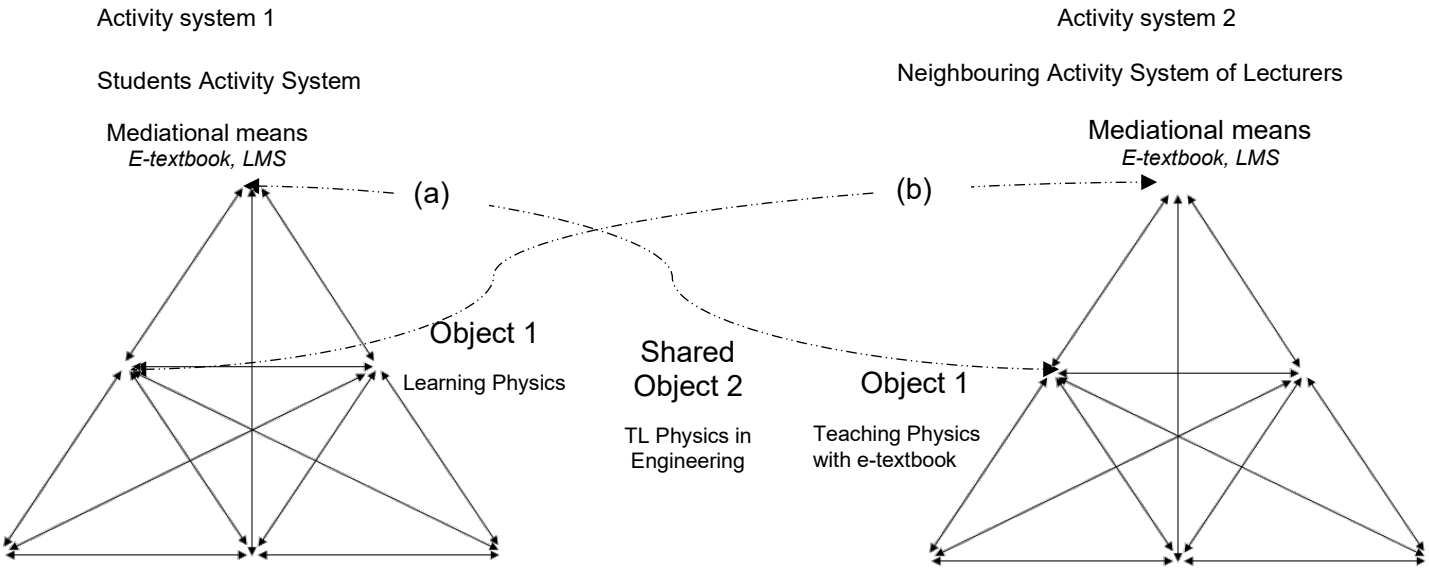
These contradictions, in the form of a conflict, highlight the complexities and challenges of providing equitable access to e-textbooks and digital learning resources. The tensions between mediational means and rules regarding accessibility and socio-economic factors underscore the need for comprehensive strategies and solutions to bridge the digital divide and ensure equal opportunities for all students. The challenge isn't just about providing resources but ensuring they are equitably accessible. This tension between the promise of e-textbooks and the reality of students' circumstances underscores the need for holistic solutions to bridge the existing gaps.

7.4 Discursive manifestation of contradictions between students and lecturers

This chapter has provided detailed discussion of contradictions that manifested as contradictions in the activity systems of students (Section 7.2) and lecturers (7.3). In

this section, I further discuss contradictions raised in the activity system of students (activity system 1) and the neighbouring activity system of lecturers (activity system 2). In other words, I discuss the quaternary contradictions present between these two activity systems, using the third generation of CHAT. In third-generation CHAT, the focus is on interaction between two activity systems through a jointly negotiated object (see Section 3.3 for more information on the different generations of CHAT). One feature of third-generation activity theory is that it uses joint activity as the unit of analysis rather than individual activity (Daniels et al., 2010). To achieve the object and outcome, third-generation CHAT includes subjects and community members with diverse points of view, traditions, and interests. Selecting third-generation analysis allows me to see how participants in this study construct the object of that activity differently and what common contradictions they have which give rise to tensions between these activity systems, in this case in relation to how the e-textbook is utilised.

Figure 7.3 demonstrates the connections between these two activity systems to identify each activity system's object using third-generation CHAT. In Figure 7.3, Activity System 1 is the students' activity and Activity System 2 refers to the lecturers' activity. The object for the students is *learning physics* and for lecturers it is *teaching physics*. However, the shared object 2 is a potentially shared object that is constructed by both activity systems (object 3, *teaching and learning (TL) physics in engineering*). Once both students and lecturers become proficient in using the e-textbook and fully understand its affordances, the focus will shift to the next object (target) of the activity. The object might be different even though there is a shared object for all of the different configurations. They both achieve the same ultimate objective, but the way in which the activity triangle is configured is different depending on the participants involved.



Name of contradiction	Type	Discussion section
(a) Responsibility gap: Who is responsible for explanation on how to operate e-textbook	**Quaternary contradiction** raised tension between mediational means in students' activity and object 1 of lecturers' activity system	Section 7.4.1
(b) Role of reading in teaching and learning of physics	**Quaternary contradiction** raised between subject of students' activity and mediational means of the lecturers' activity system	Section 7.4.2

Figure 7.3: Graphical presentation of quaternary contradictions (a) and (b) between two activities of students and lecturers. These contradictions are presented in the third generation of activity system (Engeström, 1999).

7.4.1 Responsibility gap: Who is responsible for explanation on how to operate the e-textbook?

In Section 7.2.1, the primary contradiction led me to observe a quaternary contradiction between the activities of students and lecturers, as illustrated in Figure 7.3. This figure illustrates a line connecting two activities, labelled *(a)*, signifying this contradiction. The issue arises from a discrepancy between the mediational means (e-textbook) in students' activity and object 1 of the neighbouring lecturers' activity system. This gap highlights a discrepancy between recognising the problem of operating e-textbooks and determining who should be responsible for training students on their usage. The conflict is between the students' need for instruction on e-textbook usage and the lecturers' belief that it is not their responsibility to provide such instruction. As example, Lecturer 2 explains:

> *if I were to add something, I would add that feature, maybe some videos explaining the different features they have, so the student can go on the video, see what it is, know how to do it, and then decide whether or not to use it.* [Lecturer 2]

While some lecturers acknowledge the need for clarity regarding e-textbooks, many do not view this as their responsibility. This mindset presents a significant contradiction. Lecturers believe that publishers should offer videos or tutorials to guide students. The challenge, as noted by several lecturers, lies in the lack of guidance on accessing videos and selecting specific chapters, impeding students from effectively navigating the e-textbook and leveraging its resources. The incorporation of explanatory videos detailing the e-textbook's features was suggested. Such videos would serve as instructional tools, empowering students to understand and decide on the utility of these features.

Lecturer 1 expresses concerns that without proper explanation and guidance, students may not fully benefit from e-textbooks and may resort to simply reading the digital format. This conflict arises from differing views on the instructional support required for students to maximise the use of e-textbooks and leverage their features for meaningful learning:

> *if it's not explained properly to the students, it will not bring the benefits to students for their learning. Students might end up just reading the textbook in digital format.* [Lecturer 1]

Lecturers 1 and 2 shed light related to teaching and learning with e-textbooks. While e-textbooks offer various advantageous features, there is a concern regarding the lack of instructions on how to access videos and utilise specific functions within the platform.

Students expect guidance from their lecturers, while lecturers feel it is the publishers' duty to offer this guidance. A student shared their struggle, stating:

> *I was not familiar with using e-textbook. So, I thought I was going to fail* [physics]. *I was not going to make it because I don't know how to read this book.* [Student 10]

This statement underscores the anxiety and uncertainty students feel owing to their unfamiliarity with e-textbooks. It is not just about understanding the content; the anxiety stems from not knowing how to navigate the e-textbook itself. This situation sparks a larger discussion about creating instructional materials that aid students in transitioning from conventional print reading to digital reading practices. As Lecturer 3 commented:

> *They* [students] *are scared of trying something new. But as soon as they do, it's like, "Oh, this is great. Why haven't I been using it all the time?" So, I think they need an introductory class.* [Lecturer 3]

The main argument here is that merely providing students with tools like e-textbooks is not enough. Their effectiveness hinges on an environment that values and supports their use. Some lecturers and students seem to recognise the importance of clear guidance on e-textbook usage. However, there appears to be a feeling among certain lecturers that addressing this need might not fall within their duties.

7.4.2 Role of reading in teaching and learning of physics

The last quaternary contradiction *(b)* raised tension between the subject of students' activity and the mediational means of lecturers' activity system (see Figure 7.3). This contradiction emerges from a conflict because the core issue is between the intended use of e-textbooks, which emphasises comprehensive engagement, including reading, and the observed behaviour of engineering students who prioritise calculations over reading. This discrepancy between educational intention and student behaviour forms the basis of the conflict.

Lecturer 2's observations provide a window into the academic inclinations of engineering students. Notably, they demonstrate a marked preference for calculations over in-depth reading. This trend might not just be confined to the realm of e-textbooks, but could be symptomatic of a broader educational paradigm. It could hint at an

underlying distinction between abstract, theoretical knowledge and tangible, everyday practical knowledge. One lecturer's statement encapsulates this sentiment:

> *Engineering students generally don't like to read … Generally, they skip over the part that needs reading. And they go straight into the calculations. I don't know why. I think that could be something that can really hinder the implementation of e-textbooks if used inappropriately.* [Lecturer 2]

This predilection might inadvertently hinder the effective incorporation of e-textbooks into the curriculum. Additionally, evidence from Section 6.3 suggests that students often lean towards multimedia content, such as videos, over traditional textual content in e-textbooks, as admitted by Student 14*: "I chose to watch the first video, yeah. I think videos for me; it is mostly listening to videos."* This student starts their engagement with video before they do anything else.

Engineering students typically lean towards solving "real-world" problems and design solutions, which tend to involve calculations, simulations, and hands-on work. This focus on application might lead students to prioritise direct engagement with calculations and problem-solving exercises, which they see as more directly relevant to their future roles as engineers. Consequently, they might perceive reading, particularly theoretical or scientific content, as secondary or less immediately beneficial. This behaviour could reflect a perceived hierarchy of knowledge where applied knowledge is prioritised over theoretical understanding. This distinction might extend beyond e-textbooks to other forms of educational materials as well. However, it is important to note that the relationship between the nature of knowledge and student behaviour can vary based on individual learning styles, teaching approaches, and contextual factors. Educators may need to find ways to bridge the gap between theoretical and practical knowledge, highlighting the importance of both aspects in a comprehensive engineering education.

7.5 Conclusion

In this chapter, I examined the contradictions associated with digital literacy practices in the use of e-textbooks within the South African context. These contradictions were

evident across four levels: primary, secondary, tertiary, and quaternary. They were observed among both student and engineering lecturer participants.

From the students' perspective, several key issues became evident. Firstly, a significant number of students exhibited limited knowledge and understanding of e-textbooks and their functionalities. This lack of awareness was juxtaposed with a strong desire among many to gain unrestricted access to these resources, bypassing the official learning management system (LMS) at the university of technology (UoT). Furthermore, when it came to study habits and preferences, a distinct group emerged who favoured isolation, consciously avoiding the collaborative features embedded within e-textbooks. Such preferences can often be traced to their prior study experiences and habits formed over the years.

On the other side of the spectrum, the lecturers offered their unique vantage point. The advent of e-textbooks has initiated a subtle yet significant shift in their pedagogic and assessment roles. This evolution is a testament to the dynamic nature of education, where the traditional conception of a lecturer's role is constantly being redefined. Another pressing concern raised by the lecturers revolved around the content within e-textbooks. Many observed that the examples within engineering and science e-textbooks, currently available in South Africa, are predominantly drawn from US and European contexts. There's an urgent need for e-textbooks that weave in diverse examples, deeply rooted in local languages and experiences, to foster a richer and more profound connection with the students. Beyond content, the issue of access took centre stage. While the provision of resources is undoubtedly essential, ensuring that these resources are accessible to all, without disparities, is equally, if not more, crucial.

Taking a step back, the third generation of activity analysis provided a broader lens to view these contradictions. I gained insights into the interplay between different participants' activities. The primary contradiction, which underpins many of the subsequent ones, centred on students' requests for clear and explicit instructions on navigating e-textbooks. They seek a bridge to transition smoothly from the familiar terrains of traditional study methods to the unfamiliar landscapes of digital resources. This bridge's construction led to a debate among lecturers, with many asserting that

the onus of explaining the workings of e-textbooks should fall on the publishers or developers, rather than on them. Another noteworthy point was a quaternary contradiction that spotlighted students' inclination to sidestep reading in favour of physics problems set in a "real world" context. This behaviour pattern was explored in greater depth in Chapter 6, where I explored interaction order patterns.

Lastly, from a cultural and historical lens, the rise of e-textbooks signals a paradigm shift. They open doors to novel avenues for learning, both individualistic and collaborative, which were once deemed impossible with traditional paper books. Their integration into the curriculum has given rise to what's termed a "tool-object reversal". This shift not only alters the essence of educational activities, but also introduces a new set of contradictions. As e-textbooks carve a more significant niche in students' daily engagement for academic purpose, the imperative to weave digital tools into the curriculum becomes more pronounced. This integration has the potential to democratise education, making it accessible to those even on the fringes.

Chapter 8
Conclusion

As we know, there are known knowns. There are things we know we know. We also know there are known unknowns. That is to say we know there are some things we do not know. But there are also unknown unknowns, the ones we don't know we don't know. (Donald Rumsfeld, 2002)

8.1 Introduction

The Dalai Lama once said that “whenever there is a challenge, there is also an opportunity to face it, to demonstrate and develop our will and determination”. The fast-changing nature of technology can present challenges for users (students and lecturers), particularly with regard to staying up to date with new features and updates. In the South African context, where resources are limited, these challenges can be even more pronounced. However, the emergence of new technologies such as e-textbooks can also bring new opportunities for teaching and learning, such as the use of multimedia to aid in understanding complex concepts and facilitating collaboration among students.

This study aimed to answer the following question:
How do students and lecturers engage with engineering e-textbooks?

In addition, this was addressed through the following secondary research questions:

- *What digital literacy practices do students employ while using engineering e-textbooks?* (RQ1)
- *How do lecturers deploy engineering e-textbooks as a learning aid in the classroom?* (RQ2)

This final chapter has two main objectives. Firstly, it aims to elucidate the implications of gaining a better understanding of the use of e-textbooks for teaching and learning. Secondly, it seeks to explore and envision the conditions under which the insights from this study can be fully utilised, considering both its practical applications and its

potential for enhancing the teaching and learning experience of students and engineering lecturers.

The three chapters of data analysis (Chapters 5 to 7) have addressed these questions using the lenses of cultural-historical activity theory (CHAT) and mediated discourse analysis (MDA), the theoretical and analytical frameworks adopted herein. The study findings are here drawn together to present overall conclusions concerning the main research question. This last chapter concludes by summarising the three chapters of data analysis and addressing the main research question by suggesting implications that emerge from this study. Below I highlight the results of this case study and discuss their theoretical, methodological and pedagogical implications and limitations. Then I discuss the possible directions for future studies for continued contribution in areas of teaching and learning with e-textbooks, digital literacies and engineering education research.

8.2 Theory and method for understanding the digital literacy practices associated with e-textbooks

To address the research question posed, I incorporated two theoretical frameworks, CHAT and MDA, to study the digital literacy practices associated with reading e-textbooks. I chose these frameworks due to their shared emphasis on situating literacy in context, which allowed me to analyse interactions with e-textbooks. Both CHAT and MDA are established theoretical and analytical frameworks that are extensively used in educational research. They enable the dissection of complex, real-world situations and are particularly adept at understanding the integration of new tools into a curriculum.

The fusion of CHAT and MDA in this study offers detailed insight into digital literacy practices when e-textbooks are employed in teaching and learning. As outlined in Chapter 3, these frameworks possess overlapping concepts, which have furthered our comprehension of social practices, specifically reading. CHAT allows a holistic view of the teaching and learning activity system. It illustrates the ripple effects that the introduction of e-textbooks, as a new mediational means, has on this system. MDA, on the other hand, allows an analysis of the interaction orders and sites of engagement

linked to specific digital literacy practices associated with e-textbooks (as detailed in Chapter 6). Together, these frameworks provided a rich tapestry of understanding concerning digital literacy practices in the realm of e-textbooks.

Building on the foundational works of Vygotsky, Leont'ev, and Engeström, both CHAT and MDA have been instrumental in this research. Chapter 3 elaborates on their principles and the unique tool of contradiction analysis, which facilitates the study of evolving practices over time. The transformation of pedagogical practices, especially with the integration of tools like e-textbooks, was observed. The findings were then interpreted via CHAT and MDA, visualising teaching and digital literacy practices within an activity system framework.

From a methodological standpoint, participants were sourced from two embedded units at a university of technology (UoT): Chemical Engineering and Maritime Studies. The student participants consisted of 12 first-year engineering students enrolled in an Extended Curriculum Programme (ECP), complemented by four engineering lecturers from the same university. Although the sample size may appear modest, qualitative research does not always require large samples, as noted by Mason (2010). In fact, Creswell (2012) suggests a range of three to ten for case studies, which aligns with my chosen sample size.

In this case study, the focus was on digital literacy practices observed during students' interactions with e-textbooks. Multiple data sources were utilised over a six-month period, including interviews, group discussions, think-aloud protocols, checklists, and observations. Before commencing data collection, all instruments underwent a pilot-testing phase. The subsequent data analysis employed both inductive and deductive approaches, with the assistance of ATLAS.ti 23, a qualitative data analysis software package. This tool streamlined the process, ensuring systematic data organisation and interpretation.

The initial phase of analysis was inductive, where I combed through transcripts to identify intriguing and pertinent data segments. This inductive coding paved the way for the unearthing of fresh insights directly from the data. Following this, a deductive lens was employed, leveraging CHAT's concepts as guiding pillars for the analysis.

This allowed for a more concentrated and theory-driven examination of the data. Throughout this analytical journey, ATLAS.ti 23 proved invaluable, facilitating an organised and in-depth exploration of the data's intricate layers.

8.3 Summary of findings

Digital literacy practices for reading are still developing, and the development of e-textbooks is in its early stages in the context of South Africa. Throughout Chapters 5 to 7 of this study, it was observed how students engaged in specific digital literacy practices while reading, and how lecturers used e-textbooks for teaching. In Chapter 5, I explored the digital literacy background students brought to higher education and their prior exposure to technology before they entered university. The findings revealed that many first-year students had limited access to technology. According to the findings presented in Chapter 5, the majority of the students in the study sample had no formal computer-related education in school, and their interactions with technology were mostly for leisure purposes. This hints at a potential challenge during their transition to university, especially in integrating technology into their academic routines.

In the latter part of Chapter 5, the focus shifted to four engineering lecturers, interrogating their respective roles, prior experiences, and familiarity with e-textbooks. They unanimously acknowledged the benefits of e-textbooks in teaching and learning. They emphasised the need for interactive and engaging teaching methodologies in their classrooms. The findings indicate that all of the interviewed lecturers highly value the availability and presentation of e-textbooks as valuable resources for teaching and learning. Furthermore, they shared a common perspective on adopting an interactive and engaging teaching philosophy in their classes.

Chapter 6 addressed the multifaceted engagement of students with e-textbooks, specifically those on physics. A key point of inquiry was the various affordances students leveraged when interacting with these digital resources. Affordances, in this context, refer to the unique features and capabilities of e-textbooks that facilitate and enhance learning. The depth of student interaction with e-textbooks was found to be

significantly influenced by their prior familiarity with these affordances and their established reading practices.

During the study, it became evident that students were not mere passive consumers of information. Instead, a subset of the participants adopted emerging digital literacy practices. For instance, they engaged with embedded videos to grasp complex concepts, utilised emojis to annotate and personalise their readings, and employed the highlighting feature to emphasise crucial points. Nonetheless, the degree of engagement varied among students. While some demonstrated a deep interaction with the content through the use of e-textbook affordances, others exhibited a more superficial level of engagement.

Upon further analysis, the level of engagement and the choice of affordances did not differ significantly across participants at first glance. This suggests a uniformity in digital literacy practices among students. However, upon deeper examination, nuances emerged. Students exhibited a spectrum of approaches in their e-textbook interactions. Some were well versed and comfortable with the plethora of e-textbook features, while others were still attempting to adjust. These varying levels of familiarity and comfort were grouped into four distinct categories for a more granular understanding.

One of the findings of this study was the underutilisation of e-textbooks' collaborative functions. E-textbooks enable collaborative digital reading experiences, with features like shared annotations and highlighting. Discussions with students illuminated the potential of online collaboration in higher education through these affordances. Yet, their actual usage was sparse. This limited engagement can be attributed to several factors. For example, the e-textbooks had not yet been integrated into the broader curriculum. Their introduction was still in its nascent stages, as discussed in Chapter 5, meaning students were still navigating the transition from traditional textbooks to this digital format.

One of the overarching themes of Chapter 6 was the learning curve associated with e-textbooks. Students expressed the need for a dedicated orientation phase, which would allow them to familiarise themselves with the nuances of e-textbooks. Such an orientation could significantly amplify the educational benefits of these digital tools.

During interactions, students appreciated features like the “read-aloud” function. Their feedback also highlighted how e-textbooks, especially in the absence of a lecturer, bolstered autonomous learning through their media affordances. However, a recurring sentiment was the plea for unrestricted access to these e-textbooks, ensuring equitable learning opportunities for all. There appears to be a lack of awareness among students regarding the existence of licensing agreements with publishers, which stipulate the terms of use. These agreements often restrict the use of materials, contrary to the students' expectations for unrestricted access.

The chapter underscored the importance of taking into consideration diverse student voices, particularly from lower socio-economic backgrounds, during the e-textbook development phase. These students often face obstacles such as limited access to necessary devices and internet connectivity, as well as a lack of exposure to computer-related subjects prior to their university education. The study revealed that e-textbook access was largely confined to the learning management system (LMS) adopted by the institution. This posed challenges. Furthermore, it is critical to acknowledge that publishers' enforcement of licensing agreements with universities is primarily driven by economic objectives. These agreements, while serving commercial interests, may inadvertently contribute to the difficulties faced by students with fewer resources, thus impacting the equitable utilisation of e-textbooks.

From the findings, e-textbooks can be potential tools for inclusivity. Discussions with students and lecturers revealed that these digital resources could be instrumental in integrating students who had previously been marginalised in higher education. The diverse features of e-textbooks provide students, even those with special educational needs, the means to engage deeply, ask pertinent questions, share insights, and co-create knowledge. This is a marked departure from traditional paper books, which often overlook the unique needs of this community.

Chapter 6 also investigated the lecturers' responses, exploring their understanding of and interactions with e-textbooks, as identified through a series of interviews. The findings indicate the emergence of consistent pedagogical patterns, notwithstanding an initial lack of clarity regarding the affordances and potential of e-textbooks among the lecturers. As discussions progressed, the lecturer participants achieved a deeper

understanding of the affordances offered by e-textbooks and became more familiar with their functionalities. The chapter concludes by underscoring the critical need for lecturers to fully understand the capabilities of e-textbooks prior to recommending their integration into curricula. Such an understanding is imperative for aligning e-textbook features with diverse learning styles and pedagogical objectives.

Chapter 7 has a focus on the principles of CHAT. This perspective allows for a nuanced examination of e-textbook engagement, moving beyond mere description and instead, examining the complexities of student and lecturer interactions with e-textbooks. A pivotal focus of this chapter is the exploration of contradictions arising from the integration of e-textbooks into educational systems. Every activity of students and lecturers is driven by an object or purpose. The introduction of a new mediational tool, like e-textbooks, can either amplify or hinder the attainment of this object. As students and lecturers navigate these tools, their objectives and interactions evolve, leading to shifting dynamics that are intricate and often unpredictable.

The chapter provided in-depth discussion of the second generation of CHAT's contradiction analysis, highlighting the ripple effects e-textbooks exert on various elements of the broader educational system. It investigated how participants perceive e-textbooks and the accompanying digital literacy practices. By analysing the educational system holistically, the chapter presented specific student needs and challenges. This analysis was then juxtaposed with an examination of individual student activities, fostering a comprehensive understanding. The inherent tensions and contradictions within the learning activity and among CHAT concepts are emphasised, underscoring the ever-evolving nature of the educational landscape.

Chapter 7 dissected high-level contradictions between student and lecturer activities using second and third generation of activity system analyses. A key finding was the perception of e-textbooks by some students as potential replacements for lecturers. Conversely, some lecturers expressed apprehensions about becoming overly reliant on e-textbooks, highlighting the delicate balance needed in their pedagogical approach. Chapter 7 shed light on the essential skills students need to harness e-textbook affordances effectively. It underscored the potential pitfalls of assuming a seamless transition to digital literacy practices, especially in developing countries. The

transition to digital literacy in these countries can be challenging owing to limited technological infrastructure, economic constraints, educational resource limitations, the digital divide, and potential cultural resistance to new technologies. The chapter also introduced the concept of “tool-object reversal”, evident from the voices of students and lecturers. This phenomenon points to the disruptions and tensions a new mediational means, like e-textbooks, can introduce, altering the core objectives of the educational activity system, where the focus of the student effort shifts from engaging with the physics concepts to mastering the affordances of the e-textbook.

Additionally, Chapter 7 offered a close examination of lecturers' pedagogical practices concerning e-textbook incorporation. While all interviewed lecturers resonated with an interactive pedagogical approach, the specifics of their interactions varied, influenced by factors like student demographics, contextual nuances, and subject matter. The chapter culminates by underscoring the transformative potential of e-textbooks. They not only serve as tools for content delivery, but also as catalysts for professional development for lecturers, ushering in innovative pedagogical strategies.

To conclude, this study contributes to understanding the digital literacy practices, student engagement, and pedagogical practices associated with e-textbooks (refer to Figure 8.1). It emphasises the importance of considering the contextual embedding of teaching and learning and the need for ongoing exploration in these under-researched areas.

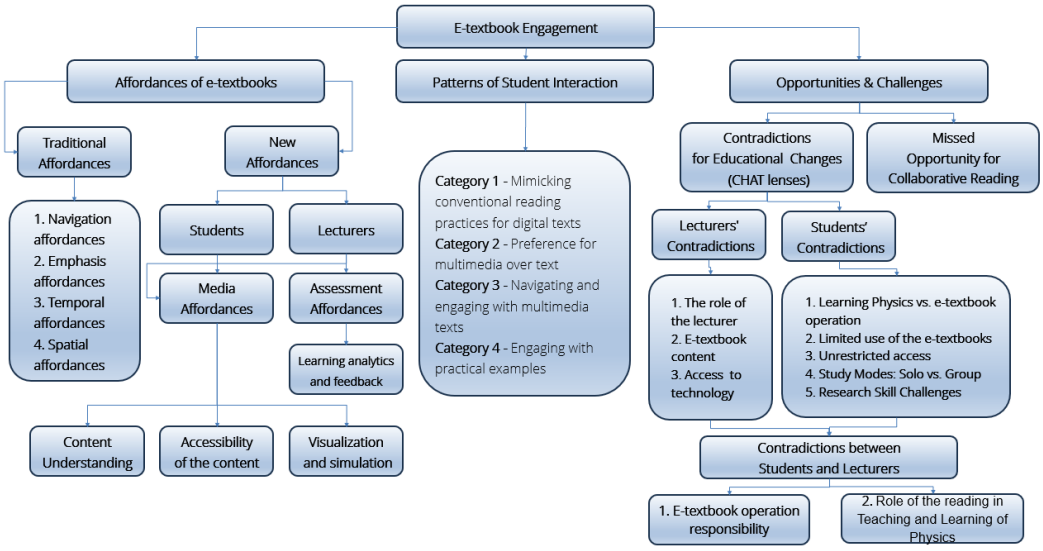


Figure 8.1: Digital literacy practices of engineering students and lecturers using e-textbooks at a university of technology in South Africa

8.4 Implications

Future engineering students, lecturers, instructional designers, librarians and other members of the engineering faculty are all challenged to create educational spaces that foster richness of student participation and interaction, taking into consideration both their current practices and their potential. Such learning environments must be open to the possibilities of new digital literacy practices for reading academic texts. This study was not about creating new solutions but on understanding existing current digital literacy practices with e-textbooks and their challenges. The findings from Chapter 7 illuminated the contradictions present in the implementation of e-textbooks within the South African educational system at a specific university of technology.

In the educational spaces shared by engineering lecturers and students at a university of technology in South Africa, there exists a disparity between the current literacy practices and the practices that are actively encouraged and acknowledged. This discrepancy results in the suppression of existing literacy practices that are already prevalent among the individuals involved. In analysing this data, I attempted to highlight the major mediated actions occurring in students' digital literacy practices and lecturers' use of e-textbooks as a pedagogical tool. This thesis examines the integration of digital literacy practices with e-textbooks at the university of technology,

and the subsequent sections discuss the potential theoretical and methodological, implications for South African higher education and the need for training of students and lecturers.

8.4.1 Theoretical and methodological implications

This thesis contributes to the existing body of knowledge within the realms of CHAT and MDA. The approach in this study involves the integration of these two theoretical frameworks, allowing for a comprehensive analysis of the data collected from both students and lecturers. By merging these analytical frameworks, I was able to gain unique insights into educational activities and identify the contradictions which create tensions that emerged when e-textbooks were introduced. Additionally, I examined how the mediational means of e-textbooks influenced the new patterns of interaction in student engagement. By selecting these theoretical frameworks, I was able to put their conceptual frameworks to use to effectively interpret the findings. The combination of CHAT and MDA facilitated a nuanced exploration of the complexities surrounding e-textbook integration in educational settings, shedding light on the various factors influencing the educational activity system.

Utilising the concept of contradiction from CHAT has been instrumental in understanding the dynamics of e-textbooks implementation and the engagement patterns of both students and lecturers. My analysis focused on the contradictions within the activity systems of study participants. Central to this analysis was the primary contradiction, evident in discussions between students and lecturers, which subsequently revealed other contradictions.

This primary contradiction exists between the use value and the exchange value of the object within an activity system. In the context of e-textbooks, this contradiction is manifested in the juxtaposition of their use for epistemological development against their exchange value in terms of digital literacy practices, such as curating trustworthy resources and, in some cases, their limited use. By identifying this primary contradiction, I gained insights into its impact on teaching and learning processes. For instance, students often find that accessing e-textbooks is not as user-friendly as expected, primarily due to licensing requirements and the need to navigate through

the LMS. Lecturers also noted that students' limited access to digital devices and lack of proficiency in using e-textbooks for learning further restricts their effective use. Recognising this primary contradiction has been key to understanding the challenges faced by students and lecturers in adapting to e-textbooks. It highlights the complex interplay between technological access, digital literacy, and the institutional structures that shape educational experiences with digital resources.

It is essential to acknowledge that the study's scope did not directly evaluate how well e-textbooks facilitated student learning and understanding of concepts. However, the insights gained from this research provide a solid foundation for future investigations into the learning outcomes associated with e-textbook usage, leveraging the theoretical frameworks that have been established in this study. Additionally, this study enhances our understanding of the interplay between CHAT and MDA by integrating these two theories to analyse data from students and lecturers. The perspectives offered by these theoretical frameworks shed light on educational activities, contradictions, and new patterns of interaction in the context of e-textbook usage. While the study did not directly assess learning outcomes, the findings provide valuable insights for future research endeavours focusing on the impact of e-textbooks on student learning, drawing upon the well-established theoretical concepts of CHAT and scaffolding within the zone of proximal development (ZPD).

8.4.2 Implications for South African higher education

This study marks a contribution to the field of digital literacy practices, nested within the broader domain of New Literacy Studies. Within the context of South Africa, and extending to other developing countries, one of the paramount challenges is stark inequality between many Grade 12 school learners, especially from marginalised backgrounds, who have limited access to university resources, a concern highlighted in Chapters 1 and 7.

The core research problem this thesis seeks to address revolves around the digital literacy practices of engineering students. This focus emerges from the pressing inequalities evident within the South African educational landscape. Even when first-year students gain university access, these prevalent inequalities can inhibit their academic progress, especially concerning e-textbook usage. Such findings

underscore the urgency for universities to ensure all students, irrespective of socio-economic backgrounds, have equal epistemic and social access to e-textbooks. This would encourage a move towards equitable learning landscapes. Potential strategies include offering access to e-textbooks or subsidising digital device purchases to alleviate the inequality burden.

Although the research is based on a small-scale case study, its findings may have broader relevance that extends beyond the South African context. The insights from this study can inform the process of e-textbook curriculum integration in such countries, guiding efficient implementation and decision-making. The pandemic has accelerated the need for a pivot in educational technology, necessitating a deeper cultural shift in its adoption. Some of the students have shown a need for collaborative learning experiences, emphasising shared knowledge construction.

The effectiveness of e-textbooks lies in their active utilisation by students and their design that fosters student engagement. Constructivist pedagogy, characterised by interactive learning, emerges as crucial. The interplay between innovative learning methods and emerging technologies can be transformative. To harness the full potential of such technologies, there is a pressing need for developers and practitioners to equip students with the requisite skills for their optimal use. Collaboration between librarians and education technology units can play a pivotal role in addressing these challenges and amplifying students' digital literacy skills. This study indicated that there is a need for greater focus on the induction process into technology for students, as the current dissatisfaction among them underscores the inadequacy of the existing orientation programmes.

It is noteworthy that the lecturers involved in the study highlighted the adaptability of e-textbooks to cater to varied student learning styles. This adaptability emerges as a defining difference between traditional paper texts and e-texts, suggesting implications for the broader South African educational landscape.

This research has illuminated the intricacies of digital literacy practices concerning e-textbooks in South African higher education. It underscores the need for a holistic approach in educational technology, moving beyond sole reliance on single tools like

e-textbooks. By assimilating these insights, transformative education becomes achievable, addressing the inherent inequalities plaguing South Africa and other developing nations.

8.4.3 The need for training for students and lecturers

According to interview transcripts with students, students were engaged and motivated to develop novel ways of studying, specifically reading and making summary notes for practising problem solving. E-textbooks served as a facilitator of students' learning. According to the findings of this study, e-textbooks provide interactive capabilities and digital affordances that are not possible with printed text, such as the use of read-aloud functions and multimedia affordances. As Chapter 6 demonstrated, e-textbooks enable collaborative learning at any time and in any place. However, owing to a lack of knowledge of digital literacy practices and e-textbook affordances, some students in this study did not use the collaborative functions of the e-textbook. Students expressed a desire to make use of online collaboration with other students. A significant finding in this study is the lack of or limited knowledge of how to use e-textbooks.

Becoming a confident lecturer and e-textbook user, similar to other professional learning and development, is not a linear trajectory from novice to expert. It requires lecturers to move backwards and forwards, altering their practices in a dynamically changing world. The lecturers should have professional training to improve their practices and adjust to the new environment. The findings of this study also highlighted the need for better training on how to teach students to effectively utilise the affordances of e-textbooks for learning. This need was expressed strongly from the perspectives of both students and lecturers. To address this, it is recommended that students and lecturers receive training on e-textbooks in general, as well as specific training on how to study with e-textbooks. Only then will students be able to seamlessly utilise the affordances of the e-texts and engage fully with the content of the subject, instead of focusing attention on the functionality and features of the mediational means. In addition, lecturers should receive more specialised training on assessment and feedback to promote formative assessment for learning and other pedagogical strategies aimed at improving conceptual understanding.

The findings of this research have significant implications at policy level, particularly for policymakers involved in shaping educational practices. The study highlights the potential of e-textbooks to support the development of training models and policies that foster the effective utilisation of technology by students. By incorporating the insights gained from this research, policymakers can make informed decisions and design strategies that promote optimal integration of e-textbooks in educational settings.

8.5 Limitations

During this study I was able to investigate the students' digital literacy practices and how they interact with e-textbooks by looking at the affordances of e-textbooks that they utilised and what interaction order they applied. However, I did not look at the actual impact of e-textbooks on student understanding of concepts. This could be done by including evidence such as assessments to evaluate student understanding. Since conceptual understanding was not measured, this can be considered as a possible weakness of this study and can be addressed in future research.

This study is a small, qualitative case study with two embedded units: four lecturers from the chemical engineering and maritime studies departments and 12 engineering students from the same departments participated in this study. This is a small sample, and the findings should be interpreted accordingly. The case study approach does not seek to generalise. The interpretive nature of the study implies the application of analysis techniques aimed at resonance rather than generalisation of results, limiting the applicability and transferability of findings to other engineering departments and higher education institutions.

It was evident from the findings of Chapter 5 that it is quite likely that more experienced and confident users of technology volunteered to participate in this study. This may have skewed the findings. However, the research findings are useful for higher education institutions and engineering educators, because they present cultural and historical contradictions in students' and lecturers' usage of e-textbooks as well as the discursive manifestation of these contradictions that influence students' reading of e-

textbooks. Other important stakeholders in higher education need to pay attention to this before implementing e-textbooks as part of the engineering curriculum.

In considering these findings, it must be acknowledged that the data were collected from a single institution with a particular type of LMS in which physics e-textbooks from two publishers were embedded. The student participants were all enrolled in a first-year physics course that formed part of their engineering degree at a university of technology in South Africa, which perhaps limits the generalisability of this study's findings. This is something that demands further investigation. It is hoped that new studies in different contexts will continue to explain the digital literacy practices of students when reading and interacting with e-textbooks.

The analysis process comprised theoretically based analysis of literature sources followed by subsequent analysis of empirical data. It is important to mention that, methodologically and theoretically, this study did not draw on expansive learning methodology or fourth-generation CHAT, since the purpose of this study was to investigate digital literacy practices of reading e-textbooks whereas expansive learning involves examining and implementing a new solution, which was not the goal of this study.

The availability of digital devices can vary across different contexts. Owing to the limited access to digital devices among many university of technology (UoT) students, their experience in studying with such devices is also limited. Consequently, the same activity may elicit different responses from students in contexts where there is more exposure to technology and digital resources. It is important to note that these findings may have limited generalisability due to the specific context and access constraints. Additionally, it was not feasible to directly observe how participants read from digital devices and utilised applications in their personal learning environments. The data collected for this study could only be interpreted based on the responses received from participants.

Opinions and attitudes towards technology can vary among engineering students and lecturers, reflecting their individual preferences and experiences. The perceptions expressed by participants in this study may be influenced by the digital devices they

have access to, as well as their capabilities and other factors such as budget constraints and accessibility. It is important to acknowledge that personal factors can shape their views on technology.

It should be noted that this study was conducted within a specific timeframe, and technology is constantly evolving. New affordances and features of e-textbooks may emerge over time, which could impact readers' experiences and perceptions. The study's findings are limited to the existing affordances available during the research period. Additionally, it is worth considering that the study focused on providing readers with a uniform digital literacy framework for reading from e-textbooks. The exploration of other aspects related to technology and their impact on learning may provide further insights and enhance the understanding of digital literacy practices.

8.6 Directions for future studies

Some of the directions and recommendations have been mentioned in this chapter earlier. However, in this section, I shall discuss some important findings that have great potential for future investigation in the education and engineering education fields. This project investigated the digital literacy practices of students and pedagogical practices of lecturers associated with e-textbooks. This study did not use multiple participants who might be involved in e-textbooks, such as learning designers, publishers, authors, librarians and even different universities who embed e-textbooks in their curriculum. These participants can contribute to understanding e-textbooks from development to implementation. As a suggestion, these investigations can be done via Change Lab expansive transformation methodology (Engeström, 2001).

As mentioned, this study was situated at one UoT in South Africa. Perhaps in future a similar study could be done in traditional and comprehensive universities in different regions of South Africa for the collection of more data for comparison and making recommendations. My other suggestion for future study is to have a longitudinal study with a bigger sample size and use of a mix of approaches for data collection and analysis. It would be interesting to track changes in the digital literacy practices as students move beyond their first year of study and become more familiar with technology and affordances offered. Another possible way to take this study further is

to develop the coding schema to analyse new sets of data in conjunction with CHAT and MDA concepts in order to further study digital literacy practices of other publishers, course disciplines, and pedagogical practices. This coding scheme can be transferred to another project as a codebook in any QDA software which is supported by theoretically derived practices associated with e-textbooks that connect the high-level CHAT and MDA concepts. This coding structure, which can transfer, adjust, and develop based on the research question, contributes to knowledge in the engineering education, physics, and education research communities.

Despite the limitations identified in Section 8.5, this study still provides valuable insights into the digital literacy practices of engineering students, engineering lecturers and engineering education research using e-textbooks. However, researchers and educators need to be aware of the limitations of the research design and analysis when interpreting the findings and applying them in educational contexts. Future research can be done by looking at the educational system of students, lecturers, and developers of e-textbooks.

This study focused on first-year Extended Curriculum Programme (ECP) engineering students and four engineering physics lecturers. This means the focal point largely excluded other engineering lecturers. A recommendation for future studies would be to conduct a more in-depth analysis of the interaction and implementation of e-textbooks by engineering lecturers. This would further contribute to our understanding of pedagogical practices in the digital world and provide valuable insights into how e-textbooks can be effectively integrated into engineering education. By exploring the specific challenges, successes, and strategies employed by lecturers in utilising e-textbooks, future research can offer comprehensive recommendations and guidelines for enhancing pedagogical practices in the digital era.

The purpose of this study was not to measure student understanding while they were reading physics concepts in e-textbooks. Therefore, future research should be on direct assessments of student understanding and how e-textbooks can develop conceptual understanding of complex engineering concepts to improve teaching and learning. This research can be done by using mixed-methods data collection and

analysis. Scholars and practitioners can collect data in the form of learning analytics collected from the e-textbook and Learning Management System.

Another suggestion is that the participants in this study did not demonstrate use of some affordances such as collaborative annotation. This should be investigated in future studies on collaborative learning with e-textbooks. For such investigation, researchers can use multimodality as a theoretical and methodological approach.

This study's findings suggest that lecturers and students demonstrate differential digital literacy skills and practices, as well as personal preferences for the use of e-textbooks as learning tools in the higher educational context. Digital differences and diversities should be explored in future research.

Another possible direction for future study is to test the framework of universal design for learning (UDL) (Meyer et al., 2014) on learning with e-textbooks for learners and students with special educational needs (Nikolić, et al., 2022). The principles of UDL, such as representation of text in different formats and accessibility for students, are covered by e-textbooks. Teaching and learning is no longer linear – it is rhizomatic and is moving away from regimentation and one size fits all towards personalisation.

As mentioned, there are various possible future studies and directions that can further improve our understanding of e-textbooks, digital literacy practices, and the development of a niche in the literature on engineering education for engineering practitioners, scholars, and community grassroots-level initiatives.

8.7 Conclusion

E-textbooks have undeniably redefined learning and pedagogical approaches in higher education. Their rising prominence in tertiary education sectors, not only in South Africa but globally, can be attributed to their advanced affordances, especially pronounced in science, technology, engineering and mathematics (STEM) subjects, that transcend those of traditional paper books. Feedback from lecturers, as gleaned from interviews, underscores the potential transformative impact of e-textbooks on pedagogical practices. These digital resources, alongside their developers, wield

profound influence over student learning, further evidenced by learning analytics which offer invaluable insights into student engagement, paving the way for timely interventions.

The methodological underpinning of this thesis, detailed in Chapter 4, relied on a qualitative analysis facilitated by ATLAS.ti 23, a computer-supported qualitative data analysis software (CAQDAS). This methodology not only enriches the existing methodological repository in educational technology research, but also ensures the rigour of this study. By blending a comprehensive literature review with a case study approach, this research synthesises theoretical insights with empirical findings.

The study's significance goes beyond academic contributions; it holds substantial real-world relevance. By examining the interplay between e-textbooks, digital literacy practices, and STEM education, it addresses a pivotal niche. I envision this thesis as a catalyst, prompting further scholarly and practical exploration into e-textbooks. In our progressively digital era, understanding e-textbooks is paramount, and it is my aspiration that this research ignites further inquiries in the domain.

The implications of this research are important. It accentuates the imperative of grasping digital literacy practices and their intertwined relationship with e-textbook adoption, especially against the backdrop of South Africa's digital access challenges. While strides are being made towards digitalisation, inequalities remain deeply entrenched in many developing nations, including South Africa. To genuinely harness technology's transformative potential in education, a holistic digital education framework is vital. This research underscores the profound impact of existing socio-economic disparities on first-year students' academic trajectories, even when equipped with e-textbook resources. It calls on policy-makers, educators, and stakeholders to heed the insights and conceptual frameworks this study presents. In doing so, they can pave the way for transformative educational practices that address the deeply rooted challenges discussed herein.

In conclusion, if we, as educators, aim to bring about meaningful change in engineering education, contradiction analysis may be useful. By examining the contradictions evident in discussions with various educational stakeholders, we can

pinpoint areas needing development and improvement. This study offers insight into the digital literacy practices within a university of technology (UoT) in South Africa. It provides a comprehensive understanding that future educators and policymakers should consider when contemplating the integration of new tools, such as e-textbooks.

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Appendix A: Informed Voluntary Consent Form

DEPARTMENT OF ELECTRICAL ENGINEERING

UNIVERSITY OF CAPE TOWN		RESEARCHER:	EKATERINA RZYANKINA
PRIVATE BAG X3		TELEPHONE:	+27-21-650 XXXX
RONDEBOSCH	7701	E-MAIL:	RZYEKA001@myuct.ac.za
SOUTH AFRICA		MAIN SUPERVISOR:	DR Renee Smit
		E-MAIL:	renee.smit@uct.ac.za

Informed Voluntary Consent Form For Audio-Taping Think-Aloud Study And Interview

Project Title

Digital literacy practices of engineering students using e-textbooks at a university of technology in South Africa

Invitation to participate, and benefits: Recently, you participated in a questionnaire, on the use of e-textbooks. On the basis of your responses in the questionnaire, you have been selected and invited to participate in phase 2 of a research study conducted with students. The study aim is to explore the use of e-textbooks (digital textbooks) in engineering. I believe that your experience would be a valuable source of information, and hope that by participating, you might gain useful knowledge about digital literacy practice when you are reading e-textbook. Data gathered from your participation will be used in the researcher's thesis, academic journal articles, conferences.

Procedures: During this study, you will be asked to read from a digital screen, and you will be asked to participate in a think-aloud study. After the think-aloud study, you will be invited for a short follow up interview about your reasoning and strategies during the reading task.

Photographs and/or Recording: We may take photographs and/or record audio as part of the study. These will be used as part of the evidence for this study. If you object to this, please indicate below. The individuals in the photographs will be not labelled by name and faces and any identifying features will be distorted. If you object to taking any photographs and/or recording, please indicate below.

Risks: No potential harmful risks for participation in this study have been identified. The think-aloud study and individual interview should not take more than 1hour 30 minutes for participants. This study on e-textbooks is related to your current subject. By participating in this study, you might enhance your learning in this subject.

Feedback: You will receive feedback about the results of this research. The researcher will contact you electronically to share the results.

Costs and Payment: None

Disclaimer/Withdrawal: Your participation is completely voluntary, and you may withdraw at any time without having to state a reason and without any prejudice or penalty against you. Should you choose to withdraw, the researcher commits not to use any of the information you have provided without your signed consent.

Confidentiality: All information collected in this study will be kept private in that you will not be identified by name. Confidentiality will be maintained as pseudonyms will be used.

Name of Researcher	Signature of Researcher	Date

What signing this form means: By signing this consent form, you agree to participate in this research study. The aim, procedures to be used, as well as the potential risks and benefits of your participation, have been explained to you in detail, using this form. Withdrawal to participate in this study at any time will have no effect on you in any way. You are aware that no benefits will accrue to you in the form of remuneration as a result of your participation in this study.

You give permission for the researcher to use the data generated in her thesis, academic journal articles, and conferences provided that I will not be identified.

You are free to contact me (rzyankinae@cput.ac.za or 0214405758), to ask questions or request further information, at any time during this research.

I agree to participate in this research (tick one box) ☐ Yes ☐ No _____

(Initials)

I agree to be photographed ☐ Yes ☐ No _____

(Initials)

I agree to be part of a think-aloud study ☐ Yes ☐ No _____

(Initials)

I agree to be audio-recorded ☐ Yes ☐ No _____

(Initials)

_____	_____	____
Name of Participant	Signature of Participant	Date

Appendix B: Informed Voluntary Consent Form

DEPARTMENT OF ELECTRICAL ENGINEERING

UNIVERSITY OF CAPE TOWN
PRIVATE BAG X3
RONDEBOSCH 7701
SOUTH AFRICA

RESEARCHER: EKATERINA RZYANKINA
TELEPHONE: +27-21-650 XXXX
E-MAIL: RZYEKA001@myuct.ac.za
MAIN SUPERVISOR: DR Renee Smit
E-MAIL: renee.smit@uct.ac.za

Informed Voluntary Consent Form For Audio-Taping Think-Aloud Study And Interview

Project Title

Digital literacy practices of engineering students using e-textbooks at a university of technology in South Africa

Invitation to participate, and benefits: Recently, you participated in a questionnaire, on the use of e-textbooks. On the basis of your responses in the questionnaire, you have been selected and invited to participate in phase 2 of a research study conducted with students. The study aim is to explore the use of e-textbooks (digital textbooks) in engineering. I believe that your experience would be a valuable source of information, and hope that by participating, you might gain useful knowledge about digital literacy practice when you are reading e-textbook. Data gathered from your participation will be used in the researcher's thesis, academic journal articles, conferences.

Procedures: During this study, you will be asked to read from a digital screen, and you will be asked to participate in a think-aloud study. After the think-aloud study, you will be invited for a short follow up interview about your reasoning and strategies during the reading task.

Photographs and/or Recording: We may take photographs and/or record audio as part of the study. These will be used as part of the evidence for this study. If you object to this, please indicate below. The individuals in the photographs will be not labelled by name and faces and any identifying features will be distorted. If you object to taking any photographs and/or recording, please indicate below.

Risks: No potential harmful risks for participation in this study have been identified. The think-aloud study and individual interview should not take more than 1hour 30 minutes for participants. This study on e-textbooks is related to your current subject. By participating in this study, you might enhance your learning in this subject.

Feedback: You will receive feedback about the results of this research. The researcher will contact you electronically to share the results.

Costs and Payment: None

Disclaimer/Withdrawal: Your participation is completely voluntary, and you may withdraw at any time without having to state a reason and without any prejudice or penalty against you. Should you choose to withdraw, the researcher commits not to use any of the information you have provided without your signed consent.

Confidentiality: All information collected in this study will be kept private in that you will not be identified by name. Confidentiality will be maintained as pseudonyms will be used.

Name of Researcher	Signature of Researcher	Date

What signing this form means: You agree to participate in this research study by signing this consent form. The purpose, procedures to be followed, as well as the potential risks and benefits of your participation, have all been thoroughly explained to you via this form. You will have no effect if you choose not to participate in this study at any time. You are aware that you will receive no monetary compensation as a result of your participation in this study.

You grant the researcher permission to use the data generated in her thesis, academic journal articles, and conferences as long as I am not identified.

You are welcome to contact me (rzyankinae@cput.ac.za or 0214405758) at any time during this research to ask questions or obtain additional information.

I agree to participate in this research (tick one box) ☐ Yes ☐ No _____

(Initials)

I agree to be photographed ☐ Yes ☐ No _____

(Initials)

I agree to be part of a think-aloud study ☐ Yes ☐ No _____

(Initials)

I agree to be audio-recorded ☐ Yes ☐ No _____

(Initials)

_____	_____	_____
Name of Participant	Signature of Participant	Date

Appendix C: Informed Voluntary Consent Form

DEPARTMENT OF ELECTRICAL ENGINEERING

UNIVERSITY OF CAPE TOWN		RESEARCHER:	EKATERINA RZYANKINA
PRIVATE BAG X3		TELEPHONE:	+27-21-650 XXXX
RONDEBOSCH	7701	E-MAIL:	RZYEKA001@myuct.ac.za
SOUTH AFRICA		MAIN SUPERVISOR:	DR Renee Smit
		E-MAIL	renee.smit@uct.ac.za

Form of Informed Voluntary Consent for Audio-Tapping Group Activities/Focus Group Interviews

Project Title

Digital literacy practices of engineering students using e-textbooks at a university of technology in South Africa

Invitation to participate, and benefits: Recently, you participated in a questionnaire (phase 1) and think-aloud study and individual interview (phase 2), on the use of e-textbooks. On the basis of your responses in phase 1 and 2, you have been selected and invited to participate in phase 3 of a research study conducted with students. The study aim is to explore the use of e-textbooks (digital textbooks) in the engineering faculty. The proposed research is expected to generate valuable insights about digital literacy practices – mediated by e-textbooks. I believe that your experience would be a valuable source of information, and hope that by participating, you might gain useful knowledge about digital literacy practice when you are reading e-textbooks. Any data gathered from your participation will be used in the researcher's thesis, academic journal articles, conferences.

Procedures: During this part of the study, you will be asked to participate in an activity involving reading an e-textbook as part of a group. As part of your normal class in this subject, you will be provided with a group task; your interaction will be observed and audio-recorded by the researcher. When the group activity is completed, you will be asked to participate in a focus group interview for approximately 60 minutes with Ms. Ekaterina Rzyankina, the principal investigator at a time convenient to all participants.

Photographs and/or Recording: As part of the research, we may take photographs and/or record audio. These will be included as evidence in this study. The people in the photographs will not be identified by name, and their faces and identifying features will be distorted. Please indicate below if you object to taking photographs and/or recording.

Risks: There are no known risks associated with participating in this study. Focus group interviews should last no longer than 60 minutes. This research on e-textbooks is relevant to

your current topic. By participating in this study, you might enhance your learning in this subject. Because the activity will be undertaken in your normal class, you will still do the activity even if you do not give consent to be observed.

Feedback: You will be informed of the findings of this study. The researcher will contact you electronically for sharing the results.

Costs and Payment: None

Disclaimer/Withdrawal: Your participation is completely voluntary; and you may withdraw at any time without giving a reason and without incurring any prejudice or penalty. If you choose to withdraw, the researcher agrees not to use any of the information you provided without your written permission.

Confidentiality: All information gathered for this study will be kept strictly confidential, and you will not be identified by name. Pseudonyms will be used to maintain confidentiality.

Name of Researcher	Signature of Researcher	Date

What signing this form means: You agree to participate in this research study by signing this consent form. The purpose, procedures to be followed, as well as the potential risks and benefits of your participation, have all been thoroughly explained to you via this form. You will have no effect if you choose not to participate in this study at any time. You are aware that you will receive no monetary compensation as a result of your participation in this study.

You grant the researcher permission to use the data generated in her thesis, academic journal articles, and conferences as long as I am not identified.

You are welcome to contact me (rzyankinae@cput.ac.za or 0214405758) at any time during this research to ask questions or obtain additional information.

.

I agree to participate in this research (tick one box) ☐ Yes ☐ No _____

(Initials)

I agree to be photographed ☐ Yes ☐ No _____

(Initials)

I agree to be audio-recorded ☐ Yes ☐ No _____

(Initials)

_____	_____	_____
Name of Participant	Signature of Participant	Date

Appendix D: Consent form for audiotaping

Consent form for audiotaping Lecturer/Senior Lecturer/Assistant Professor/Professor Interviews

XXX 2020

Dear Lecturer/Senior Lecturer/ Ass Professor/ Professor,

My name is Ekaterina Rzyankina, and I would like to formally invite you to participate in an exciting research study on digital literacy practices of engineering students using e-textbooks at a South African university of technology..

This research will be looking at understanding the significance of what digital literacy practices students use when they are reading e-textbooks. This could potentially benefit you as a lecturer, your institution as well as the broader academic community by adding new knowledge to the existing pool of theoretical and practical knowledge. There are no financial rewards associated with this study. By participating in this study, you will contribute valuable feedback on the use of these new instructional tools and the transition to e-textbooks in the curriculum.

Your participation is strictly voluntary. You may choose not to participate or decide to stop your participation at any point during the research. The expected time for the interview will be 45 to 60 minutes, and it will be audio-recorded and transcribed. All lecturers' information and responses will be kept confidential by having lecturer volunteers, and the pseudonyms will be assigned. Once the interviews are transcribed, the audio files will be kept in a safe place and locked in the researcher's office at the Granger Bay campus. The electronic data will be saved as password-protected files on iCloud and backed up on Microsoft OneDrive.

For all questions about volunteering for this study, please contact Ekaterina Rzyankina (Phone: 0214405758; E-mail: rzyankinae@cput.ac.za). Should you have any concerns about this study, please contact my research supervisors, Dr Z Simpson (Phone: 011 5593683; E-mail: zsimpson@uj.ac.za) or Dr R Smit (Phone: 0216503440; E-mail: renee.smit@uct.ac.za).

Signed agreement between researcher and participant:

I, Ekaterina Rzyankina (the researcher), hereby commit that all data obtained from the interview will be treated confidentially, and that the research participant's anonymity will be preserved.

Signed:_____Date:_____

I, …… (research participant) do hereby acknowledge that I have been informed of the purpose, method and envisaged benefits of this research and have given my informed consent to participate in the interview provided that confidentiality of my responses is observed. I give permission for the researcher to use the data generated as a result of this interview in her thesis, academic journal articles, and conferences provided that I will not be identified.

Signed: _____ Date:_____

Appendix E: Preliminary questionnaire for students

Preliminary questionnaire for students

This questionnaire has a dual purpose. Firstly, it aims to identify potential participants for the next two phases of the study. Secondly, it seeks to obtain information regarding participants' digital literacy practices before they entered their current studies at the Engineering Faculty.

Online questionnaire template.

Dear First-year Engineering Student,

I Ekaterina Rzyankina PhD student kindly ask you to complete the following questionnaire related to activities undertaken within the scope of the use of e-textbooks (digital textbooks) in engineering subjects. I believe that your experience would be a valuable source of information, and hope that by participating, you might gain useful knowledge about digital literacy practice when you are reading e-textbooks.

Please take time to complete this questionnaire https://cput.limequery.org/554627?lang=en . The questionnaire should take no more than 10 -15 minutes to complete.

Please note that this is a voluntary questionnaire and you do not have to complete it. You can also withdraw from the questionnaire at any stage without any consequences. The questionnaire is completely anonymous, and the results will be used only for in the researcher's thesis, academic journal articles, conferences.
If you have any questions, please do not hesitate to contact me directly via email (rzyankinae@cput.ac.za).

Kind regards,
Ekaterina Rzyankina

Consent form

I understand the terms and conditions and want to participate:

- Yes (please continue the questionnaire)
- No (please leave the questionnaire)

Demographic data and background

1. Which of these activities in 2020 apply best to you? (You can choose more than one option)
   A. I matriculated

B. I was working in a company
C. I was studying in a TVET college
D. I was studying at university
E. I was staying at home
F. Other (specify) _____

2. To which department do you belong?
A. Mechanical Engineering
B. Chemical Engineering
C. Other (please specify) _____

3. Are you the first one in your immediate family to attend university?
A. Yes
B. No (If no, please give some details about the educational background of your family)

4. Where do you live?
A. ON Campus
B. OFF Campus

Usage of technology prior to attending this university

1. Did you have access to a computer, the Internet, and WiFi while in high school??

	In the house	In School	Both at school and home	None
Computer (any type)				
Smartphone				
Internet (WiFi)				
Other (specify)				

2. At which age did you first use a computer (any type)?

_____

3. Which learning activities did you use technology for, before coming to university? (select all that apply)
A. Search for information on the Internet for study purposes
B. Find a book using the electronic catalogue at the school library.
C. Send assignments via email.
D. Use cloud storage to share files with your teachers and classmates. (e.g. using Google drive, Drop Box, one drive, etc.)

E. Work with classmates on the same document on file (collaboration) when preparing for an assignment or group project
F. I've never used technology in my classroom.
G. Other (specify)_____

4. What other activities have you done with technology in your spare time? Choose the appropriate options.

A. Access email
B. Use your smartphone's Bluetooth, hotspot, or an equivalent to share files and apps, games with a friend.
C. Use chat technology (e.g. WhatsApp) where you share messages, images, videos, stories etc.
D. Capture and edit images, videos using your mobile device (e.g. smartphone, tablet, Ipad)
E. Play online games
F. Record stories and live steaming
G. Other (specify) _____

5. For which computing subjects (or their equivalents) were you enrolled in high school?

A. Computer Application Technology (CAT) (or the equivalent of this subject)
B. Information and Communication Technology (ICT) (or the equivalent of this subject)
C. Programming (or the equivalent of this subject)
D. A subject that taught web design (or the equivalent of this subject)
E. A class that taught video production (or the equivalent of this subject)
F. None – I never took any computer-related classes.
G. Other (specify) _____

Digital literacy skills

1. Below are examples of digital literacies, for each of the digital literacies, tick which of the options applies to you. *Answer all rows and mark only one tick per row.*

	I'm very confident with this	**I'm not at all confident with this**	**I do not know what this is**	**I have never used or done this before**
Use of a mobile phone				
Use of a computer				
Creating blog or forum posts, tweets etc				

Creating status updates or stories on social media platforms: Instagram, Facebook, WhatsApp etc
Knowing when I should and shouldn't use emojis and abbreviated SMS language
Creating texts with embedded hyperlinks
Working on Google Drive (or equivalent, such as MS OneDrive etc.) collaboratively with others on Word and other types of documents (spreadsheets, presentations etc.)
Producing information graphics (display facts and figures on a given topic in the form of graphs, tables etc.)
Combining media (e.g. images, audio and video) into a digital product
Creating a simple online games
Sharing multimedia artefacts (images, audio and video) with others online
Understanding and creating HTML code
Maintaining a personal blog
Commenting on other people's blogs
Use a variety of search engines for different types of online searches
Filtering online information to find what is useful and relevant to me
Managing my own online identity or identities
Coping with digital distractions

Adapted from Mark, H.N.D.G. P .*Digital Literacies*. [VitalSource Bookshelf]. Retrieved from https://bookshelf.vitalsource.com/#/books/9781408296899/

2. What do you primarily make use of your mobile phone for?

A. Communicating with family and friends (text, video call and audio)
B. Browsing and reading news
C. Watching YouTube videos
D. Taking photographs
E. Recording and editing videos
F. Playing games
G. Studying
H. Other (specify)

General reading

1. How many hours PER WEEK did you utilize your Physics e-textbook to study or to complete assignments for this course?

A. less than 1 hour
B. 2-4 hours
C. 4-6 hours
D. more than 6 hours

2. When you read a traditional textbook (hard copy), how do you engage with the text? (select any checkboxes which are applied to you)

A. Highlight or underline the text
B. Use margins for comments
C. Make notes
D. Other (specify)_____

Reading from the screen for study purpose

1. I know what an e-textbook is:
   A. Yes
   B. No
   C. Not sure
2. I have used an e-textbook
   A. Never
   B. Once
   C. A couple of times
   D. Often
1. For study purposes, do you prefer reading digitally or hard copy?
   A. Digital copy
   B. Hard copy

2. If you prefer **reading digitally,** please answer question **4A,** and if you prefer to read **hard copy,** please answer question **4B**

4A I like using e-textbooks because:

(Please rate each item below on a scale from 1 = Not at all important to 4 = Very important)

	Not at all important			Very important
	1	2	3	4
I can have unlimited access to them from home/classroom	○	○	○	○
They are more freely obtainable than hard copy books.	○	○	○	○
They have a search function within the e-textbook	○	○	○	○
They are readable on a phone or tablet	○	○	○	○
They allow me to bookmark pages	○	○	○	○
They allow me to use of different colours for highlighting	○	○	○	○
They allow me to take interactive notes (add web links, photographs and videos)	○	○	○	○
They allow for the creation of flashcards (figures and text)	○	○	○	○
They have “read-aloud” options	○	○	○	○
They allow for easy navigation between chapters	○	○	○	○
Other (specify)				

4B I like reading the hard copy because:

(Please rate each item below on a scale from 1 = Not at all important to 4 = Very important)

	Not at all important			Very important
	1	2	3	4
I do not have an electronic device	○	○	○	○
The phone screen is not convenient for online reading				
I do not have data and access to the internet	○	○	○	○
Hard copy is easier to read	○	○	○	○
Other (specify)				

3. Thank you for your time. Would you be willing to participate in further activities as part of this study, such as digital reading activities and interviews?
   A. Yes (if you answer yes, please provide your contact details: *name and surname, email address and cell phone* in order for the researcher to contact you and send you an invitation for further participation in this study).

      _____

   B. No

4. Please take a moment to reflect on the questions you have been asked and offer any additional comments that you would like to share. Thank you for your time.

_____

Appendix F: Interview protocol

Interview protocol for subset of participants identified from the questionnaire responses

Time:	**Date:**	**Place:**
Interviewer:	**Interviewee:**	**Tape identifier:**

After reading individually, the participants will be invited for interviews.

Guidelines for Introduction (5- 10 min)

1. **Thank participant for the interview and explain the project.**

Title of study**: Digital literacy practices of engineering students using e-textbooks at a university of technology in South Africa**

The purpose of this research is to discover: How do students' digital literacy practices mediate engagement with content in engineering e-textbooks?

I'd like to know how you read digital texts and what digital literacy practices you employ.

The first step I will observe when you will read from the screen. The second step I will interview you by asking the questions about your learning experience with e-textbook.

Think -aloud protocol activities will look at digital literacy practices: before, during, and after reading than by focusing on connections between pre-, on-line-, and postprocessing of text (Afflerbach, 2012).

2. **Reinforce confidentiality**: the identity of the participant will be kept confidential. In addition, the findings of the study will be reported in a way that preserves the confidentiality of any private information provided.

3. **Provide participant Instruction and explain of think-aloud study technique**.

You will be reading the digital text from the Physics book (name), page XXX until page XXX. You need to read the text by using a think-aloud technique where you

would be asked to complete a reading activity, and I will ask you the participant to talk aloud everything that you think and do as you perform the activity, acting as if you are alone in the room speaking to yourself. If you are silent for any length of time during the activity, I will remind you to keep talking aloud. There is a big difference between think- aloud and reading – aloud. I do not want you to read the text aloud; I want you to talk aloud by narrating what you are doing. After one or two sentences, I suggest depending on the meaning of the text, pause reading and think-aloud about the reading process.

4. After the reading activity, the participant will be invited for an interview. The purpose of this interview is to understand your reading behaviour, during the reading activity, and why you engage with the e-textbook the way you do. The interview will be open-ended and generally takes about an hour of your time **(Ask interviewees if they have any "hard" constrains in time?).**

5. **Recording**: "I usually transcribe all interviews. Do you mind if I record our conversation? It will help me focus on the interview and keeps me from having to write everything down verbatim" **(Turn on the recorder/s).**

6. Explain that the informed consent form described their rights as a study participant. Ask them to state that audio recording is okay. **Set up a timer.**

7. **Ask the participant if he/she has any questions before starting.**

Appendix G: The Digital Activity Grid

The Digital Activity Grid

This digital activity grid is for the researcher and will apply to participants during the observation of reading activity. The researcher will make a tally mark every time when the researcher will hear or observe one of the following from the digital activity grid below by the participant:

Applied digital literacy Strategy	**Tally mark**	**Description of the process**	**Interview questions (hyperlinked text)**
Search bar: the participant search for the concept inside of the e-textbook the participant search concept outside of the e-textbook by using e.g. Google			Searching and selecting material
Using Dictionary (Glossary)			Searching and selecting material
Comfortable reading (setting up personalised reading settings to accommodate the participant needs=> indexical or using resources of composition): Font size settings Day or night reading mode Text alignment options Type of fonts Portrait or landscape mode			Reading strategy
Language and pronunciation: Using the read-aloud button Setting up the voice of the speaker			Read-aloud

Setting up the speed of the speaker			
Annotation: Link, annotate and share Using commenting bar			Annotation
Highlighting option: Highlighting the text (process) Using different colours of highlighter (resource of composition)			Highlighting
Creating personalised study notes Copy and paste the digital text Modifying /Manipulation with digital text in a word processor Notes for images, graphs Adding additional resources (hyperlinks of to the notes			Creating notes
Hypertexts Select hypertexts (process) Copy and paste hypertexts (links) from outside of the book			Hypertexts
Navigation Scroll down and up Clicking on images (figures) Bookmarks			Reading strategy
Flashcards Add the text to flashcard Using flashcard for checking definitions and creating vocabulary terms			Searching and selecting material
Using Multimedia Viewing Images Watching Videos			Using multimedia

Hotspots and page control buttons Hotspots refer to a function that is activated when users click pictures, words, or sentences. Page control, the most basic interactive function, allows readers to go to the next or the previous page.			Hotspots functions
Descriptions and distractions			**Disruptions and distractions**
Interesting facts			Attitude to e-textbooks Thoughts of improvement of e-textbooks **Space, time, site of engagements**
Closing			Last question

QUESTIONS

After reading individually, the participant/s will be invited for interviews, and possible questions after think-aloud protocol and individual observation activity are listed below. These questions will be specific for each student, and it will refer to the think-aloud protocol and observation study. The researcher will look at the digital activity grid to select the specific questions for the follow-up interview. If the participant will be interviewed the next day than the researcher will watch the think-aloud recording a few times to find particular parts where she should ask the participant for clarification about digital literacy practices.

Highlighting

When you read e-textbook for study purpose first time, do you highlight the text?

For what purpose do you highlight the text?

Can you please explain why you chose to read the whole text and then only highlight specific parts of the digital text?

What do the different colours of highlighting signify?
How/when do you return to your highlights?
What do you do after highlighting the text?
When you read the text in e-textbook, e.g. for exam purposes, do only read the text that you highlighted previously?

Using multimedia

When you read for study purpose, how do you support your understanding after reading the text?
Do you always watch videos which is available as an e-textbook?
What do you do when you come across a graph or table or photograph (visual representation)?
Can you please explain in detail what your reading strategy for engineering graphs, diagrams is?
Why did you start watching the video or looking at the graph before you engaged with the text?
Why did you read in a particular order (questions – video – graphs – text)?
When you come across graphs and diagrams, do you try to connect them to the text, or not?
How do you read the different parts/modes of the digital text to understand the engineering concepts (e.g. text-graph/formula-video)?
Do you watch the video with capturing? What is the reason for this?
Do you prefer to watch video o read the transcript to the video? In what cases do you prefer to read the transcript to the video?

Reading strategy: Skimming, Scanning and Intensive Reading

How many times do you read the chapter or paragraph for study purpose?
Do you read the digital text and follow the text when the lecturer is presenting?
I saw you went back from page 5 to 1 (or I noticed that you skipped forward). Why did you do this?
Why did you spend so much time on page 5 compared to other pages?
At one point, I observed that you looked at another side of the screen; can you please explain why you looked there? Did you have difficulty understanding a specific concept in the reading text? Did you have any difficulty working with the online mode of reading?
What is your strategy for reading for exam purposes (e.g., re-visiting the chapter, sections; organising your thoughts; making flashcards)?

Read-aloud (text-to-speech)

When you read the text for study purposes and see the word that is difficult to pronounce, what will be your reaction?

Do you always use the read-aloud option when you read the digital text, and for what reason?

In your understanding, when the students should use the read-aloud option?

Do you use standard-setting or adjust setting for read-aloud function e. g. the voice of the reader's voice and speed?

Hotspots functions and page control buttons

When you read the text for study purpose, do you click on formulas or images to enlarge the size?

When you read the text and come back to this point again, do you use bookmark function?

How do you move between the chapters?

Searching and selecting material

For study purpose when you read Physics chapter first time, when and why do you use searching?

When you read the text for study purpose and see the word/concept that is difficult to understand the meaning of what will be your action?

Why did/didn't you use the in-built dictionary?

Why did you choose to search for a term on Google, rather than using the in-built dictionary?

With the amount of material (resources outside of the e-textbook) now available online I would like to know how do you select the trusted or most relevant resource to read (curate the digital text)?

Do you use flashcards when you read e-textbook?

What is the reason to use flashcards?

Annotation

When you read the digital text for study purpose, how do you support your understanding of the concept (e.g. write comments for each paragraph or summary for the whole chapter)?

Do you annotate every single concept you find difficult to understand or use the specific annotation strategy?

For study purpose do you prefer to annotate digital text or you prefer to use your copybook?

In your opinion, why students prefer to do annotation in their copybook/ digital text?

Do you share with other classmates your annotation?

Disruptions and distractions

When you study with e-textbook, did you find the interface and layout distract you from focusing for a long time? Please explain your answer.

Creating notes

When you read e-textbooks for study purposes, what technique do you use for taking notes?

What features do you use for digital notetaking (attached links, videos and images)?

How do you write your own digital notes?

What approach do you use (collecting and copy and pasting text)?

Do you use graphical representation/visualisation for summarisation (e.g. create world clouds, mind maps) when you are writing your notes?

Do you modify/manipulate the fonts or copy and paste text (change font colours, shape, sizes)?

When you read the text, e.g. for exam purpose, do only read your notes or you go back to read the text in e-textbook?

Hypertexts

How do you use hypertext (hyperlinks) when you are reading an e-textbook? What do you do when you see hyperlinks embedded in the digital text?

Why do you think the publisher put hyperlinks in? In your opinion, what is the function/s of using and having hyperlinks in the digital text?

Do you find it easy to read an online text with hyperlinks? Why/why not?

What information in the Physics book text was hyperlinked? Are these hyperlinks a good choice? What hyperlinks would you include or leave out if this was your online text?

GENERAL QUESTIONS

Attitude to e-textbooks

How confident were you using the e-textbook? Why do you feel this way?

-Did you feel in control of your learning using the e-textbook?

Suppose I were a new student considering taking courses that exclusively used e-textbooks, and I asked for your advice. What would you tell me and why?

In your personal opinion, what is the main difference in reading between text for study and reading for pleasure?

Thoughts of improvement of e-textbooks

Do you study or learn differently using e-textbooks compared to a paper textbook?

If you could improve anything about e-textbooks, what would it be and why?

How could the layout, or the way in which the information is packaged or delivered be improved at all? What do you think would an e-textbook of the future look like?

Space, time, site of engagements

1. Take me on an average day describing your use of the e-textbook. Describe what you did, how you did it, and how you felt.

-What were your motivations for using the e-textbook? OR

What were your expectations from the e-textbook and were these met? Explain your response

-In what ways did the e-textbook contribute to your learning or not?

Tell me about what you do or your process when you study, using an e-textbook, a new chapter?

2. Has the e-textbook influenced where you read and study in this course?

In what ways did the location where you used the e-textbook influence your learning?

-In general, describe how your reading or study environment helps or hinders your learning.

Last question

What else would you like to say about your experiences that you have not already shared?

Appendix H: Observation notes template

Observation notes template

Observation Event: **Time:**

Date: **Place:**

Time	Descriptive notes	Reflective notes

Appendix I: Focus group interview guide list and protocol

Focus group interview guide list and protocol

Date:

Time:

Location:

Name of the group:

Participants names:

1. Begin with providing introductory comments:

    a. Welcome, and thank you, everyone, for volunteering to participate.

    b. Introduce yourself.

    c. Hand out the consent form.

2. Ask participants to review, ask any questions, and then sign the consent form. Offer a copy of the consent form (unsigned) to each person. Some will want a copy, others will not, but always offer.

3. Give a very brief overview of the project and the goals for the focus group or interview. For example, “We are talking to you to find out about your experiences of learning with an e-textbook. We would like to find out what works and what does not work, and how the community of learners and individual student agency can improve.”

4. **Give participants information about the process, times, breaks, bathrooms, and so forth.**

5. Distribute name tags for a focus group meeting (first names only) for face to face interview. If interview will be in virtual space ask students to write the first name when they log in into the meeting.

6. Provide basic guidelines (ground rules) for the focus group meeting, review them with participants, and consider posting them for everyone to see. Some essential rules (Johri et al., 2013):

    a. If you feel uncomfortable during the meeting, you have the right to leave or to pass on any question. There is no consequence for leaving. **Being here is voluntary**.

b. Everyone's ideas will be respected. As researcher I value your participation and contribution to the topic. Please keep discussion in respectful manner to all members of the group.

c. One person talks at a time. It is allowed to use other modes of communication during the discussions such as emojis (agree and disagree tamp up and down). Additionally students can type their thoughts in comment bar.

d. Everyone has the right to talk. The facilitator may ask someone who is talking a lot to step back and give others a chance to talk and may ask a person who is not talking if he or she has anything to share.

e. Everybody has the right to pass on a question.

f. There are no right or wrong answers.

j. Does anybody have any questions?

7. Let people know that project staff will be taking notes about what is discussed, but that individual names or identifying information will not be attached to comments.

8. Recording: "I usually transcribe all interviews. Do you mind if I record our conversation? It will help me focus on the interview and keeps me from having to write everything down verbatim". **(Turn on the recorder/s)**

Ground rules for keeping focus group interactive and productive session:

Take introductions as an ice breaker: Pass each interviewee paper and pen.

Discussion starter question: Take a few minutes to draw down emoji depict on your experience with an e-textbook?

Start group discussion.

Reading strategy

1. When you study an engineering subject with an e-textbook, how do you go about doing this (what you do first and the rest in between)?
2. Imagine you read the digital text and do not understand the engineering concept, what do you normally do to improve your understanding (looking for other resources or continue reading)?.
3. Imagine starting a brand new topic in [physics]. Describe your strategy – do you start one end and work through everything, do you look at headings to get an overview, do you skim-read, do you read and re-read, do you make notes, to you click on all the links – how do you work with the text? *[Wait for answers. Ask, 'do you all work that way? Does anyone do something different?]* Can you share way how do you deal

with reading of many pages in short period of time? What do you do when you have to get through a longer reading and you do not have much time?

Personalised reading

4. Do you ever modify/manipulate the fonts (change font colours, shape, sizes)?
5. What features of e-textbooks do you use and why? What is/are your favourite feature/s for reading e-textbooks, and why?

E-textbooks features

6. In your opinion, what are some of the functionalities of an e-text that you use in e-textbook/s for study purpose compare to traditional textbook/s based on your experience?
7. What sharing or collaborative features do you use when you are reading e-textbooks in a group? Do you share your digital notes with classmates? Do you work synchronously or asynchronously on one document with classmates? Can you explain the process of working collaboratively?

Experience of using an E-textbook

8. Can you please share and explain your emoji drawing which you draw the beginning of this interview?
9. Do you think the set-up of e-textbooks is easy to navigate?
10. Is there anything about an e-textbook that frustrates you?
11. Can you please share with me your thoughts on how e-textbooks helps you in your reading?
12. Is there anything you would like to add or mention about reading with e-textbooks?
13. What do you imagine to be the future of online reading resources at university?
14. How do you imagine students will engage and interact with engineering e-textbooks in future?

Let participants know when you are going to ask the last question. This cues participants to share relevant information that may not have come up in answer to your key questions.

15. Is there anything you feel is missing or would like to add?

Thank you very much for your participation.

Appendix J: Lecturer interview: Guide and Questions

Lecturer interview: Guide and Questions

Time:	**Date:**	**Place:**
Interviewer:	**Interviewee:**	**Tape identifier:**

Guidelines for Introduction (5- 10 min)

1. *Thank participant for the interview and explain the project*.

> Title of study: **Digital literacy practices of engineering students using e-textbooks at a university of technology in South Africa.**
>
> The goal of this study is to understand *How do students' digital literacy practices mediate engagement with content in engineering e-textbooks?*
>
> To answer this question, I will look at three dimensions: individual interaction (student – e-textbook), group interaction (a group of students -e-textbook) and lecturer and e-textbook for teaching practices: *How do lecturers deploy engineering e-textbooks as a learning aid in the classroom? (RQ3).*
>
> I want to learn about **your** experiences of using e-textbooks. I will be interviewing you now by asking the questions about teaching experiences, using e-textbooks in classroom and for assessment purpose.

2. *Reinforce confidentiality*: the identity of the participant will be kept confidential. In addition, the findings of the study will be reported in a way that preserves the confidentiality of any private information provided.

3. The interview will be open-ended and generally takes about an hour of your time. *(Ask interviewee if they have any "hard" constraints in time.)*

4. *Ask the participant if he/she has any questions* for you before starting.

5. *Recording*: "I usually transcribe all interviews. Do you mind if I record our conversation?

It will help me focus on the interview and keeps me from having to write everything down verbatim".

(Turn on the recorder/s)

6. Explain that the informed consent form described their rights as a study participant. Ask him/her to state that audio recording is okay. **Set up a timer**.

Part I: Participant Background/Profile:

1. Can you share a few words about your current position and your work responsibilities?
2. Please share your teaching experience thus far. How long have you been teaching? Have you previously worked at other universities?
3. What type of classroom atmosphere do you promote in your classroom? What type of teaching style do you prefer? What is your role as lecturer, and what is the student role? Describe a typical day in your classroom.
4. What do you mostly read now? In what format? (print? Electronic? What platform?)
5. To your knowledge, which features do your students use to interact with texts? [text to speech, highlighting, bookmarking, notes, sharing notes]

Part II: Digital literacy mediated by e-textbooks:

1. How would you explain what an e-textbook/s is to someone who hasn't used one before? What knowledge do you have about e-textbooks?
2. What is your experience of using an e-textbook?
   If you have used e-textbooks before, to what extent did it promote interaction with texts and with your students?
3. In your opinion, to what extent have e-textbooks changed access to learning for students from diverse backgrounds?
4. Do you think that e-textbooks can promote literacy? How is the e-textbook influencing students' use of language or discipline-specific terminology? In what ways? Why is it important?
5. In your experience, what are some positive effects of e-textbooks for learning engineering subjects?
6. What are some negative effects of e-textbooks for learning engineering subjects?
7. From your personal experience of working with an e-textbook/s, how does an e-textbook assist you with the teaching process?
8. What digital features, if any or none, of an e-textbook do you use when you teach in the classroom, and why?

9. What challenges did your students experience in using the e-textbooks to support their learning?
10. Reflecting on the past year, have you noticed any changes in your teaching philosophy, approach and practice as a result of using e-textbooks? If yes, what were they and how did e-textbook effect this change?
11. What resources/features (e.g. tests, readings and support materials) do you want your electronic textbooks to have? If you could improve upon anything about the e-textbooks, what would it be and why?
12. Would you recommend one of your colleague to use e-textbook for their course? Why or why not?

Part III Using e-textbook/s as a pedagogic tool

1. How do you incorporate e-textbook/s as part of your curriculum?
2. Did you notice any changes after implementing e-textbook/s as part of your curriculum? If yes, what were the changes?
3. Do you use an e-textbook for assessment purpose? How have e-textbook/s assisted you with assessment? Did you notice any changes after using assessment/s from e-textbook/s?

   Note the following question 4 is yes/no answer, and I need to follow up!

4. In your opinion, do e-textbooks allow for scaffolding learning (method of improving student independency of leaning and understanding the engineering concepts)? (if 'yes", in what ways? If "No", why not?

5. How do you use e-textbook/s in your classroom practice? What functionalities (affordances) of e-textbook/s do you use in classroom practice?

   Note the following questions below are yes/no answers, and I need to follow up!

6. Do you think e-textbooks allow a shift from a teacher-centred approach to a student-centred approach? Why/how?
7. Do you use the learning analytics provided by e-textbook/s? If yes, please elaborate on how you use learning analytics? If no, why not?
8. Do you think e-textbook/s can replace some teaching load and teacher presence in the classroom and in what ways?

Let participant know when you are going to ask the last question. This cues participants to share relevant information that may not have come up in answer to your key questions.

9. Is there anything you can think of that I should know and have not asked you?

Thank you very much for your participation.

Appendix K: MDA Analytical framework

Analytical Concept/ Unit of Analysis	Component, Parts	Characteristics of analytical concept	Description of components	Code	Explanation of what to look for in the data
Agency	- Scene - Social actor/Agent - Mediational means/Agency - Mediated action/Act	**Distributed (**among human actors, time, mediational mean and various discourses in the practice**)**; **Enacted;** **Represented;** **Contested**.	- context, background, situation (Where and when was it done)? -what kind of person, what co-agents or counter-agents (who did it)? -By what means or with what instruments (Was it done)? -Nature of thoughts (what was done, what took place in thought or deed)?	AG	What were the opportunities and/or constraints? Passages where students / lecturers explain how they use e-textbooks: in what contexts are they used (scene)? Who is involved (actors)? In what kinds of activities/actions are they used (mediated action)? And to what ends/purposes are they used (purpose)? What components/aspects of the e-textbook are used (mediational means)? How the student/s relate to the text as material object? What was done, and why?
Mediated action	-The agent; -Mediational means; -Lowel-level action; -Higher-level action; -Frozen action	Influenced; Performed ; Acted	-**agent** (student) influence mediational means (e-textbook) and mediational means (e-textbook) influence agent (student)= mediated action; -**higher level actions** as action are bracketed by an opening/closing and made up a multiplicity of chained **lower level actions**; -**frozen action** which are entailed in material objects.	MA	How, when, and where does the mediated action occur? What type of tensions can take place between lecturers and the e-textbook? How does the e-textbook influence the teaching process? How do students use digital texts to perform social action of reading? How does e-textbook allow students to conduct reading in different ways?

Mediational means/cultural tools	-Physical (technological); -psychological Multimodality: foreground visuality, composition (layout), colour	Transformed; Directed; Facilitated; Engaged	- consisting of material objects e-textbook -language, algebraic symbols system, diagrams, images, schemes, mechanical drawing	MM/CT	What are the affordances and constraints of e-textbooks? What is the limitation of using e-textbooks? How can the e-textbook be used to improve teaching and learning? How do students use engineering e-textbook for study? How do students interact with digital text of e-textbook and what type digital literacy practices students employ for reading? What setting did students used for digital reading? How the students connect different types modes for creating linkages with text? What kind of access students lecturers have to text (the physical and social contexts and how they physically manipulate the texts? How effective or ineffective can e-textbook be for engineering subjects?
Practice	Observation data (notes and recording)			Pr	What type social practices of reading do students engage across modes and combination of the modes of multimodal text in real time (home or at UoT and other spaces)? How do digital literacy practices contribute to the formation of certain kinds of relationships, social identities and realities? What are the effects of the reading e-textbooks on the participants' identities? How do participants ascribe explanations to the action of engaging with the e-textbook?

Site of engagement (	-Virtual space; -physical spaces; -relational space; -screen space; -third space. -Space and time -interaction orders		- space where the participant is performing the action e.g. lab, classroom, library, home; -created by the interfaces students or lecturer are using for communicate e.g. Vital Source, E-textbook collaboration function, Google Drive; -created by participants by the 'state of talk' between participants also relationship between participants; -the actual space of users' screens (e.g. e-textbook interface, media resources) -spaces inhabited by participant but rather referred to in the course of interaction (e.g. shopping centre, hotspot location)	SoE	What types of access do e-textbooks provide for students and lecturers? Is it space that provides access? How can the mediated action of reading from e-textbook take place? How are the sites of engagement formed through different patterns of orientation towards time and space? How social realities are constituted across time and space?

Appendix L: CHAT and ASA Analytical framework

CHAT and ASA Analytical framework

Analytical Concept/ Unit of Analysis	Characteristics for analytical concept	Component, Parts	Description	Code	Explanation of what to look for in the data
Subject (Yamagata-Lynch, 2010); (Uden, 2007);	Subject - respondent		Subject is individual or groups of individuals involved in activity. 1. Engineering students; 2. Engineering lecturers at UoT.	Subject	Who are the people participating in the activity system? What are their roles? What are the types of digital literacy practices students/lecturers applied for digital reading? What are the types of modes used by students during the reading and why? How are tasks organised among the members of the group working towards the object?
Object (Yamagata-Lynch, 2010); (Uden, 2007); (	Conducted to move the practice. Object - stimulus	Object/Motive - Activity Goal - Action Conditions - Operation	The **goal** or motive of the activity and **goal-directed action** towards the object. Object is 'the true motive'). The object characterises sub activities in the activity system and are eventually converted into outcomes.	Object	What is the goal or motive of the digital reading activity ? What is the contradiction or tension that occur between subject/object and tool?

Tool/Mediational means/cultural tools (Yamagata-Lynch, 2010	**Invented, purchased, discarded and replaced in the activity**	-Technical tools and artefacts (material tools); -physiological (for example language or symbolic systems such as algorithms) Multimodality: foreground visuality, composition (layout), colour. **Mediation by tools** to **mediation by signs** and thus use of language (semiotic tools).	- consisting of material objects e-textbook -language, algebraic symbols system, diagrams, images, schemes, mechanical drawing. The tool includes social others and artefacts that can act as resources for the subject in the activity. In this study **mediated by tools (both technological and human)**. The tools aid in conversion of an object into outcome.	MM/CT	What tools are used in this activity? Are they available to students? What are the physical tools used to perform the activity? What are the psychological tools used? How have the tools changed over time? What methods guide the activity ? How do students/lecturers use tools?

Rules (Yamagata-Lynch, 2010); (Uden, 2007);		Observation data (notes and recording)	Rules refer to **formal or informal or technical** regulations that can, in varying degrees, constrain or liberate the activity and provide to the subject guidance on correct procedures and acceptable interactions to take with other community members. The rules are the expectations and norms that regulate or influence the interactions within activity system. These rules can be either specific or implied	Rls	How do rules enable or inhibit a certain type of practice? How do participants ascribe explanations to the action of engaging with e-textbooks? How do the rules impact the identity of the participants?
Community (Yamagata-Lynch, 2010); (Uden, 2007); (Engestrom, 2001); (			Community is social group with which the subject (students/lecturers) identifies while participating/engaged in an activity. The community includes the co-participants of the activity besides the participants and they all share the same object or motive of an activity (Yakubu and Dasuki, 2021).	Com	What is the structure of the activity's social interactions? How might conflicts in other communities influence students' interactions?

Division of labor (Yamagata-Lynch, 2010); (Uden, 2007); (Engestrom, 2001);	Power -symmetrical (mediator, instructor facilitator; enquirer, reflector, collaborator) Power-asymmetrical (director, manager; respondent, performer)		Division of labour refers to how the task are shared among the community. **Group dynamics and student-instructor role, student-e-textbook. Interactions occur among students, among students and the teacher, and among students and e-textbook and materials as students attempt to create meaning through and from their constructions.** Roles (DoL) and responsibilities and task assigned to the participants and the community of the activity system	DoL	How do the students distribute and share the reading activities among themselves? How do the same roles differ from traditional roles? How does that affect work group activities? How do those roles relate to other roles? What factors drive the changing role? What are the formal and informal rules that guide the activities students are engaged in? How might these rules have evolved? How flexible is the division of labour?

Outcome (Yamagata-Lynch, 2010); (Uden, 2007); (Engestrom, 2001);			Outcome of an activity is the end result of the activity. The outcome of the transformed activity (digital literacy practices for reading e-textbook) is to complete the remainder of the semester through reading digital text using engineering e-textbook tool of mediation. Therefore, the object is transformed into the outcome through intervention of the tool.	Out	What is the outcome of the activity? What type of digital literacy practices do students employ as a results of activity? What are the criteria for the evaluation of the activity?

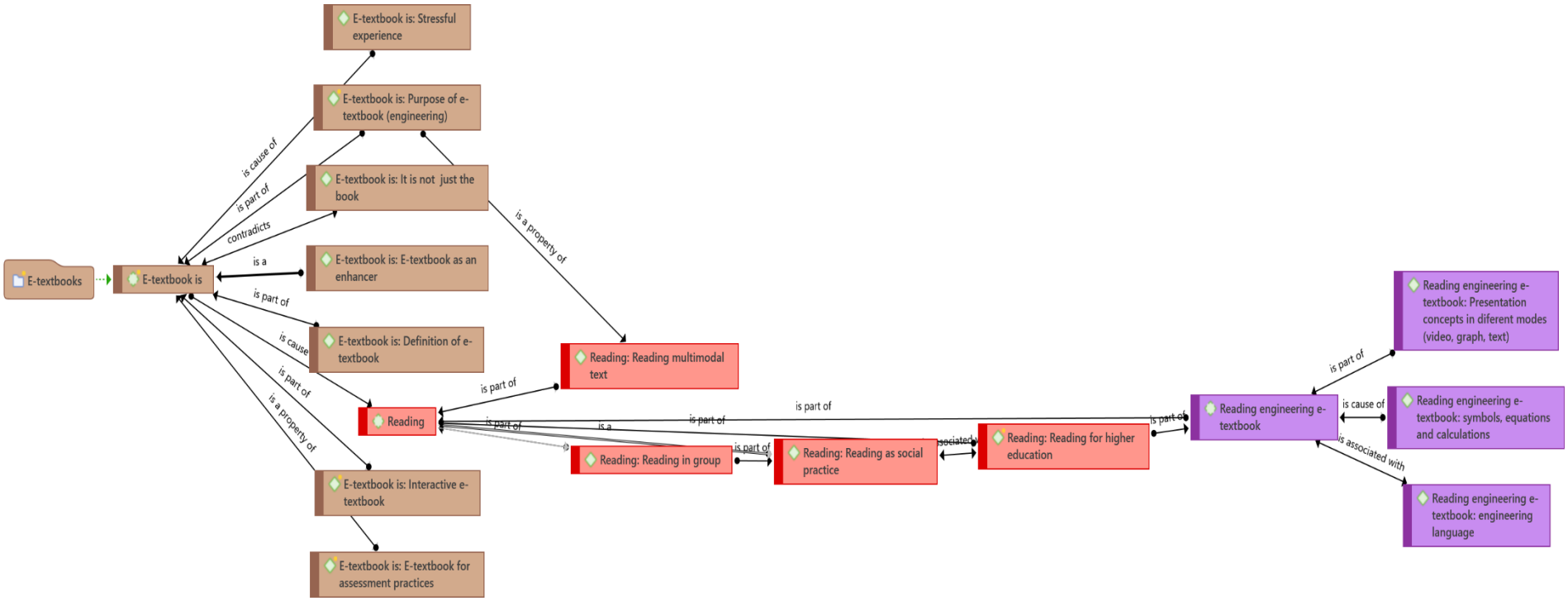
Mediated action (Yamagata-Lynch, 2010);		Zone of Proximal Development (ZPD). An educational concept, originally used to represent the space between the actual developmental level of a child as determined by independent problem solving, and the level of potential development through problem solving under adult guidance or in collaboration with more capable peers. Through the lens of CHAT, the ZPD can represent the distance between learners simply learning things by rote without understanding	Mediated action is viewed as a means of interpersonal communication through the interactions among subject, tool, sign, and object while the subject develops new signs that help them make meaning of the world.	MA and ZPD	What is power dynamic between subject, tool and object? How does the e-textbook assist students with learning? What reading strategy do the students implement? What further strategies could be used for mediating and improving future digital reading / digital literacy practices?

		the purpose, and later coming to internalise what the action really means			

Activity system (the first principle)(Engestrom, 2001)	Collective, artefact-mediated and object-orientated activity system. T The activity system consists of a subject aiming to bring about a change, which is termed the object. The subject may be an individual, community, or organisation. CHAT allows consideration of activity systems interacting with one another	Goal-directed individual and group actions	It is network relations to other activity systems it taken as the prime unit of analysis.	MA	

Appendix M: E-textbook Network

E-textbook Network extracted from ATLAS.ti 23 Win – project Digital literacy practices of reading engineering e-textbook



Appendix N: Ethics

Ethics

Office of the Deputy Vice-Chancellor:
Research, Technology Innovation & Partnerships
Bellville Campus
P O Box 1906
Bellville 7535
Tel: 021-9596242
Email: PHAHOD@cput.ac.za

17 March 2021

Ms Ekaterina Rzyankina (staff number 30087193)
Ph.D. (University of Cape Town)
Faculty of Engineering and the Built Environment
Cape peninsula University of Technology

Dear Ms. Rzyankina

RE: PERMISSION TO CONDUCT RESEARCH AT CPUT

The Institutional Ethics Committee received your application entitled: "*Digital literacy practices of engineering students using etextbooks at a university of technology in South Africa*" together with the dossier of supporting documents.

Faculty Ethics Committee Approval Date: 28 May 2020.

Faculty Ethics Committee Approval Reference No: 2020FEREC-ST-008

Permission is herewith granted for you to do research at the Cape Peninsula University of Technology.

Wishing you the best in your study.

Sincerely

David Phaho
DVC: Research