The use of social media on mobile devices to support the co-reading of eTextbooks

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Abstract

A textbook is a boundary object of interest among students within given communities, in some instance, a region or a whole country. Students in such communities have the possibility to engage collaboratively to study and gain a better understanding of similar content together. Collaborative work leverages mass communications that have become a beneficial means of enabling knowledge construction through independent and flexible learning mechanisms. Currently, textbooks are presented as PDFs on online portals with links to discussion forums for discussing the given resources. However, one major challenge is the lack of connection between the content being discussed and where it is discussed. Also, separating forums from their content leads to the discussion of topics that are sometimes irrelevant to the course content as discussions are mainly for general inquiries. In this dissertation, the feasibility of an academically focused social networking system that combines forums with their respective resources was investigated. This research explores various ways of altering the presentation of forums in an attempt to improve co-reading and increase textbook related interactions. An experimental system with internal forums, which are embedded inside eTextbooks, was created. The traditional form of rendering discussions as a standalone platform was also presented as a control system. Our objectives were to determine if the presentation of discussion forums inside resources affect the number and quality of interactions. Another objective was to determine if anonymous identity is essential for collaborating on educational learning platforms. The system was tested and evaluated with high school students as well as university students through various experiments that compared the traditional forums to the proposed system. This work adds nuance to our understanding of effective co-reading for shared boundary objects.

Declaration

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I hereby declare that I understand the meaning of plagiarism and this dissertation was solely written by myself under the guidance and supervision of Associate Professor Hussein Suleman, in the department of Computer Science at the University of Cape Town. The work in this dissertation is my own except where explicitly stated otherwise in the text by reference or acknowledgement. Relevant references have been provided on all supporting literature and resources.

This work has not been previously submitted, in whole or in part, for any other degree or diploma at any other university or institution.

Parts of this work have been published or used in:

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Acronyms and Abbreviations

API	Application Programming Interface
CDU	Curriculum Development Unit
CMSs	Course Management Systems
CSCL	Computer Supported Collaborative Learning
CSS	Cascading Style Sheets
DAL	Database Abstraction Layer
HTTP	Hypertext Transfer Protocol
ICTs	Information Communication Technologies
IDE	Integrated Development Environment
LMS	Learning Management Systems
MOOCs	Massive Open Online Courses
MVC	Model View Controller
RBAC	Role Based Access Control
RQ	Research Question
SNF	Social Networking Forum
SQL	Structured Query Language
STEM	Science Technology Engineering Mathematics
UCD	User-Centered Design
UCT	University of Cape Town
UEQ	User Experience Questionnaire
UGC	User Generated Content
UID	Unique Identifier
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
US	United States

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1 Introduction

1.1 Motivation for the Study

For students, attending class lessons helps build an understanding of a subject matter. However, not all students come out of a lesson having fully understood all the concepts that have been taught. Students sometimes find course content challenging to understand and hence seek means of understanding those concepts outside the classroom. In developing countries, learning is still highly didactic and theoretical such that learning follows a teacher-centred approach as opposed to a learner-centred one (Harasim, 2017). Sometimes it is challenging to encourage active participation and learning when working with a large group of students (Kelly et al., 2016; Seethamraju, 2014). Much research is being conducted to obtain ways of improving classroom learning (Thinley et al., 2014). Collaborative learning is an approach that is observed as suitable for promoting higher-order thinking among learners (Bali, 2014). However, the short time frame of a lecture/lesson may hinder the maximum success of this method within the classroom.

Face to face collaborations usually conducted by students after classroom lessons have been traditionally known as a way of linking formal classroom learning to informal learning and have the ability to supplement classroom teaching (Khaddage et al., 2016). From traditional perspectives, formal classroom learning forms the foundation and guides students on what to learn outside the classroom (Siemens, 2014). Educational research also recognises that there is a significant amount of informal learning that happens outside of school hours, which shows the need to connect formal learning with informal learning to yield better results (Czerkawski, 2016a; Gikas & Grant, 2013). The basis for discussion during such collaborations is usually the syllabus-based textbook content that is linked to classroom lessons. Interest in this study was, therefore, sparked by the realisation that students in various communities have one curriculum and use the same textbooks and schools write the same exams nationally. For example, in Zimbabwe, for a particular grade at high school, the whole country follows the same curriculum and writes the same final exam every year based on one prescribed textbook; in South Africa, this is reduced to provinces. At universities, hundreds of students seek to understand one subject even though they may use various textbooks. The common textbook use shows that this is a resource that students seek to understand during their learning. As a result, this creates an opportunity for collective learning, whereby students in such communities may join forces to understand their subjects by reading and understanding common textbooks together.

This research was also motivated by the issues around the traditional forms of learning, which are still the usual procedures followed in teaching students in most developing countries. The research specifically recognizes the concerns around passive learning whereby the students are barely being encouraged to construct knowledge, but they are still forced to memorise and receive knowledge from their teachers. Literature has confirmed the necessity of participating in collaborative work, which can cultivate knowledge among students and hence every child should be given a chance to read for knowledge as opposed to reading to memorise for exams only (Hamra & Syatriana, 2015). There are various limitations to face to face collaborative learning that can be alleviated by computer-based collaborations. Students, especially ladies, are culturally mandated by parents to be at home at certain times thereby limiting active collaboration with other students or teachers only to school hours (Chinyoka & Ganda, 2017, Quist-Adade, 2017). That is especially prevalent in developing African countries where parents are stringent. Also, technology now allows students to converse at any time of the day asynchronously (Wyss & Beste, 2017). Because most students in developing countries do not own computers, mobile phones have become the medium for promoting online collaborations (Chen & Denoyelles, 2013). However, the types of phones are suspected to be a hindrance to eLearning.

Lastly, according to literature, various tools like discussion forums exist and can enable co-reading (collaborative reading) and hence should be explored for such contexts with boundary objects (Pearson et al., 2012; Levy, 2008). Collaborative reading in this context is the ability for learners to communicate, discuss and interact about issues, insights and conclusions based on similar content that they are interested in. Forums have become the traditional way of enforcing online communications among distant learners (Wise et al., 2016; Wang & Baker, 2015). However, the posts refer to textbooks but are not directly linked to the textbooks. This work, therefore, explores the gaps and evaluates a system that promotes online collaborations that are more focused on boundary objects of interest.

1.2 Background

Technology has become an enabler for computer-supported collaborations (Ertmer et al., 2014). Online social media sites like Facebook, Twitter, Slack and Blackboard sites have transformed social interactions (DiVall & Kirwin, 2012). Facebook is the most popular social networking site, with approximately 2.38 billion monthly active users, while Twitter has about 275 million active users (Statistica, 2019). Several aspects of these social networks may be channelled to education for promoting active learning and course-related discussions (DiVall & Kirwin, 2012). From the wide range

of social media tools, discussion forums and chat forums were created for promoting interactions and encouraging active engagements (Hew, 2016; Wei et al., 2015). Facebook also embeds comments around media like images or videos to encourage discussions as such Facebook provides the platform and the users generate the content to place on the platform. This is usually the case for most social media sites.

While chat rooms are ideal for enabling collaborations, they are more difficult to archive and are more successful for more intimate and smaller groups. Discussion forums, on the other hand, are built through communities of people learning from one another asynchronously about specific content. Discussion forums are referred to as Computer-Mediated conferencing or Asynchronous Discussions (Zhao et al., 2014). They may also be described as Web forums, forums, online discussions, message boards and discussion boards. Online forums have been useful for a long time. They began in the 90s and are still considered an excellent tool for engaging students and extending classroom content to informal setups (Santana et al., 2014).

Online discussion forums are widely used for various educational enquiries (Pilli, 2014). For example, should one want to understand how to create a Java program, an online community of people from various parts of the community who may be interested in the topic can quickly answer that question (Seethamraju, 2014). Using asynchronous methods of learning is now crucial to the delivery of course materials, especially in higher education (Yuan & Kim, 2014). The possible benefits of discussion forums have enabled their wide adoption as educational tools for online learning in many institutions. Academic institutions have incorporated forums through Course Management Systems (CMSs) and Learning Management Systems (LMSs) (Pilli, 2014). Such institutions are combining blended learning models, which comprise of class activities and asynchronous or distributed learning activities (Liu, 2011). Technology, therefore, dramatically extends classroom learning to informal setups, which thereby necessitates the need for further studies that can improve learning (Cavanaugh et al., 2015).

The benefits of discussion forums on learning platforms are primarily to build learning communities for students to study at any time and place (Pendry & Salvatore, 2015). They provide hours of discussions as opposed to the standard few hours of shared discussions within a classroom lesson or after classes (Rabbany et al., 2014). Students get to hear other perspectives on various topics, which may strengthen or change their views and build their knowledge base (Cavanaugh et al., 2015). Forums have, therefore become an effective and efficient means of collectively sourcing information from the communications of a whole community (Cole et al., 2016). That is because forums provide a

dedicated space for users to solve similar challenges and share their understanding of common interests, despite not knowing each other. When students type their responses on the forums, they get to reflect and think carefully about topics and so contribute more thoughtful ideas (Lock, 2015). Students often have to reason and carefully back up previous posts if they are opposed hence discussions also encourage critical thinking (Cavanaugh et al., 2015). The platform also encourages students to continually express their thoughts as opposed to waiting for face to face interactions or waiting to meet the teachers in class. Forums are also known to encourage more in-depth thinking through peer to peer collaborations, which is a comfortable space for most students unlike when there are teachers (McConnell, 2014; McLoughlin & Mynard, 2009). However, should instructors be present, they are advised to not post too much on forums to avoid controlling the discussions and thereby minimising student to student engagement (Stang & Roll, 2014). Also, participants may read archived posts for an overall understanding of what could be related to their challenges.

Using forums, students can become more accountable and responsible for their learning needs. Students may easily build on face to face discussion topics based on classroom content or textbook-based challenges (Lo & Hew, 2017; Harasim, 1991). Students get to connect the course theories to practical discussions. The importance of discussion forums also stems from the fact that forums are one of the few platforms that enable anonymous interactions and therefore provide a safe environment for shy students (Wallsten & Tarsi, 2016; Sheard et al., 2003). In every class, there are dominant individuals such that some students may feel intimidated or unmotivated or reluctant to share their ideas but, on forums, any student has a voice to share and has a chance to be heard (Cavanaugh et al., 2015). The confidence that students gain by interacting in non-threatening environments has the potential to improve their face-to-face communication as well.

Several reasons, therefore, underlie the argument that online discussions are effective for learning purposes. Firstly, the Internet integrates geographically dispersed networks, i.e., it can prevent the fragmentation of students with similar interests by putting them in one space (Dekker & Engbersen, 2014). Secondly, users with insufficient resources can benefit immensely by building relationships with individuals who may help compensate for the lacking resources. Thirdly, they enable social interactions that are positively associated with constructive learning that cultivates the creation of knowledge (Kent et al., 2016). Lastly, online communications allow students to fulfil academic challenges and needs that cannot be met in their physical environments, for example, shy students may use the forums as an alternative to accommodate their insecurities (Howard, 2015; Chang et al., 2014).

There are many tools for creating forums, however, the structure is usually the same. Each discussion post has a title and body text that participants may respond directly to or create new posts in response to them. They are presented in standalone environments or as part of an LMS like Moodle, Blackboard or larger distance learning platforms like Massive Online Open Communities (MOOCs) (Pendry & Salvatore, 2015; Hamburg, 2012). According to Noriega et al. (2013), forums are still regularly used by users to derive information through social networking sites like Facebook and Twitter. According to Pendry & Salvatore (2015), forums as standalone applications are in danger of being obscured by the more common social media platforms like Facebook and Twitter. However, they state that forums and these large platforms are not the same. Discussion forums are more specific to a group of users with similar interests. However, integration of forums and social networks makes them more powerful because of the pool of users that social networks bring while the forums support the discussions that the users may require within that network.

Although discussion forums are an excellent tool for collaborations, they come with their own challenges. In the context of forums in LMSs, the significant challenges are that discussions may go off-topic from the original posting on forums such that they end up not being beneficial and, also, some posts may not receive enough responses to help students (Ren & Kraut, 2014). These challenges reduce the meaningful contributions of forums for knowledge generation among students. As a result, various mechanisms are being adopted to counter almost all these challenges. Researchers have among other things suggested improving forum guidelines, developing online activities to work with forums, adopting moderation as part of forums and enhancing the design of the environments (Ertmer et al., 2014; Ng et al., 2012). Other issues include privacy of participants on the forums. This is a huge issue as it decides if users stay to use the forums or not. The degree of importance of privacy on forums is often ignored and as such it affects the interactivity of users on educational systems.

While there has been a significant amount of research conducted on improving collaborations on discussion forums, not much of the research is being channelled towards design reconsiderations on how or where these traditional forums should be presented to encourage maximum interaction. Seethamraju (2014) agrees that few studies consider the effectiveness of the design and presentation of forums because they do not challenge the traditional standalone frame, which has discussion pages that are linked to various other pages of resources. Gao et al. (2013) explain that the hierarchical structure of forums makes them unsuitable for maximising discussions. The primary focus of this research is, therefore, to enhance or find an alternative way of presenting forums such that they promote better collaboration.

Literature implicitly highlights that there is a direct link between the content and the forums that enable the discussions. A study by Seethamraju (2014) explored the effectiveness of forums for a case study in a business class set-up; the results indicate that there were more interactions when students discussed on forums with case studies for reference and to guide their discussions. The results from their experiment suggest that the gap between text and its relevant discussions should be minimised by creating embedded systems. As a result, this dissertation minimises this gap by reporting on the effectiveness of a pedagogical approach that merges eTextbook content with the associated discussion forums. This means that users are provided with the content and discussions based on that content are encouraged. Comparing the traditional approach to discussion forums with this proposed blended approach is the primary purpose of this research work.

Also, the use of mobile devices as the media for content delivery is key to this research work. The new generation of learners is quickly becoming familiar with the latest mobile technologies which heighten the need to integrate mobile phones into learning and teaching (Maseleno et al., 2018). This is especially because learners can access their mobile devices at any place and time as such they can learn on the go. This is important in developing countries where people rely more on mobile phones than on computers or laptops. This research work especially focuses on affordable mobile phones with internet capabilities for education purposes. Mobile pedagogical practices are, therefore, being adopted to enhance meaningful learning.

1.3 Research Questions

The following research questions and their sub-questions were posed:

a) In what ways can mobile phones be used to support collaborative interactions embedded in textbook content? (RQ 1)

- How can textbook content be represented on a mobile phone in a navigable way that is deemed usable by students in promoting interactions?
- Which platform do students consider to be more effective for their needs: embedding discussions within the content or separating discussions from content?

b) What is the effect of embedding discussions within textbook content? (RQ2)

- Does embedding discussions within content encourage more content related collaborations?
- What distractions do embedded discussions within content bring and how can they be mitigated?

c) **How does mediated privacy of users on academic networking platforms affect user interaction? (RQ3)**

- Does the use of anonymous profiles increase the level of interaction?
- What concerns around privacy do students have in revealing their identities on online discussion systems?

1.4 Scope

This research focuses on evaluating a prototype application using high school students and tertiary university students to cater for two levels of learning when collaboratively reading. The high school learners selected are those that were in their final year of high school ranging between 15 to 18 years of age while university learners used were those in their first year of learning ranging between 16 to 20 years of age. University students were selected because they will be having less than a year having left high school and also have the experience of using forums for that period. High school students were selected because of their lack of experience and how much raw information they would provide to the research work. Literature also shows that very little research is conducted for secondary or high schools. Tertiary students are already using collaborative applications. As a result, their experiences were helpful in determining if collaborations are presented to them in ways that satisfy their needs, or if there is room for improvements. The work was conducted with students from the University of Cape Town (UCT) and students in schools from urban areas in Zimbabwe because of convenience in reaching learners as well as established contacts. These communities were also chosen because they have the textbook as their object of interest for large numbers of students in similar subjects. The Mathematics and computer science subjects chosen for this work are problem-solving in nature, and they were considered the most discussed subjects by the students. The developed application can be used on both desktop computers and mobile devices. However, for this study, all experiments were conducted on mobile devices because the research addresses outside the classroom learning, whereby many students only have access to mobile devices.

1.5 Research Approach

This research follows a mixed methods approach. It combines both qualitative and quantitative research methodologies. The first step involved studying and understanding how students learn in class and study for exams, thereby following a qualitative approach. It also involved quantitative analysis of the number of students that have mobile devices and use them for academic purposes. That knowledge brought insight into the kinds of challenges that students are facing and determining how their use of technology is being channelled to their individual and communal needs. The research approach was also exploratory as the results obtained from the students helped channel the direction

of the research and the kind of system to be created. In this case, anonymity and teamwork collaborations were highlighted as the most important.

Focus groups were used to elicit user requirements and determine the kind of system that would be relevant to students who share common textbooks for similar subjects to address those challenges. User requirements analysis helped to identify more about students' needs to find ways to support them in the proposed system. This approach provided insight into what is expected and identified what to include on the system before embarking on the system development. To achieve this, the participatory design approach was chosen. This approach attempts to involve stakeholders who can yield valuable information for drawing valid conclusions. The participants designed their expected systems using paper prototypes that were compared and analysed to come up with one single system that incorporated all the highlighted issues. Once the system was designed, it was implemented and then later evaluated with two levels of students.

The evaluations followed both qualitative and quantitative approaches. Participants were given some questionnaires to describe their perceptions about the features of the created system so as to answer the research questions. Some statistical analyses were also conducted.

1.6 Thesis Organization

Chapter 2: Related Work
Chapter 2 provides an overview of the literature and related work that centres on collaborative learning and interactive eTextbooks. This chapter discusses five subtopics: Mobile learning; importance and adoption of Computer Supported Collaborative Learning (CSCL) systems as the foundation for interactive group learning; social media and tools that enable collaborations like discussion forums; messaging platforms and chat rooms; and eTextbooks for learning and eTextbook based collaborations. The chapter also highlights gaps and opportunities in the literature.

Chapter 3: System Design
This chapter describes three studies conducted to obtain user inputs for a prototype application. It considers the user requirements from a technology probe as well as a preliminary study conducted with high school level students at high schools in chosen communities. The chapter also obtains design requirements through focus groups, interviews and paper prototypes with tertiary level participants. The chapter, therefore, integrates the literature considerations from chapter 2 together with results

from this chapter and proposes a prototype application that incorporates all relevant points. The inputs formulate the basis for designing the prototype system.

Chapter 4: Implementation of the Prototype

In this chapter, the implementation of the internal and external forums proposed in the system design chapter is described. It explains how the application was developed using Web2py, a python web framework while incorporating other vital features using tools like WIRIS editor, Facebook log in mechanisms. The chapter also elaborates on the choice of eTextbooks selected for each of the platforms.

Chapter 5: Experimental Design

This chapter describes the methodology followed in evaluating the two platforms of the system: 1) control platform (eTextbook plus separate discussion forum) and 2) experimental platform (eTextbook embedded with discussions). The chapter gives detail of how the experiments were conducted while explaining the various data collection techniques that were utilised to help answer the research questions.

Chapter 6: Results

This chapter is divided into two parts, according to the level of education: 1) results for high schools and 2) results for tertiary education experiments. Each part follows the process of presenting the qualitative and quantitative findings of the experiments. Results are presented for each of the two platforms of the system: the external forums and the internal forums. These results are then discussed in relation to answering the research questions. The chapter concludes with a discussion comparing the two parts so as to formulate patterns based on the two levels of participants.

Chapter 7: Discussion and Conclusion

Chapter 7 describes how the findings of this research have addressed the research questions. The significant contributions of this research are highlighted. After that, the implications of the study are outlined. Finally, the chapter discusses the limitations of the study and opportunities for future research.

2 Background and Related Work

This chapter discusses the importance of collaborative learning and describes how Computer Supported Collaborative Learning (CSCL) has been adopted for promoting active student learning in the educational environment. It discusses traditional eLearning, as well as social media for enabling collaborations. The chapter also discusses content delivery through mobile technology.

2.1 Collaborative Learning

Traditionally, formal classroom learning has always depended on rote memory and knowledge, which is described as the foundation for learning (Huang et al., 2019). Bruffee (1995) associated foundational knowledge with primary education where students are still trying to find their place in society, yet for more advanced students, the understanding of various concepts is essential for learning. Traditional methods of learning are didactic and characterised by low rates of retention, inflexibility in applying learning, lack of knowledge transfer and one-way communication of transferring facts in a teacher-centred approach (Gillies & Nichols, 2015; Koschmann, 2002).

Chen & Bryer (2012) indicate that formal learning is only a small part of learning and is usually done in specific places like a classroom. Their statistics show that only 19% of learning is acquired formally at primary and secondary education while only 8% of learning is received formally in undergraduate learning and lastly 5% at university. Their research shows that as one progresses from primary to graduate learning, informal learning becomes more significant as it is a collaboration among connected parties. Collins & Halverson (2018) and Koschmann (2002) agree that collaborative learning is one way of addressing the known failures and challenges of traditional methods of instruction. Literature defines collaboration as the working together of peers to solve common challenges through contributions in an attempt to build mutual understanding (Kerr & Hiltz, 2013; Lipponen, 2002; Panitz 1999).

The uptake of social media in informal setups provides opportunities for innovating learning (Dabbagh & Kitsantas (2012). Ngai et al. (2015) describe social media as a computer-mediated technology that encouraged the creation and sharing of information. Through social media, users can also build ideas together and explore common educational interests. Mao (2014) describes social media as a platform that enables users to collaborate, share and create content or participate in social networking. The development of social media has greatly impacted education over the years (Eger, 2015). It is known to foster a learner-centred pedagogy that promotes inquiry-based learning as well as problem-based

learning (Middleton & Beckingham, 2015). The introduction of Internet-based social media allows individuals to converse and share knowledge about similar interests with thousands of people. A new framework known as Social Media for Learning (SM4L) has even been constructed by some researchers to help determine how social media can be utilised for active learning (Middleton & Beckingham, 2015). The framework is a set of principles that can be used wholly or in part to guide the design of social media enhanced pedagogies. Middleton & Beckingham (2015) report on analysed literature by Voss & Kumar about social media. The results concluded that student-centred learning themes of visibility, listening, engagement, relationships and authenticity were most relevant to learning.

2.1.1 Benefits of Collaborative Learning

Vygotsky (1962) states that knowledge generation is a group work participation process as opposed to an individual process. Brown (1994) also stresses that individuals cannot exist alone, nor can they know everything; instead, they need to collaborate with others to survive. The importance of collaboration as a fundamental human activity necessary for development is also stressed in various other literature (Collins & Halverson, 2018; Noh & Husuf, 2018; Tomasello, 1999). Koschmann (2002) also reinforced this argument that learning in groups is necessary and more favourable than individual learning because it provides opportunities for exposure to multiple perspectives and interpretations as well as allowing learning to generate knowledge through reasoning and questioning.

The process of confirming one's understanding in collaborative groups provides a means to enhance and broaden one's perspectives and facilitates the resolution of any cognitive conflicts (Jonassen, 1992). Vygotsky (1962) states that through engagement with others in collaborative activities, individuals start to understand concepts that they could not before. Collaboration, therefore, facilitates an individual's cognitive abilities through socialisation. Vygotsky (1962) also argues that the lack of mechanisms that enable an experienced learner to share their knowledge with less advantaged learners limits the intellectual development of many learners. In summary, environments that foster interactions and collaborative activities have been associated with positive learning outcomes (Savery, 2015). Among others, there are four main pedagogical benefits of collaborative learning: 1) improving critical thinking skills; 2) promoting the co-creation of knowledge and meaning; 3) enabling learners to reflect; and 4) promoting transformative learning (Jeong and Hmelo-Silver, 2016; Zhang et al., 2007).

Mayer and Alexander (2016), as well as Paritz (1999), emphasise the combination of two instructional methods of a teacher to student learning and student to student learning as equally essential to

successful learning. Paritz (1999) explains the need for traditional lectures as crucial for presenting complex ideas that may not be readily available to learners. Johnson et al. (1998) also explain that formal learning creates the conditions necessary for the construction of knowledge by giving out learning material that is processed by existing cognitive structures within the schools. In informal set-ups, learners get the opportunity to process the material further and hence reconstruct meaning to understand the classroom lessons and the supplied studying materials.

2.1.2 Computer Supported Collaborative Learning

Traditionally, students have conducted collaborative studies through face to face group meetings to help one another overcome classroom learning challenges. Instead of only relying on teacher expert frameworks and textbook-based frameworks, they build their understanding by discussing various topics with others after the formal school lessons (Johnson, 1991). As students engage with others, they create their own conceptual framework and meaning to discourse, tying current and prior knowledge for better understanding of what they are learning in the classroom (Jeong and Hmelo-Silver, 2016).

Although there are many advantages of face to face collaborative group work studies that supplement the traditional classroom learning, there are also various challenges that have existed for a while now (Forsyth, 2018; Simpson, 2018). Some of these include:

i. Scheduling meetings may be difficult. This challenge is especially prevalent in most African homes where students have household chores and religious commitments or parental time restrictions (Simpson, 2018; Fiechtner & Davis, 1992).
ii. Student-selected groups often involve teammates who are friends. This challenge prevents diversity as intelligent students may cluster on their own while others feel left out.
iii. Large groups usually have insufficient time to be cohesive. As a result, groups must be small enough (usually 2-4) to promote interdependence yet large enough to encourage diverse opinions (Mullen & Copper, 1994).
iv. Group work may have issues like power and dominance from specific individuals. Introverts become left out (Forsyth, 2018).
v. Forming groups can be challenging hence, students tend to dissolve them, making them less reliant continually (Forsyth, 2018; Fiechtner & Davis, 1992).

The challenges mentioned above have been here for a while. However, with advances in technology, almost all these challenges can be mitigated. With the introduction of technology, collaborative

learning evolved to computer supported collaborative learning (CSCL). CSCL focuses on the use of technology to facilitate the sharing and distribution of knowledge through peer to peer interactions (Lipponen, 2002). Technologies have changed how people interact (Schummer & Lucosch, 2013). Although computer technologies also have issues of their own like most digital phenomena, they are good at solving particular kinds of challenges: time, distance, space and communication challenges (Chen et al., 2018; Ramnarain, 2014). Stahl (2012), however, also states that face to face interactions can shape CSCL applications. Harasim (1991) and Brandon & Hollingshead (1999) also agreed that the design of online group work studies should draw its concepts from the traditional face to face interactions. Technologies help create an active participation environment that is readily available to students, enabling instant interactions and longer cycles of productivity (Ramnarain, 2014; Gikas & Grant, 2013). Also, individuals do not get to choose group members but join communities as equals. The benefits of CSCL are said to be most evident in large groups of students, which may allow the discussion of complex problems (van Boxel et al., 2001).

One concern of CSCL is the lack of social cues, which may lower the sense of belonging among group members (Chen et al., 2018; Wainfan & Davis, 2004). Negative communication is an ongoing problem. Lack of participation is also another challenge and research towards increasing interactions are ongoing to address the problem. However, research shows that the Web has the potential to promote users to be confident in asking simple questions that they would otherwise not ask when they are in traditional group work set-ups (Mlotshwa & Chigona, 2018). Bali (2014) states that when socialisation is correctly engaged in, it may be beneficial rather than disruptive.

2.1.3 Theoretical Frameworks of CSCL

CSCL is based on two critical parts that follow two theoretical frameworks: constructivist theory and collaborative theory through socialisation (Lipponen, 2002). There is, however, still uncertainty as to the theory directly associated with collaborative learning since it tends to touch on many theories (O'Donnell et al., 2013; Stahl, 2012). Figure 2.1 summarises the essential parts of CSCL. CSCL supports groups of people in online communities who want to solve problems together, sharing ideas socially in order to negotiate and derive meanings. CSCL is also important for the construction of knowledge that formulates meaning to participants who are collaborating in virtual communities (Chen et al., 2018).

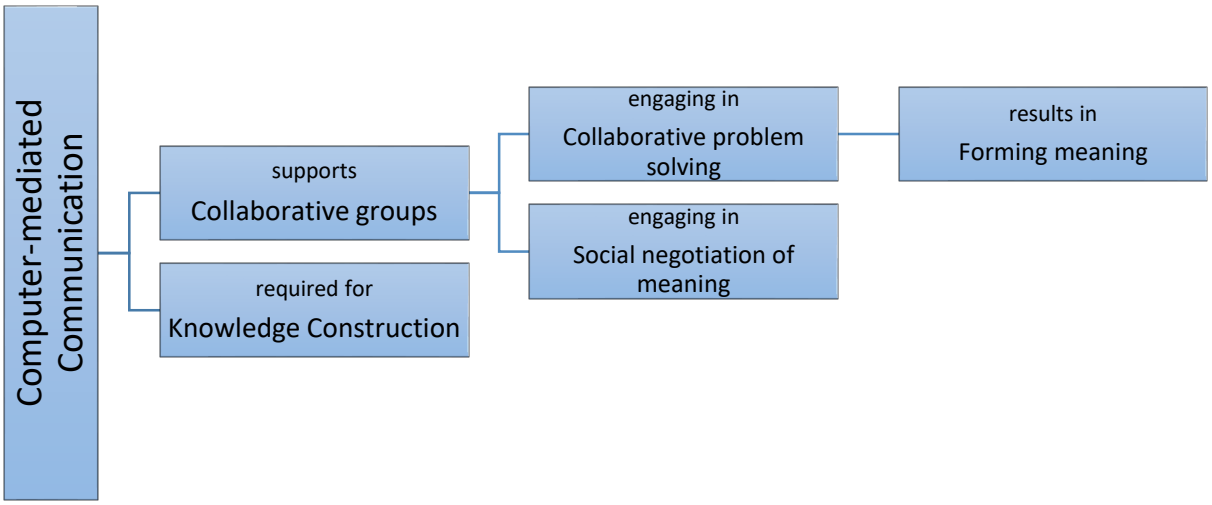

Figure 2.1 Computer-mediated communication (adopted from Lipponen, 2002).

According to Panitz (1999), collaborative learning models were founded on the constructivist epistemology, which was discovered by John Dewey, an educational philosopher, and Jean Piaget, a psychologist. As the name suggests, constructivism is focused on constructing new ideas based on known knowledge to gain understanding (Bada & Olusegun, 2015; Lipponen, 2002). As an individual is exposed to multiple perspectives, they begin to create knowledge. Constructivism emerges within a social context, i.e., a group of individuals communicating together to find a mutual understanding of common issues (Pritchard, 2017).

Learners tend to have different perspectives despite being on the same level of cognitive development (Hanko, 2016). Cognitive objectives of learning may be broken down into simple mental tasks that involve memorisation, translation and applying simple rules (Howells, 1995). They also represent complex cognitive tasks, which involve combining concepts, making decisions based on facts and understanding relationships within the content (Howells, 1995). From a social-cohesion theory perspective, better outcome results from a group of individuals who combine resources (Brandon & Hollingshead, 1999). During interaction with others, there is the resolution of cognitive conflicts and information is actively processed by each, which then transforms the individual's reasoning (Chen et al., 2018; Pritchard, 2017). Vygotsky (1962) views the cognitive development of structures as a process of mediation and modelling, which happens as individuals communicate. Webb & Palincsar (1996) also explain that cognitive structures occur when students use examples to explain concepts. Brandon & Hollingshead (1999) agree that one may use multiple visualisation techniques, e.g. diagrams, images and figures to differentiate concepts, create analogies, to support and justify their opinions. Such elaborations may help members of the group to reach mutual understandings of various concepts and help each other build understanding (Hanko, 2016).

2.2 Technologies that Promote Collaborations for Learning

2.2.1 Electronic Learning

Electronic learning, also known as eLearning, is defined as computer-based learning (Horton, 2011). It is also the use of information technologies to build learning experiences (Mahmoud et al., 2016). Horton (2011) explains that eLearning is not only restricted to coursework content but comes in various forms: through games, standalone course subjects and simulations. eLearning is also associated with mobile learning, social learning and virtual classroom learning. eLearning has evolved over the years, moving from focusing on the tools and technologies to the exploration of various pedagogical practices that technology enables (Garrison, 2011). Traditionally eLearning has been used to promote learning outside the classroom in the same automated model of classroom learning. The difference in traditional classroom learning is that learners do not have to be together but can learn at home. Most eLearning platforms have been primarily focused on self-paced learning (Dabbagh & Kitsantas, 2012). LMSs and CMSs are examples of eLearning platforms. Learners usually engage online using desktop machines and laptops to learn together. However, with mobile technology, it has become known as mLearning. MLearning is considered to promote potent user-centred tools that foster learning at any place or time (Kasim & Khalid, 2016).

LMSs are software applications like Moodle and Blackboard that enable the administration of course-work, documentation and sharing tracking and reporting of course content by enrolled students (Ting et al., 2015; Pilli, 2014). The primary function of LMS software is to deploy and track online initiatives related to courses (Pilli, 2014). Many universities widely adopt LMSs for managing course content. Some research shows that a high number of learners tend to use the system only for specific tasks like uploading assignments and reading course-related news (Pilli, 2014; Unal & Unal, 2014). They are characterised by containing quizzes, recordings, presentations and enable the uploading and sharing of academic materials. However, one missing essential component of LMSs is the group social networking interactions feature that is found on social platforms like Facebook and Twitter (Facebook in Education, 2016). That means they support formal, non-social learning, using technology. Pollaro & Zhu (2011) clarify that LMSs already offer collaborative measures through chats blogs, wikis and discussion forums, however, according to a case study they conducted, in comparison to Facebook, students interacted better on the Facebook platform. This ascertains the lack of collaboration on CMSs.

The connectivity and openness of social learning are lost in the current LMSs (Chen & Bryer, 2012). Chen & Bryer (2012) elaborate that LMSs provide limited support for discussions and chats. LMSs can

be combined with social media features like commenting, instant messaging, group discussion boards, videos, audios, and posts. Offering social capabilities on LMSs can promote better learning and self-motivation (Prior et al., 2016; Pilli, 2014). Chen & Bryer (2012) suggest that social media can easily connect formal to informal learning by grouping world-wide experts in the field onto one platform with learners. Skiba et al. (2016) highlight that computer-based instruction is better than the traditional-based instruction where social learning is concerned.

2.2.2 Social Media for Learning

Social media is a Web 2.0 technology. Web 2.0 technologies enable user-generated content (UGC), thereby allowing the easy sharing of information and collaborations among social media users (Carroll et al., 2015). Anderson (2005) defines social technologies as tools that give users the freedom to choose the "time, space, presence, activity, identity and relationships". Both definitions agree that social media is the integration of technology in group communities to communicate and collaborate on content without hindrances.

Collaborative learning in an online set-up can involve a whole classroom or groups within a classroom or many classes or many schools (Chao et al., 2015). Universities are hubs of knowledge with a group of people seeking similar interests. The Internet enables connectedness, which then promotes interactions. The ease of access to the Internet allows prompt communication and knowledge sharing. Collazos et al. (2007) state that there are two learning goals in collaborations, learning to collaborate and collaborating to learn. When students are given questions to ask and answer, this helps to test the theory of learning to collaborate. Learning the subject matter through collaborations helps to test the theory of collaborating to learn. In this experiment, two groups of participants attempt to complete tasks in the process of learning to collaborate and collaborating to learn. The system provides communication and coordination support for asking and answering questions as a way of collaborating in an online community.

Social learning or learning as part of a group has many benefits that help students to think critically about their work, reflect on what they are learning and then co-create knowledge to share with others (Dabbagh & Kitsantas, 2012). The social context explores a model of communication required to motivate group work interactions (Goldie, 2016). As such, knowledge emerges and gets distributed through a network of interacting individuals. Networked learning environments are stated to be the best applications for collaborations (Czerkawski, 2016b; Lipponen, 2002; Harasim, 2000). Wellman (2001) views communities as interaction networks, i.e., online communities are a hub of participants

with common interests to share. Online collaboration is, therefore, an opportunity for students to belong to knowledge communities whose object of interest is different from the interest of the communities they already belong to (Czerkawski, 2016b).

Greenhow (2011) summarises that using social media tools promotes active learning that focuses on the learner. Redecker et al. (2010) also outlines the four major dimensions of social media on Learning 2.0. as content, collaboration, connection and creation. Social media allows students to have ease of access to content and resources for their learning needs. Redecker et al. (2010) explains that when people have a common objective, collaboration allows the group to share resources from various places and also share knowledge and understanding, thereby becoming more effective. Users that are connected can also transfer tacit knowledge among peers and experts while having access to relevant information in a given subject (Czerkawski, 2016a; Goldie, 2016). Lastly, social media promotes the creation of content that is generated by users to benefit both students and experts (Carroll et al., 2015).

According to Goldie (2016) and Chen & Bryer (2012), assessment is difficult to conduct with social media. Chen & Bryer interviewed personnel who instructed using social media and found that they did not have any assessment strategies. That is because the curriculum does not cater for grading on social media yet. The challenge is what exactly is assessed unless the social media is linked to conventional fixed criteria assessment quizzes or assignments. They concluded that students could be evaluated for their learning progress by reviewing their reflections on what they have learnt through networking platforms. This may be observed through the content being discussed.

Although social media has great benefits where learning is concerned, there are some concerns about it (Greenhow & Lewin, 2016; Moran et al., 2011). The major concern is around privacy and security for both students and instructors. For instructors, social networks have the potential to ruin professions if not appropriately utilised. Since one cannot control what is distributed on the Internet, several instructors tend to avoid using social media for learning. Observations from various research show that learners usually do not associate social media with learning. They do not consider social media as necessary for facilitating learning (Chen & Bryer, 2012). Another concern is that of social media providing distractions to learners. Instead of focusing on educational needs, students may end up focusing on other interesting media on the platforms. As a result, some instructors or institutions avoid them since it is easier to control information using traditional methods of learning (Gikas & Grant, 2013). Other concerns centre on ethical issues around befriending students, as a result,

instructors tend to avoid any form of social communication with learners till after graduation (Chen & Bryer, 2012).

However, to curb this, research has shown that support from faculties may be necessary for the success of social media. This is because students are usually disciplined on formal course management systems. Also, teaching and training learners around social media for learning may make the platforms successful for the learner needs (Simoes et al., 2013). Siemens (2014) distinguished enacted learning to that of objective learning as relevant, i.e. using the Facebook tool as is and adopting it for teaching and learning or altering Facebook such that it fits into the goals of learning. Chen & Bryer (2012) suggests that we need ways of measuring the effectiveness of learning in such real-time contexts.

Social media is considered an "excellent fit" with the current pedagogical activities that promote collaborations (Blaschke & Brindley, 2015). With the different social media platforms that have been adopted in learning, the major challenge is choosing a type that is suitable for a specific learning context as well as designing it appropriately to meet the tasks that encourage learning (Dekker & Engbersen, 2014). Table 2.1 shows an adapted framework that combines Prensky's comparison to the classification scheme given by Kaplan & Haenlein (2010). The table also includes other new tools that have become common to the classifications given, particularly the social networking class. The classification categorises various social media tools that are best suited to support different skills (Ally & Khan, 2015). However, for this work, only tools that promote the acquisition of collaborative skills are shown on the table. An in-depth discussion of these tools is provided underneath to enhance exploration and understanding of their effectiveness in collaborative work.

Table 2.1 Skills and classified social media software applications for enabling collaborations (created by Ally & Khan, 2015)

Classification	**Skills generated**	**Software Applications**
Collaborative Projects	Collaborate; communicate (read, write, discuss and interact); construct knowledge (individual and group); socialise; navigate; socialise; solve problems; think deeply, critically and logically; reflect; evaluate.	Wikis, Google Docs, Brainstorming tools (e.g. mind maps), Mashups, Dropbox, Box.net, Asana, Slack
Social Networking	Collaborate; communicate (read, write, discuss, interact); search; explore; listen; connect; share, think critically; reflect;	Twitter, Facebook, LinkedIn, Social Tagging

	support others; build community, promote (self); exchange.	(e.g. Flickr and Pinterest), Cloud works
Content/Information Sharing Communities	Collaborate; communicate (read, write, discuss and interact); search; compare; inquire; combine; think critically; reflect; observe; share; build community, promote (self); distribute.	YouTube, Diigo, Twitter, LinkedIn, News Aggregators (RSS), Evernote

i. Collaborative Projects

Collaborative projects can support student interactions and collaborations. Collaborative projects also promote knowledge construction, help solve problems, encourage peer reviews, help understand texts and engage students in classroom tasks for either individuals or groups (Savery, 2015; Harris & Rea, 2009). Collaborative tools, like wikis and Google documents, are stated to be suitable for supporting student-student collaborations, promoting discussions and dialogues on shared project tasks (Savery, 2015). They are associated with bringing balance to the student-teacher relationship.

Wikis are websites that may be edited and are easily accessible to contributors of that content, thereby creating a sense of responsibility and ownership by the whole group (Ioannou et al., 2015). With Wikis, users can write text on a Website or post images and videos collaboratively, thereby continuously improving and updating the site (Eteokleous et al., 2014). The advantages of Wikis are that they are very quick and easy to access. According to a study conducted by Raitman et al. (2005), at the commencement of Wikis, they were considered to be less efficient and to have poor interfaces that lacked organisation of content on a page due to cluttering. However, current case studies that attempt to use Wikis in educational content show that Wikis facilitate collaborations, problem solving and peer editing (Eteokleous et al., 2014). Like Wikis, Google Drive and Dropbox also allow users to share files that can be edited collaboratively (Kilgus et al., 2016). Besides editing, Wikis, Dropbox and Google Drive help individuals that are collaboratively working together on similar projects to have access to similar resources (Gomez et al., 2018). Asana is also one of the currently popular project management software that manages, tracks and promotes collaborations among team members. Slack is also a cloud-based system that allows team work collaboratios to ensure easy knowledge sharing and transparency of a project. In summary, all these tools grow a knowledge base around particular content for interested individuals. For example, a folder containing documents, spreadsheets, PowerPoint presentations and other media files may be shared among interested individuals to benefit a project. This is beneficial in that everyone has access to the required files

whenever they need them to advance the project. Users may also chat on the side for discussions that are not to be conducted inside the document, which may be very useful for users who want to work together on mutual documents (Bergner, 2017).

ii. Social Networking

Literature states that virtual communities and online social networks are suitable media platforms for managing knowledge (Kimble et al., 2008). These platforms promote eLearning by enabling content sharing and collaborations among learners (Veletsianos & Navarrete, 2012; Grenhow, 2011). Ting et al. (2015) suggest that the interactive function of Facebook groups is a favourable feature that may be adopted together with the traditional LMS features, thereby developing a Facebook-based LMS. However, Facebook is known to have its challenges of less-structured responses, privacy and security issues that are key to LMSs (Ting et al., 2015).

The literature agrees that interaction is an important feature and must, therefore, be provided in LMSs (Ting et al., 2015). Ting et al. (2015) state that much research is now shifting from traditional eLearning to social networking-based eLearning. The belief is that social networks can provide better interactions. Much deliberation rests on how social networking has a significant influence on education (Eid & Al-Jabri, 2016). Social networking tools support interactions among community members (Eid & Al-Jabri, 2016). Conole (2012) and Rodriguez (2012) describe them as tools that offer new pedagogical learning practices and peer-peer support. Social networking sites help create communities and connections among peers who want to share resources, views and exchange ideas (Pilli, 2014; Conole, 2012). Social networks are also focused on building online communities with similar interests. Their popularity has channelled investigations of their success for enabling collaborative educational interactions (Eid & Al-Jabri, 2016). Social media applications are viewed as the appropriate tool for the emerging pedagogies of modern learning that require solving problems in groups (Ally & Khan, 2015).

Eger (2015) states that social networking can have a positive effect on education, particularly distance learning. Because social networks promote easy communication among students, allowing dialogue and the exchange of information, social media should be a tool for enhancing the quality of learning (Anshari et al., 2016). Ally & Khan (2015) also state that the acquisition of understanding complex concepts in collaboration with peers can be aided by the active application of social media in social learning environments. Because social media is associated with fun and general social connectedness, some researchers argue their usefulness in education (Grenhow & Askari, 2017). Grenhow & Askari (2017) also state that to others, social media is not a serious environment for teaching and learning.

Eger (2015) describes the pros and cons of social media as a controversy since there is a wide range of documentation around the inappropriate utilisation of computers and mobile devices during class time. Much documentation also exists on the use of ICT to support learning activities and learning outcomes.

Examples of social networking tools include wikis, blogs, content communities, forums, chat tools and social networking sites. Each tool has unique affordances that can be tailored to meet different learning challenges (Bates & Sangra, 2011). For example, video tools have a high degree of communication but have a low degree of cooperation (Giannakos et al., 2015). It is therefore vital to choose appropriate media and their tools in order to provide collaborative and dynamic learning spaces that are considered useful by learners.

Facebook, Twitter and LinkedIn are social networks that have become a way of communication for millions of individuals every day (Dron & Anderson, 2014). These tools have been prominent for socialising and messaging. They are also being channelled for educational purposes. Although social networking has many advantages that may be utilised in the educational system, especially considering its success in promoting conversations among groups of people, they were not primarily designed for learning and hence are not yet strongly tied to the educational system to be very effective (Eger, 2015). A workspace is necessary for students to communicate and learn since it would trigger interactions (Lee et al., 2010). Social networking platforms have forums that promote collaboration (Geelan, 2014). Forums have become common in eLearning environments because they support the social constructivist pedagogy (Iouannou et al., 2015).

iii. Content and Information Sharing Communities

Online communities promote the sharing of resources and information among learners. Conole (2012) states that such an environment supports "self-directed learning, inquiry-based learning, collaboration and interactions among learners". Conole (2012) also says that online communities act as a suitable platform to distribute, in various ways, multimedia, e.g. presentations, recorded lecture videos, images. These resources act as additional classroom content to students. Both LMSs and social networks encourage the delivery of content among learners (Pilli, 2014).

From the above social media tools and the skills they provide, this work mostly focuses on social networking and content sharing for enabling learning.

2.3 Discussion Tools for Enabling Collaborations

When learning from distance learning platforms like MOOC applications such as Coursera and Udacity, forums and chatrooms are known to be the critical support for learning to those who need assistance (Coetzee et al., 2014a; Hew & Cheung, 2014). Coetzee et al. (2014a) suggest that asynchronous forums work best with chat rooms or private messaging. Learning can either be synchronous occurring at the same time or asynchronous occurring at different times. Asynchronous learning environments allow users to leave messages and information for others to read when they enter that environment (O'Malley, 2012). Even though some applications allow scheduling of appointments for meeting times when everyone is available for collaborations, asynchronous communication is preferred for CSCL environments because it is flexible for distant learners who may never be available at the same time (McConnell, 2014). Hawkes (2006) and Motiwalla (2007) both found that asynchronous online environments promote more reflective learning through archived interactions if compared to face to face interactions. Synchronous environments, however, promote more in-depth discussions that involve immediate clarifications and further probing from those with better knowledge (McConnell, 2014).

2.3.1 Chatrooms

A chatroom is an instant messaging and communication channel through the internet for individuals with common interests (Coetzee et al., 2014a). Chatrooms have a limited barrier to conversations and allow users to obtain answers faster than when using forums that can take longer (Spencer & Engenberger, 2016). Also, there is the advantage of back and forth interaction among peers, thereby allowing relationships to be created and communities to be built. Coetzee et al. (2014a) also conducted a study where they embedded chats parallel to videos and results show that this scenario prevented self-study but had no other adverse effects. They conclude that embedding tools on artefacts provide greater communications than when separated. Also, chat rooms preserve chronological order of discussions, thereby avoiding communications that are fragmented across a given artefact.

A study conducted by Coetzee et al. (2014a) suggests that chat rooms do not affect assessments or understanding and even user participation. They explain that chat rooms do not create a sense of belonging to a community. Their results conclude that there is no benefit of including the chat rooms where students are concerned. Chats do not degrade forum participation or learning and can allow those who prefer private conversation to not participate in forums (Anshari et al., 2016). However, their operating cost must be minimised to justify supporting only a few learners (Coetzee et al., 2014a). New ways of chat interactions are also being explored, for example, recent technologies are

investigating computer-mediated spoken interaction that allows few individuals to interact at the same time using voice-based technologies (Brandt & Jenks, 2013). MOOCs also incorporate chat rooms for interactions. Students may join various chat rooms for their needs. However, chat rooms need to be sizeable to be effective (Nelimarkka & Vihavainen, 2015).

2.3.2 Discussion Forums

Discussion forums or forums are platforms where messages are exchanged over time (Onah et al., 2014). In most online distance learning platforms, forums are the main means of interaction (Vigentini & Clayphan, 2015; Onah et al., 2014). Their primary function is to support asynchronous communication and collaborations among students. Forums support social constructivism as such, they are widely adopted in eLearning setups (Rabbany et al., 2014). Traditionally, they are used within LMSs as a means for enabling dialogues among connected individuals about course content (Chen & Bryer, 2012).

Largely, the discussion forums and chat rooms in LMSs tend to have structured communications that may be monitored and with character limits (Maleko et al., 2013). Salter & Conneely (2015) state that the structure of the traditional forums can affect how students engage in discussions. Forums are categorised into topics that individuals may follow and create discussions upon. The major drawback is that when used on LMSs, they are confined to students within a school who are registered for that course. However, this is also considered a security measure for the varsity in terms of enrolment fees and also for removing clutter from uncommitted external parties. Because of their focus on selected groups, they do not reach out to broader communities (Brady et al., 2010). Students who do not belong to the classes but have an interest in the subject cannot have access to them. However, on applications like Google groups and Slack, the forums reach out to wider communities that have similar interests.

Forums are communities of people learning from one another asynchronously about the course content. Instructors can observe what students are having difficulties with through the discussions they initiate. Forums are also associated with MOOCs (Coetzee et al., 2014b). MOOCs incorporate collaborative measures through peer to peer learning as well as peer feedback for larger communities. Examples include Coursera and EdX. MOOCs, unfortunately, have faced considerable numbers of dropouts and investigations are in order so as to improve the way that students learn online (Yang et al., 2015). One of the challenges that students face on these platforms is the time available to complete online task obligations (Zheng et al., 2016). MOOCs are expected to change the way of learning; they are more focused on learning electronically as opposed to attending traditional classes.

In this thesis, the focus is on students who attend formal lessons and yet require discussion forums for understanding the content learnt in class with others who share similar interests.

Although forums facilitate better learning, Baxter & Hayhock (2014) state that they tend to affect how students remain excited about a subject and how their identity status is perceived. Onah et al. (2014) explain that forums are not good at handling large amounts of posts with fragmented topics over too many threads. They also explain that the search facility is important in identifying posts on forums. Notifications have been created to help keep track of posts (Ioannou et al., 2015). Onah also states that forum usage is usually noted as low and confined to a few individuals in a group. Also, peer answers to posts may be unreliable and hence reduce productivity (Schweizer, 2013).

Although some past studies indicate that discussion forums are not as useful for learning (Thomas, 2002), other subsequent studies find them very essential to learning (Onah et al., 2014; Cheng et al., 2011; Palmer et al., 2008). Prior research has shown that threaded discussions are an effective means for engaging learners (Johnson & Johnson, 1999). Threaded discussions are effective in that they enhance individual thinking capabilities, promote participation, enable reflection of peer contributions and promote self-analysis of diverse ideas before sharing opinions (Onah et al., 2014).

Because instructors may not have the time to assess every student's work for large classrooms, peers communicate and assess one another's work on student-based discussion forums, forming communities (Onah et al., 2014). Such communities have become useful for seeking assistance since they form a large group of individuals who share common interests and voluntarily work together to benefit each other despite not knowing one another (Wellman & Gulia, 2018). The Web-based environments in which forums are deployed provide support to students through the sharing of ideas, knowledge and feedback (Abel, 2015). Students achieve this by posting questions and receiving responses on various topics. The aim of modern learning strategies is to promote active learning, and discussion forums promote this (Miller et al., 2014).

In most network environments, collaborations are mediated mainly through written language. Some literature states that writing down thoughts makes thinking visible and allows students to reflect on ideas (Swain et al., 2015). This helps students of varying knowledge and competencies to take time in understanding various sources of information before reaching a consensus about it. Discussion forums typically occur as open platforms, which discuss unbounded topics like on Stack Overflow or as bounded discussion topics, that are course oriented (Hsiao, 2015). However, both forms rely on the

community to share knowledge and ideas interactively. In this work, course-oriented discussion forums are our focus. The popularity of LMSs for managing course content and enabling course-related communications is indicative of the current trends of learning that occur at any time and are conversational in nature (Farin et al., 2016). The discussion forums have become the knowledge source for the coursework (Miller et al., 2014). The idea is to share knowledge on given resources. Discussions seek answers from the course community, following a Q and A model for discussion forums (Anbalagan et al., 2015; Cui and Wise, 2015). Most questions are either informational with one definite answer or conversational with many posts building to a mutual understanding.

Miller et al. (2014) describe discussion forums as necessary for learning. They also state that forums are presented as an 'afterthought' for learners to use anyhow, which may make them dysfunctional. Cui & Wise (2015) conducted a study that identified if discussion forum posts were content-related. Their study revealed that, of all the posts, only 28% were related to content even though the course offered other dedicated areas for asking non-content related matters. Traditional forums tend to support topics focused on course administrative issues like reporting problems and directing other learners, however, a more directed discussion forum may filter such posts (Onah et al., 2014). McGuire (2013) also agrees that forums attract many student complaints instead of focusing on course material challenges. Students overlook boundaries and ask unrelated course questions. Non-content posts therefore dominate.

Miller et al. (2014) investigated the idea of producing high-quality interactions through seeding the forum with content and varying the sections of comments revealed to students. Results from their study indicated that seeding, which is selecting prior-semester comments from stimulating topics and incorporating them into the new semester, inspired an above average amount of discussions. They also subdivided the forum into sections to give everyone a chance to discuss since students complained that discussion forums were usually filled with the same comments that they would have liked to share themselves. Their results show that the quality of annotations increased when previous posts where added on current forums to initiate and encourage discussions.

Many other studies seek to improve the quality of posts. Yang et al. (2015) attempt to improve the quality of posts by removing confusing posts that tend to lead to student dropouts or lack of participation. Other research focuses on encouraging more interactions. Yang et al. (2015) state that making many posts improved learning, while contradictory research argues that a high number of posts does not necessarily improve learning outcomes (Onah et al., 2014). Yang (2013) also explore

the increase of interactions through the instructor's presence and highlights the value of their input in directing the forum discussions.

Although there is a body of work that investigates mobile learning applications, much of the research is not related to high school education but is more focused on tertiary education. Only a few applications have been adopted for secondary or high school learning. Won et al. (2015) reports on a social networking forum (SNF) that was used by middle school youth in the United States (US) for a Science, Technology, Engineering and Mathematics (STEM) learning program after school. Won et al. base their application on SNF as a form of social media that enhances interactions with the ability to record interactions that can be accessed at any time or place, allowing the youth to connect the classroom environment to their after-school environment. Facilitators played a significant role in encouraging the youth to post on the SNF. Results show that through the forum, students were able to connect and share knowledge while exchanging ideas. Results also show that the use of SNF helped in tying formal learning to informal learning via social media. According to their experiment, collaboration took place in three ways: discussing ideas, comparing methods and posting questions.

According to Finkelstein et al. (2010) and Dillenbourg et al. (2009), with the use of Web 2.0 tools, CSCL is flourishing and should be explored further. Popescu (2014) suggested combining many Web 2.0 tools for the creation of collaborative learning environments. In an attempt to achieve this, Popescu created a platform called eMUSE, which uses mashups that integrate Twitter feeds, wikis and blogs, for easier integrated collaborations (Popescu, 2014). The outcome of their research suggests that an integrated platform, with all tools provides a sense of community among learners, this is considered important in academic setups. Rennie & Morrison (2013), on the other hand, had previously argued that if the content is created to include various networking systems like blogs, social networking sites, wikis and more, tracking might be challenging, and content might not be accessible.

2.4 Content Discussed on Interactive Platforms

As already explained, the content to discuss is significant for any collaborative platform. When discussions among students occur, there is usually an object of interest that leads to those interactions. Most discussions occur concerning course content or other available resources (Reychav & Wu, 2015). Textbook and classroom PowerPoint presentations, therefore, frequently act as the source of content that drives discussions. An entity of interest among communities is referred to as a boundary object; it can either have various identities in different communities or maintain a common identity across communities (George & Kohnke, 2018; Harvey & Chrisman, 1998). Boundary objects can coordinate a group of individuals without a consensus about their aims and interests. They can

serve as the glue that binds and connects different communities. Boundary objects enable interactions through communication, coordination and collaboration across boundaries to jointly transform knowledge (Harvey & Chrisman, 1998). One example of a boundary object is a textbook, which is a familiar object to students within a school or many schools (Montoya, 2017). There are many ways of linking the content related to courses with CSCL activities. Discussion forums are usually linked to various resources like an eTextbook, presentation notes and assignments for the associated course.

2.4.1 Using eTextbooks for Learning

eTextbooks, as opposed to hard copies, have become common due to their cost, lightweight and ease of use on mobile devices (Matthew, 2014). The popularity of electronic textbooks is due to their great flexibility and accessibility when compared to the hard copy textbooks; students can now read them on any device, at any place and at any time. Besides their low cost, eTextbooks are also appealing because they can include static or moving visuals, video clips and supportive materials like audios, links to Web sites or dictionaries (Dennis et al., 2015; Woody et al., 2010). Woody et al. (2010) conducted a study to determine if students preferred paper-based textbooks to eTextbooks; the results from their study showed that students still preferred paper-based textbooks. However, over the years, eTextbooks have gained popularity, and students now prefer electronic textbooks to paper-based eTextbooks, perhaps not by choice but because they are cheap and light in weight (Mulholland & Bates, 2014). Dennis et al. (2015) also did a study and found that participants who used the eTextbooks, with videos and annotations embedded, scored significantly higher marks on tests compared to those who used hard copy books. eTextbooks have become a cheaper source of information, however, access to them does not necessarily improve learning outcomes as students sometimes may not understand the content of the books (Dennis et al., 2015).

The primary challenge of eTextbooks is both incorporating technology to enable understanding of textbooks and the free accessibility to eTextbooks. In developing countries, publishers and authors who own books are reluctant to convert those books into eTextbooks. Publishers are reluctant to digitise their traditional paper textbooks because of concerns about piracy, and the risk of losing sales (Cheung et al., 2015). Many authors have spent years writing books and feel like putting their books on the Web will lower their sales; this makes the eTextbooks seem like an unwelcome interruption to the way they distribute books. Butler (2005) stated that publishers make more than 90% of sales of printed textbooks and hence are not willing to walk away from that market. However, other publishers have realised that eBooks are here to stay. In developed countries, over the past few years, publishers of educational textbooks now offer eTextbook alternatives to the majority of their hard copy school textbooks (Laski, 2017). Pearson, McGraw-Hill Education, John Wiley and Sons and a few other

publishing groups came together to form a consortium for eTextbooks, selling the books at half the price of the original print texts (Laski, 2017). However, these books were governed by digital rights management, which means that students only had access to the eTextbook for a semester, after which it expired. Students also could only print the eTextbook once and could not copy the books from one device to another, which enabled the publishers to maintain their sales and limit the competition with second-hand books.

Butler (2005) describes a model that may be adopted, which includes licensing content broadly through libraries such that students electronically access them out of the library as they would usually do with hard copy books. Some sites like Wikibooks now offer free eTextbooks to download without any digital rights restrictions (Hoosen et al., 2016; Ioannou et al., 2015). Open-source textbooks are usually short texts that are created by a domain of teacher experts who come together to create modules for student guidance.

2.4.2 Accessibility to Open Source eTextbooks

Local content that is freely accessible to students is limited (Hinic-Frlog et al., 2019; Tambo et al., 2016). In South Africa, dedicated experts author books that are accessible online, peer-reviewed, interactive, and free of charge (Czerniewicz, 2016; Pitt, 2015). These books are considered supplementary textbooks to the hard copy textbooks, however, they are not enough. Open source textbooks refer to eTextbooks that can be downloaded for free by users. The free educational textbooks use copyright licenses that allow anyone to freely “reuse, revise, remix, and redistribute” them (Wiley, 2014; Robinson et al., 2014). Research has been done to conclude that open source textbooks have the potential to improve educational outcomes as well as increase accessibility to students who would otherwise not have content (Robinson et al., 2014). Hinic-Frlog et al. (2019) have even explored the interactivity of open source eTextbooks through interactive elements to support student learning. Their study also helped identify possible challenges to improve future studies in the same regard.

Some publishers are offering their books electronically (Hinic-Frlog et al., 2019; Clark & Philips, 2014). Addressing licensing issues is a major challenge (Wiley, 2014). Approaching publishers to convince all of them of the digital change might prove difficult considering that there are many authors associated with each book. To address licensing issues, educational stakeholders are now responsible for creating local content that is curriculum-based and is relevant to students in their regions (Clark & Philips, 2014). The urgency is to appropriate digital technology into schools with freely accessible content

even though that will also mean transforming the pedagogical practices in these schools (Czerniewicz, 2016). This tends to affect high school students who utilise dedicated standard books and have teachers who are accustomed to specific physical textbooks for teaching.

2.4.1 Co-reading of Textbooks and other Shared Resources

To promote collaborative learning, Chang et al. (2018) proposed a multi-user real-time co-reading system based on WebSocket whereby learners watch videos simultaneously in the classroom. The results show that teachers were able to observe the progress of learners immediately thereby adjusting the learning activities accordingly. Their system incorporated a chat room for discussing and sharing ideas based on the videos. Thoms & Poole (2017) highlight the challenges and benefits encountered when collaboratively reading. Co-reading encourages a more open approach to learning and also enables students to critically analyse the text that they are reading. The challenges, however, include having comments that hinder others' understanding of the text and ensuring that students actively participate by providing distinct comments from others to avoid being socially viewed as lethargic. Collaboratively reading online is also assumed to be better than face to face collaborative reading. A study was conducted to compare the quality of a summary text after co-reading an academic book online or face to face. The results showed that a higher quality was observed from online co-reading of the text (Passig & Maidel-Kravetsky, 2016).

The major challenge of textbook representation electronically is that they are still presented as a replica of the original paper textbooks (Craig et al., 2018). As such, the lack of interactivity does not increase the interest of using eTextbooks by students. Craig et al. (2018) explored the potential of interactive eTextbooks by creating a web-based interactive eTextbook with videos and quizzes inside. The results showed that making eTextbooks interactive can change learning perceptive as well can positively impact learning. Various attempts have been undertaken to enable the understanding of educational resources like eTextbooks. eTextbook related studies have incorporated dictionaries within the textbooks so that students do not have to exit the textbooks to seek word definitions in an attempt to understand the content (Dennis et al., 2015).

Brusilovsky et al. (1997) described two adaptive tutoring systems that may be used to support the student's learning capabilities. They propose a system known as PAT online that supports problem solving activities of a learner while tracking the student's procedural knowledge. They also propose InterBook, a system that supports the learning from eTextbooks while tracking the student's conceptual knowledge. These two systems work together, sharing knowledge about a student so as to enhance their learning experience. As students work out problems, the tutoring systems provide

assistance, identify issues and keep track of the student's progress (Brusilovsky et al., 1997). All this is to improve the student's comprehension of what they are learning.

Dennis et al. (2015) state that various eTextbooks also incorporate automatic interactive assessments to help students test themselves as they read. Content interactions through tablets exist, however, they are mainly novel-based (Pearson et al., 2012). Research into the co-reading of educational content is scarce as most research tends to focus on creating an excellent individual experience through the incorporation of videos and annotative features (Wimmer et al., 2014; Pearson et al., 2012). Alternatives utilise group chats or discussion forums outside content. LMSs share resources on their platforms with links to discussion forums that enable students to converse around course content (Pilli, 2014). This has been a key feature to enable understanding of shared content by students even though it is currently mostly being used for administrative announcements.

Dennis et al. (2015) state that other research projects have focused on redesigning the eTextbook because of its flexibility; the Kindle and iPad provide new formats of presenting eBooks, with lots of multimedia. However, the high costs of producing multimedia books make them harder to scale for every textbook (Dennis et al., 2015). As a result, they suggest that it would make more sense to tailor existing eTextbooks to the needs of students at low cost, which may mean focusing on how students and their instructors interact with the content and one another and doing a minimal redesign of eTextbooks. Dennis et al. (2015) also state that it is better to focus on improving learning outcomes without changing existing textbooks to lower costs while expanding learning beyond the classroom. They also highlight that learning can be improved by verbally and visually presenting material for easy remembrance.

Various experiments have resulted in the good usage of videos within eTextbooks to help understand the content of textbooks (Matthew, 2014). This is especially important for practical subjects like programming, mathematics and other calculation or handwork based subjects. Electronic content with instructor annotations can also guide students beyond the classroom as they read a textbook (Dennis et al., 2015; Matthew, 2014). This may improve the way that students interpret and understand the content. Underlining and highlighting also contributes to recall (Lee et al., 2010). Asking questions contributes to meta-cognitive monitoring, thereby improving learners' self-regulation, recall and comprehension (Lee et al., 2010). According to Fouh et al. (2014), exercises are the most critical pedagogical feature of interactivity since they provide a better experience on a topic, especially since students try exercises often as they read. They investigated the relationship between

Open DSA, which is a platform for open source material and interactive exercises that support computer science-related courses, and student performance on tests and results show that a high number of completed exercises results in high performance on written tests (Fouh et al., 2014).

2.5 Mobile Devices for Learning

Computer communications are a cheaper medium of communication to telephones, mail, and sometimes face to face meetings. With the proliferation of mobile devices, also known as wireless devices, especially in developing countries, learning has also become mobile as people can now collaborate remotely via the Internet (Hosman & Fife, 2012). Although desktop computers and laptops are considered the best for online learning, mostly because of their screen size, students do not have the luxury of a computer as well as Internet connectivity (Conrad & Dabbagh, 2015). Even at school, computer labs can only allow a few students to use computers at a time. As a result, mobile devices like tablets and phones are a cheaper and more convenient alternative to owning a computer (Anshari et al., 2016; Page, 2014).

In developing countries, mobile devices were previously reserved for the wealthy. West (2015) explains that as the price of smartphones continues to fall, mobiles have ceased to be a tool of an elite minority. Now, a high percentage of individuals, from both rural and urban areas, have access to mobiles despite background challenges and inadequate incomes (West, 2015). In a pilot study conducted with high school students at the beginning of this research, more than 70% of the students own mobile devices. The cheaper Chinese-made products are a common substitute for the expensive brands like Samsung and Apple, allowing a majority to have touchscreen mobile phones that permit Internet accessibility (Bulawayo24, 2013). Despite the costs of data bundles, many students in urban areas can afford to use the Internet regularly (Eger, 2015).

With mobile devices, learning can now occur when, where and how learners choose (Chen & Yan, 2016). Mobile devices are flexible, and they have no restrictions on learning even outside school environments (Motiwalla, 2007). The use of portable mobile devices has channelled a convenient way of communication, which enables students to study when it is convenient for them while reaching many learners or educators for clarifications (Motiwalla, 2007). The use of technology as a tool for collaborative learning is inevitable in learning because it maintains details for more extended periods, allowing learning to be visible, shareable, reflectable and modifiable as students who are geographically spaced participate (Chen & Yan, 2016; Zhang et al., 2015). So & Kim (2009) explain that the mobility of mobile phones enables a shift from one-to-one to many-to-many communications, which are not individualistic but are collaborative, creating decentralised systems.

Mobile devices are theoretically known to impact education in two ways: improving access to educational resources; and promoting alternative learning practices that are constructive and engaging (Ally & Tsinakos, 2014; Thinley et al., 2014; Gikas & Grant, 2013). Motiwalla (2007) states that accessing information at the point of relevance may improve the productivity of a learner. Currently, mobile devices replicate the traditional teaching and learning techniques of sharing and supplying students with information (Thinley et al., 2014). Students now have access to books for reading, however, incorporating the new ways of learning that enhance knowledge building and sharing is not yet fully explored (Thinley et al., 2014). Access to information alone is not enough. While access to education is important, education should be more than access to information in that it promotes interactions to help understand the accessible information. As a result, most online systems now offer alternative collaborative means like discussion facilities or chat systems as a support system for students to understand the resources on their sites (Motiwalla, 2007). Sung et al. (2016) state that very few projects use mobile devices for improving constructive thinking or reflection. They further explain that the mobile device affordances of cooperative or team communication are being underutilised. It is therefore essential to explore mobile technologies for promoting collaborative learning.

The affordances of mobile phones have the potential to significantly advance the learning experience to be much more productive and more engaging by allowing the continuous distribution of vast amounts of information and knowledge (Kidd & Murray, 2013; Valk et al., 2010). However, even though mobile phones have potential, many students primarily own them for social reasons and not for educational purposes. Although mobile phones have motivating advantages, for some functions, interactions on mobile phones are not as natural as on computers (Wang & Smith, 2013). Wang et al. (2016) however, states that there is now an insignificant difference between mobile phones and PCs. One of the significant reasons highlighted is that smartphones have increased in screen size as well as resolution, which now sits at varying pixel sizes, e.g. 1440 * 2560 pixels. Also, bandwidth has improved due to Wi-Fi, 3G and 4G networks; and phones have memory cards that can now handle gigabytes of data. Although some limitations of using mobile technology for education existed (Wang & Smith, 2013), the above reasons show that mobile phones are evolving, and their operational functionalities are becoming more like that of PCs, thereby making them suitable for extending education through them (Wang et al., 2016). The gap in the operational functionalities between mobile phone and PC technology has narrowed down (Wang & Smith, 2013).

However, mobile phones are considered a distraction in academic environments if used within the classroom (Chen & Yan, 2016). They are understood to be better only when used outside formal classroom teaching (O'Bannon & Thommas, 2015). Sung et al. (2016) describe studies conducted to access laptop-based learning and mobile phone-based learning. The results show that there is a positive impact of individual learning when mobile technologies are integrated with classroom activities. Students have time to work on their school activities, thereby reflecting on their learning. With regard to mobile devices, they explain that the functionalities of mobile devices can increase interactive behaviours and social cohesion among learners, however, the social aspect of mobile devices does not necessarily enhance learning. They explain that it is not yet conclusive if more collaborations are related to better learning outcomes (Sung et al., 2016).

Tablets are also a mobile device that being used for learning, especially in the classroom as a blended approach (Couse & Chen, 2010). They have been channelled into education as they promote active learning. The main activities of students on tablets include watching and listening to music and videos. Some also use applications for text editing, presentations and for enabling communications with classmates or teachers (Rossing et al., 2012). They are also used for conducting exercises with educational applications, taking notes and sharing information and documents (Watson et al., 2014).

Advantages of using digital tablets include their bigger screen when compared to phones. They also provide easy access to information using the Internet even though they do not have a fixed network connector but require Wi-Fi. The device is portable such that it can be used anywhere at any time and offers multi-functionality to cater for different learning activities (Ando & Ueno, 2010). Furthermore, they are associated with the change to modern learning, whereby teachers offer student-centred learning and facilitate the use of collaborative information-sharing environments (Hamid et al., 2015). They are often used at high schools as part of the curriculum. Also, schools get to make savings when they utilise electronic textbooks as opposed to traditional textbooks. However, schools need to check that the publisher of their selected eTextbook supports their range of devices. Romney (2011) conducted a study that concluded that students showed higher retention and performance in Mathematics when using technology, particularly on tablets compared to only relying on classroom learning. Instructors also agree that tablets make the marking of assignments more effective (Freake, 2008). Tablets also have disadvantages; they generate an increase of class-preparation time when searching and creating resources for the pupils (Galligan et al., 2010). They are also costly, as a result, students default to using mobile phones instead as an alternative (Sung et al., 2016).

2.5.1 Representation of Content on Mobile Devices

The representation of information through various media is an important aspect of content delivery (Kim et al., 2016). Although students have access to eTextbooks, they do not own desktop computers with large screens to books easily (Sung et al., 2016). University students are at an advantage because they have better access to desktop computers in the freely accessible labs. However, for high school students, they have to rely on mobile devices for reading textbooks. Earlier studies show that students wanted paper-based text compared to reading on electronic devices (Lan et al., 2009; Waycott & Kukulska-Hulme, 2003). As the years evolved, novels became a common text to be read on mobile devices, particularly on the tablets. Wang & Smith (2013) states that this was a positive indication that students may look favourably at reading texts on mobile phones in the near future. There is significantly less research on the use of mobile phones for reading (Wang & Smith, 2013). This is probably attributed to the screen size of mobile phones. The detail, visibility and readability of information delivered on mobile phones are critical to the success of a mobile application (Motiwalla, 2007). Although handheld devices have powerful multimedia capabilities as well as collaborative and communicative abilities, most of the mobile learning approaches tend to focus on the design of mobile devices as opposed to what learning applications should be created to suit those devices (Kearney et al., 2012).

Different types of computers should support different opportunities for collaborative learning. For example, it is considered not practical to read on a mobile screen for hours. Although this might be true, one cannot rule out that it is possible to read on a mobile phone and technological applications should take advantage of such abilities. Moll (2007) highlights that the mobile Web should be treated as its own environment with potential abilities as opposed to being viewed as a crippled extension of the desktop computer. This presents the mobile phone as a device with limitations that restrict its use. Instead, Moll (2007) suggested that designers must begin to understand how to embrace the nature of mobile phones while exploring its potential possibilities. The emphasis is that it is paramount to develop for mobile devices by looking at them as a whole instead of looking at them as insufficient. There are, therefore, opportunities for presenting mobile reading on small screen devices like phones and designing solutions that are suitable for them (Traxler, 2007). As devices mature, from feature phones to smartphones, learning on mobile phones has evolved and now presents new possibilities for active, constructive learning (Kearney et al., 2012). Even though the screens are not as big as desktop screens, nowadays mobile phones have screens big enough to present opportunities for eTextbook reading even for more extended periods of time (Kim et al., 2016).

Wang & Smith (2013) state that delivering smaller modular chunks of information may be better suited for mobile phone learning experiences. In one study, Wang & Smith (2013) investigated the understanding of reading and grammar learning on mobile phones by giving students short essays and short quizzes to conduct on phones at their own time. Results indicate that students enjoyed using their mobiles for learning. However, they preferred reading essays to doing quizzes. The research concluded that students require motivation to read projects online, learning materials should not be challenging, nor should they be time-consuming. Not all the students who participated in the project completed it because the material was not directly beneficial to the students regarding grades. This provides an opportunity to investigate how mobile-based applications should consider including a grading system to be considered beneficial.

In one study, students were presented with two sets of English vocabulary words either through mobile phones or paper (Wang & Smith, 2013). Students who learned via mobile SMSes understood better than those who used paper (Wang & Smith, 2013). Kennedy & Levy's (2008) research also investigated the acceptability of using mobile phones for learning by sending short messages containing a mix of known words and new words for students to learn. They discovered that the students found the content useful and enjoyable and also appreciated the experience of reviewing learnt information using their mobiles.

2.6 The Gap in the Literature

The literature discussed has demonstrated the importance of interactions. However, there is a gap in the literature. The studies have not attempted to change the context in which discussion forums are presented in trying to improve collaborations. A majority of research seeks to identify strategies for improving the quality and quantity of traditional forum posts. Discussion forums have always been presented as standalone discussion boards; however, this research seeks to find alternative ways of presenting forums to users. This study proposes the creation of a discussion forum around the intellectual content of textbooks, thereby reducing the distance between the learner and the resources to be discussed. There is a close relationship between discussion forums and eTextbook content. Dennis et al. (2015) describe an idea of sharing annotations, which may enable students to communicate with one another through their points inside textbooks. However, little practical research has been conducted to explore the possibility of enabling collaborations within shared content by integrating social interactions through discussion forums within eTextbooks. Although providing students with resources and a platform to make queries is the norm for encouraging course-based interactions, this work attempts to understand how integrating eTextbooks with interactive social activities may improve learning. Perhaps, discussion forums should not be presented as an

afterthought. The design and presentation of discussion forums may affect the way that students learn.

Again, forum participation has also been stated to contribute to imminent drop-out on educational platforms, especially MOOCs (Burge, 2015). Some students may not understand the discussions as such they fall behind and the literature states that there is not much support for such students. Integrating forums to their content may address this problem by ensuring that all discussions are relevant to given sections of resources. Lastly, social media platforms currently are more focused on promoting the creation of content, for example, Facebook and Twitter. This work adopts a similar concept but focuses on using common existing content so as to drive discussions centred on content.

2.7 Summary

This chapter has highlighted the importance of collaborative learning in that it brings understanding that would likely not be achieved if one worked independently. Literature has also highlighted that spoken and written interactions are beneficial and can increase understanding of complicated matters. This chapter has discussed the importance of CSCL together with its theories. The chapter has also highlighted social media tools that promote the generation of collaborative skills while addressing how these tools have been adopted to enable collaborations in the educational environment. Although research has previously focused on how individuals function in groups, current research is now more focused on establishing parameters for effective collaborations as well as understanding how such parameters mediate interactive activities. This has led to discovering more tools for the analysis and modelling of interactions. A gap has been identified in the literature, and this presents an opportunity to explore how discussion platforms should be presented in a way that promotes collaborations and understanding of what is being discussed.

3 System Design

Following the literature review, preliminary research studies were conducted to gather user requirements and a prototype of an eTextbook collaborative system was then proposed for development. This chapter discusses how the proposed system was designed and developed. The chapter is divided into four sections: 1) a technology probe using Facebook; 2) preliminary study in a community in Zimbabwe; 3) design study at UCT; and 4) proposal of the prototype system.

The objective of the design study was to find a suitable design for answering research questions related to the representation of eTextbooks on mobile devices for their co-reading. The project targeted and investigated both face to face and online learning challenges at high school and tertiary levels. A community in Zimbabwe was identified as suitable for use in representing high school students, and the University of Cape Town was also selected to represent tertiary education. Both communities were selected because they have textbooks that act as boundary objects among students.

3.1 User-Centred Design Approach

Design is a practical yet creative activity that aids in developing products that help users achieve their goals (Sharp et al., 2007). The design considerations of this chapter focus on how students discuss course content, interact with textbooks, and how their needs can be supported, designed and implemented for use on mobile devices. This work followed a User-Centered Design (UCD) approach. UCD is an iterative process that follows four crucial stages that are significant for developing usable systems (see Figure. 3.1). The UCD approach is defined as an iterative process for designing usable systems that are co-created with the help of potential users of the system (Gulliksen et al., 2003). Norman (1986) emphasises that UCD's purpose is to cater to potential users by dominating an interface with their needs. This study adopted this approach because it promotes the generation of user opinions and reactions to the functionality of a usable system (Carlson et al., 2014).

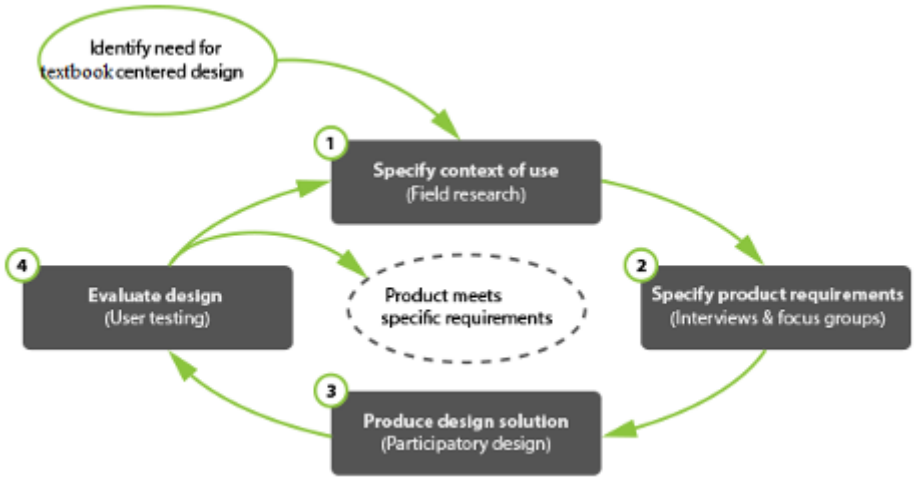

Figure 3.1 UCD cycle for developing the eTextbook collaborative system (adapted from Beinema et al., 2018)

The initial stage involves identifying a problem and understanding the context of use for that problem through research; this has already been done in the previous chapters. The next step is to specify the system requirements with users and then identify possible design solutions. The designs are assessed to come up with one prototype solution that captures all user needs. There are various techniques used at every stage of the cycle. The participatory design allows users to partake in the creation of the design of the system and also test the feasibility of the design (Carlson et al., 2014; Loup-Escande & Lecuyer, 2014). Therefore, when participants are actively involved in the design process, there can be a continuous iteration based on the application requirements (Osman et al., 2009). This research approach is exploratory. Explorative studies are usually adopted when a new subject is investigated or when there is little information about an area of interest. The explorative method was chosen to find different perspectives on the area under investigation and assess the needs of the students without making assumptions about their needs. The first part of this chapter describes a technology probe that was conducted to help determine the need for a textbook centred application.

3.2 Technology Probe

A probe is a tool that is used to get insight about a subject that is not fully known (Hutchinson et al., 2003). However, such tools are known to have a risk of failing or bringing up the least expected results. Technology probes are stated to follow three goals: “the social science goal of understanding the needs and desires of users in a real-world setting; the engineering goal of field-testing the technology; and the design goal of inspiring users and researchers to think about new technologies” (Hutchinson et al., 2003).

As already stated, social networks promote collaborations and Facebook has been known to draw many users from various parts of the world to share content and hold discussions (Manca & Ranieri, 2013). Many students are already familiar with the Facebook platform, and its advantage is that it has the potential to bring many students together to share and discuss resources. As such, this advantage leads us to assume that the platform should also work when adopted for educational collaborations. However, there are conflicting views on the suitability of Facebook for collaborative learning despite being a tested favourable medium for sharing content (Ortigosa et al., 2014; Popescu, 2014). Given this scepticism, Facebook was explored to understand its shortfalls in supporting academic collaborations among students and also to come up with ideas of how effective academic collaborations may be conducted on social networks.

3.2.1 Set-up of the Facebook Technology Probe

A group called “MathDiscussions” was created on Facebook. After creating the group, eTextbooks for Mathematics and past exam papers for high school students were uploaded for use and discussions (see Figure. 3.2). Mathematics was chosen because it is known to be a complicated subject that often promotes group work discussions among students. A private teacher who tutors high school students distributed the links to various relevant resources and the group was advertised on Facebook to recruit participants. Seventeen students joined the group at the time of this experiment.

Figure 3.2 Clip of files uploaded to the MathDiscussions group on Facebook

3.2.2 Results

Because this was a probe, results were gathered by observing how participants who joined the Facebook Math group interacted. The students who joined the group were monitored. Findings indicated that Facebook is a good collaborative environment that can bring students together as students could invite each other to join the group or find the group out of interest by searching on Facebook. However, observations showed that there were limitations related to discussions of content on the group forum. Students in grades 11 and 12 joined the group from various high schools. They participated only by observing posts on the group and viewing eBooks that were shared. Facebook allows one to view who has seen a document that was uploaded. The results showed no active collaborations around the shared Mathematics course resources. However, the group enabled accessibility to content. Non-participation on the group showed that the shared resources did not motivate the students to discuss. Also, accessibility to content is not enough as it does not guarantee that the resources are read, understood and beneficial to the students.

Also, mathematical eTextbook resources are characterised by visual notations like diagrams, formulas, tables and pictures. For mathematical calculations, it can become complicated to type the questions. Sometimes the mobile phone limits one to enter some mathematical notations and it is difficult to arrange the characters easily, especially with the formulas. To counteract this, some students take photos of questions or their answers and share them with others for discussions. One student asked a private question directly to the admin people of the Maths Discussion group. The student asked to switch to the WhatsApp application instead so as to use a series of pictures in better describing their problem. When asked why the participant was asking questions privately, the response was that they were not confident in asking on the group, which shows that some students have trouble expressing themselves on group forums when their identity is known. This is despite being in a group with unknown individuals. Also, they found that their question was too complicated to type on a platform like Facebook. The fact that the student selected content from a textbook to ask on an online platform shows that students do sometimes need assistance solving problems that they encounter as they study.

3.2.3 Technology Probe Summary

This probe enabled us to observe how students react to social media technology for learning. It also enabled us to test Facebook as a collaborative learning environment for educational purposes. Observations gathered from this study have encouraged ideas of how to structure collaborative systems for educational purposes by using the successful features of existing technologies like Facebook to cater for educational purposes. For Facebook to work as a collaborative medium for promoting collaborations among students who come from various regions, a design that is specifically tailored to the needs of students might be more successful as the Facebook application was primarily designed for social interactions (Manca & Ranieri, 2013; Ellison et al., 2007). Some researchers argue that Facebook is only suitable for announcement tasks that require observations associated with schedules, course tests and exams and also for distributing resources (Selwyn, 2009). From this experiment, we suggest two alternatives that one may take in ensuring collaborations take place:

- Create a Facebook App that is designed to incorporate students' educational needs.
- Create an independent social site that is tailored to the needs of students, drawing some inspiration from the Facebook features.

This research proposes the latter option, considering that Facebook is an app that has "social, play, fun" attached to it and students use the app to reconnect with friends and family, as opposed to serious academic work (Skeels & Grudin, 2009). This, therefore, leaves us with the idea of creating an

education-specific platform that adopts some of the Facebook features that make it successful for communication purposes.

From this short probe, it cannot be concluded that Facebook failed as a learning platform as more tests would have to be conducted, however, one can state that for mathematical group discussions, mathematical notations or imaged enabled interactions are important to enable users to express themselves. From our observations, real identity on educational platforms might hinder some students from participating in the forums.

Apart from Facebook being a tool for education delivery and collaborations, other comparable tools like Whatsapp, Twitter, Google documents could be explored to obtain more insight onto different other technologies. QR codes could also have been explored to reference content for many people to access and discuss. Facebook was selected over these other technologies because of the ability to pool a high number of participants in group discussions, use hashtags, upload many pictures and various content while the other technologies have limited uploads like Twitter that only allows a certain number of characters for responses and Whatsapp only allows one to converse with people in their contact list. However, these technologies also have great potential for education as standalone applications or even as a way of adopting some of its successful characteristics for use in a social learning application.

As the next step, a preliminary study was then conducted with selected high school students to elicit more detailed user requirements for an eTextbook system by understanding students' daily educational needs and challenges.

3.3 Preliminary Study at High Schools in Zimbabwe

The purpose of the preliminary study was to gain a better perspective of the current state of learning practices of high school students with common interests. The study sought to obtain insights on ways of enhancing learning while also observing if the current mobile technologies can be used to address formal learning hindrances informally through collaborations outside the classroom. Informal set-ups were chosen because the educational authorities would not allow any distractions to students in experiments conducted within the classroom formal sessions. The primary goal was to find challenges faced by students as well as opportunities for channelling technological tools for enhancing learning with understanding.

As discussed, provided there is an object of interest, different communities will come together to transform knowledge collaboratively. The Zimbabwean community was selected to participate in this work. That is because it has textbooks that act as boundary objects among students countrywide per grade. The Zimbabwean textbooks maintain a common identity for all subjects throughout the country, which enables students to work together in an attempt to understand the subjects. Across the country, for every form or grade in a school in Zimbabwe, students have a standard textbook for learning. Although research states that there should be a significant move away from textbooks to adopting a variety of sources for learning, in the African context teachers and students still depend on textbooks and accompanying teacher manuals (Le Fevre, 2014). Other textbooks can be used as additional sources, but this only occurs in highly resourced private schools.

The Curriculum Development Unit (CDU) also releases a syllabus that is followed by all schools within the country (Ministry of Primary and Secondary Education, 2013). Although teachers or schools follow different approaches, they all have one goal of following the syllabus using the given standard textbook and curriculum. At the end of the year, final year students write the same national exam that qualifies students for either higher learning or tertiary education. This, therefore, creates a community of students with similar interests and conditions despite coming from various sectors of the country. As such, this community was purposefully selected as appropriate for conducting this study.

3.3.1 Ethical Clearance

Using UCT ethical clearance to conduct a study with participants outside UCT, we were able to approach the Zimbabwean schools. In order to work within the Zimbabwean schools, the ministry of education in Zimbabwe (Bulawayo), also gave a permission letter to access any of the schools within the city. This letter provided leeway for doing any form of study with the selected schools should the headmaster of the school give consent. Each of the students signed consent forms or had teacher representatives to sign for all students. All consent forms were created as per the ethical considerations of the University of Cape Town and were signed before the study could be conducted.

3.3.2 Study Procedure

A total of 120 students from 2 different schools were involved in this study. Four different grades (form 3, form 4, form 5 and form 6) were chosen to make up 60 randomly selected participants from each school. The students comprised of both girls and boys within the age groups of 15 to 18 years. The schools selected were urban governmental schools in middle-class areas with a higher chance of accessing computer-based technologies.

During the students' spare time, a selected teacher representative allowed the researcher to present a summary of the research work to the students. The study was explained to the students, and the role of participating in the study was elaborated on. After an agreement and answered questions, the students were given questionnaires and had about 15 minutes to fill it in.

The questionnaires were distributed to the two high schools. Each questionnaire was designed to ask students questions categorised into four areas: 1) availability of resources in schools, 2) level of participation in class lessons, 3) how students supplement formal classroom learning and 4) reasons for acquiring assistance outside the formal classroom. Additionally, the questions aimed to gather information on hindrances that are related to supplementing classroom lessons, as well as students' accessibility to technology and their mobile Internet use. Appendix 1 shows the questionnaire utilised in this study.

3.3.3 Results

The students acknowledged that the school provides them with textbooks. However, the textbooks tend to be very few, and two to four students often share each textbook. In this study, one of the schools seemed to have more resources than the other. Although sharing textbooks is a common practice, 64% of students complained that when a textbook is lost, they do not obtain another one; they, therefore, have to spend the year without a textbook or pay to buy a new one. Also, some students do not cooperate in a fair sharing schedule of the textbooks. That means some students hold onto the textbook for longer than the agreed time, especially towards tests and exams. Students stated that they sometimes rely more on notes given during lessons although they indicated that sometimes there is not enough time for explanations of the notes hence they still require the textbook for verification.

A major challenge that students face is that, when they do not understand lessons taught in class, they usually do not get the opportunity to receive detailed clarifications and hence feel challenged when the syllabus has to continue despite their difficulties. 42% of the students agreed with this. That is because lessons are short (about 35 minutes each) and there is no time to keep insisting on a difficult concept especially when a majority understand, or the teacher has a goal to finish a topic within the allocated time. Some students argue that they are slow learners, and hence more time should be allocated to difficult topics. That explains the different cognitive levels of students who participate in the same subject yet achieve understanding at different paces.

One of the open-ended questions in the questionnaire was to obtain suggestions on how the students can be assisted to improve their understanding and learning. 72% of the students indicated the need for more time to understand difficult concepts. They also highlighted the need for attending extra lessons at no cost. When the students were asked if they participate in class lessons, students expressed their inability to express their opinions freely without being ridiculed by other students. In Figure. 3.3, School A shows that 56% of students found it hard to participate in class while 42% said the same in School B. Students stated that they do not ask questions or respond to questions in fear of what their peers or teachers would say. This seemed like a major concern for most students. Some students further explained that they are quickly criticised, have low self-esteem, lack confidence or are intimidated. As a result, they do not participate in class to protect themselves.

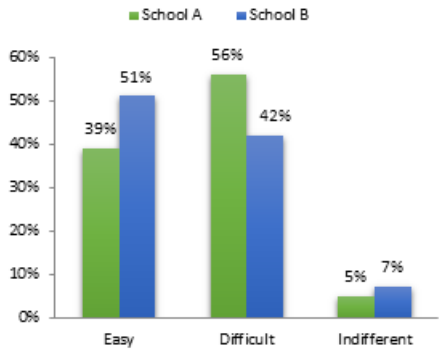

Figure 3.3 Student participation during class lessons.

Students were also asked if they are involved in outside activities through extra lessons or study group discussions; some students stated that they supplemented classroom lessons using various means. 39% of the students in school A and 51% in school B stated that they sometimes attend extra lessons (see Figure. 3.4). Students consider extra lessons to be helpful and essential but, because of financial difficulty as parents cannot afford to pay for more than their school fees, a high number of students do not attend extra lessons. For those who managed to attend extra lessons, their reason for attending was to gain a better understanding of difficult concepts at slower paces (see Figure. 3.5). When students cannot afford extra lessons, they end up lagging on some topics.

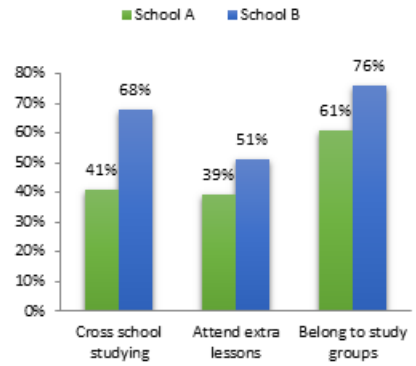

Figure 3.4 Outside the classroom activities.

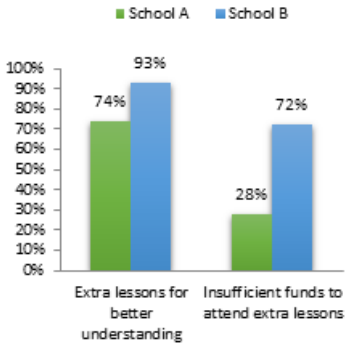

Figure 3.5 Purpose and hindrances to extra lessons.

A clear pattern that emerged was related to the study groups. The study groups allow students to share ideas with peers on what has been taught in class or to study the textbook for tests and exams together after formal lessons. School B indicated over 70% of students belonging to a study group, yet School A only showed 61%. Also, to ascertain if students from different schools can inter-relate due to the common textbooks and curriculum, the students were asked to state if they studied with other students in their grade from other schools. About 41% of the students (see Figure. 3.4) from school A and 68% from school B admitted to usually working with students from other schools on similar challenging subjects, mainly because they can refer to the same textbook and they tend to learn the topics almost concurrently even though they belong to different schools.

Although some exceptions exist, students who studied less in groups were affected by various hindrances (see Figure. 3.6). One challenge was that of forming groups and maintaining them. This was problematic to participants due to lack of cooperation from other students or due to cultural issues. Some students, especially ladies, are required to be at home before evening hours by their parents hence have no time for additional studies after school. Finding group mates is also a challenge because it is difficult to reach out to other students who are considered smarter. Because study groups are dependent on time outside the classroom, teachers and parents usually have no influence on their creation. Instead the learners themselves have the choice to be part of groups depending on their individual circumstances, especially at home. Teachers only have influence on homework related study groups that are elected less often during a class lesson to address a particular concept. Lack of teacher feedback on unresolved issues of a study group also makes students readily dissolve groups. Additionally, students face time and venue constraints as they finish school late and sometimes other learners may occupy the classrooms.

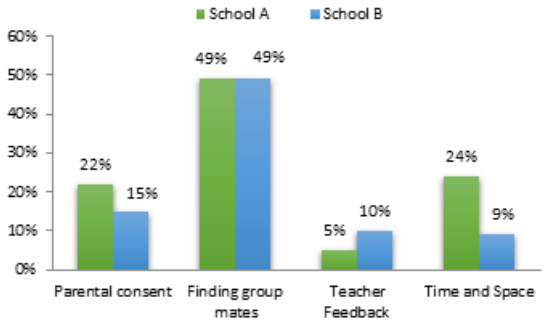

Figure 3.6 Hindrances to attending group work studies.

Over 50% of the students who hold group discussions ascertained that the discussions were very beneficial to their studies as they tend to understand better through peer explanations, which usually come with detailed life illustrations or examples and in local languages. Students also have the liberty to ask questions until they understand since they are more comfortable with making mistakes when in their small circles with known peers. They also enjoyed that they have control over the inquiry topics. Even though having group discussions is beneficial, the hindrances make it problematic for them to be held whenever students need to.

The last section of the questionnaire was related to technology and Internet use by students. Over 80% of the students from both schools admitted to owning a mobile phone (see Figure. 3.7 for a sample of the phones). Some stated that they have easy access to a mobile phone at home. Of those phones, around 85% have Internet capabilities from school A and 76% from school B.

Figure 3.7 Phones that students own from one of the schools used

When students were asked to state how often they use the Internet, over 60% from both schools said they use the Internet just sometimes while approximately 25% said they are always using the Internet. The students were asked what limited their Internet usage, and the reasons varied, with cost and time

being the major challenges. Lastly, the students were asked for which purposes they use the Internet. Approximately 50% of the students from both schools spend their time on Facebook and 30% on WhatsApp. Over 80% said they sometimes use the Google search engine for school-related queries. However, they sometimes do not know how to search and obtain relevant answers from the Web. Figure. 3.8 shows the statistics of mobile phone usage by students within the two schools.

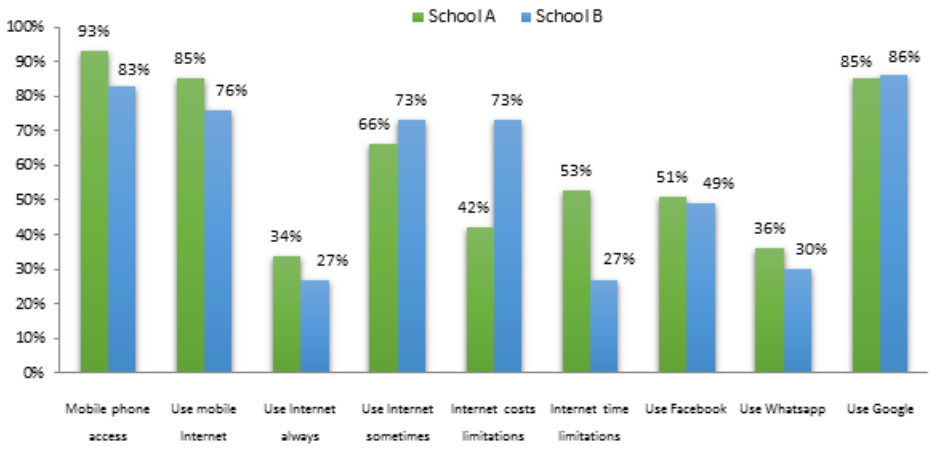

Figure 3.8 Mobile accessibility and mobile Internet usage.

The rest of the questions were open-ended to allow participants the freedom to express themselves about their experiences. Students gave detailed insight into their learning practices, showing the need for getting more help to get a maximum understanding of difficult topics learnt in the classroom. They also requested more textbooks, getting access to free Internet services at school, obtaining free school holiday studies as opposed to extra lessons that cost money, obtaining opportunities to study with others during school hours and having controlled classes that encourage participation without intimidation.

3.3.4 Discussion

In this section, the results of the previous section are synthesised, and possible solutions to challenges highlighted by participants are discussed. The unavailability of textbooks to students indicates that the problem of lack of books for learning is still prevalent for many students. Also, since most of these students only have mobile phones, the research could be focused on how to represent textbook content on mobile devices. Students also have mobile phones with Internet capabilities, hence there are opportunities for promoting collaborations among them. Although not every child has a mobile phone, the ones who do not own mobiles sometimes use technology by sharing their siblings' or parents' phones.

Students are not allowed to carry phones to school even if they stated that they carry their phones to class and use social networks to collaborate with others and obtain information on the go (Popescu, 2014; Gikas & Grant, 2013). Even though data for Internet is expensive in most developing countries, mobile networking companies are promoting free education for all. Companies like Econet, a data service provider in Zimbabwe, now offer free Internet to selected educational sites and also as promotional packages they occasionally have selected domains that can be viewed from their network for free (Econet, 2013; Mupaso, 2013). These companies also have promotions for allowing subscriptions that are affordable for users to access particular sites for more extended periods. Associating with such network providers could help lessen the cost burden on the student.

Students recall better when they express their ideas, yet speaking out in class is a challenge to them due to lack of confidence, criticism and low self-esteem. Asking questions helps students comprehend what they are learning and hence generate knowledge (Ramnarain, 2014; Thinley et al., 2014). Since students across the country may not know one another on a shared platform, students can interact and learn to improve their confidence by freely asking even the simplest of questions that they cannot ask in person. A concept to test therefore is if the more challenged or introverted students would become motivated to discuss more of their ideas and work, given a platform where their real identity was concealed.

Students are now able to receive education outside the walls of the classroom via the mobile phone. Students coming from elite schools have a chance to relate to students coming from impoverished backgrounds. That means the students from low resourced backgrounds can now get exposed to external resources and knowledge, which is important in the diversity of learning practices (Ramnarain, 2014). Technology, therefore, also complements the availability of resources to all learners. Students can broaden and deepen views while reflecting upon one another's views as they study-related content for examination purposes. It, therefore, allows them to combine different perspectives of subject concepts into a single representation of conceptual understanding highlighted as essential to learning by empirical studies.

Since mobile platforms already bring distant communities together through social networks, the problems of finding group mates, hindrances to having study groups and cost-related extra lesson problems can be minimised. The fact that students from various schools can inter-relate to discuss textbook or syllabus-related content indicates great potential for this community to work together. SNSs attract people of all ages all around the world to communicate on shared interests. Beyond

distributing information, SNSs have features that enable communication and participation within communities that foster collaborative interactions (Judele et al., 2014; Gikas & Grant, 2013). According to the results of this study, a significant number of students already use social networking sites like Facebook and WhatsApp, and this can be channelled to education.

From observing and comparing the results of the two schools, they may be in the same areas yet may follow different cultures of educating students. From the graphical representations of the results, Figure. 3.4 showed that students from school B participated more in class than students from school A. This confidence may be attributed to the fact that students from school B have a high number of students that are involved in group discussions, extra lessons and inter-related school collaborations (see Figure. 3.4). Students from school B also required less parental consent, which allowed them to partake in group discussions freely.

A collaborative app on a mobile phone may offer solutions to some of the challenges encountered by students in forming groups and belonging to study groups or attending extra lessons. The challenge of having little opportunity to ask teachers questions in-between classes is minimised as mobile platforms are available all the time at any location for peers to help one another. One can also study at home but still be connected to their peers. Hence the need for obtaining parental consent for conducting discussions after school with other students is removed. The task of finding group mates is also taken away as the platform would involve a community of students who come from different schools, thereby increasing the spectrum for obtaining help. Students can also have an extended session for collaboratively discussing difficult questions until they understand them. They can also reflect on what others are saying before sharing their own opinions. Since one of their challenges was that of being laughed at, students have a chance to ask questions without being ridiculed by others. This research work, uses technology and attempts to address these challenges in ensuring that students all have a fair chance of obtaining knowledge through group works conducted online, especially where textbook related and class related issues are concerned.

3.3.5 Preliminary Study Summary

From the preliminary study conducted, an opportunity of building an online application for enabling collaborations centred on the textbook as a common object of interest among the students at the Zimbabwean schools is identified. The application would be used mainly to address the hindrances that students are currently facing to conduct face to face collaborations. The needs of Zimbabwean

students provided input in the requirements stage, which was essential and useful to the design process. The following section describes the design process conducted with UCT students.

3.4 Co-designing the eTextbook Collaborative System

Following the results of the preliminary study, there was a need for gathering system requirements and coming up with possible design solutions. Since it has been established that sharing resources among students is not enough to promote collaboration, the required solution had to promote the understanding of textbooks through combined efforts from students. In this study, a system that is textbook centred and incorporates the highlighted requirements gathered from the preliminary study is the goal. The objective of this study was to obtain user requirements and engage users in a participatory design session through prototyping. The study aimed to find a suitable design for representing textbook data on a mobile device while incorporating student collaborations. To build such a system, a study was conducted with students from the University of Cape Town to help design an interactive eTextbook. The study reveals insights into what users need on social media platforms, taking advantage of the opportunities they bring to the co-reading of eTextbooks online.

3.4.1 Participants

Participants were recruited through email advertisements at the University of Cape Town. Students interested in participating responded to confirm their acceptance. Each student was invited to attend a 45 to 60 minutes tape-recorded interview session. According to availability, the interview procedure involved a focus group session with seven students, two pairs of students and four single participants. A total of 15 students participated in the experiment and were selected based on the following criteria.

- undergraduate students
- must be enrolled in Mathematics and science courses
- must do a computer science subject with basic knowledge of software development
- must use electronic textbooks often

The research project was explained to the prospective participants who were selected, and all participants signed consent forms to take part in the research. The consent forms were created according to the UCT ethics clearance that was obtained before the preliminary study.

3.4.2 Data Collection

i. Recordings

The interview sessions were recorded using a mobile phone audio recorder for processing after the experiments. For backup purposes, two of them were utilised per session, which enabled the researcher to focus on the participants. The audio recordings were named appropriately for each interview with dates and pseudonyms to keep track of the sessions. Participants gave consent to record the sessions.

ii. Interviews and Focus Groups

Interviews and focus groups were chosen as the methods of establishing the essential requirements of representing student-centred textbooks on mobile devices to encourage engagement and collaborations when answering subject challenges. Seven participants formed the focus group, while the other eight were interviewed either individually or in pairs. The interviews were used together with a 'wants and needs' analysis technique. Wants and needs analysis is done by asking participants to brainstorm about what they would want or need within a product (Daae & Boks, 2015).

Both the focus group and the interviews were semi-formal and sought to address critical requirements, including views on the representation of textbook information on a mobile device and views on the usability of collaborative systems. The participant experiences on their current ways of using textbooks and electronic textbooks were discussed. The researcher used both broad and narrow questions to stimulate discussions from participants (see Appendix 2). Broad questions were asked to introduce the topic such as "What is your opinion of textbook reading on a mobile phone?" The narrowed down questions were specific questions, such as "What requirements would you find necessary when representing a textbook on a mobile phone?" The interview techniques of probing were also used. These included promoting as well as summarising statements of participants to encourage elaboration of points.

iii. Paper Prototypes

The participants created their design solutions for the system as they understood and envisioned it using paper prototypes. Prototyping early is essential for designing usable systems (Gulliksen et al., 2003). Paper prototypes were used as a low-fidelity design technique for obtaining design ideas from users as input into a final prototype to be developed. The participants visualised their ideas together, illustrating their views of the possible system as a form of exploring the best design for the system.

iv. Scenarios

For participants to be directed in their design process, a scenario was given to each participant so that participants design their paper prototypes with perspective. Robinson & Perez-Quinones (2014) states that it is important to define a typical user model of the system to participants.

3.4.3 Design Task

The design activity was divided into two parts. The first part was to understand how users utilise electronic books and obtain system design requirements through interviews and the focus group and the second part was a participatory design activity through paper prototypes.

The experimental protocol followed per experiment is as follows:

- The topic was first introduced, and a brief description of the problem and the process to be conducted was explained.
- Participants were presented with consent forms
- The researcher started the interview with semi-structured questions (see Appendix 2). This was audio-recorded and lasted approximately 30 minutes.
- The researcher then introduced the second part of creating designs
- Participants were again briefed about the overall objectives of this part of the session and what was expected of them was explained. The importance of the session and the relevance of the prototyping technique in the study was highlighted. The participants were also informed that there was no right or wrong way to develop a paper prototype. The participants had the liberty to freely explore their creativity.
- The following scenario was given to the students as a guide in designing a system for someone.

  "Mary is a high school student who loves Mathematics but has difficulty understanding it. She has no time to ask other students while at school or soon after school. While she studies her textbook at home, she feels the need to get help on some questions that are within the textbook. Design a system that Mary can use on a mobile device to interact with other maths students, who have access to a similar electronic textbook. Mary should be able to easily reference the questions she wants to ask when explaining to the other students online."
- Participants were given blank papers and pencils with erasers to mock-up their design ideas. The participants had approximately 10 to 15 minutes to paper prototype their design of the system.
- Afterwards, the participants explained their designs to the researcher.

- Participants had a chance to ask questions or even give suggestions.
- The session then ended with each participant being given a R40 token of appreciation.

3.4.4 Interview and Focus Group Results

The questions were categorised into sections. Below is a description of the themes that emerged.

i. General Understanding of Social Media

The participants all had a clear understanding of what social media is and even had examples to give. All participants could easily define social media and the various types of media available. They were also asked if they use social media for their studies and 67% of the students stated that they do not use social media often for school-related matters. However, they stated that they sometimes use Facebook to find classmates for school-related inquiries because they know their friends would be online on the site. 87% of the participants explicitly stated that they use WhatsApp to communicate about assignments and schedules or meet-ups for discussions. All agreed that they belonged to WhatsApp groups with close friends to discuss assignments and challenging problems of various common subjects. However, 77% of those who belonged to groups stated that the groups they belonged to, often were filled with jokes and pictures not related to school work, which resulted in many users leaving the groups. This is one of the reasons why Whatsapp was not explored further as a potential platform for this work.

ii. Study Groups Outside Classes

When the participants were asked how often they conduct study groups after classes, many agreed it was important to enhance their understanding as some topics were complicated. All participants stated that they usually meet to study, especially for assignments and tests and exams, sharing knowledge about past exam papers.

iii. Use of Electronic Textbooks for Studying

The participants were asked what resources they used during study groups with others and as individuals. 46% stated that there is a recommended textbook that they buy at the beginning of the year, and that is their base book. However, 54% of the participants stated that they usually could not afford the hard copy books and so they buy the electronic textbooks at a lower price. 50% of the participants that buy the textbooks also use electronic books. All participants who use electronic books highlighted the advantages and disadvantages of the eTextbooks that they use. They stated that the textbooks are light to carry around campus and are always available when they need them, even on the go. Although useful and preferred by many students, electronic books were considered text-heavy, inflexible and too long to scroll on the small screens of mobile devices. However, they were seen as

flexible and a necessity to read on the go. Also, due to legal issues related to the copyright of textbooks, the range of textbooks available for free were limited.

40% of the participants stated that their phones are sometimes too small to read for long periods. They use the eTextbooks to reference when verifying or to read concise chapters to understand when they are confused about. They also stated that eTextbooks can easily be obtained for free from the library and are easily shareable with others while textbooks cannot easily be shared and have to be sold after a semester of a course. The primary challenge was that every semester they had to find textbooks for all the courses they were doing, which was expensive. When asked if they use alternative books to the recommended ones, they agreed that they did but particularly for problem solving subjects as they could also refer to online searches when they encountered challenges. The participants highlighted that usually when one person had an eTextbook, friends shared it with friends of friends such that almost the whole class had access to it. As a result, they had no lack of textbooks to read for their courses.

iv. Using Mobile Phones to Read Electronic Textbooks

Another major inquiry during the interviews and focus group session was that of devices that the students possessed and if they were adequate for reading. All the students had smartphones like Samsung and iPhones. 80% of the students agreed that they used the school resources when they were at school, i.e. desktop machines in the labs. Also, about 40% of the participants who lived in the school residences with free Wi-Fi used laptops at home to study online. A majority stay outside school campuses and hence use their laptops for reading electronic books offline. Not all the students have laptops; 47% often used their mobile phones and tablets to read when they are at home even for those with laptops. The challenges for those who use phones was that they could not read for more than two hours at a time as the screen was small. However, the devices helped them verify and get understanding for most of their work. Also, the phone screen LED lights made it impossible to read for long as they had to keep adjusting the lighting to ensure it will not affect them. Overall, students own mobile phones and are utilising them for research on the internet and for storing textbooks to use whenever necessary.

v. Experiences Using Discussion Forums

Since the experiments centred on discussions of shared content, participants were asked if they used forums for enquiries. On social networks, many stated that they belonged to various groups of interest that they followed. However, not all of them posted on the sites. On educational forums, mainly the UCT LMS forum named VULA, 73% of the students stated that they had never asked questions but did

follow some important questions when they were on the site. 80% of the participants stated that they only used VULA to obtain assignments and get their course marks. They admitted that they had no idea of what resources were available for them to read on the site. Their reasons were that everyone would know them if he or she asked an unthoughtful question on the site. As a result, they did not want to be judged on such a platform. Instead, they preferred to ask their close friends who would laugh at them but not ridicule them. Also, 27% of the participants stated that the forum questions on VULA were usually related to course enquiries, which were helpful, especially if related to assignment deadlines and exam timetables.

33% of the students used sites like Stack Overflow for academic discussions, however, many admitted that they only went there to ask questions about programming when they were stuck as opposed to going to answer questions that others had posted. When asked reasons for this, they stated that the site had professionals and hence there was no need to waste time waiting to answer other people's questions. A follow-up question was that they would gain badges and be known for their expertise, and they stated that at their level, they were only concerned about correct answers and doing their work. Most of the questions had likes or votes attached to them, which convinced the students that they were important and the answers could be trusted. Lastly, the participants were asked if they valued discussion forums for their studies, and all participants agreed their importance even though sometimes their posts did not get comments or responses on them. This is what usually made them prefer to create private groups as one could ask freely among close friends and keep asking until they obtained an answer, which would be considered annoying on forums like Stack Overflow or VULA.

vi. Features Necessary for Conducting Discussions Online

In the focus group discussion, participants were asked how they shared questions when they were far from one another, be it on VULA, WhatsApp or Facebook educational forums. The participants agreed that for Mathematical or programming courses, students would write solutions down and ask for corrections online. They stated that there are symbols on their phones that they could use to compose formula questions. However, that was not necessary and was a long process. Writing down a solution on paper was much faster and could easily be corrected. Those who responded also wrote down their answers and shared them. For non-mathematical subjects, participants would take a picture of the textbook section and share it with the group members. Many agreed that difficult questions were shared in the form of pictures. Others also stated that they would reference a section of the book for others to find as they usually had the same textbook either as hard copies or on their mobiles.

When they were asked how they reference the textbook when reading online to others on a big forum like VULA, they would first explain where sections are located in the textbook or share relevant pages. However, they explained that since they used similar books, it would have been easier if the book could be referenced easily using a Web link without having to explain where the text is located. Students gave examples of using the electronic Bibles to read text that was linked to other media. Some gave examples of using the dictionary; when one wanted clarity on a word, they were automatically linked to search engines for explanations without them having to exit the dictionaries.

40% argued the need for notifications so that one could keep track of posts. However, 60% did not want to be notified of the information that is posted as it can be intrusive and 87% wanted to remain anonymous. This feature is, however, one of the most useful components of forums that enables users to not miss any information like new posts for the sections they like.

vii. Wants and Needs of an Integrated Textbook with Forums

The participants were asked what kind of system they would create that catered for all their needs. This session was particularly insightful where the focus group was concerned as they brainstormed together about what they would want to see in the system. From all the participants, the following are the wants and needs of the collaborative system that they envisioned.

- Discussions that are directly linked to their text resources to efficiently reference them without having to use data to take pictures and share them or remembering the exact sections in the books. That would help minimise the navigation steps of referencing. This feature presented a dialogue as to how to make it possible. Some suggested that the discussions should have a link to the textbook section that they were referring to while others stated that the textbook was more important than the discussions hence the discussions should be an additional feature inside the textbooks. They based this theory on the social media platforms that have content-based discussions, where people are first provided with resources, and they discuss them. 73% preferred the latter option arguing that there would be too many links which may be accidentally opened thereby disrupting the reading.
- Also, 80% of the students stated that they wanted to share the electronic textbooks such that one could see what the other friends were highlighting as challenging for them. Seeing others online reading a similar book would motivate them to read as well.
- Users could also highlight exercises that they did not understand, sharing them with friends and maybe other members of the classes.

- Ability to hide the user identity by choosing an alias name for academic forums like VULA. 87% of the participants stated that on such a platform, they would have the liberty to ask any question as they would be more confident even if their question was considered too easy by others.
- All participants agreed that the eTextbooks were too long. As a result, if the textbooks were broken down into chapters or themes, then it would be easy to focus on particular sections at a time. Also, they would not have to scroll or swipe much for shorter chapters as compared to the whole textbook. The literature agrees with this requirement of delivering small modular chunks of information when designing for mobile reading (Wang & Smith, 2013).
- Students also indicated the need for a chat forum for discussing other content with specific users that they felt had more knowledge on the topic. Others disagreed saying that chatrooms created a place for hiding for others and people ended up chatting about other things that were not school-related. Also, those who stated they were shy would end up defaulting to chats instead of conversing with others online. There was a debate, however, many ended up agreeing that to get more insight, one required many users to participate in the discussions.
- A user can post a question, browse through posts, vote for a post or comment, view posts by votes or dates or users and search for particular posts.
- View hidden step by step solutions to exercises in case no one responds to the posted questions. Maybe those can be viewed after a certain number of posts.

viii. Paper Prototype Results

The participants created a total of 13 prototypes: seven from each of the focus group members; two from the pairs of participants; and four from single participants. The results showed sketches with some of the features already discussed above. 27% defaulted to a similar design to what they already knew, for example, VULA.

3.4.5 Discussion

From the results, it is evident that study groups are essential in the academic life of a student. Students tend to meet-up to share knowledge on various subjects. Students have mobile phones and can access school resources on the go and even share resources on them or discuss difficulties. Being far away from each other is no longer a restrictive measure as they can use mobiles to connect. This suggests the need to take advantage of the smartphones that they use to benefit them academically. Although platforms like Facebook exist, they are not considered for academic purposes. WhatsApp seems like a typical application used, yet it also has its challenges of being misused for other non-academic posts. This suggests that sites like VULA are essential. However, they need some enhancements to ensure

that they can be used more often. For example, students were not aware of the extra resources placed for reading on the site. The gap is in the distance placed between what students should read and what they converse about.

Students are already reading eTextbooks on the go and the question arises as to what they do when they are clueless about something in the textbooks. The fact that students take pictures to reference textbook text or questions shows that there is a link between questions on forums and textbooks. The need for discussions linked to their resources was highlighted even though a clear solution was not given. However, ideas of linking textbooks with discussions came up, and this needs to be incorporated into the prototype system. Also, students complained about the long eTextbooks that required a structure that is more readable and motivating to students. The books can be divided into similar topics or even chapters to ensure that even the references are more straightforward as sections to read will be shorter. Students are concerned about their identity on the platforms to ask questions freely, and that seems to be an essential feature for interactive educational systems.

The participants, even though at tertiary level, complained about the discomfort of revealed identity on the existing platforms, which made them particular about posting on the platforms. It is therefore important to allow the students the liberty to choose if they want to show or hide their identity. Most reasons for revealing identity are to avoid foul language and abuse of the systems, however, specific rules when joining the system with concealed users would have to be placed to govern the sites. It is evident that user identity affects what and how students write posts on discussion platforms. This is also the reason why there was a debate about the use of chat rooms, which are said to encourage individual learning and not interactivity and information sharing. Chat systems are useful for communicating with few individuals, but for this research work, we explore communications for many people.

Students are sharing media to explain their enquiries to others. They, however, have no time for typing out mathematical symbols as they consider it tedious. Students want to use as less time as possible typing on their mobiles to ask questions. Taking a picture seems more efficient for them. It is therefore not so important for these students to have mathematical or computational notations on discussion forums.

3.4.6 Co-designing Summary

The design study has shown the importance of discussion forums and eTextbooks. Students know what they need and can even visualise it. Among other features, those that were identified as key to

the participants on such applications are linking resources to forums and the concealed identity of users. The results provided insight into the research work and helped formulate the research questions. Participatory design is useful for highlighting important features that may be overlooked by designers. The list of necessities given by the students will then be analysed and considered in the design of the final system.

3.5 Summary

This chapter has described the design of an eTextbook collaboration platform concerning the requirements gathered from potential eTextbook users. Since the design obtains requirements from both tertiary and high school students, this system was to be prototyped, designed, developed, tested and evaluated by both groups of participants. The following chapter describes how the system was prototyped and developed based on the gathered requirements.

4 Prototype Implementation

The following section describes the details of how the proposed prototype was designed and implemented. A Web framework called Web2py was used for developing the system. A Web framework was chosen because it allows developers to build new apps quickly and efficiently through Application Programming Interfaces (API) and tools that reduce and simplify the amount of coding. The different parts of the development are explained in detail below.

4.1 Proposal of a Prototype System

Based on the literature, technology probe, preliminary study with high school students and the brainstorm and design session with university students, a system proposal was designed for development.

Participants have the option of logging onto the system using their Facebook names, which is usually the name that one is identified with by friends or using an alias name to be anonymous. Facebook disciplines the user such that it keeps users in check on the kinds of posts they share and the discussions they engage in. Although on Facebook one may choose to use a nickname or fake name, one still requires being identifiable by close friends and family to be able to create connections with others. Also, Facebook is an easier way to centralise users without the need for registrations on linked applications. That means users for this research could log onto other applications using their Facebook login credentials.

A tool which selects images, formulas and texts from open source textbooks and bundles them up such that they can easily be accessed and represented on a mobile phone is proposed for the internal forum platform. That is because one of the requirements by the participants was that of a textbook that is broken down into short, readable sections. Originally, hard-copy textbooks are arranged in various topics that have sub-sections for easy readability and referencing; the same or better would have to be considered for representation on a mobile phone to promote readability. Literature also stated that it is important to provide engaging learning materials that are neither too long nor overly-demanding. Since there is a need to collaborate on the platform, a PDF file would be less interactive than a Web-based textbook hence the extraction of images, formulas and text to generate an HTML file that can easily be highlighted or made interactive.

For high school students, complicated subjects like Mathematics may require mathematical notations while the tertiary students insisted on having a feature for uploading images. As a result, the system will cater to both and observe which of the two is utilised more. Extracted digitised textbook images, graphics and text could be used as a reference when asking questions while mathematical editors can aid students in typing responses with complicated notations. Literature also highlighted the importance of respect for privacy and creating a safe and secure mLearning technical environment for successful interactions.

There are two similarities in the results of the three experiments. The first is that students in all the experiments indicated the uneasiness of asking questions using known identities. That indicates user identity should not be ignored when designing platforms for collaborations. The proposed system, therefore, requires that users have the choice to either use a known identity or a concealed one. The fact that all three groups of experiments discussed above highlighted this feature as a hindrance to discussions show that it is important and should be enabled to maximise on discussions. To observe if the number of questions asked increases, users will, therefore, have a choice of obscuring their identity on the application to allow anonymous users.

Participants highlighted that referencing is difficult on forums and sometimes they are not aware of the resources available to them on such sites. As a result, they suggested linking the textbook to the forums. An innovative suggestion was to combine textbooks to discussions as there was no reason to separate the two especially since discussions centred on the text, hence the proposed system will allow a student to ask a question related to content within a book. Either the discussions are found in the text, or the text is linked to the discussions. For this research work, we explore the route of locking students into the content and allowing them to ask questions within that content. As suggested by the prototype design, inline editing within books may be the answer to promoting collaborations found inside textbooks.

To develop the prototype that is mentioned in the previous chapter, we proposed a system architecture that is shown in Figure. 4.1. The architecture of the system will be discussed in detail.

4.2 The Architecture of the System

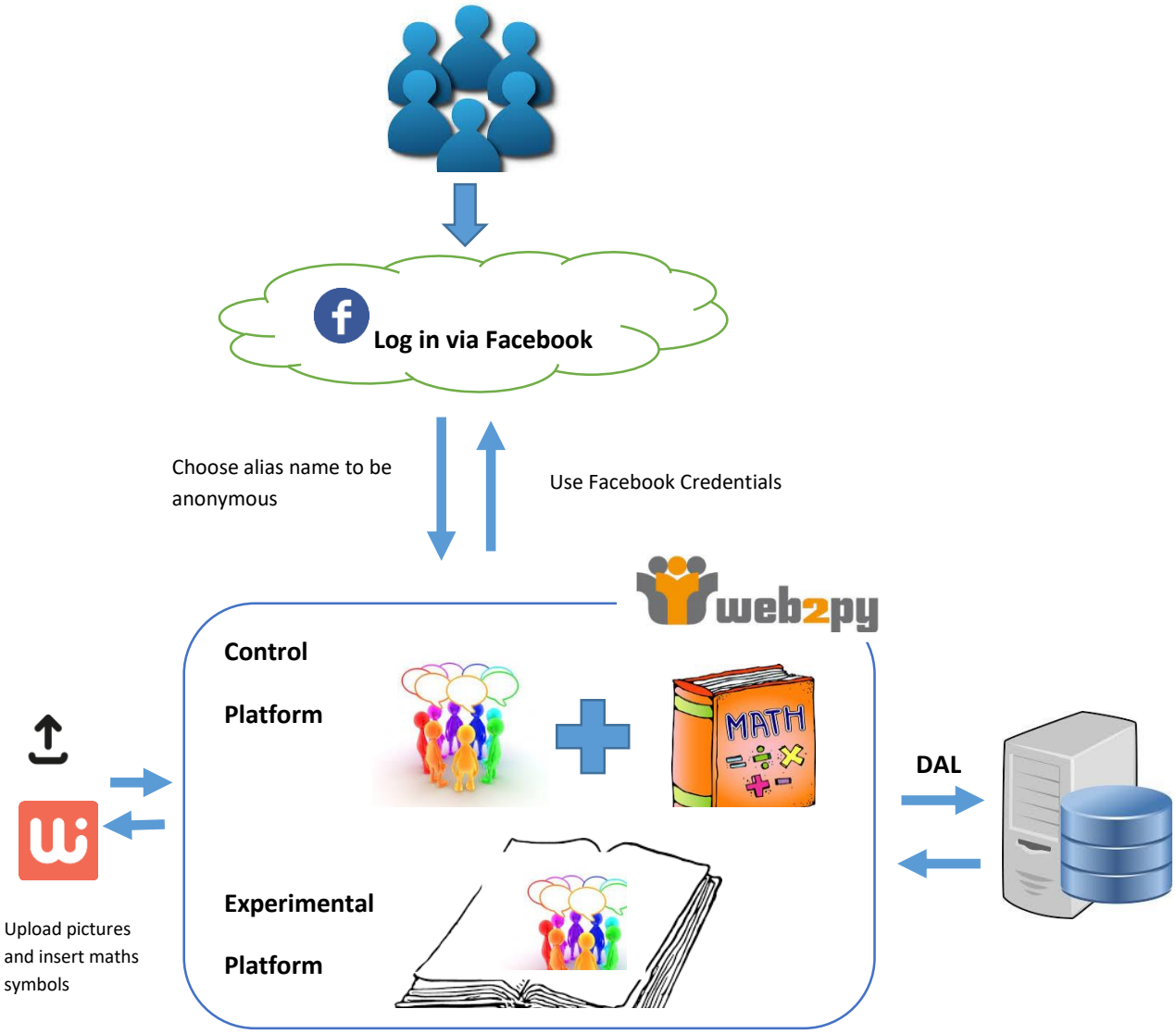

Figure 4.1 The architecture design of the system

4.3 Web2py as a Web Framework for Development

Web2py is a secure database-driven Web application tool that is open source (Di Pierro, 2011). The Web2py framework offers an easy way of creating and integrating many database tables that are required for the storage and management of thousands of messages. Therefore, Web2py is a suitable tool for designing prototype platforms that are similar to social networking platforms. It is programmable in Python. It does not require any installation but runs on any architecture with Python support like Windows, UNIX and iOS. It also contains all the components necessary for the creation of an entirely functional Web application (Di Pierro, 2009). Web2py contains the following components (Di Pierro, 2011):

- Libraries that provide the core functionalities of the framework.

- Rocket WSGI Web server.
- Admin application that provides a Web-based Integrated Development Environment (IDE) for building Web2py applications. The IDE also allows other functionalities such as Web-based shell and Web-based testing for creating, designing, and managing other Web2py applications.
- An example application that provides documentation and interactive examples.
- A welcome application, which is a scaffolding template for any application that a developer requires. The application includes pure Cascading Style Sheets (CSS), cascading menus and user authentication functionalities.

Web2py follows the standard Model View Controller (MVC) pattern for development, enabling developers to follow good engineering practices (Di Pierro, 2009). Web2py follows the MVC pattern by separating the model, which is the data representation, the view, which is the data presentation and also the controller, which is the application logic and workflow of the software being developed. This framework also provides support in the form of libraries that help developers to design, implement and test their software either as individual parts or in an integrated manner.

Web2py includes a Database Abstraction Layer (DAL). The DAL dynamically writes Structured Query Language (SQL) for the developers (Di Pierro, 2009). The DAL can create SQL transparently for SQLite, PostgreSQL, MySQL, Oracle, Ingres and many other databases. A developer defines database tables, and Web2py automatically generates a Web-based database administration interface to access stored information. However, it is highly recommended that database queries be written using the Web2py Database Abstraction Layer instead of raw SQL to avoid dependence on a specific database engine.

Figure. 4.2 shows a typical workflow of a request in Web2py (Di Pierro, 2011). From the diagram, the browser represents any Web browser applications like Chrome and Mozilla Firefox. The server used can either be the built-in Web server in Web2py or a third-party server, such as the Apache Web server (Di Pierro, 2011). The server handles multi-threading. In our design, the Apache Web server that is open source was used. It is considered to be more secure and efficient.

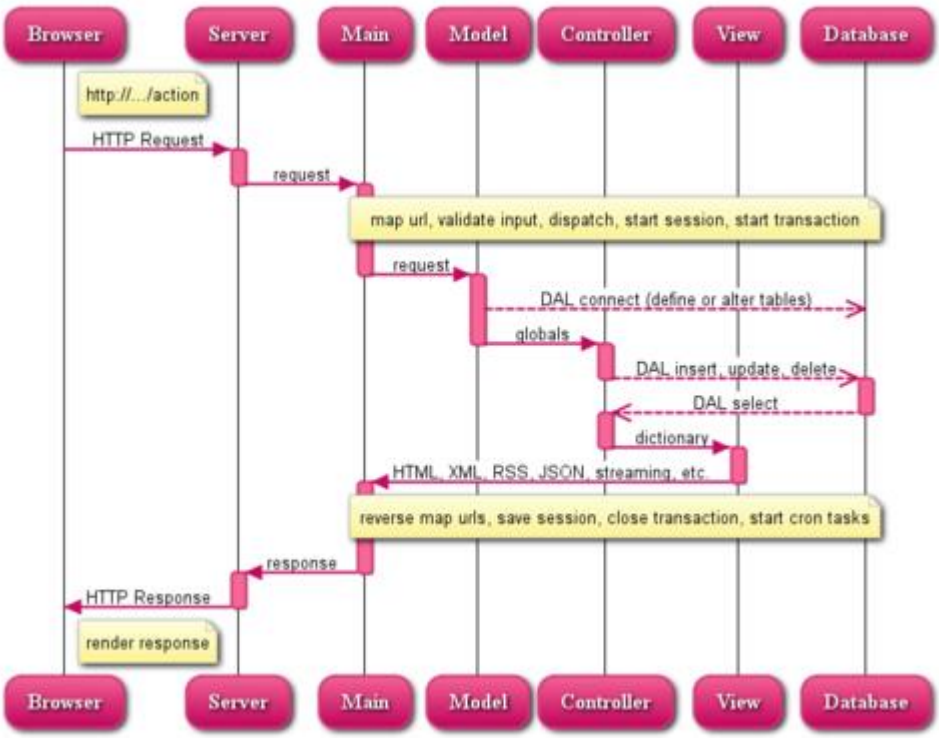

Figure 4.2 Workflow of a request in Web2py (Di Pierro, 2009)

"Main" is a Web Server Gateway Interface (WSGI) application, a specification interface between the Web server and the Web applications or frameworks for Python programming, which performs all tasks in Web2py and wraps all user applications. Static files can also be streamed via the Web server. "Main" also handles cookies, sessions, transactions, Uniform Resource Locator (URL) routing and reverse routing, and dispatching (Grisostomi et al., 2014). The MVC components are the user applications already described above. Web2py can host multiple applications within a Web2py instance (Grisostomi et al., 2014). The dashed arrows represent DAL communications within the database engine.

The requested URL is mapped onto a function call within the controller, and this generates an output of the function. This can be a string or a dictionary of symbols. The view displays the data that is stored in the dictionary (Ng & Ling, 2010). Depending on user requests, views can be HTML pages (default) or any other supported protocols like XML, JSON, CSV, RSS or RTF (Di Pierro, 2009). Should a call fail to execute, it results in an exception that causes a rollback, otherwise, the execution is committed. The program then returns the output via a browser for the user to view.

4.4 System Description

All the components described in detail above helped build the designed prototype system. The system is divided into two collaborative platforms: 1) the traditional forum platform to act as the control platform, also known as the external forum and; 2) the internal forum platform for testing the idea of combining textbooks with discussions, also known as the internal forum. The section that follows describes the login and home page features and then explains the differences between the two collaborative platforms.

4.4.1 Logging onto the System and Alias Name Registration

For this application, various users from different locations need to log in, however only logged in users can have access to the Web pages. Web2py has a class that implements a Role-Based Access Control mechanism (RBAC) called Auth. Auth provides multiple login methods (Di Pierro, 2011). The default mechanism identifies users based on a local authentication table. Besides the inbuilt Auth, Web2py handles OAuth2.0 authentications. Oauth2.0 is defined as an authorisation framework that enables users to access many applications using one account (Di Pierro, 2009). Web2py allows users to be verified against any configured OAuth2.0 provider during login (Di Pierro, 2009). OAuth2.0 providers may also be used on any Web2py application using APIs to access other resources. Google, Twitter, Facebook and other social media platforms are third-party or single sign-on providers that all have APIs that can be easily accessed by a Web2py application.

Since the findings from the preliminary study showed that many students were using Facebook, the system being created allows users to log in through Facebook accounts (see Figure. 4.3). The first step in linking Facebook to Web2py is registering the domains of the new application on the provider's site, in this case on the Facebook developers' page. This is done to get an app ID, which is required by Web2py. Firstly, one needs to install the Facebook SDK for JavaScript, which is the programming code that enables people to sign in a Web page with their Facebook credentials (Graham, 2012). Secondly, the Facebook Graph API is required as it has various methods that obtain details from Facebook account holders, for example, the get_user () method that helps obtain the username, surname, ID and email of a Facebook user (Graham, 2012).

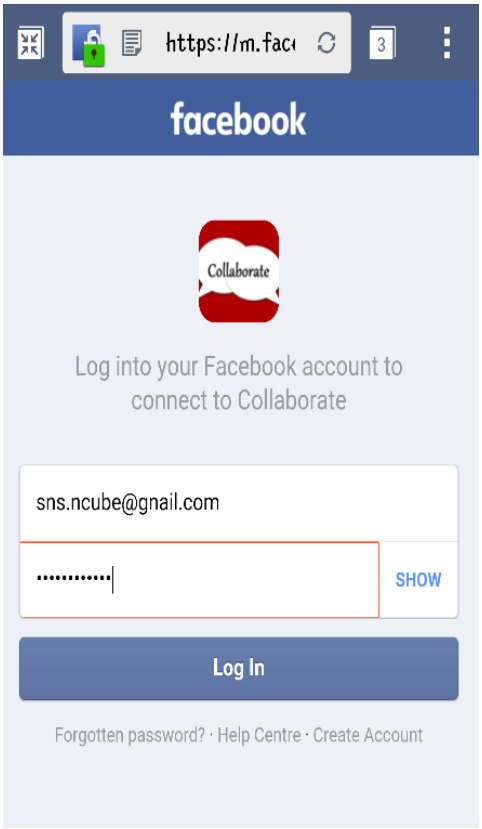

Figure 4.3 Logging in via Facebook

On Web2py, in order to enable the Facebook OAuth2.0 provider to an application, one requires the Authorization Uniform Resource Identifier (URI), the Token request URI; and the application identification token and secret that are received upon registration of the new application on the Facebook developers page (Feiler, 2008). One also needs to specify the permissions that the provider must grant to the Web2py application, i.e. the "scope"; and the API call to receive a Unique Identifier (UID) of the authenticating user. The Web2py application can then access the API of the provider, at any time by using the OAuth2.0 access token. After users log onto the system, Facebook assigns a “Session” for the system to authorise the users. The users' basic information such as their names and email addresses can then be acquired through the Facebook Graph API methods. Users finally can confirm their profile and access the eTextbook system.

On Facebook, the name of the developed application was called Collaborate. One could access the system by going to Facebook and searching for the “Collaborate” app. Alternatively, one could access the system by going directly to the link that opens the app, which would also direct the user to Facebook for first-time users. After a first-time user logs onto the system via Facebook, they are directed to a registration page (see Figure. 4.4), which gives users the option to participate anonymously on the system through alias names. Otherwise, users who do not sign-up to use an

anonymous name automatically sign-up to use their Facebook account names on the system. On the registration page, high school students also get to select their school to keep track of the separate groups of students. On successful submission of the registration details, the user is taken to the home page of the system. For returning users, on logging onto the system, they are immediately directed to the homepage with no need for re-registration.

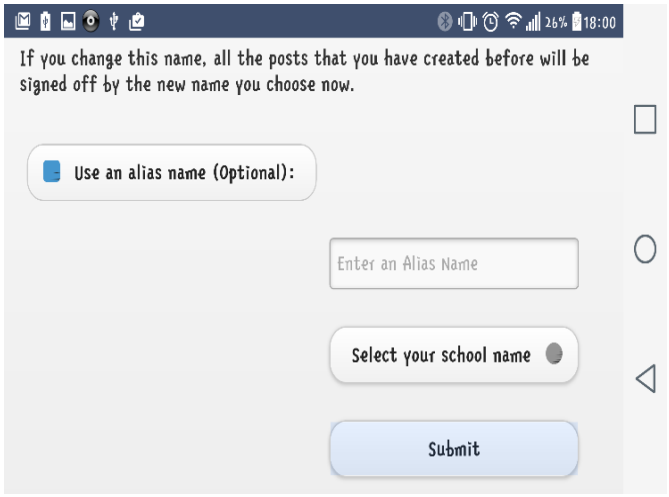

Figure 4.4 Choosing an alias name on the registration of first-time users

Some functions or pages of the system also may be restricted access using Auth such that all logins come with restrictions as to who may access pages and up to what level. Web2py Auth restrictions on a Web page are enforced by using the following line of code:

```
@auth.requires_login
//the line above restricts this function to only logged in users

def homepage():
      return dict(message='hello %(first_name)s' % auth.user)
```

The code above states that for one to access the homepage, they need to be registered on the system and logged in. If they are not logged in, they will be taken to the Facebook authentication page. However, if they are logged in, they can view the home page that greets the user by their first name.

4.4.2 The Home Page of the System

The home page of the system is the one that differentiates the two parts of the system. On the homepage, there is a standard menu bar with four buttons (see Figure. 4.5). The Topics button allows

one to always navigate to this home page with various textbooks and its topics. For this research work, only two topics of one textbook are shown. Otherwise, it would be a list of topics/chapters for various textbooks.

The home page also has the Settings button that allows users to change to or from alias name status at any time. The menu also has a Back button to allow users to return to the previous pages quickly. Lastly, there is also a Logout button, which allows users to exit the system and also log out of the app via Facebook. That means, on the next usage of the app, the user will have to log onto the system again. However, for returning users, on a mobile device, if the Facebook app is not logged out, the Collaborate app automatically allows a returning user to log in without submitting credentials.

On the home page itself, the page shows the topics available for a given textbook. In Figure. 4.5, it shows the title of the textbook and the class that takes the course followed by the two topics of the Python Textbook for the University students. For the high school students, it shows the two Mathematics topics chosen for the experiments. Each topic has three links. The first two links follow a similar approach to the traditional platform that gives students access to a textbook and then also links the user to a separate discussion forum. From Figure. 4.5, this is shown by the “Platform A: Textbook” link and the 'Platform A: Discussion Forum” link. The third link takes the user to the internal forum platform that has discussion forums embedded within the textbook. The internal forum platform allows one to view discussions in the textbook sections that one is reading or is interested in. As already stated, and shown in Figure 4.5, for university students, the first textbook chapter for the platform is called “Loop Control Statements”. The second topic, which follows a similar pattern, is “Strings”.

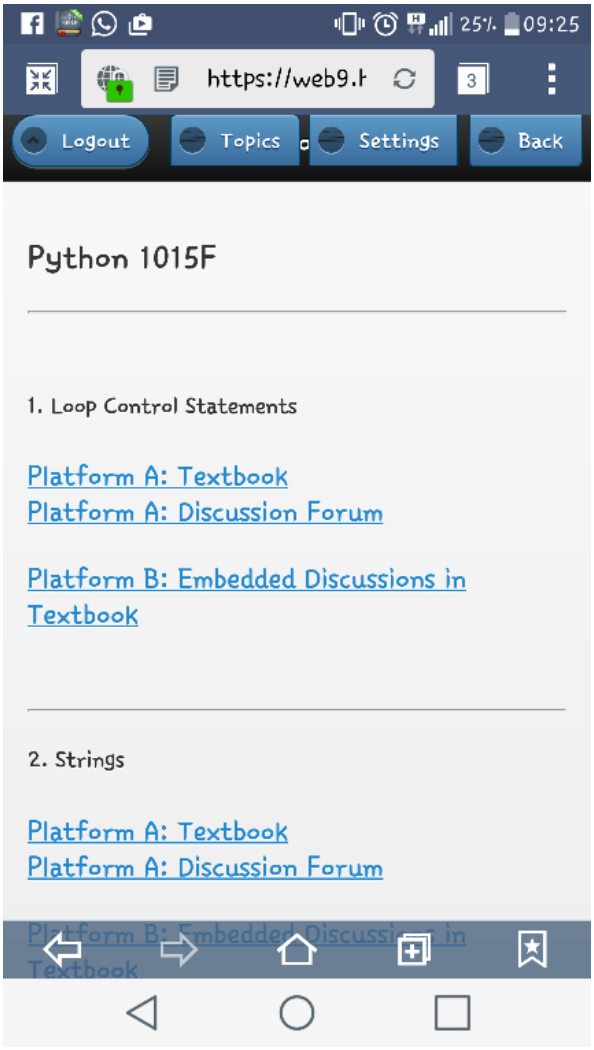

Figure 4.5 Homepage of the system

4.5 Choosing the eTextbook Topics for the Platforms

Since this application was textbook-based, the relevant source of content for the proposed system for high school students and tertiary students respectively had to be chosen. From the different textbooks selected, the relevant topics were also selected.

4.5.1 Choosing a Textbook for High School Students

Obtaining an eTextbook to use in the system proved difficult for high school students. The first step was to approach the Zimbabwean educational authorities to obtain authorisation such that one could digitise a few selected chapter pages of the common Mathematics textbook. According to the preliminary study, already discussed, Mathematics and Science were the main subjects that students discussed; hence Mathematics was chosen for the experiments. A Mathematics teacher representative was obtained from each of the four schools that participated in the experiments. These were approached to obtain a consensus on the chapters that would be relevant to the educational

needs of the students. Also, the topics used on the system had to be the same topics that the students were learning at the time of the experiments. On agreement, two chapters Linear Programming and Circle Geometry were selected from the common Mathematics textbook known as “New General Mathematics 4: An O’ level Course” written by Channon, Smith, Head and Macrae and published by Longman International Education. This textbook is common to almost all the schools in Zimbabwe including those chosen for the experiment and has been so for many years. Students study the textbook for tests and exams, and teachers use the book for teaching the mathematical topics in the syllabus.

The next step was to obtain authorisation from Longman publishers to digitise the two selected topics for the experiments. After seeking details of whom to contact through the Ministry of Education in Zimbabwe, Pearson was discovered to be a co-publisher to Longman, and they held all copyrights to the chosen textbook. Pearson was therefore contacted to obtain authorisation to which they requested terms and conditions of use of their textbook for the project. The terms and conditions document was sent to them together with a project summary to which many follow-up emails were sent to obtain feedback but with no success as all responses stated that they would make a decision very soon and yet it never came. Since this took a long time (months) and was delaying the progress of this project, an alternative solution had to be obtained to address this challenge. Pearson publishes almost all scientific and mathematical textbooks for high schools in Zimbabwe hence changing the subject of the textbook for use in this experiment was not going to help. Also, a connection with Zimbabwean schools had already been built, and the schools seemed relevant for our study to change them.

One of the options was to switch to smaller communities that use shared textbooks in South African schools. The community, however, would be confined to districts or cities with boundary objects of interest. This is unlike in Zimbabwe where the whole country shares a common textbook per subject. For testing purposes, it would have been suitable to use South African schools for testing. Unfortunately, obtaining authorisation to conduct experiments with students of South African schools is a long process as the educational authorities find it intrusive to the students. This would have delayed the project further.

It was observed that students in Zimbabwe did not have access to textbooks and providing a supporting textbook that was very similar to the standard textbook that student are familiar with would be an alternative. Moreover, if the representative teachers recommended it, students would

use it. A company called SiyaVULA Technology Powered Learning creates open source eTextbooks for students (Jimmes et al., 2013). These textbooks are created by experts in various subjects who co-create this content and supply it for free to students. The open-source textbooks are in portable document formats and are supplied on their South African website for any student to download at no cost (Emmons & Thierstein, 2009). Grade 11 in South Africa is the same as Form 4 in Zimbabwe, hence the teachers who were recruited earlier were shown the portable documents to help guide the selection of the chapters that would be relevant to their students on the Trigonometry and Geometry subjects. When this was finalised, SiyaVULA was approached to ask for raw files of the Mathematics textbook since they also had HTML versions of the book chapters for easy integration with Web2py for representation on the Web. The raw files consisted of diagrams, images of formulas, questions and answers as well as HTML based Web pages of the grade 11 textbook content. In case more grades had to be used, grades 10 and 12 were also provided. This made it easy to design the system quickly instead of extracting the different components of the books ourselves.

SiyaVULA provided compressed files for our usage. The images were compressed to .jpeg files that have a much smaller size to the .png images so as to easily and quickly load the files on Web pages. This was done to ensure low data costs when accessing the Web. Small sections of the relevant chapters selected by the teachers were obtained from the given HTML files, and these were utilised in the development of the system together with all other relevant files.

4.5.2 Choosing a Textbook for Tertiary Students

At the tertiary level, many courses already have open-source eTextbooks. These are either bought online or given for free by lecturers of courses. They can also be found in the library with licences for usage online. A course in Python already had an open source eTextbook, on the VULA LMS. The textbook was created by experts within a Python Programming Course. This made the subject a suitable course to use for this experiment since Computer Science programming is a problem solving subject similar to Mathematics. Two chapters were selected for experimental purposes. After conversing with the lecturer for the course, the experiments were to run concurrently with the subject topics being taught at the time for two weeks. The subjects that the lecturer was teaching in time for the beginning of the experiments was Loops and Strings, hence these subjects were selected for use on the system.

4.6 How the System Works

To evaluate the system, users were supposed to use both the control and the experimental parts of the system and compare them to select the platform that better suited their needs. These two platforms differed in the positioning of the forums relative to the textbook content.

4.6.1 The External Forum Platform

As already stated, the control platform represents the traditional discussion forums that are separate from their resources. As a result, it was designed in a similar manner, whereby one can access the textbook resources on one Web page and then access the forum on another Web page. So when a user clicks on the “Platform A: textbook” link, they are taken to the page that has the Loop Control Statements chapter text. The textbook resembled a PDF textbook that could only be read without modifications. The user can read that text; however, when they encounter challenges, they can exit the textbook page and click on the “Platform A: Discussion forum” link that takes the user to a page where they can ask or comment on any questions related to the chapter they are reading. That means that each chapter has a dedicated forum for it. Breaking down the textbook promotes the categorisation of questions and group related posts. The user is, therefore, free to alternate between the two Web pages toggling between reading the textbook chapter and asking and answering questions about the chapter on another page. This is usually the case to separate functionalities to each page.

On the textbook page, there is the chapter title and the text related to the Chapter (see Figure. 4.6). The text is arranged for readability on a mobile device. On the discussion forum page, there is also a title of the chapters, which is always visible (see Figure. 4.7). The page has a list of previously posted discussion threads created by the users. Each thread has a comment section to it as well as buttons for voting (see Figure. 4.7). Users can, therefore, respond to a question through comments to help answer a posted question. Users can up-vote the question as good with a '+1' or down-vote a question as not relevant or useful with a '-1'. The discussion forum page can arrange the posts according to the number of votes or by date of postings (see Figure 4.7). The user can, therefore, toggle on the different view options as per their needs. Currently, each page can show at least ten posts each, and one can navigate through the pages to view the many threads.

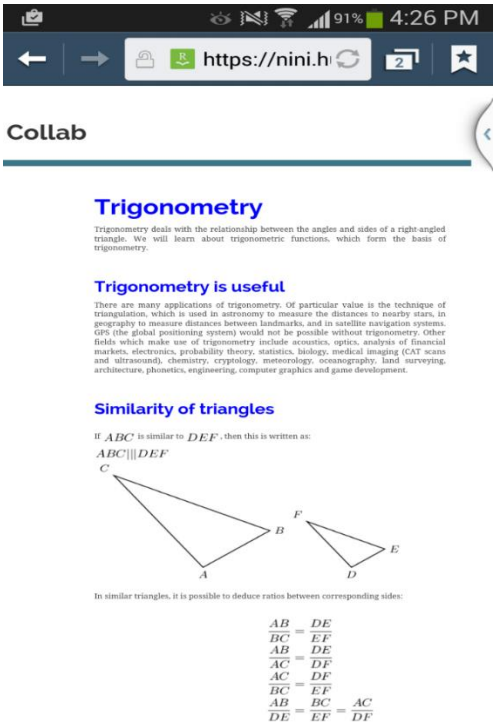

Figure 4.6 Trigonometry Chapter on Platform A

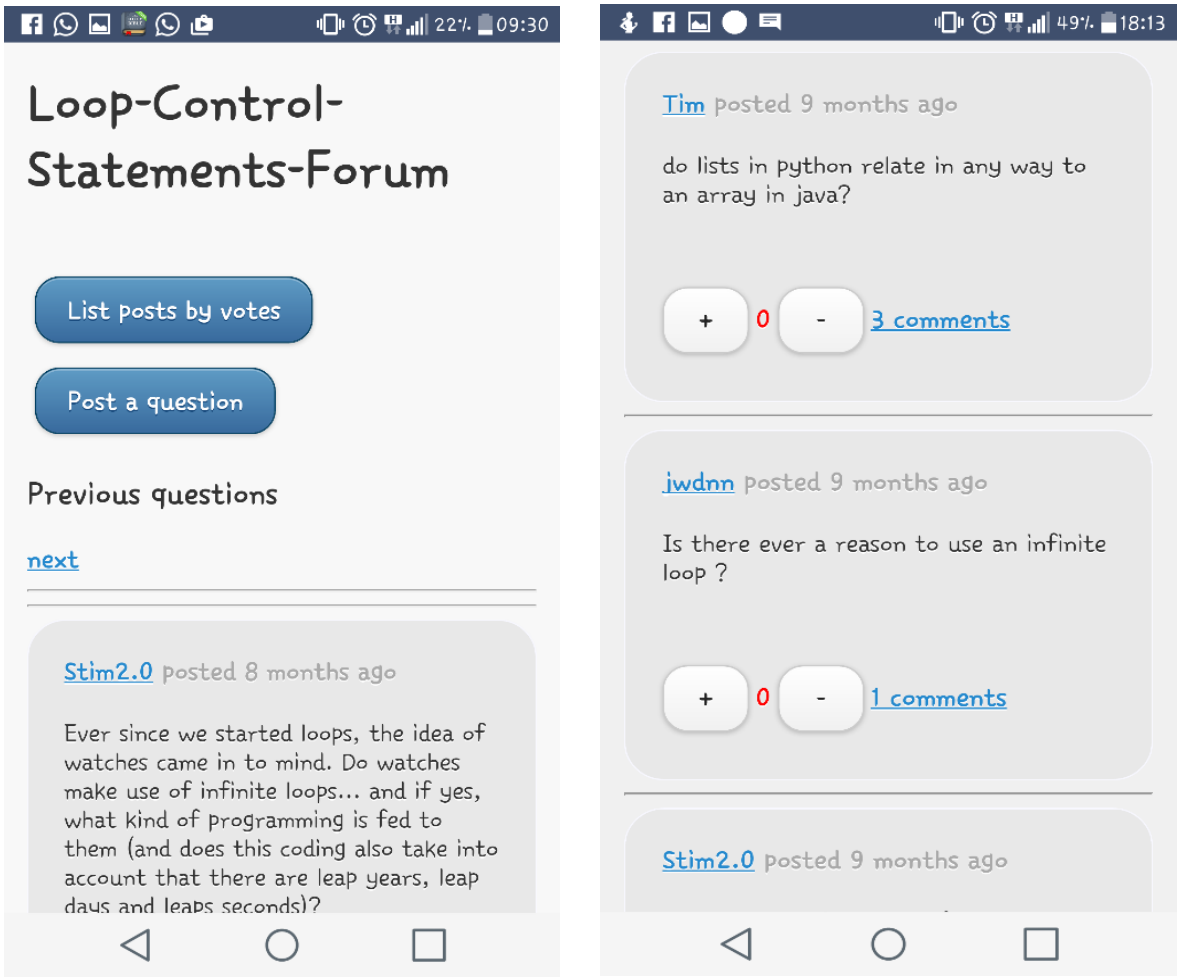

Figure 4.7 Discussion forum for the Loops Chapter showing the title, menu buttons and the forum posts

At the top of the page, there is a button that allows a user to post a new question to the forum. This button takes the user to a page that has all the features for asking a question. A user is allowed to edit their post. The user also has the option to use the mathematical notations or add pictures to their posts. However, the users were not allowed to delete their texts for the sake of keeping a record of all the posts the users had created.

Mathematical Notations using WIRIS Editor

The textbook chosen for high school students was in Mathematics with many mathematical formulas. To ensure that the students could efficiently use the formulas they learn in class, a calculations plugin for HTML Web pages was used. WIRIS editor is a visual editor that is also known as an equations editor or a WYSIWYG formula editor (Mora et al., 2011; Marques et al., 2006). It allows the use of handwriting as input or the use of a collection of icons. It can run on any browser and operating system since is it based on Javascript and is compatible with HTML5 (Mora et al., 2011). This editor enables users to edit and insert mathematical notations on Web pages. The WIRIS editor is based on MathML standards for internal representation and the PNG image format for displaying formulae (Mora et al., 2011). However, it can also handle other formats like LaTeX, flash, SVG and EPS. The WIRIS editor can easily be integrated on both Web applications and desktop applications for Windows. It comprises of two components: 1) The Javascript editor, which displays a toolbar showing the active formula and captures mouse and keyboard events to dynamically build formulas (one can easily embed the editor on a Web page); and 2) Web services that provide extra features like the generation of PNG images from the MathML and converting from or to LaTeX.

When creating Web applications, WIRIS editors may either be hosted at WIRIS.net or one may install the editor on their server such that the Javascript editor and its images are provided from the site. To achieve this, one may install a WIRIS plugin. A WIRIS plugin is what one installs on their Web application to enable the usage of WIRIS editor and WIRIS CAS (Computer Algebra System) tools on applications and content managers or directly on the HTML pages (Mora et al., 2011). A WIRIS editor is a mathematical visual editor, whereas a WIRIS CAS is an online platform for mathematical calculations created for educational purposes (Marques et al., 2006). Several plugins exist that work on any HTML (see Figure. 4.8 for an example of the WIRIS editor that was used). These plugins are targeted at different technologies like PHP, Java, ASP. Net and also various Html editors like CKEditor as well as existing platforms like MOODLE, Joomla and Sakai. The WIRIS tool may also be used on HTML text areas.

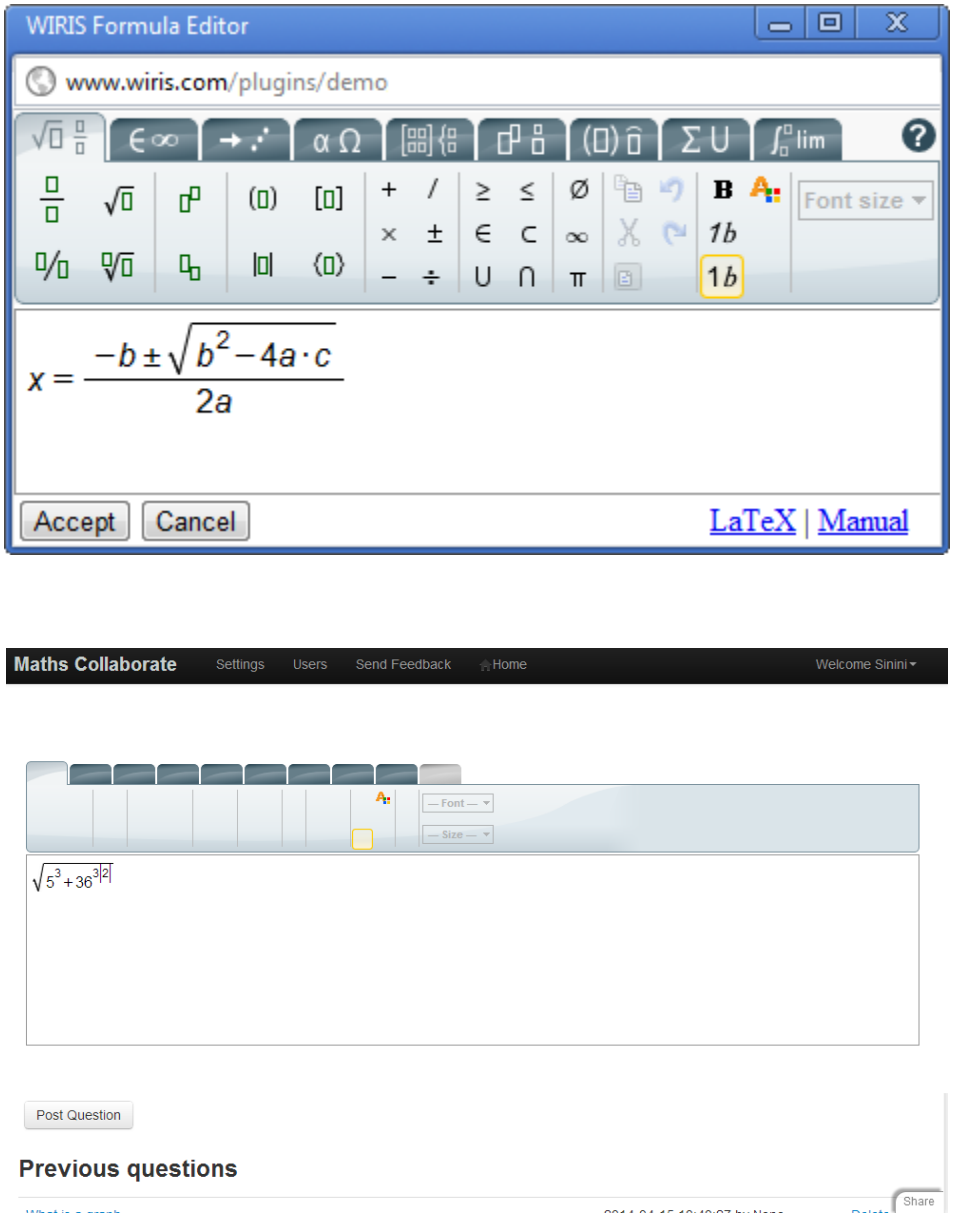

Figure 4.8 Views of the Wiris editor when posting a question on the external forum platform

From Figure 4.8, when a user clicks on accept, what has been typed in the editor box is converted into an image and displayed on the Web page where the WIRIS editor plugin is installed. The WIRIS Editor comprises of an extensive collection of icons, which are organised in thematic tabs for quickly creating formulas for any Web content. To use it, a user clicks on the editor to create formulas or double clicks on the formulas to edit the formulas. The WIRIS CAS comprises of a calculation toolbar, which was displayed through an HTML page. WIRIS CAS covers all mathematical topics from primary to university level as such it was suitable in this design. It includes integrals and limits calculations, function graphing in 2D or 3D and symbolic matrix manipulation, among others.

Embedding WIRIS editor

There are two steps in embedding the editor on Web pages. One needs first to display the editor and then they also need to be able to call the API for setting and retrieving the MathML. The snippet of code below shows how easily one can embed a WIRIS editor on a Web page.

```
<script src=http://www.WIRIS.net/demo/editor/editor></script>
<script>
      var editor;
      window.onload = function() {
        editor=com.WIRIS.jsEditor.JSEditor.newInstance({'language':'en'});
        editor.insertInto(document.getElementByID('editorContainer'));
      }
</script>
```

Calling the editor API to get the MathML:

```
      alert(editor.getMathML());
```

Setting the MathML for display:

```
      Editor.setMathML("<math><mfrac><mn>1</mn></mfrac></math>");
```

One may also change the language to use on the editor or change the size of the editor. The editor also comes with various toolbars for editing purposes. One can use a simple form with basic formulas or customise their toolbar or choose a specific toolbar like Chemistry toolbar with its buttons. The editor may also be changed in style, e.g. the font size, font family, colour and background colours.

4.6.2 The Internal Forum Platform

This platform represents the experimental feature that this research work is testing. It is designed such that the discussion forums are embedded within the textbook content itself. As a result, when a user clicks on the "Platform B: Embedded discussion within textbook" link on the home page (see Figure. 4.5), they are taken to an HTML Web page that shows the embedded forums that are based on the "Loop Control Statements" chapter (see Figure. 4.9). Each textbook chapter is designed such that it is divided into various chapter subsections. After every sub-section of text within a chapter, there is a discussion forum.

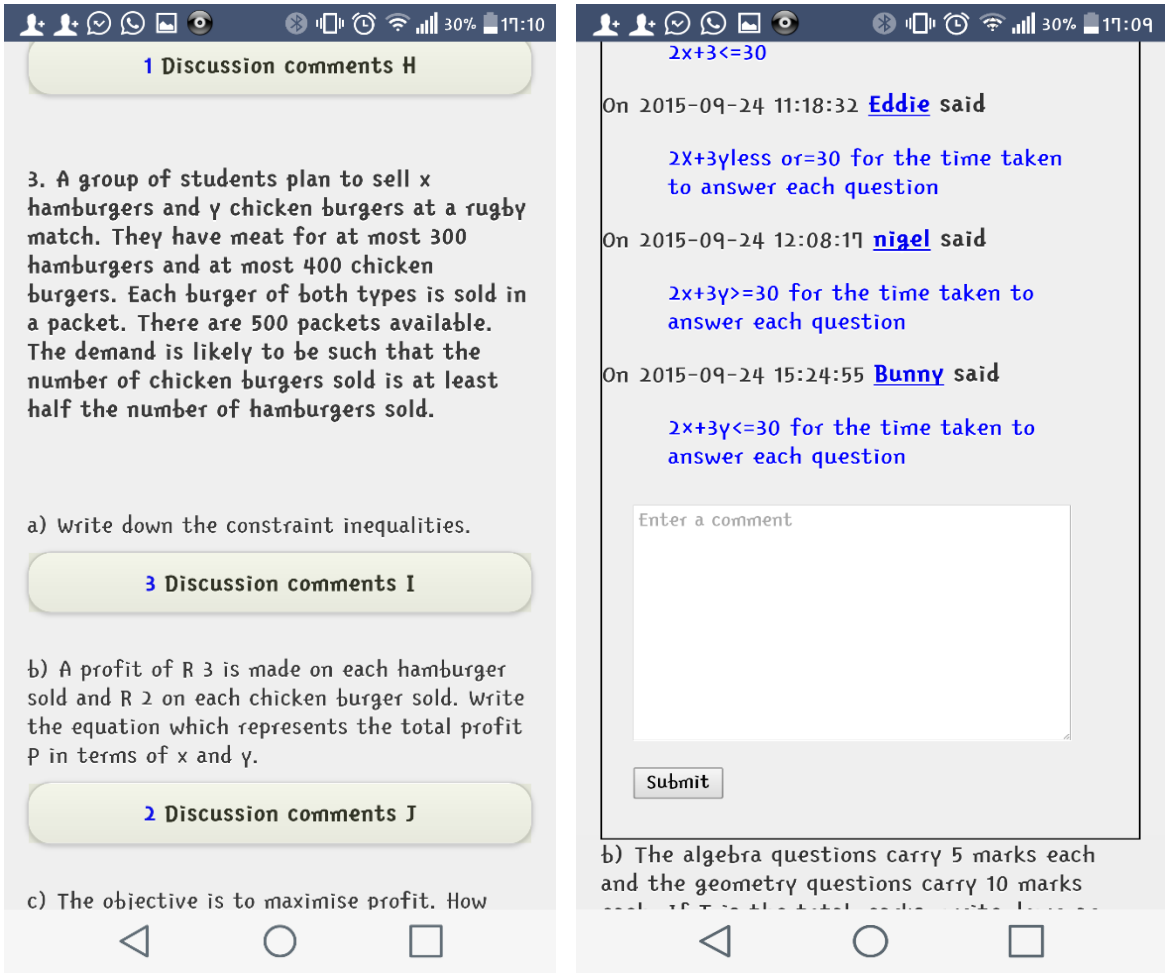

Figure 4.9 Textbook exercises and the discussion areas within the text.

From Figure 4.9, the letters H, I and J helped to identify and name the discussion forum sections, particularly for high school students who were being directed on where to post. This was not necessary for university students. Each button had an alphabet attached to it. This helped keep track of who was posting and where they were posting in the book given. It was designed in such a manner to allow users to ask questions related to what they have read, thereby organizing the forums according to their relevant text for easy referencing of posts. Also, it follows the concept of representing text as small chunks for reading on mobile devices. A user is, therefore, able to click on a comment section and type any questions related to the topic. The comments are hidden by toggling the view and hiding to avoid too much clutter when reading the textbook. Each button shows the number of comments related to its section (see Figure 4.10). However, a user has the choice to keep the discussions open as they read. To view the comments, a user clicks on the comments button, and it expands the view so that all comments are visible to the user (see Figure 4. 10). The user can then also add a comment or respond to posts. After every section, there are usually exercise questions. Each of these also has its discussion section for users to post answers or queries about those questions.

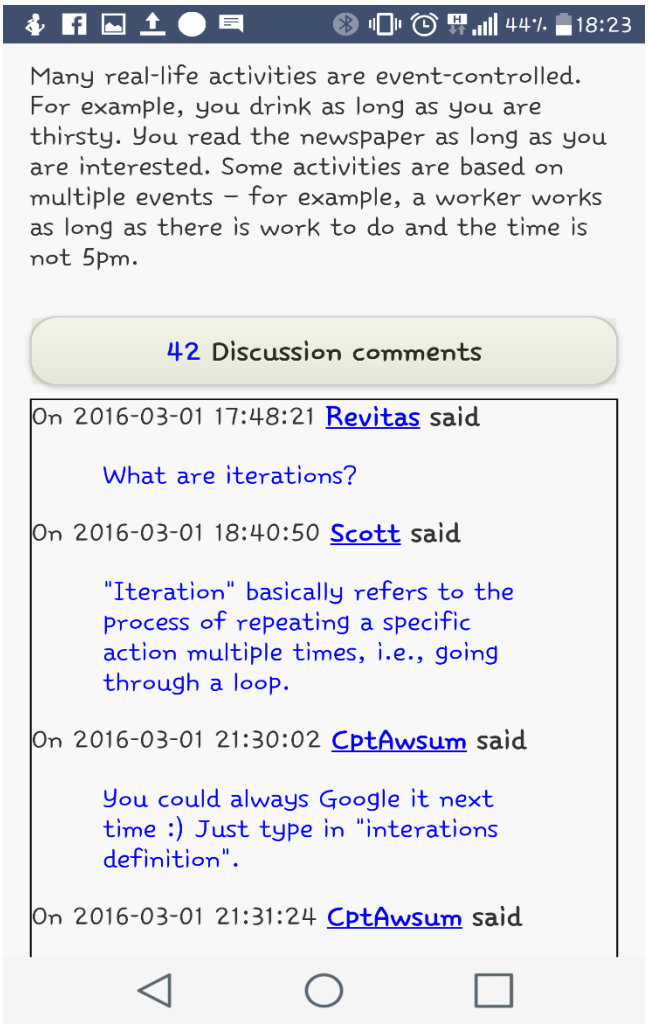

Figure 4.10 Button with the expanded view of comments in a section of textbook content

4.7 Summary

This chapter has described the implementation of an eTextbook collaboration system as per the user requirements and designs in chapter 3. The chapter has outlined how the system data was obtained in the form of eTextbooks, how complicated formulas were used and how users logged onto the system. The final result is a complete prototype system developed for testing and evaluation. The next chapter describes the methodology for evaluating the system with users.

5 Experimental Design

This chapter describes the experimental plan for evaluating the collaborative eTextbook mobile application designed and developed in the previous chapters. The primary objective of the experiments was to answer the research questions.

5.1 Evaluation

The experiments were conducted to address three research questions that test the usefulness and organisation of embedding discussions within the content and outside content on mobile phones. The experiments observed differences, similarities and preferences of two different groups of students: novice and expert users (novice being high school students who are not accustomed to eLearning discussion forums and expert users being university students who are familiar with eLearning discussion forums). Following are the research questions with their subcategory questions that had to be answered:

1. **In what ways can mobile phones be used to support collaborative interactions embedded in textbook content? (RQ 1)**
    - How can textbook content be represented on a mobile phone in a navigable way that is deemed usable by students in promoting interactions?
    - Which platform do students consider to be more effective for their needs: embedding discussions within the content or separating discussions from content?
2. **What is the effect of embedding discussions within textbook content? (RQ2)**
    - Does embedding discussions within content encourage more content related collaborations?
    - What distractions do embedded discussions within content bring and how can they be mitigated?
3. **How does mediated privacy of users on academic networking platforms affect user interaction? (RQ3)**
    - Does the use of anonymous profiles increase the level of interaction?
    - What concerns around privacy do students have in revealing their identities on online discussion systems?

The next sections describe the essential parts of the experimental design for evaluating the system to answer the above research questions.

5.1.1 Experimental Design Approach

The experimental design approach used in this study was adopted from existing randomized experimental designs with repeated measures. This design is also known as within groups design. The same participants take part in each condition, in our instance the same group participated in using both platforms (Kirk, 2012). The advantage of this design approach is that the same participants are used in each condition as such individual differences are reduced (Myers et al, 2013). Also, fewer participants are needed to take part in all the conditions of the experiments (Myers et al, 2013). . This is one reason why the independent measures approach to the experiments was not followed, this approach is also known as an in between groups approach. Independent measures involve the use of two groups of participants for each different condition (Kirk, 2012). One major weakness of the repeated measures experiment is that there may be order effects whereby the group that began with one platform may be at a disadvantage or advantage than the other group. As such for the experiment of this study, a technique called counter balancing was used to combat the order effects by alternating the order in which participants perform different conditions of the experiment (Myers et al., 2013). Participants were divided into two groups and the first group was exposed to Platform A which is the traditional platform and then exposed to the Platform B with embedded forums and the second group was exposed to Platform B then A.

Later in the last task of each experiment, the participants chose their platform of interest between the two given platforms. This was to observe reasons for influencing the choosing of either platforms. These grouping were random as the users themselves chose their preferred platforms. Each of these groups were then compared in a between groups design approach where each group was exposed to their own condition based on their selection.

5.1.2 Participants

Three UCT students were used to pre-test the evaluation experiments to be conducted for all students. That ensured that the experiments ran as anticipated by the evaluator. Any challenges and problems with the system were fixed before the actual experiments were conducted.

Participants for the evaluation study were learners registered at either high schools or university. Communities of learners that have textbooks as boundary objects were identified to participate in the experiments. For high school students, teachers acted as mediators between the evaluator and the students for all the activities conducted within the schools. Available teachers helped identify willing students as participants. For university students, this was not necessary, the qualifying students were contacted directly through emails on a first come first serve basis.

5.1.3 Ethical Clearance

To conduct these experiments, permission to use human beings for any of the experiments was obtained through ethical clearance from the University of Cape Town. The same permission used in the preliminary study was used for conducting these experiments.

Consent forms to be signed by all participants were created as per the ethical requirements of the University of Cape Town. For high school students, either the teacher signed a consent form on behalf of the students or each willing participant received a letter to seek parental consent at home, indicating the willingness of parents in allowing their child to participate in this study. For students under the age of 16 years, consent from parents can be a requirement (Scott & White, 2005). In the schools that insisted on parental consent and not teacher consent, all students were asked to obtain consent from their parents or guardians regardless of age. Teacher consent was selected over parental consent in some schools as teachers tend to have more knowledge about what is suitable for learners than parents. However parental consent was also important in ensuring that parents do not feel that their children are being deviated from their everyday studies through participation in research studies. However, the type of consent followed depended on the policies of the individual schools. Although parents gave passive consent for the students to participate, students, as the active participants, were also fully informed concerning the nature of the study. Students still had the right to refuse to participate even after parental or teacher consent. They also could choose to discontinue the session at any time if they were uncomfortable. For students at the University of Cape Town, consent was given at the beginning of the experimental session.

5.1.4 Data Collection

After each evaluation task, questionnaires were used to collect qualitative feedback from learners. High school students used hard copy questionnaires while university students used questionnaires created on the Lime Survey software. The questionnaires used in this experiment included rating items to measure variability in peoples' attitudes towards the system. Respondents reported how much they agreed or disagreed on a 7-point scale that was numbered from -3 to +3. According to Heiberger & Robbins (2014), diverging stacked bar charts are the most suitable tool for representing Likert scale data that visualises cases with more than two categories. In this case, RStudio plots were used to develop the diverging stacked bars for the analysis of gathered results.

Computer logs were also used to observe if all the students logged onto the app and to ensure tasks were being completed. Google Analytics and Clicky were used as free Web data collection tools. The

following section is divided into two parts: part 1, experimental study for high school students and also university students; part 2, a revised experimental study for high school students.

5.2 University Experimental Details + High Schools Experimental Details (Part 1)

The high school students and university students were both expected to follow a similar experiment so as to compare results easily.

5.2.1 Participants from High Schools

A total of 60 learners of the same grade (Form 4/Grade 11) were selected from four different high schools. The high schools all followed one curriculum which is the Zimbabwe Council of Higher Education (ZIMCHE). Each school had approximately 200 students per grade. 15 participants from the 11th grade were selected in each school to partake in the experiment. The learners ranged from 15 to 18 years in age. The skills of all learners prior to the experiment with regard to discussion forums, social media, electronic books and co-reading is limited. Their teachers chose them based on availability to conduct the experiments and some students volunteered to partake in the study. The schools were selected because they were closely located to the researcher, consent from the school heads and the willingness of users to participate in the experiment. Only urban schools in middle-class areas were selected as the students could afford basic mobile phones and yet could not afford enough resources for learning. Two of the schools chosen had also participated in the preliminary study. Each of the experiments occurred at suitable times to each school, usually during free lesson slots or before and after school. The experiments were conducted at the beginning of the school terms to avoid disturbing the learners in their learning activities and final year exams.

i. Eligibility Criteria for High School Students

Each school teacher representative screened the 15 suitable students based on the following eligibility criteria:

- Must own a mobile phone with Internet capabilities. This eliminated issues associated with teaching students to use an unfamiliar device or a new operating system
- Must preferably have a Facebook account or be willing to open one
- Must have basic knowledge of browsing the Web on their mobile phone
- Must be in Form 4 or Grade 11
- Must be taking the Mathematics subject

5.2.2 Participants from University Students

30 students in their 1st year of study were randomly selected from a class at UCT. A class of Computer Science undergraduate students was identified as suitable for the experiment as they shared a common textbook for studying. An email was sent to the class of students and the first 30 students were selected to participate in the experiments. The participants ranged from 16 to 20 years of age. The skills of all learners prior to the experiment with regard to discussion forums, social media, electronic books and co-reading was advanced compared to high school learners. UCT was chosen because of its proximity to the researcher.

i. Eligibility Criteria for University Students

- Must own a mobile phone with Internet capability
- Must have a Facebook account
- Must have basic knowledge of browsing the Web on their mobile
- Must be an undergraduate student
- Should be taking Mathematics or Computer Science programmes

5.2.3 Experimental Tasks

The participants were each exposed to both platforms of the system, i.e. the internal forum platform with discussions embedded within textbook content and the external forum platform with links to the textbook and a separate discussion forum. Due to the nature of the experiments being focused on social networking collaborations that occur anywhere and anytime, natural settings were adopted for this experiment. Participants could, therefore, conduct the experiments in the comfort of their homes or any other place as they required. All students had mobile phones to conduct the experiments. The order of using the platforms was up to the participants.

In the experiment, the two groups of participants were required to complete two tasks each. Tasks are known to be the easiest way to evaluate mobile sites (Duh et al., 2006). However, the number of tasks should be minimised to avoid overloading the participant. Since the created application is for collaborating, the experiment took participants through a typical use case of asking a question, answering a question, and conversing with others on the system. Pre-tasks and post-tasks surveyed students about their experiences before and after using the system, respectively.

University students were given two weeks to conduct the experiments as they were more technologically advanced than high school students, who were given four weeks to complete the experiments. Each task given was for half the total period given, i.e. task 1 and 2 for two weeks each

at the high school level and task 1 and 2 for one week each at the university level. The participants were expected to spend at least 15 minutes a day on the platforms to conduct all tasks. However, due to the nature of the application, they were also expected to spend even more time than what was requested of them. Task 1 and 2 were related to the two platforms of the system. The evaluator presented participants with surveys after each task was completed to learn if participants were able to complete the specified tasks successfully and find out how satisfied participants were with their experiences in using the platforms.

Each task was based on a specific topic relevant to the group of students at the time of the experiments. This means that task 1 had its topic that was different from the task 2 topic to ensure that participants would not be influenced by a topic to choose a platform. Following is the organisation of the experimental tasks followed by a description of each task (see Table 5.1).

Table 5.1 Organisation of the experimental tasks for both university and high school participants

Pre-task survey
Task 1 (Topic 1) Use both platforms External forum platform **AND** Internal forum platform +Survey
Task 2 (Topic 2) Choose one platform External forum platform **OR** Internal forum platform + Survey
Post-task survey

i. Pre-task Survey

The pre-task survey was to obtain insight into the participants' previous experiences with discussion forums, eTextbooks and collaborative platforms in general. This survey did not answer any research questions, but it offered background information that could be associated with the user reaction to the system. The questions that were asked related to the participant demographics, like age and gender, the experiences of using forums and eTextbooks, and lastly enquiries related to collaborations and social media. The pre-task survey was designed to query both levels of participants. More advanced questions were added for university students to obtain more information about their experiences in using collaborative platforms as they were more technologically savvy. See Appendix 3a for the high school pre-task questionnaire and Appendix 3b for the university pre-task questionnaire.

ii. Task 1

The first task assumed natural setup whereby the task was completed in the participants' free time hence participants were given the platforms to read the eTextbook and collaborate for a given period. The purpose of task 1 was to observe how students post and answer questions based on given content on both platforms. That was necessary to help answer RQ1 and RQ2. On each day, participants were expected to ask 1 question and answer 1 question on each of the two platforms. They could ask the same question on both platforms. Users were not given any questions or answers to ask on the platforms; they were to read and ask for their understanding of the class lessons and in reading the textbook especially since the content of the experiments was the same content being taught in the classes at the time. UCT students completed task 1 in one week while the high school students were expected to complete the same task in two weeks. Appendix 4 shows an example of the task 1 instructions given to participants. After completing task 1, a mini-survey questionnaire for task 1 was given to participants for completion (see Appendix 5). The survey questions for this task was aimed at understanding how the participants used the two platforms when asking and answering questions.

iii. Task 2

Task 2 also followed a natural setup and students completed the task in their free time. UCT students took one week to complete the task, while high school students were given two weeks to complete the same task. The purpose of this task was to help answer RQ1 and RQ2 about the best platform to use for collaborations. After having used both platforms in task 1, participants were supposed to choose one platform and use it to complete task 2. Participants were supposed to ask 1 question and answer 1 question daily on their chosen platform. The researcher posted some questions before task 2 so that participants had questions to answer if few people selected that particular platform. The participants were also free to answer more questions. Appendix 6 also shows the detailed task 2 instructions given to participants to complete the task. Afterwards, the participants completed a task 2 survey (see Appendix 7).

iv. Post-task Questionnaire

A similar post-task questionnaire together with the usability questionnaire was used for both groups, the high school students and the university students (see Appendix 8). For high school students, on completion of task 2, students were to be given the questionnaire by their teachers to fill out. The teacher would then collect the questionnaires for submission to the evaluator. For university students, they received an email with a link to an online post-task survey on the last day of their experiments.

The post-task questionnaire also included feature-related questions in order to answer RQ3 and also evaluated the usability of both platforms. The first part of the questions was open-ended and related to the use of alias names as a feature on the system as well as the voting feature. The features of the system were evaluated to understand the users' appreciation for them and observing if they affected collaborations. The questionnaire also helped to obtain additional comments about the system from participants. This survey was also for understanding the user experience of the system. A User Experience Questionnaire (UEQ) was used to elicit information from participants so as to answer part of research question 1 (RQ1) about usability and satisfaction of the system. This type of questionnaire is known to be more appropriate for evaluating interactive systems. The kind of questions asked allows users to express their opinions, attitudes and feelings when using the system. The UEQ is divided into two major sections that gather information about usability aspects like attractiveness, efficiency, perspicuity and dependability and also user experience aspects like originality and motivation.

A seven-point Likert scale was used to uncover the degree of participant opinions. All questionnaires in this experiment used the same Likert scale. A seven-point scale was used as literature states that participants usually have difficulty deciding if the scale is greater than 7. A 7-point scale is stated to be more relevant for bi-polar measurements with two anchors. In this case, the 7-point scale was used with numbers ranging from 3 to -3 (recommend for or against) so that one end is precisely the opposite of the other with a neutral point for better understanding. Although the scale was numbered, words were also added to ensure participants understood the scale, and this was also explained to them. The questions in the questionnaire were changed slightly such that they comprised of both positive and negative questions to limit "acquiescence bias". Acquiescence bias states that people are more likely to agree with a statement than disagree with it. Also, some words were simplified as high school students could have trouble understanding them. Appendix 8 shows the layout of the post-task questionnaire.

5.2.4 Experimental Procedure

Following is the experimental protocol followed for this first experiment:

- The evaluator first introduced the purpose of the research and explained the significance of the experiments as well as the participants' role in participating. The evaluator also described what was expected of the participants.
- Participants presented signed consent forms that had been given before the experiments.
- The participants were asked to fill in the pre-task questionnaire, which was expected to last approximately 15 minutes.

- The participants were informed of the dates the task would commence and close.
- Task 1 instructions were sent on the morning of the task 1 experiment via emails or given to high school participants by their teachers.
- Participants logged onto the system using their Facebook accounts and got onto the home page of the system with the two topics for each of the two tasks.
- First-time users were taken to a page for registering if they wanted to use an alias name. They were also informed of the settings page where they could change their identities when they required.
- After a week or two, respectively, the participants were given the task 1 survey to complete.
- Task 2 instructions were sent on the morning of the task 2 experiment via email for UCT students and as printouts by assigned teachers for high school students.
- After a week or two, respectively, the participants were given the task 2 survey to complete.
- The participants then filled out an overall post-task questionnaire for evaluating both platforms that had been used by the users.
- For completing the experiment, an incentive was given in the form of airtime for high school students and R200 each for university students. High school students obtained $1 airtime for every week that they conducted the experiments, which means they obtained $4 worth of airtime for the duration of the experiments.
- Computer logs were used to confirm that the system was being used by the participants. The session was then closed.

5.3 High School Students Experimental Details (Part 2)

Due to the type of responses obtained from the high school participants through the first experiment being inconclusive, another experiment had to be set up to gather detailed results. Following is an explanation of the second experiment given to high school students only.

5.3.1 Set-up

The same criteria used in the first part of the experiments for high school students was used. 15 students were selected from each of the four selected schools to make up 60 participants. All students used cell phones with Internet capabilities for conducting the experiments. Since students at some high schools, especially the Zimbabwean schools, are not allowed to take phones to the school, they were authorised by the head of the school to bring them only for that day for the experiment. The phones were kept by the teacher for safety, used only for the day of the experiment and then given back to the teacher and back to students after school.

A controlled setting was used to conduct the sessions by making use of empty rooms within the selected schools. The evaluator, the teacher who acted as the mediator for the students, and the student participants were the people available during each session. The evaluator, in this case, was the researcher. In each experiment, the fifteen students from each school were randomly (within the session) divided into two groups to minimise bias in responses. One group was exposed to the internal platform that has discussions embedded within textbook content and then later exposed to the external platform that has a textbook with a separate discussion forum. The other group was exposed to perform tasks on the control set-up and then experiment set-up of the system afterwards. Participants in both groups worked on the same content and tasks at the same time. Cohen et al. (2002) highlight the essential points of a valid experiment; this design adopts some of them. They state that an experimental design involves the following:

- At least one control group;
- At least one experimental group;
- Uses random allocation to control and experimental groups;
- Issues one or more interventions to the experimental group;
- Observes isolation, control and manipulation of independent variables; and
- Observes non-contamination between the control and experimental groups.

5.3.2 Experimental Tasks

In this experiment, participants were required to complete three tasks each. The experiment also took participants through a typical use case of asking a question, answering a question, and conversing with others on the system. A pre-task survey asked students about their experiences before using the system and post-task survey asked participants questions after using the system. Each task was expected to last approximately 20 minutes. Task 1, 2 and 3 were related to the two platforms of the system. Participants filled out mini-surveys after each task was completed to evaluate the system they had used. Task 1 and task 2 were similar, however, task 1 was about asking questions on the forum and task 2 was about answering the posted questions on the forum. The tasks were broken down to ensure participants understood them.

In the experiment, the participants who were first exposed to the separate discussion forum platform with a link to external forum represented Group X while the participants who were first exposed to the internal forum represented Group Y. The content on both platforms was the same to minimise bias to a particular platform.

The first two tasks were based on the topic Linear Programming, and the third task was based on the topic Circle Geometry of the Mathematics textbook. Using two topics ensured that when users perform task 3, they would not be influenced by previous posts in choosing a platform. Following is the organisation of the experimental tasks followed by a description of each task (see Table 5.2).

Table 5.2 Breakdown of all tasks in the order in which they were conducted

Pre-task survey	
Task 1 (Topic 1) --- Ask Questions	
Platform B (Group X)	External forum platform → Internal forum platform → Survey
Platform A (Group Y)	Internal forum platform → External forum platform → Survey
Task 2 (Topic 1) ---- Answer Posted Questions	
Platform B (Group X)	Internal forum platform → External forum platform → Survey
Platform A (Group Y)	External forum platform → Internal forum platform → Survey
Task 3 (Topic 2)	
Chosen platform (Group X and Y)	External forum Platform **OR** Internal forum Platform → survey
Post-task survey	

i. Pre-task Survey

Since the students had already done the pre-task interview before, there was no need to redo it. An informal focus group session with students was held before the commencement of the experiments. This served to teach and ensure students understood the concepts of discussion forums and eTextbooks. Also, the session was meant to find any challenges that student had about such systems or in conducting the previous experiments. A detailed description of each task follows.

ii. Task 1

The purpose of Task 1 was to capture the experience of posting questions on both platforms. That would help to answer RQ1 and RQ2. Participants were supposed to ask two given questions on each

platform. The questions to ask were randomised for each participant so that they differed per group or school to avoid bias in the results. This also ensured that the results of the experiment were not dependent on the order of questions or answers collaborated on. However, the same question was posted on both the external forum and the internal forum platforms for easy comparability. Each participant was given two specific questions to ask (see Appendix 9 for the questions used). Participants had the liberty to ask more questions of their own if they desired. Following is a breakdown of the task 1 steps and their instructions (see Table 5.3 and Appendix 10 for the detailed instructions of task 1). Group X began with the external forum platform followed by the internal forum platform while Group Y began with the internal forum platform and ended with the external forum platform.

Table 5.3 Breakdown of task 1 steps

Step 1: Task1 (external forum)	**Step 2: Task 1 (experiment)**	**Step 3: Survey**
• On the topic page, click on Platform A (External forum). The textbook with a separate link to the discussion forum will be shown. Click on the textbook chapter to read the content • Read through the chapter and go back to topics to click on the discussion forum • Ask the two given questions on the discussion forum page • (Optional) Ask any other questions you may want to ask	• On the topic page, click on Section B (Internal). The textbook chapter (embedded discussions) will be shown, click on it • Read through the chapter and type to ask the two given questions within the text • (Optional) Ask any other questions you may want to ask	At the back of the instructions page, fill in the short survey about the whole task.

After completing task 1 instructions, participants filled out a mini-survey questionnaire. The survey questions for this task were aimed at understanding how the participants used the two platforms when posting questions. The questions also compared the two experiences of posting on the external forum platform and that of the internal forum platform. Appendix 11 shows the survey questionnaire used to complete task 1.

iii. Task 2

The purpose of Task 2 was to ensure that participants were able to answer questions. This task was designed to answer RQ1 and RQ2. The procedure followed in task 2 is the same as task 1, except that task 2 was focused on answering the previously asked questions in task 1. The order of performing the task for groups X and Y were maintained by the participants.

Two questions to answer were specified for each participant. This was done to avoid bias and having all students answer a particular question on the platforms. Participants were supposed to answer both questions on each platform. To answer the questions, there were two options:

- Each participant was given one specific question to answer dependent on all students having completed task 1 such that there were questions to answer. In cases where the specified question to answer was not available, the participant was given another. An answer was provided for the question to ensure that the experimental focus was on the collaborations and not on the answering skill of learners (see Appendix 9 for the answers to the task 1 posted questions).
- The participants were informed to answer another question based on the content of the given textbook since the experiment only utilised a small part of a chapter.
    - Should the answer not be in the textbook, or the participant could not figure out the answer, the participant had to answer the specified question by stating that they could not find the answer to the given question and they needed help in answering that question. This was to help students understand how the system would work in a natural setup where they would have to provide the answers themselves.

The participants also had the liberty to answer more questions if they desired. They also were tasked with using the voting feature to rate posts and comments. Following are the steps followed to complete task 2 (see Table 5.4 and Appendix 12 for task 2 instructions).

Table 5.4 Breakdown of task 2 steps

Step 1: Task 2 (external forum)	**Step 2: Task 2 (experiment)**	**Step 3: Survey**
• On the topic page, click on Section A (external forum). The textbook with a separate link to the discussion forum will be shown. Click on the textbook chapter to read the content • Read through the chapter and go back to topics to click on the discussion forum • Answer the two stated questions • (Optional) Answer any other questions you may know • Vote for two specific questions or comments by others that you like	• On the topic page, click on Section B (internal forum). The textbook chapter (embedded discussions) will be shown, click on it • Read through the chapter and type to answer the two stated posts within the text • (Optional) Answer any other questions you may know • Vote for two specific questions or comments by others that you like	At the back of the instructions page, fill in the short survey about the whole of task 2.

Task 2 survey questions aimed to understand how the participants used the two platforms in answering questions and compared the two experiences. Appendix 13 shows the survey questionnaire given to evaluate this task.

iv. Task 3

Task 3 was conducted to allow the participants to choose a platform that they preferred following the comparisons of the two platforms when performing the first two tasks. This task was designed to help answer RQ1 and RQ2. The participants remained in their respective groups, X and Y. They were presented with a new topic (topic 2: Circle Geometry). Two specific questions were given to each participant. Participants were supposed to post the two questions on the platform they selected. The participants were also expected to answer two posts on the platform they had chosen as well as vote for any two posts that they liked or disliked (see Appendix 14 for both the questions to post on each Platform and answers for the posts). Considering that participants had to choose platforms, a platform might have no questions to answer because participants did not select it hence the researcher already posted a few question posts. Participants, therefore, found posts to answer on the platforms they chose regardless of whether others selected it as their preferred platform or not. The participants

were also free to answer more than two questions. Following is a breakdown of task 3 steps (see Appendix 15 for the detailed instructions of task 3).

- Go to Topic 2 and choose the platform to use to post questions
    - Section A is the discussion forum separate from the textbook chapter content (external forum)
    - Section B is the textbook with embedded discussions (experiment)
- Post two of the given questions
- Answer two posted questions
- Vote for at least 2 of the posted questions or answers to a post that you may like
- (Optional) Ask any other question or answer any other posts
- Fill in the task 3 survey questions

A short survey then followed the experiment (see Appendix 7). The task 3 survey questions were created to give details of their preferred platform after using both of them in the previous tasks. The survey helped gather reasons for preference and compared the two platforms being tested.

v. Post-task Questionnaire

The same post-task survey used in the first experiments was used in this second experiment. The survey was meant to answer part of RQ1 and RQ3. Participants were given this survey to complete after finishing tasks 1, 2 and 3. Appendix 8 shows the post-task questionnaire used.

5.3.3 Experimental Procedure

The summary of the experimental protocol followed in the experiment is as follows:

- The evaluator first introduced the purpose of the research and explained the significance of the experiments as well as the participants' role in participating. The evaluator also described what was expected of the participants.
- Participants presented signed consent forms that had been given prior to the experiments, either from parents or the school teacher representatives.
- A training and information session about social networks for education was given by the evaluator. That was done to ensure that all participants understood the platforms they were going to use.
- Participants were randomly divided into the external forum and internal forum platform groups and made to each sit separately and not in clusters. That was to ensure that each user experience was not influenced by another user's and all collaborations were strictly via the

device. The purpose of this was also to simulate the natural settings of using forums on social networks whereby students will not be together. The evaluator addressed any system-related problems as students participated.

- Participants were given data bundles worth $1 to access a Facebook app for the entire session. However, for some high schools that utilised Wi-Fi, permission was sought from the school heads and students used Wi-Fi instead even though they were still given their $1 data bundles.
- Participants logged onto the system using their Facebook accounts and got onto the home page of the system showing the two topics for the three tasks. First-time users were taken to a page for registering if they wanted to use an alias name. If they chose alias names, their real identity was obscured on the system. However, this was also changeable on the settings page. The school name of the participants also helped to distinguish the participants in the database for easy analysis.
- The participants were issued the printouts containing Task 1 details.
- After completing task 1, the participants filled out a mini-survey.
- The participants were issued the printouts containing Task 2 details.
- The participants then filled out a mini-survey afterwards.
- The participants were then issued the printouts containing Task 3 details.
- The participants then filled out a mini-survey afterwards.
- The participants then filled out an overall post-task questionnaire. That included usability questions of both platforms used by the users. The usability questionnaire was conducted at the end since that is when users had finished using the platforms and so could evaluate how easy it was to use the system. This was expected to last approximately 15 minutes.
- Participants had the opportunity to ask any other questions related to the experiments.
- For completing the experiment, an incentive was given in the form of small chocolates for the high school students to avoid issues related to monetary incentives, especially where children are concerned.
- Computer logs were used to ensure all the participants were using the system. The session was then closed.

5.4 Summary

The experimental design was created to answer the research questions stated at the beginning of this chapter. This chapter has described the experiments that aim to evaluate the user preferences in using a platform with eTextbook embedded discussions or with a separate discussion forum for a given textbook. The results of these two experiments will be analysed and discussed in the next chapter.

6 Results and Discussion

In previous chapters, details about the design, implementation, and theoretical considerations of the proposed eTextbook based collaborative system for both tertiary and high school students was presented. The main goal for the collection of data and the subsequent data analysis was to develop a knowledge base about the perceptions and importance of collaborative mediums and conclude how they ought to be presented to users. This involved determining if the current traditional method of presenting discussion forums as standalone systems to their resources is more efficient than the proposed method of embedding collaborations with their text resources. The evaluation tested the system through a set of tasks including the following metrics: usability, functionality, acceptability, efficiency and adaptability. In this chapter, the tertiary school results are discussed first followed by the high school results. Lastly, a comparison of the two groups concludes the chapter.

Table 6.1 Statistics showing the experiments conducted and the number of participants

Experiment	Level of education	No. for the control group	No. who completed all Tasks	No. for the experimental group	No. who completed all Tasks
1	**(Tertiary level)**				
	UCT	30	24	30	24
2	**(High school)**				
	School A	15	0	15	0
	School B	15	0	15	0
	School C	15	0	15	0
	School D	15	0	15	0
3	**(High school)**				
	School A	15	13	15	13
	School B	15	10	15	10
	School C	15	11	15	11
	School D	15	3	15	3

Table 6.1 shows the number of experiments conducted plus the number of students who agreed to participate in the internal (experimental) and external (control) platforms. From Table 6.1, 24 out of 30 students from the university completed their experiments in full. From high school students, two experiments were conducted. The first experiment resulted in no conclusive results; hence the experiment methodology was reconsidered to ensure useful results are obtained in the succeeding experiment. The second experiment resulted in 34 participants from school A, B and C that were considered who completed their experiments in full. One other school that had agreed to participate in the experiment could not participate fully with only 3 participants completing the experimental activities; as a result, School D was excluded from the study.

Tests for Analysing the Data

The questionnaires of this evaluation consisted of a 7-point Likert scale. Likert scale data is data that is ordinal and in ranks. A 7-point Likert scale was selected instead of a 5-point Likert scale because it is stated that a broader scale yields better results (Allen & Seaman, 2007). For all the results discussed, a cumulative total for strongly agreeing and agreeing, or strongly disagree or disagree, as per the 7-point Likert scale is reported as well as the neutral value per question. That is, only the extreme results that were observed through visualisations are explained.

Two techniques that can be used as an alternative to the t-test for parametric tests were chosen based on the number of participants and the type of experiments for this study. In this study, we use the Mann Whitney U test to compare the three schools (A, B, C) for significant statistical differences. It is also used to compare school students and university students for any statistical differences in their satisfaction in using either system (Control and Experimental systems). Man-Whitney U test is a non-parametric test that analyses ordinal data (McKnight & Najab, 2010). It is an alternative to the t-test that is used for numerical data. The Mann Whitney U test is known to be suitable for working with different sized groups, descriptive data and helps compare differences between two independent groups McKnight & Najab, 2010). The Mann Whitney test however also has disadvantages, the calculations may be prone to human error and the results do not explain why there is or there is no difference (Fay & Proschan, 2010).

For testing the differences between the external forum and internal forum tasks, we used the Wilcoxon signed-rank test, which is an alternative test to the paired T-test. This test was selected because it is typically used when data is not normally distributed or can only be ranked (Rey & Neuhäuser, 2011). It can also help to compare related groups that are exposed to two systems, one after the other in a pre-test and post-test scenario or cross over design (Rey & Neuhäuser, 2011). Since our data is ranked and the same group of participants were exposed to the internal and external forums one after the other, the Wilcoxon signed-rank test was suitable. The advantage of this method is that it does not make assumptions about the distribution of the samples being tested (Fay & Proschan, 2010). The test allocates signs to the observations based on a hypothesised value and does not take the degree of observation into account (Fay & Proschan, 2010). Compared to parametric t-tests, both the Mann Whitney u test and the Wilcoxon signed-rank tests were more suitable despite their disadvantages.

6.1 Experiment 1: Tertiary Student Results and Discussion

The results of the data analysis conducted on the eTextbook collaborative system with tertiary students are presented. The evaluation results were gathered and processed in response to the research questions posed in chapter 1 of this dissertation. As already explained in the methodology chapter, a class of Computer Science students with a common Python textbook was selected for the experiments. The participants were given the internal forum platform as well as an external forum platform to use for two weeks. Each experimental task was conducted in succession with a survey questionnaire. The detailed experimental results of the participants' experiences follow.

6.1.1 Pre-task Questionnaire: Demographic Results

This questionnaire was designed to gather the age and previous experiences on technology and eTextbooks of recruited participants. The pre-task survey also sought to identify user preferences when logging onto the system.

Age of Participants

Table 6.2 Ages of participants

Age	Frequency	Percentages
17 years	4	15%
18 years	10	38%
19 years	3	12%
20 years	6	23%
21 years	3	12%
Totals	26	100

Table 6.2 shows the participant ages. 26 participants completed the demographic survey. The results show that a majority of the participants were 18 years in age at 38% and 20 years in age at 23%. The remainder were almost equally distributed for the ages of seventeen, nineteen and twenty-one at 15%, 12% and 12% respectively.

Types of Phones the Participants Used

Table 6.3 Types of phones used

Phone Type	Frequency (x/26)	Percentages (x% of 26)
Samsung Galaxy (+ 1 Android)	15	58%
IPhone	3	12%
HTC	2	8%

Dodgee	1	4%
Sony Experia	1	4%
Motor X	1	4%
Huawei	1	4%
Tablet/Ipad	2	8%

All the participants had modern smartphones. The most common type of phones used by the students were the Samsung smartphones with 58%, followed by the iPhone and lastly the HTC (see Table 6.3). The other phones that were distinct included Doogee, Sony Experia, Moto X and Huawei. One of the participants used a tablet and another used an IPad mini. Only one participant described their phone as an Android phone, which is the operating system, and not the actual phone name.

The type of phones that the students possess are advanced to mid-range types with big screens and multiple functionalities. More feature phones were expected, but that was not the case. The students stated that they use their mobiles daily to meet both personal and educational needs.

Table 6.4 Devices used for educational needs

Device	Frequency (26)	Percentages
Mobile	16	62%
Laptop	8	31%
Desktop	6	23%
Tablet	1	4%

The students were also asked about the types of devices they use mostly for their educational needs when at home and four devices came up as the most used (see Table 6.4). The students use laptops and their mobile devices interchangeably. 62% use their mobile phones for their educational needs. Also, 31% said that they use laptops to study. 23% use desktops and only one indicated that they use their tablet for school work. Participants relied on more than one device for meeting their educational needs.

Experience with Participating in Discussion Forums

The participants were asked if they had used discussion forums before. They were each asked to define a discussion forum, and every one of them gave a reasonable answer highlighting terms like share views, interact and exchange information, obtain expected responses to topics, people interested in similar topics, debate and communication of ideas and opinions and discussion of problems. All the participants use social networking sites, especially Facebook and WhatsApp.

Table 6.5 Experiences with discussion forums on favourite social networking sites

Social Networking Site	Frequency (x/26)	Percentages (x% of 26)
Facebook	26	100%
Twitter	12	46%
WhatsApp	23	88%
Instagram	7	27%
Snapchat	5	19%

Table 6.5 shows the top 5 social networks used by students. Also, Periscope, Vula, Stack Overflow, LinkedIn, BBM, Reddit, IRC, Google plus and Skype were distinctively used by some participants. The results on the table show that social networking forums found on Facebook, followed by WhatsApp are the most commonly used by participants. Students belong to many Facebook discussion forums. However, many stated that they only participate in WhatsApp group chats. They stated that they spend most of their time reading the forums out of interest as observers and not active participants. Instagram, Twitter and Snapchat are the other platforms that participants are using for interactions even though at minimal levels.

Frequency of Participation

The participants who admitted to using forums were asked how often they participate in the discussion forums they had indicated they use, particularly VULA LMS and WhatsApp. From those who answered, Figure. 6.1 shows that 48% use WhatsApp forums daily, 32% use it weekly and 8% use it monthly. When it comes to VULA, 18% use it daily, while 28% use it weekly and 44% use it rarely. VULA LMS is a discussion forum on the Moodle site for students at the University of Cape Town. They only recognised VULA as a discussion forum in an LMS when being asked about the frequency of participation. Some participants acknowledged that they had never asked any questions on the sites but had responded or likes other posts.

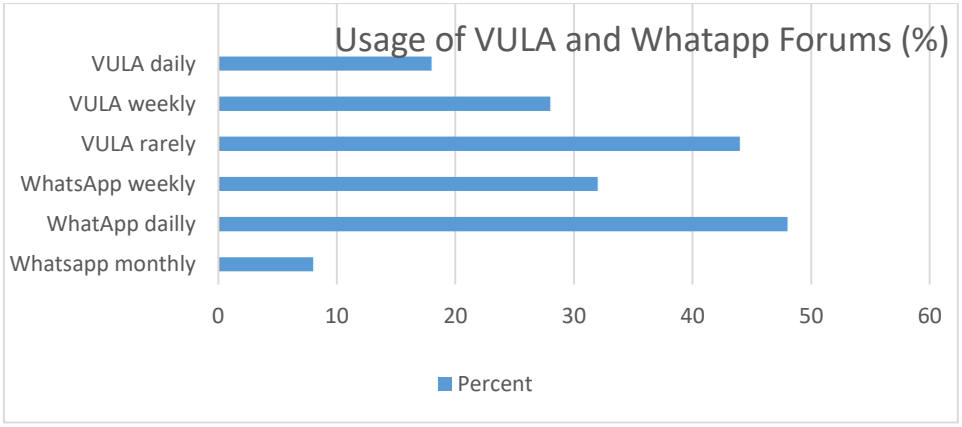

Figure 6.1 Usage statistics of discussion forums on VULA and WhatsApp

Using Social Media for Academic Purposes

69% of the participants are using social networks to study, particularly on WhatsApp. Students send each other pictures to explain their questions. One of the students explained:

"Messages are largely image-based as typing Mathematical statements on phone keyboards is difficult."

The participants stated that they used images to reference questions taken from books, the internet or other sources. Sometimes images helped respond to posts as a form of providing feedback.

Some participants indicated that they sometimes used Skype to converse about specific topics, others use chat rooms on VULA for one on one discussions while others stated they use voice notes when explaining on the WhatsApp platform. From the open answer results, all participants had used Facebook discussion forums but only 8% of the participants indicated that they had discussed educational problems using them. However, WhatsApp seems common because it allows one to control who joins the groups. All participants who use WhatsApp stated that they belong or have previously belonged to groups with close friends which corresponds to face to face group discussions whereby students choose group members they prefer for conducting discussions. The students also stated that they usually use WhatsApp to discuss projects, complicated subjects like Physics, Mathematics and Programming, challenging questions and assignments. A few individuals highlighted that when they search forums online, they almost always obtained answers to their questions; hence they never ask questions to obtain assistance on any group forums. Those who use VULA daily stated that they use VULA for discussing course-related issues like assignment deadlines and submissions, requirements, tests and any other administrative work.

Experience in using Electronic Textbooks

Table 6.6 The use of educational and social electronic textbooks

Question	Frequency (x/26)	Percentage (x% of 26)
Have used an electronic book before	26	100%
Have used an educational electronic textbook	22	85%
Have used the Python eTextbook found on VULA	10	38%

100% of the participants have used electronic books like novels before (see Table 6.6). 85% of the participants have used educational electronic textbooks before for reading. Some stated that they used electronic textbooks because they are free and readily available for use. However, others had no idea that they had access to a free Python eTextbook related to their course. They stated that:

> "I did not use it because I did not know there was a soft copy of Python" or

> "Daily I use it because it is free of charge (I do not have money to buy the hard copy textbook)

Another also stated that:

> "I have not used it yet, the lecturer does not tell us to go through the textbook."

While 38% of the participants stated that they used the Python eTextbook (book chosen for use in the experiments) often, 62% indicated that they were not aware or they did not feel the need to use the eTextbook as they had hard copies of the book. They mostly used eTextbooks to check for something while on the go, thereby avoiding the carrying of heavy books.

Students are using electronic books for reading. However, for most, it is non-educational eBooks that they read on their devices. Students did not search for any resources freely accessible to them on a site like Vula. Participants, however, can use VULA every day to browse for resources that are available for use on the site. Students were also asked if they participated in the forum dedicated for the Python course on VULA; half the participants stated that they had used the forums before even if it was not for discussing the course content itself. The other half stated that they had never used the forums before.

Lastly, students were asked if they had ever used an eTextbook with discussions embedded inside of it, and only 4% of the participants agreed to have seen something similar. They explained that they had used an application called "Waft pad" and they found it useful to interact inside it. They could annotate the textbook for others to read their thoughts. The rest of the students had never seen such a concept in practice. However, others had seen books where one could annotate notes. This gave assurance in the idea of testing this concept with students as they had no prior experience of it before hence could compare it to what they had experience with so as to bring insight to the new concept.

Discussion

The demographics have shown the prevalent use of mobile phones by participants for educational purposes. The types of phones the participants use also indicate that systems may be tailored to work on mobiles to encourage their usage as participants prefer their mobile phones compared to other devices. This section has also revealed the university students' background in using social media, particularly social networking sites and the forums found in them. They have shown that they have a good knowledge of forums and understand why they are important. They have also shown that they understand the benefits of electronic textbooks. However, results also showed that students rarely converse about these electronic books on the provided educational forums. Lastly, the idea of combining forums with discussions is not yet explored as a small number of participants explained having encountered such a book even though it was not educational and was more about annotations. Following are the results obtained after the evaluation was conducted with the university students for the two major tasks of the developed experimental system.

6.1.2 Tasks Results: Using Alias names vs Real Names on Academic Forums

According to the results, 69% of the participants opted to use an alias name as opposed to their real names when using the two platforms of the system. The findings showed that 31% of the participants used their real names and found it unnecessary to be anonymous on an academic system. Participants explained that being identifiable increased chances of possible meet-ups for face to face interactions with other students in the same class. Their responses were confident in that learning is a cooperative activity, and students learn from mistakes. Although 31% were comfortable to share their identity online, a majority of the students who chose to use their real names emphasised that the system should never post anything on their behalf on the Facebook platform. Participants were willing to use their Facebook names but did not want their academic posts being associated with their personal spaces on the Facebook platform.

From the 69% that chose to use alias names, the participants highlighted the need to be anonymous and to owning anonymous posts. To some, using alias names for online activities was out of habit, however, to most participants, students like to protect their identity and have a sense of security and privacy as they tend to feel uncomfortable to share their identity with strangers. From the open-ended questions, 72% of the participants who chose alias names explained that they selected this option to avoid feeling "stupid", a term they used to describe how they feel if they ask obvious questions or answer other posts wrongly. Using an alias name provided them with a means to test their thoughts in writing and obtain feedback from peers without anxiety.

Effects of User Identity on Collaborations

When the participants who opted for alias names were asked what their challenge would be in using their Facebook names on the platform, they stated that they feared being classed academically or being judged negatively by peers. Some of the comments from the participants stated that:

"My greatest challenge would be asking more questions and answering or commenting on other posts. Fear of being judged or perceived in a way that I would not like."

"That people could find me on Facebook and class me academically based on my interaction with the platforms.

Other participants stated that some students might become biased when answering their posts because they know them in person. One particularly stated that:

"It could possibly allow other users to show a bias in responding to my comments."

However, on the positive, one participant explained that peers who would never help others in person had the opportunity to do so if users kept their identity anonymous. Other participants insisted on being anonymous because they were shy to express themselves freely, hence using their real names would result in fewer or no posts and comments from them. However, participants stated that there are instances when academic platforms may include lecturers or tutors and using alias names in such instances would be important as one does not want to be considered incompetent by their instructors. Students felt it is better to make mistakes in front of peers than in front of their lecturers or tutors.

Table 6.7 Point Likert scale mode and median results to attitudes when using alias names

Question	Median	Mode
Using an alias name made me free to ask any question	2	3(strongly agree)
Using an alias name made me want to participate more	1	0 (neutral)
I feel safer using an alias name than my real name on such discussion forums	2	3(strongly agree)

From Table 6.7, of the 69% of participants that chose alias names, 68% agreed that using an alias name gave them the liberty to ask questions while 5% disagreed. On average, participants agreed that alias names made them free to ask questions with a median of 2 (agree) from the Likert scale. The results

show that using an alias name affected their participation on the system. 42% of the participants agreed that it increased their participation but 5% disagreed. About 63% of the participants felt safer using alias names than their real names however 5% didn't feel it was safe using an alias name.

Table 6.8 Using real identity on the platforms

Question	Median	Mode
Using my Facebook name makes me more confident	0	0 (neutral)
Using my Facebook name made me want to participate more	0	0 (neutral)
I do not mind using my real name on academic discussion forums	3	3 (strongly agree)

Of the 31% of the participants that chose real names over alias names, Table 6.8 shows that the participants did not mind using their real names on academic platforms. Also, the participants stated that their choice did not really affect their confidence levels in posting questions or in increasing their participation levels on the forums. 13% of the participants stated that using their real names made them feel confident. The participants also stated that the use of real names also increased their participation on the forums at 25%. About 88% of the participants also reinforced that they did not mind using their real names on any educational platform.

Alias Names Discussion

It is evident from the results that the use of alias names should not be overlooked when creating academic online platforms for university students. Academic posts are different from social posts. It is easy for one to post a cool picture of themselves and obtain positive feedback. However, even on social posts, some users fail to share posts due to fear of being judged. Academic posts reflect the intellectual ability or struggles of a person, and not many students want to be vulnerable by being viewed as less intelligent than others.

Although at a higher level of education, university students also have confidence challenges on online platforms, not everyone prefers a secret identity. However, for discussion forums to cater to everyone, they can be presented such that students have the choice to be anonymous or not. LMSs tend to have discussion forums but, because the students must be registered for the course, they can only use their real names. Often this is to protect against inappropriate posts. Although this is very important, 69% of the participants in this study chose alias names, which indicated the need to express themselves freely without being judged. 42% of the participants who agreed that enabling anonymity would

encourage better participation from them shows that real identity can be a hindrance to participation. Results show that user identity on educational systems affects the type and level of participation. The choice to hide one's identity provides an environment that is conducive to promoting collaborations as students feel comfortable and safe in such online spaces. Based on the results of those that chose to hide their identity, obscured identity can also increase participation and encourage the initiation of posts. The design of academic forums could, therefore, consider user identity options to encourage more interactions.

6.1.3 Task Results: Control/ External Platform

The first task in the experiments involved posting questions and commenting on posts made to the platforms. We will first present the results from participants in the external forum, followed by the internal forum and then discuss the comparison of the two platforms and participant choices for their preferred platform in the system.

In Figure 6.2, results show that participants had no challenges in using and understanding the external forum, when posting and commenting, with over 92% agreeing. Participants found the platform easy to use at 71% and 8% felt the system was not easy to use. They also felt that sometimes one wanted to focus on the textbook without any distractions, and the external forum was best for this. Hence a separation of the discussions from the textbook encouraged a focus on studying the textbook. About 19% of the participants felt it was easy to reference when posting, however, 35% disagreed stating that it wasn't as easy. 37% felt that having separate forums was convenient but 42% felt it was inconvenient. Some participants stated that they only used the discussion forum when they had finished reading, which made it easy to refer to the textbook if they had written down sections and challenges to ask in the forum. The participants also stated that the system was pleasing to use at 19% but 38% felt it was not pleasing to use.

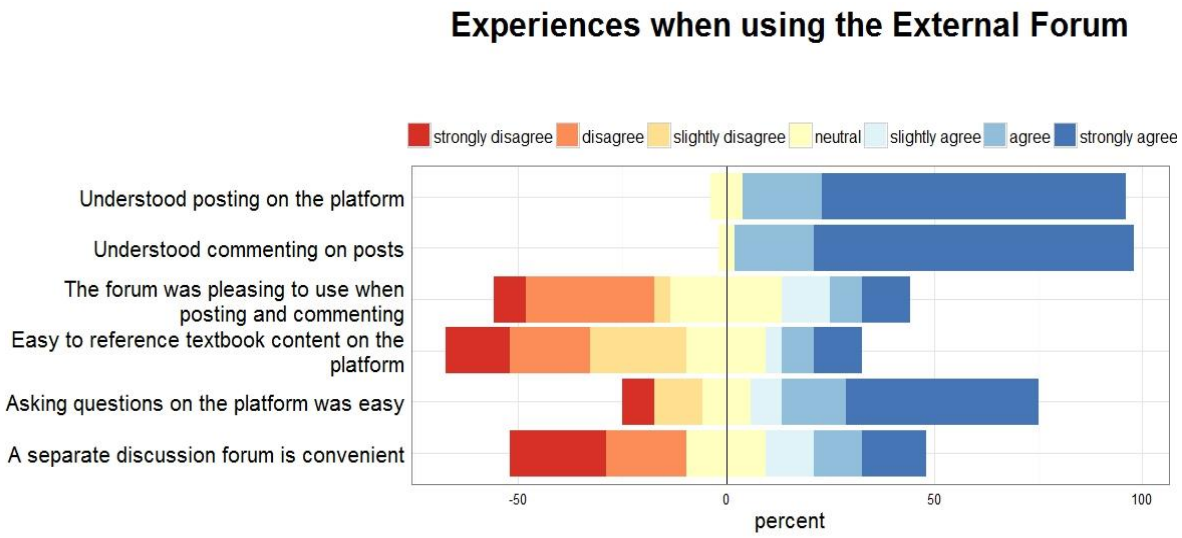

Figure 6.2 Experiences of participants when using the external forum

Results highlight the desirable qualities of the external forum to be the ease of separating the questions from the answers without the interruption of the textbook. Participants highlighted that it is easier and faster to view all posts in separate dialogues and, since posts were easily identifiable, they could be answered much faster. Participants also liked that one had the freedom to identify and select questions of interest to them among many questions. That enabled participants to respond to posts as they browsed questions they needed answers to. Another positive quality of the external forum is the promotion of general inquiries. Each question had its comments, which made it easier to scroll and identify answers to a specific post. One could also search and find a needed post

The not so favourable points of the external forum included the difficulty of switching from the forum to the eTextbook for easy referencing of text to verify or confirm facts. They found the process of continuously exiting the forum to open the linked eTextbook cumbersome. The participants also stated that the forum ended up with many posts such that it was harder to navigate without tags. Some participants stated that the external forum presented different ungrouped topic posts. It, therefore, became a challenge to quickly identify relevant or particular posts as the forum posts were general and covered numerous topics. Participants also noted that if responses to posts were not given on time, the post would probably never be answered as most participants said they were usually biased to newer posts and were reluctant to search or respond to older posts. Participants also stated that they would have liked a notification system as it was sometimes hard to find particular questions they were interested in to check if they had been answered.

Participants suggested incorporating Web links on comment boxes to share useful links to the Web or textbook that explained their answers. Other media, like videos and audio, were noted to aid users in providing explanations for their posts. Although pictures were provided on the external forum platforms, learners did not utilise them at any time. Even the mathematical notations provided were not utilised. Students wrote responses down as their explanations. Participants also suggested inserting a sidebar linked to the textbook for easy referral by tagging relevant sections of the textbook. Participants suggested that questions listed on the forum should also be categorised and grouped to avoid repeats and for better focus on particular topics of interest.

6.1.4 Internal Forum (Experimental Platform)

Participants understood how the system worked without training even though this was an internal forum platform that they had not encountered before (see Figure 6.3). Over 92% of the participants agreed that the system was easy to understand when posting and when commenting on the system. A short demo was given when participants filled the pre-questionnaire. 44% of the participants agreed that the internal forum was pleasing to use when asking and answering posts and 24% felt it was not as pleasing to use. About 72% found the system to be highly convenient while 4% felt it was inconvenient. 76% found that referencing the textbook when making posts was easier and none disagreed with this. When asking a question, 64% of the participants felt it was easy and 8% felt it was not.

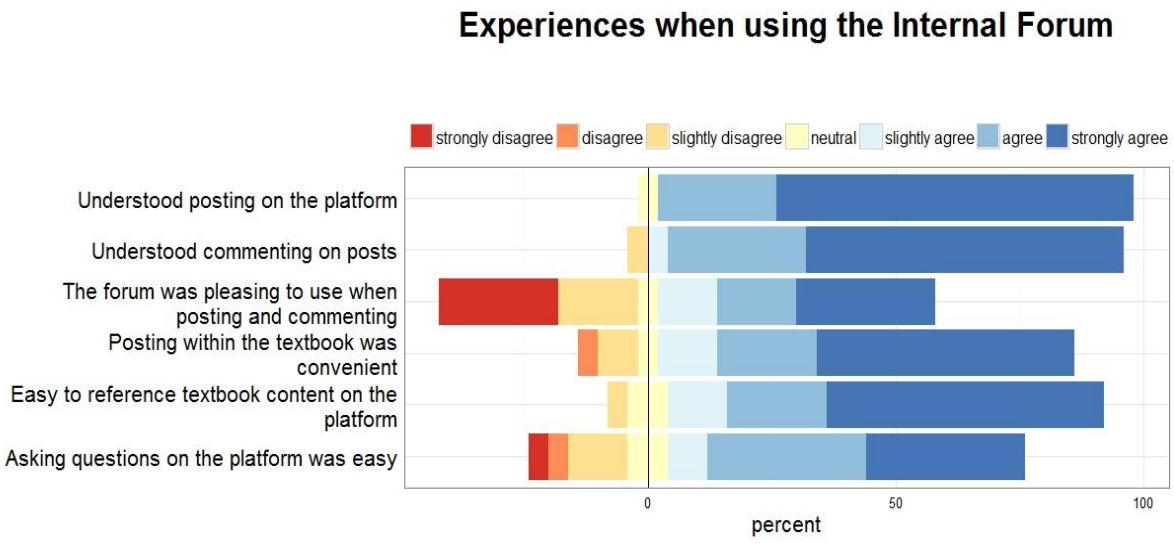

Figure 6.3 Experiences of participants when using the internal forum

On open-ended questions, many comments were obtained about the internal forum. Participants were asked what they liked most about their experience in using the internal forum. Results showed

that dividing the textbook so that questions and relevant content were sectioned, made reading the book desirable and convenient. They highlighted the convenience of having the textbook and posts being combined. Each section of a textbook was directly above a discussion forum section, making it simpler to make references to the relevant textbook content for clarifications while one reads. According to the participants, viewing the internal forum comments based on textbook sections made it easy to verify and argue answers in response to other participant posts. The eTextbook was flexible to use since examples were right next to exercises, thereby making it easy to switch between the text and discussions when attempting to answer the exercises.

The internal forum system offered a platform to ask specific questions related to the chapter topics at hand. Participants stated that the internal forum allowed for a more focused in-depth analysis of a given topic of the textbook as many users had views to share per section they were interested in. The platform made it easy to see what other people were discussing about a given topic.

Participants stated that the direct approach of topic-based discussions made it easier to find answers to similar problems. It was also easy to identify the section one had to read to attempt the questions before asking. Participants stated that having one area that centred on a topic promoted a wide range of posts, leading one to view the topic in many dimensions. The hub of questions related to a particular topic enabled participants to find answers to common challenges while also revealing hidden challenges. The highlight of the internal forum to many participants was the quick and readily available assistance from other users of the system. Because one could easily verify answers from others or the textbook when in doubt, participants stated that most discussions were relevant as answers or opinions made sense. Participants also agreed that the discussions around a single topic were easy to follow and understand.

Participants explained that the internal forum was convenient in that there was no need to exit the eTextbook while reading to ask a question on another page. The organisation of comments below each section, aligned by topics, was easy to follow. Each section had few posts enabling one to check if their question had been asked, before asking the same question. One could also quickly test if they understood a section by attempting to answer questions from others within that section of comment posts.

Some participants even stated that the internal platform enabled them to obtain help on some challenges that they were facing in class since the topics used in this experiment ran concurrently to

the topics they were learning in class at the time. Some already made a comparison of this platform to the external forum and chose the internal forum, with embedded discussions, as their preference. Others also committed to using such a system as it provided a platform to collaborate while reading.

The internal forum system was designed such that people could comment below a section since one of the suggestions was to break down the book for easy reading on mobile devices. However, one was not able to comment on a comment. Most of the negatives about using the internal forum centred on the inability to comment on a specific post. The reason for this not being favourable was that a thread might deviate to other questions; as a result, the original thread could remain unanswered. Also, when a section has many comments where one cannot tell if a comment is a question or answer, many comments may become cluttered and challenging to follow. Some students found the internal platform frustrating to use, and this is attributed to the fact that they could only ask questions related to the textbook and not general enquiries about the book as the textbook had been broken down into chapters.

Suggestions for improving this platform included the ability to switch off the forum should one need to focus on the textbook. Also, providing the user with a preference to view the textbook as a whole and not in chapter fragments was deemed to be necessary should one require it.

6.1.5 Comparing Participant Responses for the External Forum and Internal Forum Results

Table 6.9 Statistical analysis of internal vs. external forum

Question	**Mode**		**Median**		**z-value**	**p-value (0.05)**	**Significant/not significant differences**
	External forum (n= 25)	**Internal forum (n = 25)**	**External forum**	**Internal forum**			**Not significant**
Understanding the systems	3 (19)	3 (18)	3	3	-0.4045	N/A	Not significant
Asking Questions Was easy	3 (20)	3 (16)	3	3	-1.7748	N/A	Not significant
Answering posts was easy	3 (12)	3 (8)	2.5	2	-0.3421	0.72786	Not significant
Separating/combining forum to the textbook was convenient	6 (-3)	(3) 13	0	3	-2.9057	0.00362	Significant
Referring to the textbook from the platform forum was easier	-1 (6)	3(14)	-1	3	-3.6669	0.00024	Significant

Platform was frustrating to use when asking or responding to posts	2 (8)	-3 (7)	0	-1	-0.9124	0.36282	Not significant

To observe if there were any difference between the results of using the external platform (task1) and that of the internal platform (task2), we used the Wilcoxon rank test. The participants started either with the control group and ended with the experimental group or vice versa to avoid any biases. A similar questionnaire was given to observe individual experiences in using either platform. The assumption was that there would be differences in using the two systems. A total of 25 participants were used with one being removed because of incomplete data. Table 6.9 shows the results.

When comparing the results of using the external forum versus the results of using the internal forum, the students felt that they understood both platforms without observing a significant difference in usability. The same was found for experiences when asking questions on either platform. Another question was if students felt a significant difference in terms of difficulty when answering posts on either platform. The p-value was 0.73, which is less than 0.05 hence there was no significant difference.

According to the Wilcoxon test, there were two major differences in the results. Participants showed a significant difference in the convenience of posting in the internal forum and external forum, showing favour to the internal forum. The results further highlighted that referring to the textbook from the external forum with a separate forum to textbook was more difficult than when referencing the textbook in the internal forum. These results will further be compared to task 3 results to confirm that there was a significant difference between the internal forum and the external forum. Lastly, there was no significant difference when evaluating each platform as they both did not give a feeling of frustration when posting questions or responding to posts.

6.1.6 External Forum vs Internal Forum Results

In task 2, the 25 participants who completed task 1 in full had the opportunity to compare the two platforms and select a platform that appealed to them. 63% of the participants chose the internal forum and the other 37% chose the external forum. Figure 6.4 shows the statistics of the participant reasons for the platform choices of both internal and external platforms. Both groups strongly felt that the platforms they chose were enjoyable, easier to use when posting and responding to posts. The participants also felt the posts were easier to follow on their platforms. Participants also felt their

platforms were much simpler, faster and easier to understand than the platform they did not choose. Some participants felt the platforms they chose met their educational needs better.

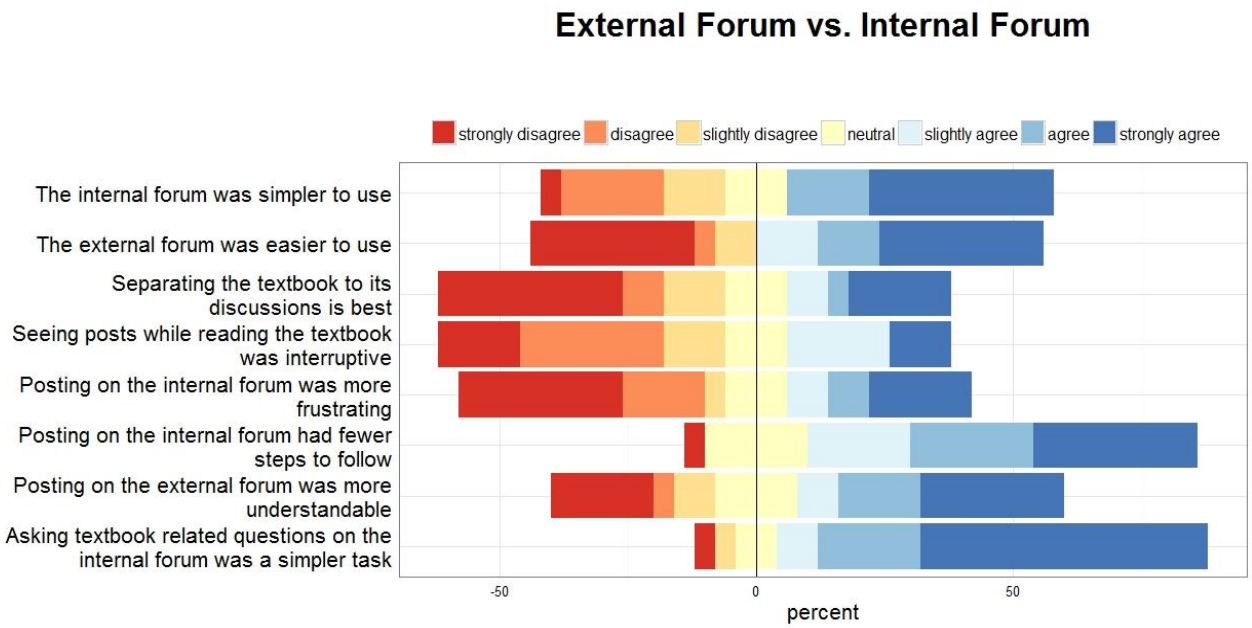

Figure 6.4 User comparison of experiences in using internal forums vs external forums

In Figure. 6.4, participants show favour toward the internal forum than the external forum. Participants found the internal forum simpler to use at 52%, but 24% disagreed. In terms of ease of use, 44% stated that the external was easier and 36% stated the internal forum was easier. In terms of fewer steps to follow when completing tasks, 4% supported the external forum while about 56% supported the internal forum. Asking questions on the internal forum was considered a simpler task than on the external at 76% and 4% respectively.

Separating the textbook to the discussions in the external forum was considered best at 24% while 44% did not prefer the separation. Those who chose the internal forum identified the platform as more focused and specific to textbook sections, more user-friendly and convenient overall. Incorporating everything into one platform is what made the system convenient and appealing to participants. They described the platform as more comfortable to use since the readily visible questions and answers helped one to learn quickly from their peers or reference the text quicker. About 12% of the participants found combining the textbook with the forum to be interruptive while 44% disagreed. Many participants preferred the internal forum to the external forum and stated that they would recommend the internal forum more than they would recommend the external forum.

However, the external platform was found to be more understandable when performing tasks compared to the internal forum at 44% while 24% disagreed.

The reasons that led them not to choose the external forum included that the platform was more challenging to follow since posts were very independent and sometimes one may be clueless as to what others are discussing. Referencing specific sections of the textbook was found to be difficult and time consuming on the external forum. One participant stated that:

"You have to keep switching back and forth between books and forum when asking questions hence did not choose the external forum."

This is also ascertained by the results from the previous section that show that there was a major difference when referencing the textbook. One had to direct their peers to browse through pages of the textbook to find the relevant section to the questions. Separating the textbook meant that a user had to switch to the separate discussion forum every time they had a question. They said that the external forum stops the flow of reading as one could get distracted while reading questions on the forum or even in following new topics instead of going back to reading. Since the questions on the external forum were unordered except by date and number of replies like most Moodle forum platforms, one had to go through the unrelated material, which could be distracting for people who wanted to focus on particular topics.

Of the 37% who selected the external forum, they found their platform user-friendly with much freedom for editing posts compared to the internal forum. They found that it was easier to ask questions and answer questions. Some of the users felt that the internal forum was unfavourable because having discussions got in the way of the textbook content. They stated that there were too many writings on the internal forum platform. Their foremost negativity of the internal forum was the lack of posting within a post to better organise comments within each section.

To improve on both platforms, participants suggested emoticons as a mechanism of grading answers. Emoticons are exciting and require little effort from the user compared to the voting mechanism that was provided. A high number of clicks on the academic emoticon would show a consensus among readers about their thoughts on the post. Other suggestions stated that notifications would be necessary for reminding people to follow up on their posts, as well as keep users motivated to read.

However, the way they are to be designed would have to be subtle in an appealing way as notifications can be intrusive if given too often.

6.1.7 Discussion of Internal vs External Forums

In many LMS platforms, the discussion forum is considered to be one of the critical support mechanisms for learning offered to students. Discussion forums are often confined to a minority within groups; hence many tools are being established to increase the number of interactions that include the majority of the groups. The use of the eTextbook with embedded discussions in it was perceived to be the best at meeting the student learning needs and increasing interactions, with an average of 40 discussion responses per section in the textbook.

Since students had two weeks to use the system, they had ample time to learn and be able to choose what they figured was the most effective platform for their learning needs. There is a noticeable difference between the internal forum and the traditional external forum. Despite the widespread use of traditional forums, there is still room for improving interactions and embedding discussions within textbooks as one of the strategies for improving engagement and locking students into a zone of relevant content to encourage participation. In this experiment, the addition of forums to the textbooks appealed to more learners as shown by the statistics that there is a significant difference between the internal and external platforms.

Even though preference was for the internal forum, those who preferred the external forum had valid arguments for separating the discussions with content. The structure of the independent external discussion forum encourages a question and answer kind of interaction, whereby people focus on receiving a response or asking a question. This was observed in the length of each forum thread, which tends to have an average of two or three responses. Also, allowing the user to focus on the textbook without interruption is an important consideration. Therefore, a system that encompasses the best of both platforms evaluated in this experiment seems more appealing. Learners may toggle between having interactions within their textbooks and switching them off when they need to focus more on reading. In terms of learning, where learners have different needs, having a one size fits all system might not be ideal. As such building a system that caters for various needs might be a viable solution in encouraging all users to enjoy their learning experiences.

6.1.8 Usability of the System

A user experience questionnaire (UEQ) was used to test the usability of the system. The UEQ tested the internal and external forums in six parts, which include an overall impression of the system, familiarity with the system, efficiency in performing tasks, user control of the system, motivation to use the system and creativity of the system. Again looking at the extreme negatives (disagree and strongly disagree) and extreme positives (agree and strongly agree). The results in between were taken to be neutral to mean the system was ok for use.

According to the participants (see Figure 6.5), participants' overall impression was that it was mostly good, friendly and enjoyable at over 50% each. 33% thought that the system overall was satisfying. However, only about 21% found the systems to be both attractive and likeable.

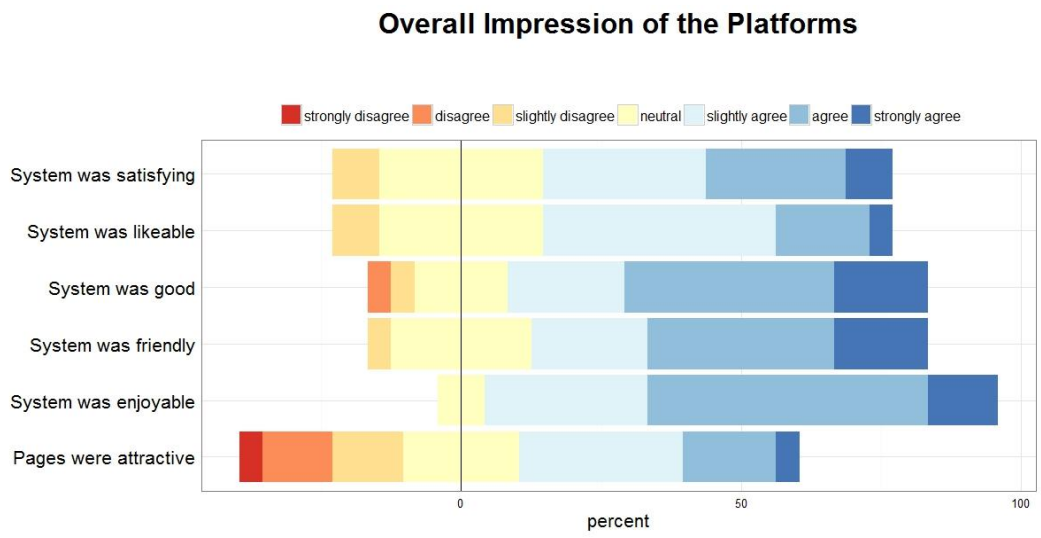

Figure 6.5 Overall Impression

The participants thought the system was familiar (see Figure 6.6). Over 71% felt the system was both understandable and easy to learn while about 8% disagreed. About 54% of the participants also felt the system was clear while 62% felt the words and buttons used were consistent and none disagreed. 46% felt the system was simple to use.

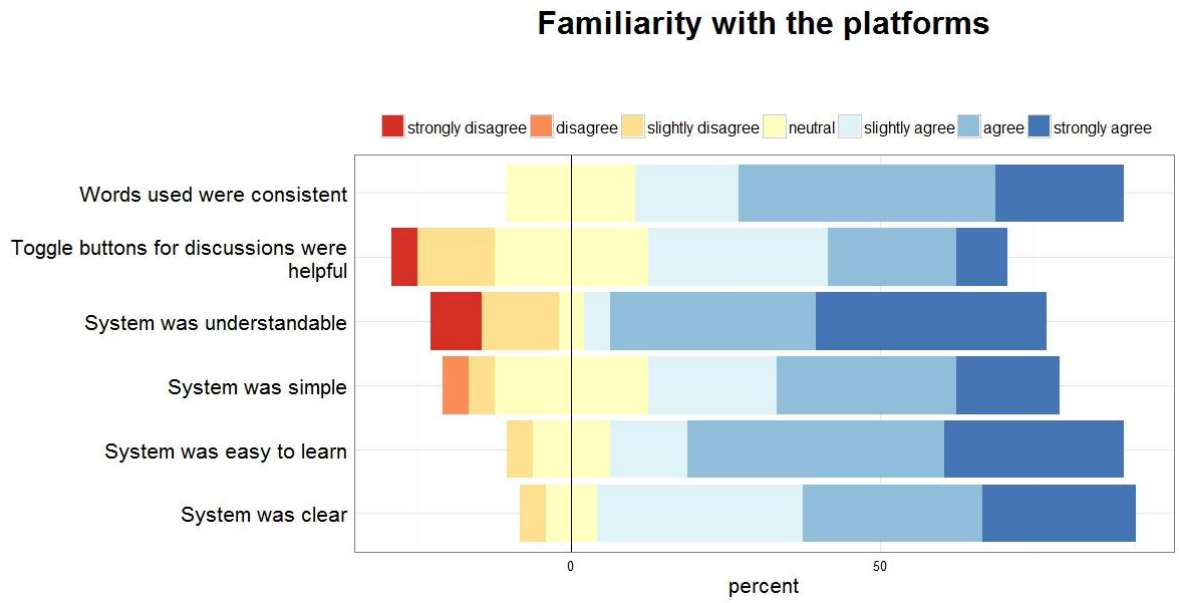

Figure 6.6 Familiarity with the platforms

Figure 6.7 showed that the system was highly straight forward (67%), learnable (71%) and well organised (67%) and none disagreed. However, there was an almost equal analysis of efficiency in terms of how quick the system was and the effort required when using it at about 30% each but 13% disagreed. 38% thought the system was practical. 17% thought the system was efficient while 21% disagreed. The pages on the system were considered to be organised at 62% and no one disagreed.

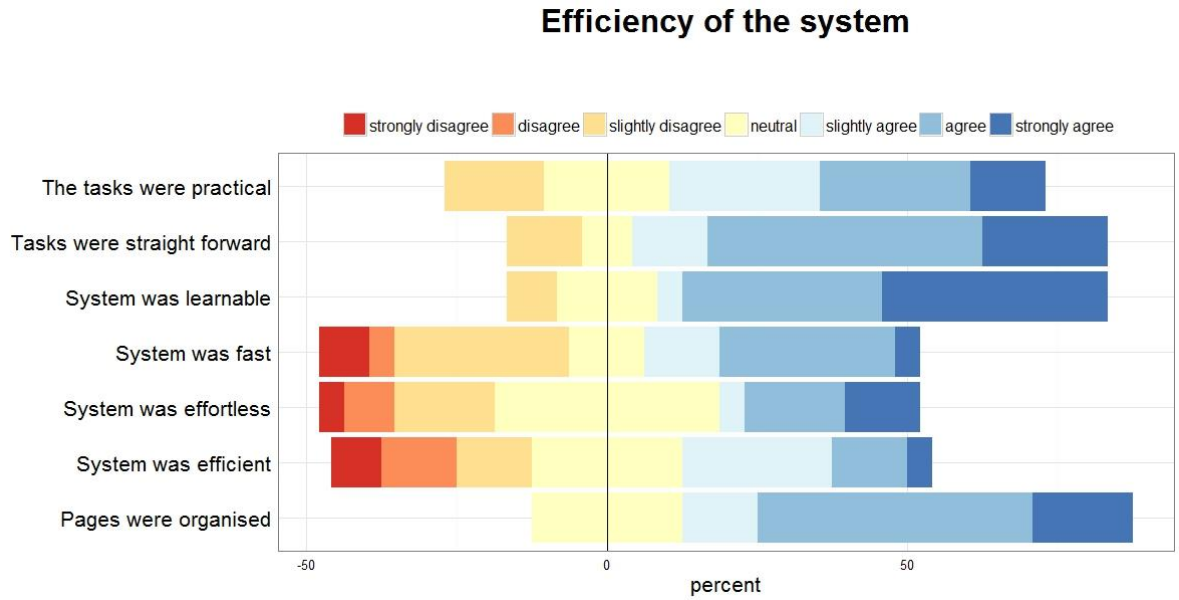

Figure 6.7 Efficiency of the platforms

Participants stated that the system met their expectations at 42% while 4% disagreed and they felt confident when using the system at 58% while none disagreed (see Figure 6.8). However, 8% of the participants felt that the system provided support to ensure user control while 29% disagreed and also another 12% showed that the system was predictable while 21% disagreed.

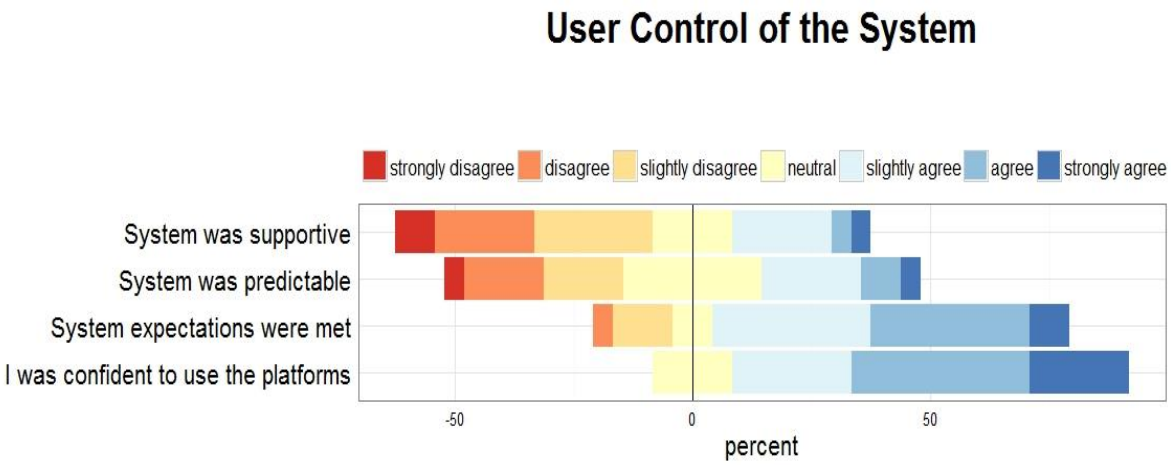

Figure 6.8 User Control of the system

Participants showed that they were highly motivated to use the systems and felt it was a valuable system at 50% each. Only 4% disagreed that the system was valuable and none felt it was not motivating. From Figure 6.9, about 21% of the participants felt the system was interesting while 12% disagreed. 11% thought the system was exciting while 28% disagreed. The results show that that the system usefulness was appreciated however didn't consider the platform exciting.

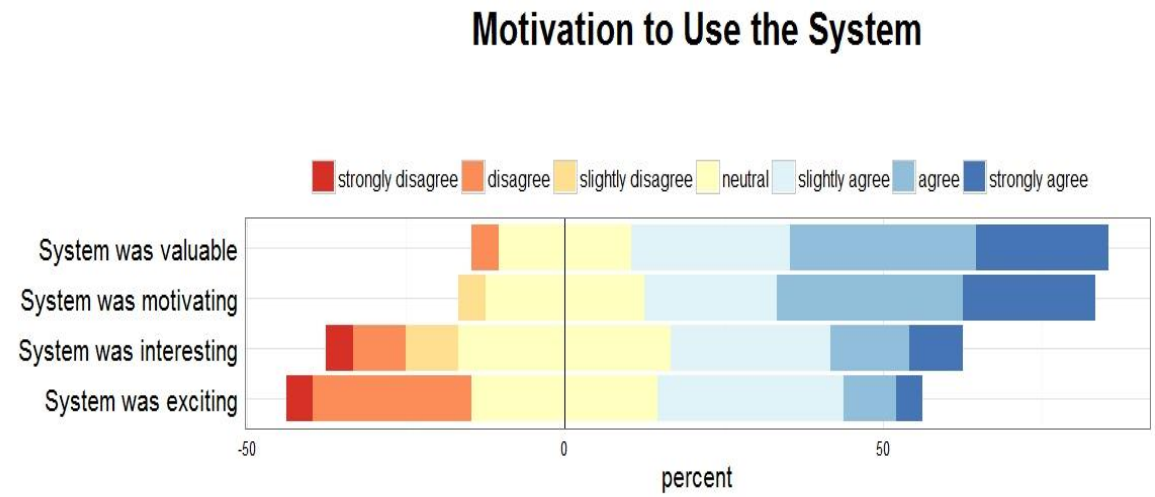

Figure 6.9 Motivation for using the system

Figure 6.10 explains the creativity of the platforms. 46% of participants felt the system was innovative while a few individuals (about 13%) felt it was not. About 29% thought the system was creative and approximately 13% thought otherwise. 25% of participants felt the voting mechanism on the system helped identify important questions, while 13% thought the votes were not helpful. Also, about 29% thought the votes on answers made them trust the responses while 13% disagreed. 29% felt the system was common, the same as what they had seen before, and the other 13% thought the system felt not common to them.

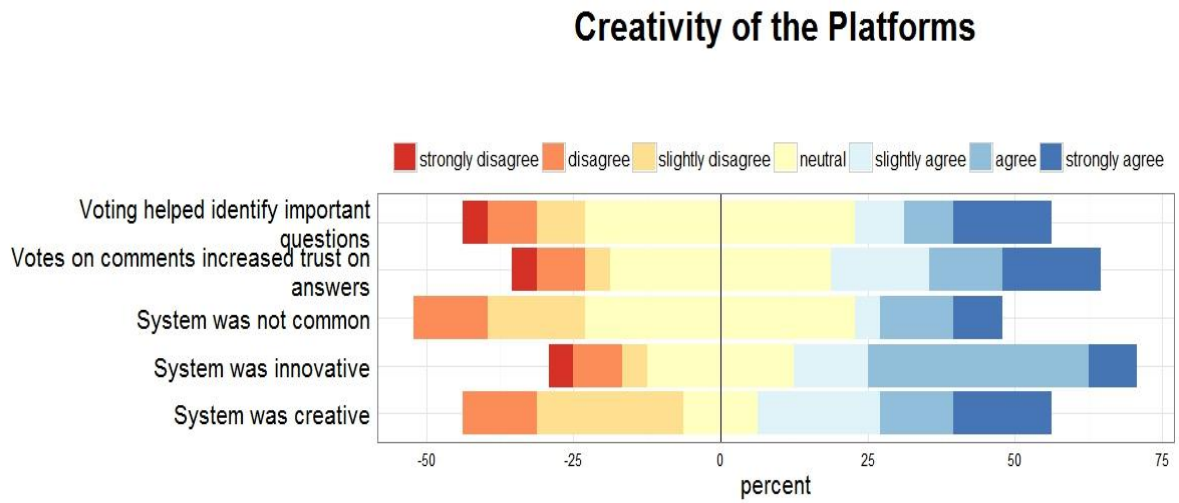

Figure 6.10 Creativity of the platforms

6.1.9 Summary on Usability of the Systems

Overall, the system was considered usable according to the participants' responses with more positives than negatives. This allows us to state that the system was usable enough to consider the results for the experiments as valuable.

6.2 Experiment 2: High School Student Results

Experiment two presents the analysis conducted on the eTextbook collaborative system with high school students. Firstly, the demographic results of the students are presented. This is then followed by the results of the experimental tasks. Lastly, the analysed results are then discussed with a focus on the research questions posed in chapter 1 of this dissertation.

6.2.1 Pre-task Questionnaire: Demographic Results

This section gathered the age and previous experiences with technology and eTextbooks of recruited users. Though this is not central to this study, the demographic data helped contextualise the findings for particular age groups.

Age of Participants

The participants were asked their ages, and the following table depicts the frequency of their ages (see Table 6.10). The importance of these results was to identify at what age groups participants are comfortable with a specific technology.

Table 6.10 Ages of participants

Age	Frequency	Percentages
15 years	4	11%
16 years	21	63%
17 years	9	26%
Totals	34	100

Table 6.11 List of participants' phone types

Vodafone Android 858 (2)

Samsung Galaxy Ace (2)

Blackberry (1)

Huawei Ascend (5)

HTC WildFire (1)

Nokia Asha (2)

Samsung Galaxy Orro (1)

Samsung Pocket Neo (2)

Samsung Galaxy Young (1)

Call Touch Tab/Galaxy Tab (3)

HTC Cricket (2)

ZTE (1)

Types of Phones the Participants Used

Participants had basic smartphones but with small screens. Two of the participants owned a Samsung Galaxy tablet, and one had a "call-touch" tablet. All the three participants with tablets considered them mobile phones because they allowed sim cards and hence worked like phones to them. Six students did not disclose their phone types while five described their phones as Android phones and not by their phone names. Of the 20 students that disclosed their phone types correctly, Table 6.11 shows the list of the phones and the numbers of participants that own them. The most popular phone among the students was the Huawei Ascend.

The perception was that students could not afford smartphones with internet capabilities. However, the types of phones that students are using are smartphones except for Nokia Asha, which is a feature phone even though it also allows social networking apps like Facebook and WhatsApp to be installed. Although these phones are small in screen size, participants stated that they rely on them for various technological needs, which also include educational necessities. To these students, mobile devices are the closest they have got to technology as they cannot afford laptops or desktops. The type of devices that students in high school in developing countries use show that we can be developing for smartphones as feature phones, which were expected, are being used less often now. All the devices that the participants use have Internet capabilities, and students can download apps that they like onto their devices. In the year 2016, the cheapest of these phones was approximately $30 (USD) in price while the most expensive was less than $100 (USD). Phones keep improving in functionality and are also getting cheaper.

Experience with Participating in Discussion Forums

Table 6.12 Experiences with discussion forums on popular social networking sites

Social Networking Site	Frequency (x/34)	Percentages (x% of 34)
Facebook	20	59%
Twitter	1	3%
WhatsApp	32	94%
Other: Mxit	2	6%
Other: Viber	1	3%

When the participants were asked if they had used discussion forums before, there was a 100% positive response as participants stated that they had experienced discussion forums on various social networking sites. Table 6.12 shows the discussion forums utilised by students.

The results above show that WhatsApp is the most commonly used discussion forum platform for many participants at 94%. The Facebook discussion forums follow with 59%. Of these participants who use Facebook discussion forums, 91% indicated that they had joined discussions group pages. The rest of the other networking sites had fewer users, with 3% of the participants using Twitter to converse with others. 6% of the participants revealed that they use Mxit forums, while one other participant stated that they had used Viber forums for discussions. Many participants actually agreed that they buy data specifically to use WhatsApp and not any other social networks. Others, however, said they buy combo deals of Facebook and WhatsApp data bundles. The participants rarely had data bundles to browse the internet.

Frequency of Participation

The participants were asked how often they participate in the discussion forums and that they had indicated they use, particularly Facebook and WhatsApp. From the results, 15% of the participants ignored the question about how often they use Facebook. Figure 6.11 shows that 22% of participants mostly use the Facebook forums daily, 18% weekly and 14% rarely. When it comes to WhatsApp, which seems to be the common social networking site among students, 68% use the application daily, while 26% use it weekly. Only 6% of the participants acknowledged that they had rarely asked questions on the WhatsApp sites.

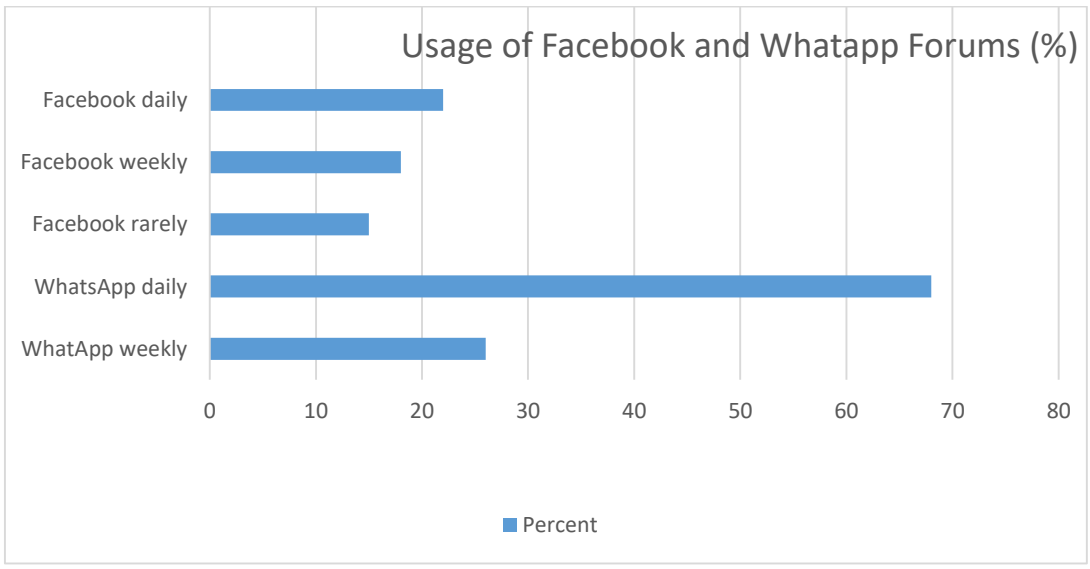

Figure 6.11 Usage statistics of discussion forums on Facebook and WhatsApp

Using Social Media for Academic Purposes

59% of the participants had used social networking for educational purposes before. A few other participants stated that they had used social networking platforms to discuss any questions they come

across in their learning. Some of the students stated that they use social networking for sharing opinions and discussing questions and answers related to Biology, Literature, Geography many stated Mathematics as their main subject of discussion for educational discussion forums. The students who referred to Biology discussion forums indicated that they used the group together with their teacher. In some schools, teachers have a role of continuing to monitor their students' learning even after classes. Participants in one of the schools indicated that they were part of a WhatsApp group for students in their class for that year where they discussed various topics and subjects.

The social network that most of these students have used is WhatsApp. On WhatsApp, participants' can create electronic study groups with other students that they know in their classes or the same grade from other schools as it is easy to relate to similar topics with them. However, the administrator had to know the participant phone numbers prior to joining the group, which becomes a limitation to adding everyone. Recently, this is no longer the case, one can join a group via a shared link and does not have to be on the administrator's phone book. Also more than 30 people, 250, can now join one group.

The subjects that the students discuss in these platforms still require the use of hard copy textbooks in combination with the WhatsApp study groups. One of the participants said,

"Yes, but questions with no diagrams only".

They further explained that some questions with diagrams were difficult to share on some of these social networks for students to discuss them. On the other hand, another participant said:

> *"Yes I use social networking sites for educational purposes, we use screenshots to send each other questions and answers with friends".*

The need for screenshots highlights a method of referencing the textbook content during discussions. The students refer to their textbooks or write their challenges down to send them to their peers for discussions. Screenshots provide an immediate solution for participants to send diagrammatical questions for discussions on the forums. However, for subjects like Mathematics, providing handwritten screenshot solutions meant writing and retyping solutions on paper no matter how long they were to clarify an answer. Sometimes students referenced questions by stating page numbers or explaining the sections in books.

Experience in using Electronic Textbooks

62% of the participants had the opportunity of using electronic books before participating in the experiments. A majority of such books included novels as well as the Bible, and one participant referred to a dictionary. The examples that the participants gave demonstrated an understanding of electronic books. About 21% of the participants had used educational electronic textbooks before for reading. One example was a science textbook they used at one of the schools. None of the participants had used books with embedded discussions before.

This section revealed the students' background in using eTextbooks and discussion forums for learning. Most of the respondents are 15 years of age and have used forums before but not academic textbooks or online learning platforms as much. Their experience of using technology for education is limited, although they had experienced forums through social networks.

6.2.2 Experimental Results and Discussion

60 participants each signed consent forms on their own and with parents, or through their teacher representatives at their respective schools to participate in the tasks. The task experiments had a duration of 4 weeks and were to be conducted in succession with two survey questionnaires at 2-week intervals to obtain feedback on the participant experiences regarding the internal and external platforms.

Students did not collaborate on the app. The logging sheets indicated that about 10% of the students were present on the site. The participants did not converse or collaborate with others. There were no posts or comments made on the site. After two weeks of inactivity, the students were not given any more data, and the experiments were stopped. Two weeks was considered enough to conclude that the remainder of the two weeks would yield no results.

An investigation had to be made as it was evident from the results that the students had no reason to be on the application even though they had free data and the system had already been tested for usability before the experiments started. However, several reasons could be attributed to the lack of platform usage by the students.

- Unusable system. The most apparent reason could be that the system was not user-friendly and the interface was confusing and difficult to navigate or even boring. Alternatively, participants did not trust the anonymity on the system.

- Access to the Internet. Participants could have had challenges logging onto the system because of data and connectivity issues or phone-related challenges like screen too small to read the textbook online. They might have misused the data given to use the application.
- Fear of Technology. Academic discussion forums were foreign to many participants and students did not want complications of using technology to study. They were used to their friends and using the traditional ways of collaborating face to face. Participants did not understand what discussion forums are, as well as the purpose of the technology and taking advantage of how it could assist them. Also, participants might not have understood their role or what was required of them despite the orientation. Lastly, they considered Facebook to be fun.
- No monitoring. Participants could have expected their teachers to be present on the system and for them to assist and direct them every step of the way. Since there were no marks associated with the tasks, participants could have felt like they were wasting their time.
- Change is not easy. Participants could have just thought the app was adding lots of work to them. Perhaps the app intimidated them, and hence they felt they had nothing to offer to others. Participants did not want to be the first to use the site and so waited for others to begin, which never happened. When Facebook started, there was much research on people having a phobia to post anything on the site due to fear of the unknown. Perhaps this is also what happened (Caplan, 2006).

6.2.3 Plan of Action to Improve the Experiments

The reasons stated above gave guidance as to the kind of questions to ask students about their inactivity on the system. A follow-up was made with the participants to find out what their challenges were to inform future evaluations. The primary objective of this was to find out how the system can be improved based on the results of the participants. The follow-up was done in a semi-formal focus group session in each school. The sessions were made very informal to make the students comfortable to answer honestly. Participants were informed that they were free to express themselves as they were not going to be asked to pay back the free data they had been given. The focus group was used as it allowed a quick analysis of responses with detailed explanations. This was then incorporated into the next experiments. Following are some of the questions that were asked:

- How many used the experimental app? (We already had logs, so we knew that only a few individuals had been on the site)
- What are the reasons that hindered you from using the app?
- Did you understand how to use the app for the experiments?

- Do you trust that you were anonymous on the system?
- Was it complicated to use the system?
- What is your general understanding of discussion forums?
- What benefit do you think discussion forums can provide for you?
- Did you expect the teacher to be of assistance regarding instruction when using the application?
- Did you have Internet access throughout the experiments?
- Did using the system feel like a burden and taking up your free time?

6.2.4 Results and Discussion of the Follow-up Assessment

After the students were asked about their inactivity on the system for the experiments, the following significant reasons were gathered:

i. Confidence in using the Application

The students felt that they were not so confident in using the application despite having had a pre-session where they were shown how to use the application. This revealed that participants needed longer sessions in testing the application to build confidence before allowing them to use an application alone. Many stated that they were afraid to break something or write the wrong things on the application. About 75% of the students in all the schools raised their hands to agree that fear made them not to use the application as required. This also explains the few individuals who were on the site but did not do any activity on the system as asked. Others stated that they were waiting for their friends to be the first to post on the site. When no one started, they were also scared to start. Also, they highlighted this is the same reason they rarely post comments on Facebook forums because they are afraid of the unknown. They like the sites and follow them, but they can never post anything on them. Another reason was that of writing correct English on the platforms.

ii. Knowledge of the Benefit of the Application

Although the majority said they had a good idea of using the application and that the system was simple, some stated that they did not really value spending time on the application. In other words, there was little motivation for using the application especially since it did not add marks to their subjects. As a result, they did not put in the effort because the benefits of using the application just to test it in an experiment were not as motivating for them. Students are usually motivated by activities that give them marks, especially at the high school level. It is clear that for high school students there

should be a link between formal schoolwork and the electronic applications they may be presented with. An incentive could be a system that awards students for participation.

iii. Dependency on Teachers

Another reason for not using the system was the dependency on teachers. Students are accustomed to being always reminded of work to submit and hence there was little motivation in using the application. Almost all the participants agreed that they had no pressure to use the system as the teacher did not force it on them or continuously check on them. When they were asked who follows them up when they converse on Facebook, they stated that what is discussed on Facebook does not require much thought and was general thoughts. For high school students, the presence of instructors may be vital to using the proposed educational systems as part of the curriculum. However for this work, teachers were not added to the system to promote student to student interactions, provide a non-threatening environment for free interactions and to mimic the natural setup of social media communications without interference from the teachers/ superiors.

iv. Other Factors

Some students were honest enough to say that they only joined to use the system because of the free airtime. Since the airtime was given as a voucher, they could use it to buy other bundles that they liked besides Facebook. As a result, they ended up not having airtime for the experiments. About 25% of the participants stated that they were just lazy; it was extra work for them to spend time on the site. They meant to do it but never did.

v. Plan of Action Post the Results

One of the reasons that were assumed to be a significant contribution to the lack of activity on the site was the design of the system. However, no student complained about the design, stating that it looked simple enough. As a result, there was no need to co-design with the students to build a new system for them. However, the usability of the system had to be tested to make sure that the problem was not the system itself. As such, considering the results did not complain about the application itself, the assumption was that there was nothing wrong with the system but the attitudes toward it made it challenging for the students to use it. Strategies that would seek to encourage the students to use the application were drawn from the results:

- Have a lesson about forums and social media and its importance to conversing for learning to reinforce the importance of forums for learning.
- Make students trust the anonymity of the system through examples during training. This will ensure that students do not have to wait for others to post questions.

- Instead of using a natural setup experiment, as the motivation of using systems may take some time, conduct a task-driven controlled study to test the system such that students develop and connect with the system features and can easily evaluate the system. That would also ascertain if the application was usable at their level of understanding. Students can post or answer questions on the app and compare the two platforms with a deeper understanding of the differences and benefits.

The results obtained in this section motivated further experiments that would allow the comparison of University students to high school students. Perhaps the level of learning or the environment thereof is a contributing factor to the results. The UCT students chosen for the experiments were first-year students, which means they were coming straight from high school and hence had an almost similar understanding of forums. However, UCT students are considered to be students mostly taken from top-performing schools. These results also helped ascertain if lack of experience and proximity to technology was a contributing factor. Also, an observation was that the culture of the schools did not promote eLearning as such, it was difficult to adopt the technology when the school only promoted physical teacher-centred learning.

6.2.5 Summary

The results of this experiment show that systems that are not designed to be part of the curriculum or those that do not add to student marks, do not motivate usage. Since the site was not for entertainment but for academic purposes, it made the motivation to use the system even more challenging as it was considered another place of learning. Also, although students use forums on social networks as seen through the demographic results, they may not associate them with positive benefits when placed in the educational environment. We can, therefore, conclude that high school students require more time and more motivation to adopt such systems that occur in natural setups with no teacher guidance especially since they are not accustomed to eLearning. However, we also conclude that giving students an application that works does not guarantee usage and adoption. Other factors not related to the system may be a major hindering factor that prevents adoption. More training is required to ensure high school students find value in the applications that they are presented with.

From the results, there were many assumptions that needed verification through a secondary study. Since the evaluation study results were not conclusive, another field test had to be done. As a result, a second study was conducted to obtain further feedback about the system for high school students.

However, a new approach had to be taken. Following are the detailed results of the second study conducted with the high school students.

6.3 Experiment 3: High School Student Results

Following are the results obtained from the follow-up experiment that was designed to obtain information from the high school students.

6.3.1 Time Responses to Using the System

On average, to post a question for a tech-savvy person, it would take less than two minutes. However, students were allocated 20 minutes as their knowledge of academic discussion forums was limited. Students spent much time conducting each task. Most participants from all the schools spent about an hour on each task. Therefore instead of completing the experiment in one day, it was completed over two to four consecutive days. Even though the participants were given detailed instructions with step by step guides of performing their tasks, they still needed confirmation and encouragement to continue each step. This delayed the process. This also further explained the lack of confidence and the need for constant guidance and encouragement of the participants in performing tasks in the first experiment given to them. The need to teach students before putting it in natural settings was key.

6.3.2 Response Rate

60 students were randomly selected from four different schools, with 15 students from each school to participate in this experiment. Only three schools were successful in completing the experiments. One of the schools had challenges with scheduling a time slot that catered for all students at once; hence only three participants finished the experiment out of 15 students selected. Because of the massive difference in numbers to the other participating schools, the results from this school were discarded and will not be discussed as they barely represented their school grade. From the three schools, there were 13, 10, 11 respondents, respectively from school A, B, C, that completed all the experiments. This made it 34 of the 45 recruited participants who completed the experiments in full, giving a response rate of 76%. However, for task 1, 37 participants were evaluated and 3 participants did not complete task 2 hence only 34 of the participants finished all the experiments.

After signing the consent forms indicating the participants' willingness to participate in the study, they conducted the tasks of the experiment by using the system provided to them and afterwards completing the questionnaires. All tasks performed by each participant were number coded to help identify a full set of responses by an individual in performing all tasks. Following is a discussion of the results. The findings are discussed according to the tasks conducted within the experiment as follows:

- Pre-task: Lesson on social media

- Task 1: Evaluation of the control system
- Task 2: Evaluation of the experimental system
- Task 3: Comparison and preference between the two systems
- Post-task: Usability of the system

6.3.3 Results: Lesson on Social Media

The first study did not go as expected, as discussed in the previous section. As a result, a new approach was followed to conduct the experiments and obtain feedback about the systems. Since the rejection of the first experiment was not due to the usability of the app, as stated by the participants, our option was to change the approach and test differently in a closer investigation. That means we had to ensure that participants were knowledgeable of social networking sites, discussion forums as well as electronic textbooks. The demographic results indicated that the students knew about forums and social networks, however, to ensure that students understood what they meant, the participants were first given a short information session about social networks, discussion forums and electronic textbooks to obtain a deeper understanding of collaborative platforms. This is because one of the challenges that affected the students was that of being afraid of the system, even though the session had a pre-trial before the students used it.

According to the results, students seemed to answer all questions related to forums and social networks easily. However, they were not totally aware of LMSs and how they work to aid in educational environments. They explained how they use social media for learning and what sort of media they shared with one another. They also explained reasons for not participating in entertainment forums, which included being afraid to post, afraid to misspell words and liking to be observers. After the lesson, a pre-practical session was conducted with the participants. However, for those who did participate, they felt it was informal, and the posts were related to everyday life. In conducting the test question, all participants were able to post a question within five minutes of a step by step instruction. Afterwards, they also practised as individuals. They felt it was an easy task and hence they moved on to the actual tasks of the experiments.

6.3.4 Differences between School A, B and C Results

First of all, the results from all schools were tested using the Wilcoxon signed-rank test to determine if the participants from the three different schools yielded significantly different results. This was done to help determine if the schools should be considered separately or as one group of participants. Based on the tasks given to the students, there were no significant differences in the results from the

three groups. This, therefore, means that we could assess the students as a collective and not as three separate groups.

6.3.5 Task Results: Alias Names vs Real Names on Academic Platforms

The students were given the option to use an alias name or their real names. Results show that many of the students selected to use alias names on the system. A total of 74% chose alias names, while 26% chose Facebook names. When the students were asked why they did not choose to use alias names, they stated that they wanted others to see that they had posted questions so that those who knew them could easily recognise them and because they also felt there was no need to hide. Those who used alias names stated that they chose them because they felt it protected their privacy and made them secure; it helped them not to be easily recognised. Others also preferred using nicknames on social networks, or generally did not like their real names. Lastly, others thought it was "cool" to be associated with an anonymous name. Only 6% of the participants converted from real name to alias name during the course of the experiments. Also, they both stated that it was easy to convert to alias name on the settings page. They converted because they felt better hiding their real identity.

The participants who selected alias names were asked to elaborate further by stating what challenges they would have should their real names be exposed to the system. Many were afraid of being exposed, having stalkers as they would be known by everyone in the system and that their comments would now be associated with them. A majority stated that they preferred alias names because they did not want to be mocked for asking easy questions or generally to obtain negative comments because of who they are. One of the students stated

> "Many people especially my friends would see my wrong answers."

While another said

> "If you answer wrong you will be humiliated."

One student explained that sometimes their peers do not take them seriously, as a result, might fail to obtain useful information on the site.

i. Effects of User Identity on Collaborations

The students were asked if alias names made them feel safer or encouraged them to participate more on the platforms than when using real names (see Figure. 6.12 for the results). The results show that the participants felt safer using their alias names as it protected their identity and gave them the

liberty to ask questions and comment on posts. 64% felt safe using alias names, 12% did not feel safe, while 25% were neutral. The participants chose alias names because they did not want to be ridiculed by others, therefore, that became a way of protecting themselves. The participants explained that at high school, there is a high tendency for students to mock one another to make themselves look good, which intimidates others. Including alias names on forums, made it easy to control students and ensure that they are at the same level and no one can easily pick on particular individuals. When explaining the need for alias names, participants stated that clusters and clicks are a big problem as they do not belong to "cool student" groups. However, with alias names clicks were avoided as no one knew who was cool or not, who is more intelligent and who is struggling with the subject, who is elite and who is poor. Also, about 72% of the participants agreed that using alias names made them want to participate more as no one knew who they were hence no one could judge the type of questions they asked, especially when they were considered too easy for them not to know (see Figure 6.12). 4% did not think an alias name would be linked to their participation levels. The results show that students were not afraid to make mistakes in attempting to answer questions because of alias names. Also, they know that giving a wrong answer means someone will correct them and therefore they can easily learn from one another.

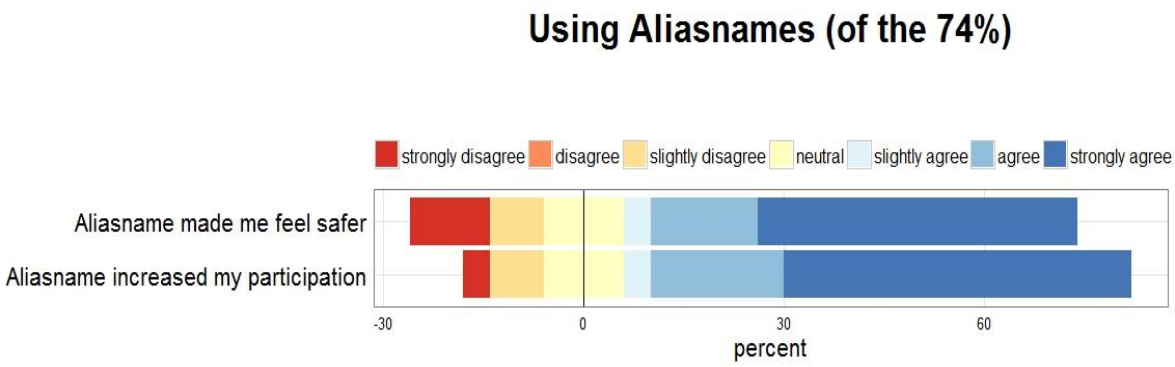

Figure 6.12 Effects of alias names on forums

From those that chose real names, they felt neutral in terms of participation and improving user confidence.

ii. User Identity: Alias Name vs Real Name Discussions

The results have shown the preferences for alias names on collaborative platforms. The results also highlight that the freedom to use an alias name on an educational platform should not be ignored as it may be beneficial to students. Students still fear to conduct activities because they do not want to be judged. On platforms that do not allow aliases, only selected individuals who are very confident participate. Those who are not confident only observe as they are afraid to make mistakes. Results

also showed that participants would participate more with alias names. The results indicate that academic discussion forums must consider allowing alias names even though they also have side effects to deal with. Since students are known to abuse the system with foul language when they use alias names, this challenge may be counteracted by ensuring that students are suspended for specific periods from benefiting from the system to show the seriousness thereof. This is what users experience on some Facebook platforms to control posts. Many other mechanisms can be established to control the participants. However, the benefits of using alias names cannot be overlooked and should be made a consideration when building academic platforms for interactions. If obscured identity can encourage the initiation of posts, as that is the primary challenge on most forum platforms, then it should be tested at a larger scale to determine how to minimise the disadvantages over the advantages.

6.3.6 Posting Questions on the Platforms

Participants conducted task 1 and task 2 in posting and responding to posts on both the external and internal forum platforms of the system for a duration of 20 minutes each. Following are the results of posting questions and responding to them on the system. This section is divided into four, first describing results of posting on the internal and external forum system and then describing the results of commenting on a question on the internal and external platforms and thirdly choosing between the external and internal forums and lastly the usability of the system. The tasks given to the high school students were similar to those given to the university students, however, for high school students, they were broken down for easy analysis, and the experiments were conducted at closer proximity to participants so as to offer guidance on using the system. The following results are given for the three combined school results since there were no significant differences among the school results.

The importance of task 1 was to determine what was more comfortable for the students when using both platforms where posting and initiating questions was concerned. The questionnaire given gathered which platform was considered more natural, faster, convenient and less complicated to use. Figure 6.13 shows the results of comparing posting when conducted on the external platforms, and Figure 6.14 shows the results of posting on the internal platform. As already explained, the participants were each given two questions to ask on the external platform. The students were given questions to encourage participation on the platforms even when students did not know what questions to ask. The results show that students easily understood how to post questions onto the external platform at 41% while 16% thought otherwise. They found that the system was easy to use

and as a result they did not face complications in conducting task 1. The participants knew where and how to post their questions on both platforms. The participants agreed that they understood the use of both platforms. According to the demographic data, a majority of the students, over 50%, indicated that they had used forums before and hence were familiar with how they are presented as standalone applications like the external forum. They could easily post on the external platform as they could on the internal forum platform.

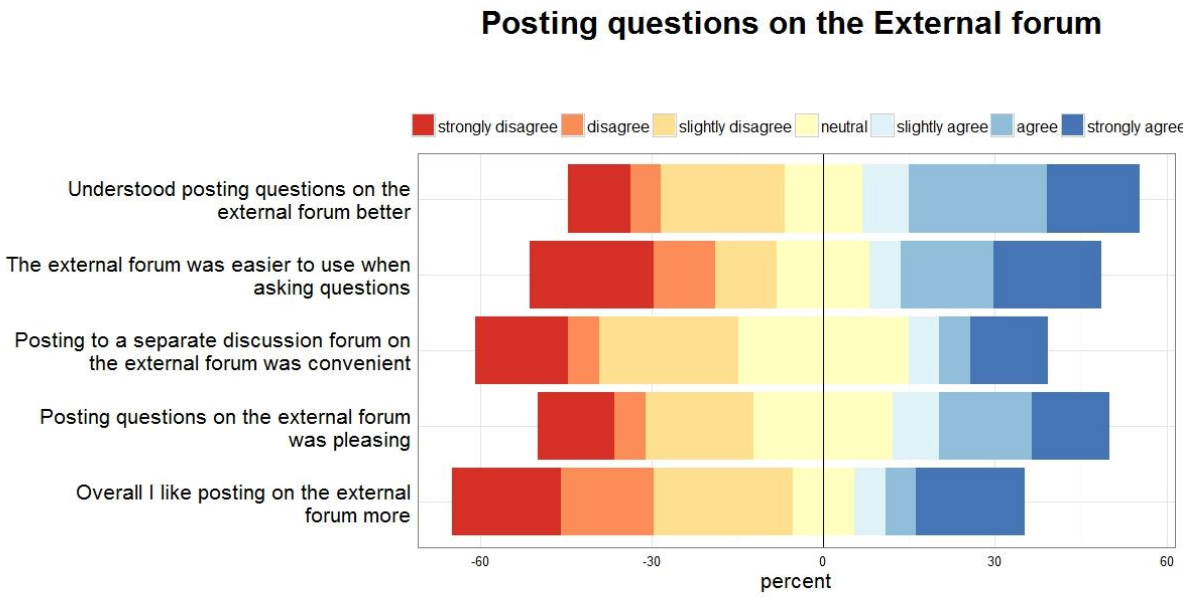

Figure 6.13 Attitudes toward posting questions on the external platform

From Figures 6.13, when it comes to ease of use, participants almost equally agreed that both systems were easy to use. A total of 35% stated that the external platform was easy to use, while 32% showed that the internal platform was easy to use.

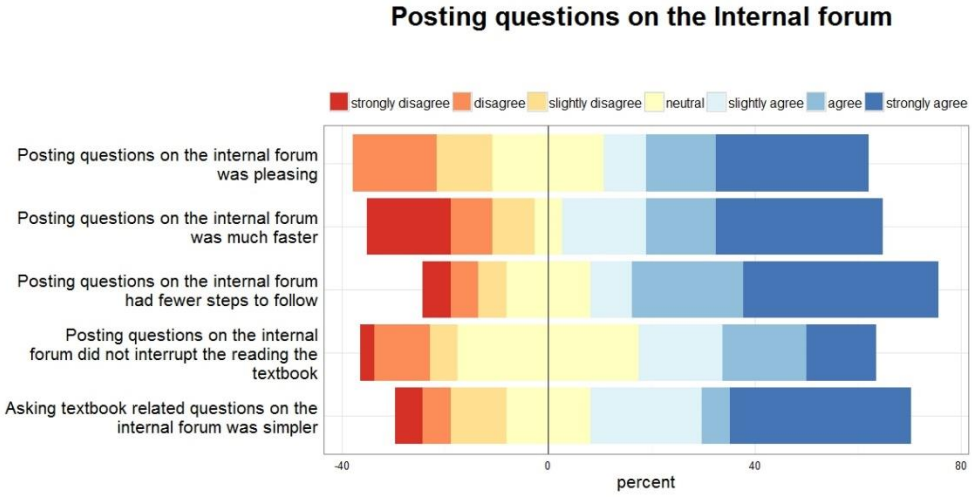

Figure 6.14 Attitudes toward posting questions on the internal platform

The participants were asked which platform made it simpler to post questions related to the textbook that was given, and a majority preferred the internal forum platform. From the participants, about 41% positively agreed while 11% of the participants said the external platform was simpler. Participants also had to determine which of the platforms was faster to use with fewer steps required to conduct their tasks. 24% felt the external platform was faster than the internal platform. 46% felt the internal forum platform was faster. When it came to the number of steps to complete the tasks, 59% chose the internal forum platform while 11% chose the external forum platform.

One of the major questions was that of determining if combining textbooks with forums was disruptive compared to when using the traditional forums. The results show that 14% agreed that when they posted a question while using the internal forum platform, they felt interrupted in focusing on reading the textbook. However, 30% disagreed and stated that having discussions within the book was not an unwelcome interruption. Others felt that it did not make a difference whether they read with discussions on the internal forum platform.

The main difference between the two platforms was the positioning of the forums. To post a question on the external forum, one had to exit the textbook to go to the forum page and ask a question. To post a question on the internal forum, one could do so within the same page of the textbook as they had been combined. The participants were, therefore, asked if moving to another page on the external forum platform was convenient for them. Results show that 21% of the students showed that it was inconvenient to move to different pages in order to ask a question. However, 19% stated that it was convenient and it was reasonable to change pages to post questions and to read the textbook.

The participants were asked if they found any of the platforms frustrating to use as independent platforms without comparing them. For the external forum platform, 19% said it was frustrating to use, while 29% stated that it was not. 52% were neutral and did not think it was neither frustrating nor pleasing. When it came to the internal forum platform, 16% felt it was frustrating to use while 62% stated that it was pleasing.

Participants agreed that the external forum was pleasing to use at 30% while 19% disagreed. Based on the internal forum, 43% found it pleasing to use while 16% did not agree. Overall, the participants were asked which platform they liked to use when posting questions over the other, and the results showed that they liked the internal forum platform better. 35% liked posting on the internal forum than posting on the external forum platform. 24% liked posting on the external platform. When they

were asked why they liked posting on the external forum platform, they stated that one could post any question even if it were not related to the textbook, unlike on the internal platform, which restricted students to focus on the textbook mostly. On the other hand, participants liked posting on the internal forum because it had fewer steps to follow hence it was easier when compared to the external platform. The easy referencing was positively noticed by the participants when evaluating the internal forum platform. Those who were neutral felt that the system almost did similar things hence were neutral in determining which platform they liked better.

The not so favourable points about posting on the external forum platform included the many steps followed when posting a question hence it was slow, and it was designed such that it shows a list of questions that were not grouped. Others felt it was too complicated for them as it was not necessary to keep changing pages to read and converse on topics, especially if one was reading a textbook and quickly wanted to ask a question. They argued that, once one was on the forum, they could get distracted by the different questions on various topics such that they ended up focusing on them instead of the chapter they were reading. Also, others stated that one could quickly forget the question as they moved from one page to another thereby wasting time in the constant exchange of pages to perform tasks. Participants explained that sometimes it was complicated because one had to remember the exact section to ask a particular topic. However, having specific sections in the internal platform made it difficult to remember where to post a question unless one had been reading the textbook section already.

In the end, the participants were asked to give any other comments, and they stated that they enjoyed using the system. One participant stated that

> "The system is helpful because I now understand some of the mathematical problems I saw."

The results have shown that there are differences in posting questions on the two platforms. Overall it is favourable for students to perform tasks quickly. As a result, they liked the internal forum platform for that. The burden of changing platforms to ask questions or read the textbook seemed like an unwelcome disturbance on the external forum platform. However, the fact that on the external forum platform one could easily ask any question was liked by many participants. They felt that the internal forum platform was more restrictive in that area by forcing users to ask only text related questions in assigned sections. We can conclude from these results that using the internal forum platform to ask questions was easy and quick for many participants and on the other hand, the limitation of asking questions on particular sections of the text was not entirely preferred.

6.3.7 Task 2: Commenting on a Post in the System

For task 2, the students were expected to use both the external forum and the internal forum system in responding to the posts in task1. Students were given answers to comment on the system. The participants received answers to avoid having difficult questions as the factor that hinders participants from collaborating. This section explains the differences of commenting on a question on the external forum compared to commenting on posts on the internal forum. A similar questionnaire of task 1 was asked but this time about responding or commenting on posts.

6.3.8 External Forum vs Internal Forum when Commenting on Questions

Participants were expected to respond to two questions on the external forum platform. They generally felt that this task was now more straightforward compared to task 1 due to familiarity with the system. The participants felt that posting on the external forum was not difficult but easy to perform without asking for much help from the instructors. Participants also felt they had no challenges in responding to posts on the internal platform. Due to familiarity as well, they felt this task was much easier to complete. As a result, they did not require much help from the researcher as they did when conducting task 1.

The results for task 2 show that the participants understood how to comment on either platform (see Figure. 6.15 for the participant attitudes). Participants felt that they understood commenting on the internal forum better than commenting on the external forum. About 12% positively agreed that posting on the external forum platform was easily understood. About 21% stated that the internal forum was easy to understand.

Participants were asked if they found it easier using the external forum platform better than the internal forum platform when responding to questions, results showed that 18% agreed that the external forum was easier. However, 24% disagreed and felt that the internal forum was a much easier system for commenting on questions.

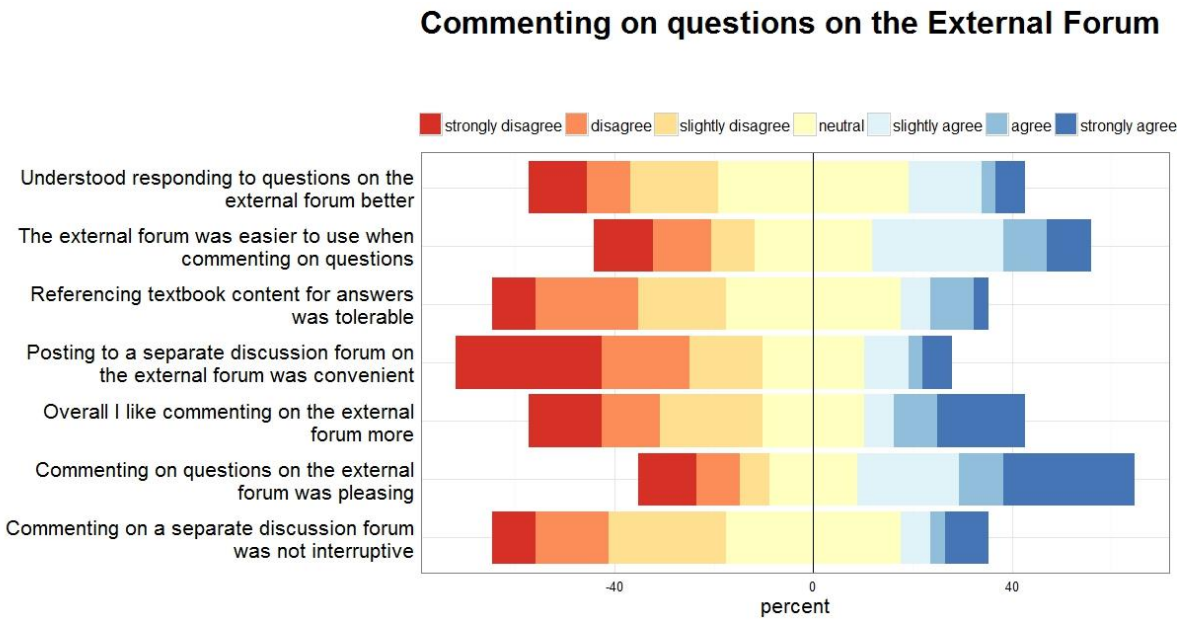

Figure 6.15 Attitudes toward commenting on the external platform

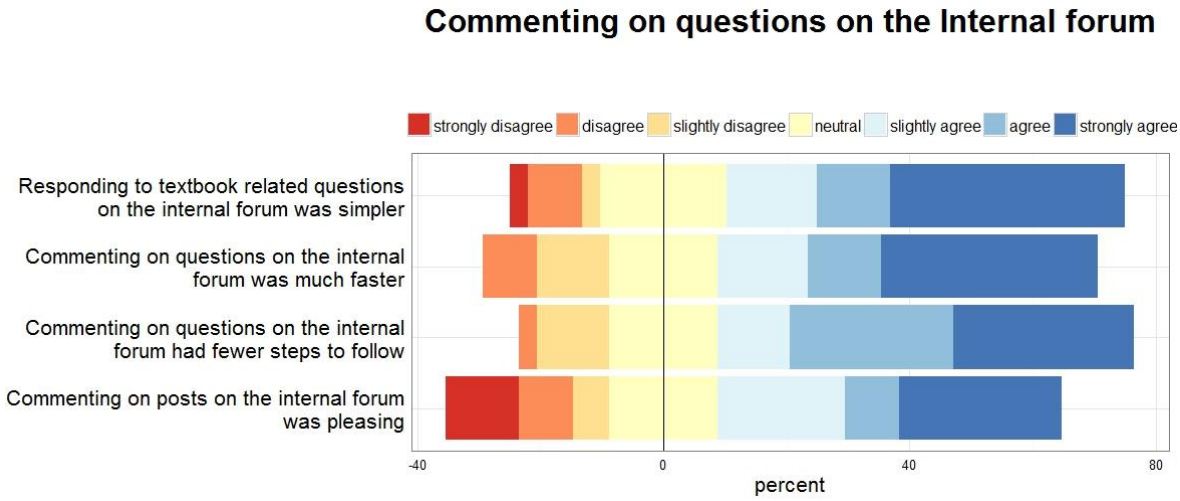

Figure 6.16 Attitudes toward commenting on the internal platform

The simplicity of commenting on either platform was also enquired upon. The results showed that 50% of the participants found it much simpler to respond to questions related to the textbook on the internal forum platform (see Figure 6.16). About 24% of the participants disagreed with that and favoured the external forum platform. A follow-up question was to check if they felt it was convenient to move from the textbook page to the discussion page when making comments. 47% felt that it was inconvenient to move pages in order to comment on questions. However, 9% had no problem moving from one page to another in the external forum platform.

The speed of commenting on the platforms was also evaluated on the questionnaires. Participants felt that commenting on the internal forum platform was much faster, with 47% of them agreeing while those who disagreed and felt that the external forum was better made up 12% of the participants. 56% of participants also concluded that the internal forum platform required fewer steps to comment, while 3% thought the external forum platform required fewer steps.

The assumption made was that inserting discussions within the text may be disruptive, especially when reading the textbook, seeing that it is an experimental concept. The participants were asked if they felt that commenting on the external forum platform interrupted the reading of the textbook when compared to the internal forum platform, and 23% said that it did interrupt their reading when using the external forum platform. In contrast to that, 12% stated that they were not interrupted at all when using the different pages of the external forum platform. Also, a question about referencing the textbook was asked. 29% participants stated that referring to the textbook to find answers on the external forum platform was burdensome while those who thought it was not much trouble switching pages to find answers were about 12%, showing that they disagreed that referencing was burdensome.

In this section, participants were also asked if they thought either of the platforms was frustrating to use. Approximately 19% stated that they were frustrated with using the external forum platform, while 40% disagreed. On the other hand, when it came to the internal forum platform, 21% found the platform frustrating to use while, 36% thought the internal forum platform was satisfactory. 35% of the participants were pleased with both the internal and external platforms and about 21% disagreed. Overall assessment of the system, a total of 27% liked commenting on the external platform. However, 26% stated that they liked commenting on the internal forum platform better.

The students highlighted that they liked both platforms because one could easily ask a question and obtain an answer for it. They especially liked the external forum system because the posts were clearly separated for a particular question, and they specifically liked separated discussions for revision and not reading the textbook itself. However, the participants disliked that the external forum platform encouraged less comments. For the internal forum platform, they especially liked that it was straightforward and easy to use than moving from one page to the other just to comment on a question. Also, referencing a section of the textbook right above the relevant text made it easy to verify answers. However, they highlighted that finding the comment block for a specific question might be a challenge. Sometimes they did not know if a question is under Algebra or Equations or any

other topics for Mathematics. Also sub commenting on a specific comment was observed as necessary for the internal forum. This was considered important in following different threads within one section.

6.3.9 Task3: Choosing a Platform between the External Forum and Internal Forum Platform

Task 3 involved allowing the participants to choose one of the two platforms so that they could deeply analyse it and compare it to the other platform they did not select. Results showed that 68% preferred to choose the internal forum platform as their preferred platform for conducting educational needs. They liked the platform because it showed more favourable functions. Those who selected the external forum also felt strongly about the features of their chosen platform. There was a 32% agreement that the platform was the best platform to use for their educational needs.

Both groups of participants agreed that the platform they chose was easier and simpler to use when posting and answering questions. They stated that the platforms were easy to understand and performing tasks on them was straightforward. After performing task 1 and 2, they found it simpler to use their chosen platform. They also stated that they rejected the other platform due to the many steps one takes to conduct tasks, which contributed to them spending too much time on the platforms. 94% of those that chose the internal forum strongly agreed that they would recommend their chosen platform to friends. 89% of the 26% that chose the external platform stated that they would recommend the platform to their friends.

For the internal forum platform, one of the students stated that it was much better and reliable to answer questions when there was text to back it up, highlighting the importance of verification and referencing. Also, they stated that comments were easily visible on the internal forum platform, and one could come across a question that they had an interest in also and obtain answers to it while reading their text. One stated that:

> "Questions and answers are within range hence it is quick to ask and comment."

On the external forum platform, they felt the platform was time-consuming, especially if one had many questions that they encountered while reading the textbook. It meant that one had to keep exiting the textbook in order to converse and seek help on particular questions.

On the other hand, the external forum platform provided a place where one could revise by going through questions already asked on the platform. Also, there was a clear separation between

questions. The only challenge was the few comments found on the external platform as such, it did not encourage many discussions.

Open-ended feedback indicated a positive endorsement of embedding forums within eTextbooks. The students showed a liking for the internal forum platform compared to the traditional forum. The results have also shown that students also prefer alias names for interacting in academic forums and that can encourage more discussions.

6.3.10 Usability of the System

The same UEQ questionnaire given to the tertiary students was also given to the high school participants to test the usability of the system. In general, the participants found the system to be usable. Discussion of the results follows.

From Figure 6.17, participants regarded the platforms they used positively, indicating that they were satisfying, likeable, good and enjoyable at over 82% each and none disagreed. However, over 71% of the individuals agreed that the system was friendly or attractive. Overall, the impression of the system was much positive.

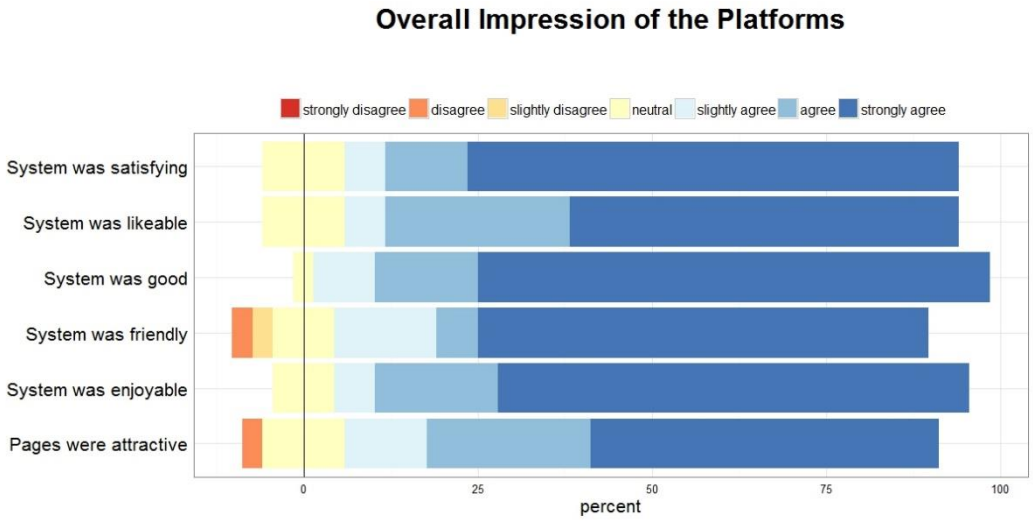

Figure 6.17 Overall impression of the systems

From Figure 6.18, participants evaluated their familiarity in using the system. 79% of the participants understood how the system worked and 3% did not. Participants thought the system was clear at 44% while 24% disagreed. They also felt the system was simple at 50% but 24% disagreed. 85% felt they could easily learn the system and 3% disagreed with that. The system was also considered consistent in the use of text throughout the system at 65% while 6% disagreed. However, almost

two-thirds of the participants felt the buttons used to open and close discussions were helpful and they also felt that they understood most parts of the system.

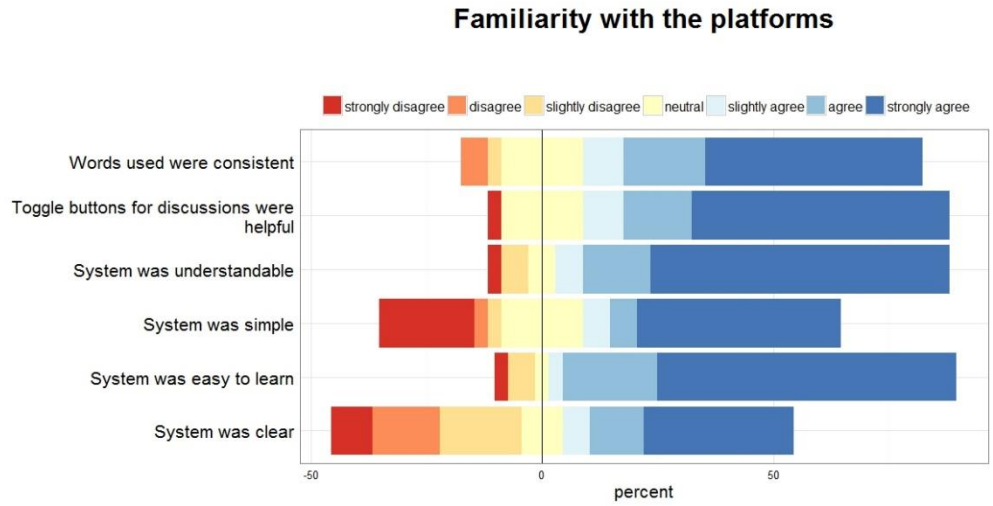

Figure 6.18 Familiarity with the platforms

In terms of efficiency, Figure 6.19 shows that the participants positively identified the system as efficient. 97% described the system as learnable. Over 82% described the system as organised and straight forward. 73% considered the system to be efficient but 3% did not. 76% felt it was fast and 3% did not feel it was fast. The system was considered to be practical and effortless at 62% each, however, 12% felt it was not practical and 6% felt it needed too much effort.

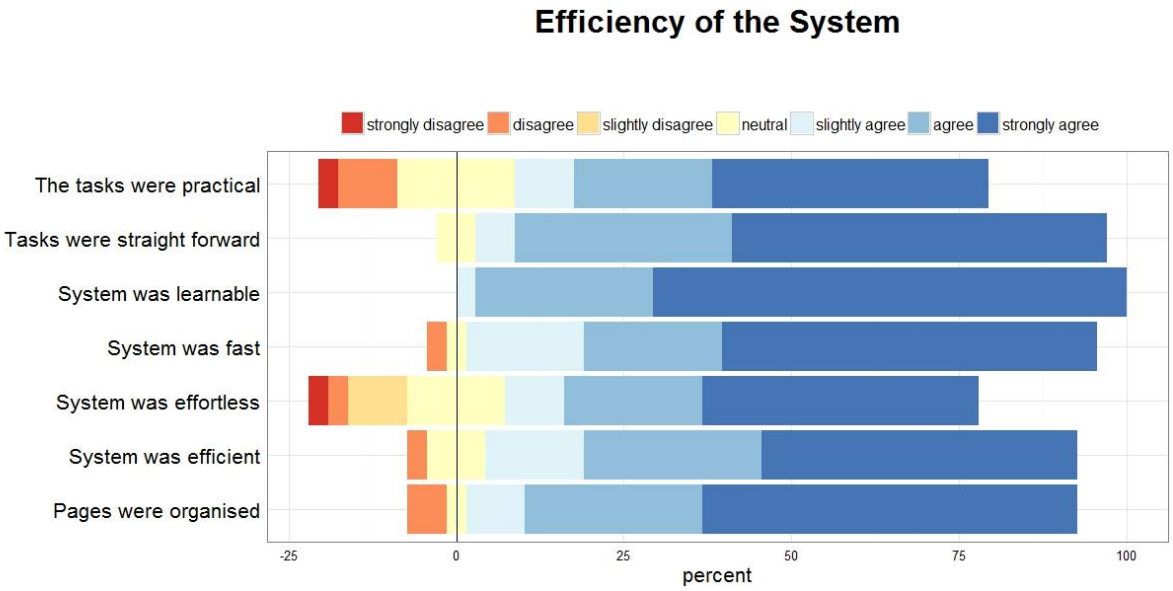

Figure 6.19 Efficiency in using the systems

The participants felt that they were in control of the system showing over 71% of the participants to be confident in using the system while 3% were not that confident (see Figure 6.20). Participants found the system predictable at 44% but 12% felt it was not predictable but surprising. 65% felt that their expectations were met and none disagreed. 68% also felt that the system also provided support in controlling the system through buttons, page titles and labelling. 6% felt it was not that supportive.

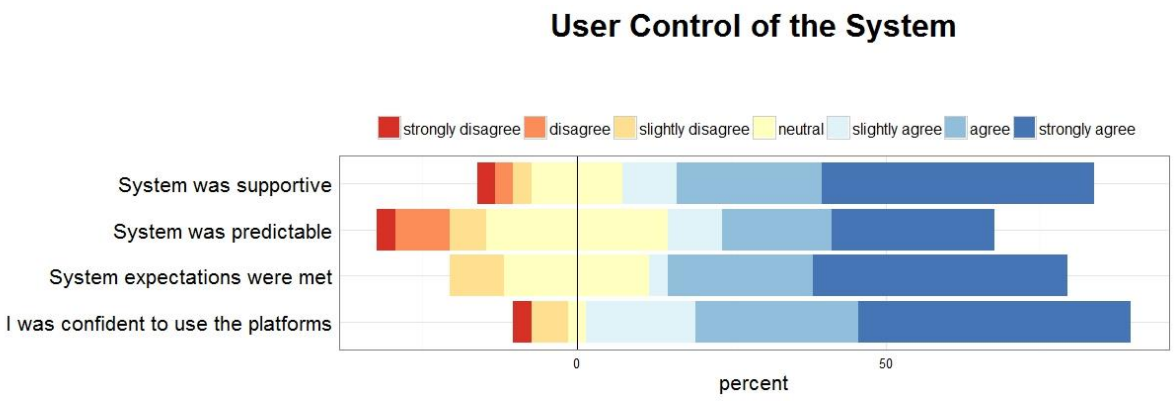

Figure 6.20 Control of the system

Overall, about 85% of the participants felt motivated to use the platforms and also considered the system to be interesting with no objections (see Figure 6.21). Participants thought that the system was valuable and exciting at over 76% each. Only 6% thought the system was not valuable to their needs.

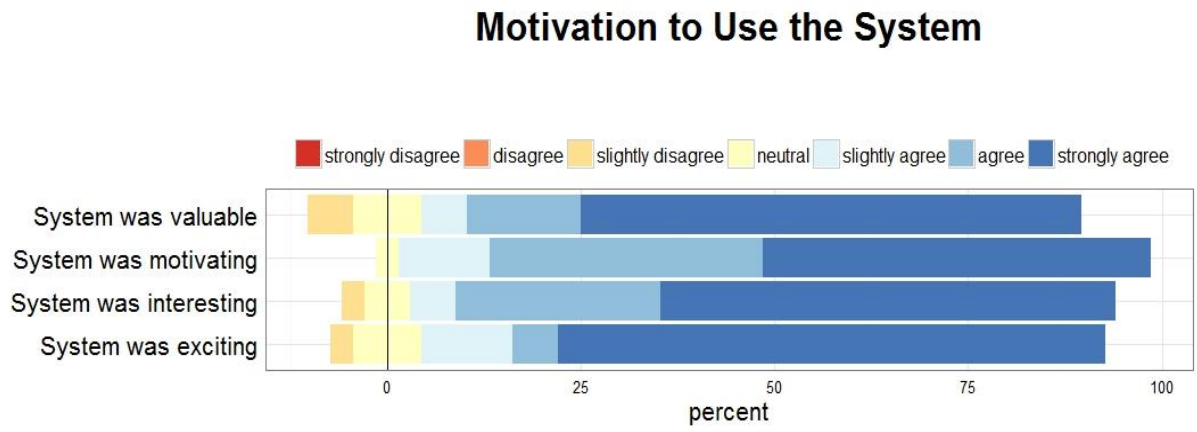

Figure 6.21 Motivation to use the system

From Figure 6.22, in terms of creativity, the participants felt the system met their needs; about 88% thought the system was creative while 74% felt it was innovative. 6% thought it was not innovative. Voting on the system was also considered useful in identifying important questions and in trusting

answers at over 74% each. The system was also not considered common at 65% and 21% stated it seemed common, like they had seen it before.

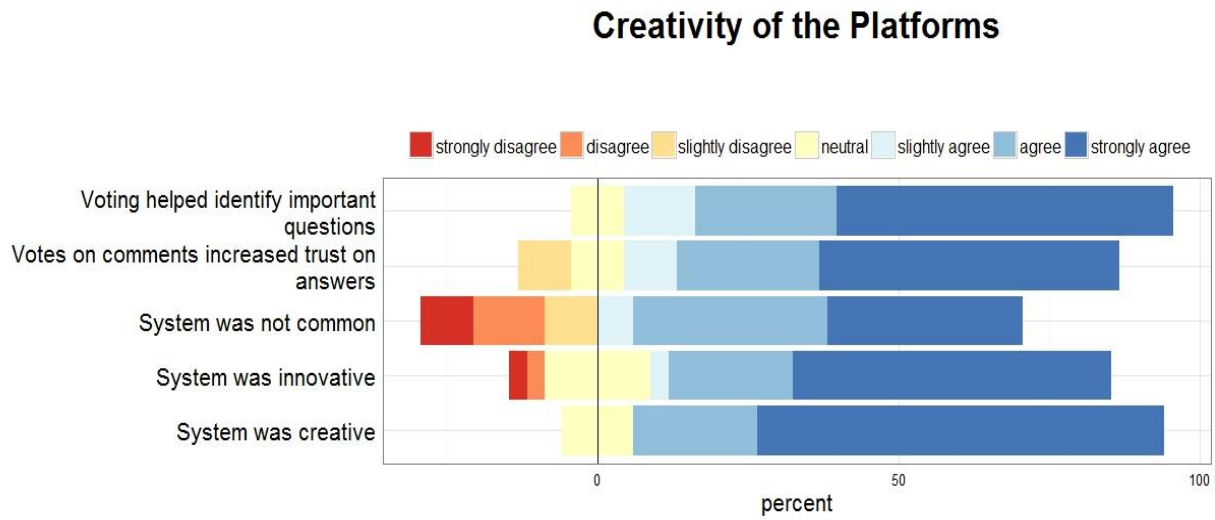

Figure 6.22 Creativity of the system

6.4 Overall Discussion of all the Experiments (University vs High School Students)

Table 6.13 shows a summary of the factors that were evaluated and the comparison between high school students and varsity students. This clearly shows the differences between the two groups.

Table 6.13 Summary comparison of University to High School Results

Demographic factor	**University**		**High Schools**	
Age	18 years	38%	16 years	63%
Type of phones	Samsung Galaxy	58%	Huawei Ascend but mostly varied	25%
Device for educational purposes	Mobile	62%	Mobile	100%
Most used social network forum	Facebook	100%	WhatsApp	94%
Second used social network forum	WhatsApp	88%	Facebook	59%
Have used electronic books	100%		62%	
Have used educational eTextbooks	85%		21%	
Have used eTextbook with collaborations	4%		0%	
User identity factor	**University**		**High Schools**	
Chose alias names	69%		74%	
Chose real identity	31%		26%	
Felt safer using alias names	63%		64%	

Felt alias names increased their participation	42%		72%	
Felt alias names made them free and confident to converse on the platforms	68%		100%	
Using real identity made them free and confident to converse on the platforms	13%		--	
Felt real identity increased their participation	25%		--	
Factor	**High School External Forum%**	**University External forum %**	**High School Internal forum %**	**University Internal forum %**
Task 1 (university students) and Task 1 and Task 2 (High school students) Using internal and external forums				
The system was easy to use or pleasing	18%	71%	35%	64%
The system was easy to understand when posting questions	41%	92%	43%	96%
The system was easy to understand when responding questions	12%	96%	35%	92%
A separate forum was convenient (external forum)	14%	28%	--	--
Forum within text was convenient (internal forum)	--	--	47%	72%
Easy to reference content on the platform	12%	18%	45%	78%
Embedded discussions not interruptive	--	--	21	44
Task 2(university) and Task 3 (High school) Selecting a platform to use between the internal and external forums and comparing the platforms based on choice				
Factor	**High School External Forum%**	**University External forum %**	**High School Internal forum %**	**University Internal forum %**
Choosing a platform	32%	37%	68%	63%
Forum simplicity	11	24%	41	52%
Forum use faster	24		46	
Pleasing to use	30	22%	43	41%
Fewer steps	11	4%	59	56%

Considering first the demographics of UCT students when compared to those of high school students, there is a considerable demarcation of technology understanding between the two groups. The ages of the students were almost the same for both groups but the level of education, culture and background were a contributing factor in making the results differ distinctly between the two groups. The background of tertiary learners showed more understanding of technology and how it could benefit them. The level of education is therefore important to the results because at tertiary level students tend to fend for themselves as opposed to the teacher dependence nature at high school. As a result, students always have to make it work without consultation at the tertiary level. Literature has already explained that at the tertiary level most studies are self-initiated hence the results agree with this also. The demographic results therefore were expected to have an impact on the evaluation of the experiments.

The type of phones that tertiary students use are more advanced. Table 6.13 shows that the common phone used at high school was a Huawei ascend, which has got a small screen and limited functionality, while at varsity it was the Samsung galaxy, which has a huge screen display and multiple functionalities. However, all the phones had internet capabilities which is key to eLearning systems. Almost all the students at the tertiary level are using social networks like Facebook at 100% and Whatsapp at 88%. At high school level many are using Whatsapp at about 94% but just about 59% are using Facebook. Tertiary students are using more advanced mobile devices as such they have experience with systems that utilise discussion forums.

Despite the different level of the students, alias names are important to learners on online platforms. Results from both levels of students indicate the importance of alias names in influencing the students' participation in forums. Although the use of real names disciplines the discussions compared to alias names, many were afraid to post when their identity was revealed, however, with the alias names they became confident and could post even simple questions that needed clarity. Analyses of the responses show that users were reluctant to submit their comments in the initial stages of the experiment but grew confidence as the days went on. From table 6.13, students felt more confident to collaborate as they had freedom to express themselves. They also felt safer using the platforms. This was especially beneficial to high school students. 72% of the high school students felt it would increase their participation while 42% at university felt alias names would make them to participate more. However from the tertiary students who chose real names, 25% felt it increased their participation but only 12% felt confident and free to use the system with revealed identity.

The literature already agrees that students who use anonymous names have more freedom contributing to forums Kang et al. (2013). However, the literature lacks empirical evidence on how deep the problem is for high school students (Kang et al., 2013). Even if that is the case, the use of alias names is overruled because of the disadvantages, especially in the abuse of the systems. As a result, the literature highlights the normal use of student names and their student numbers on LMSs and in turn discussion forums. However, there is a need to consider the use of alias names on educational discussion forums as the advantages may surpass the disadvantages and solutions may be identified to solve issues if tested for more extended periods. A suggestion would be to have mechanisms to control the behaviour of students on the forums, which is a major concern for many learning platforms. Students may have controlled access to the forums using alias names, and any misbehaviour may result in them being removed or using their real names.

All the students at varsity are using electronic books. This is what made it easier for the students to utilise the system without needing assistance. The tertiary students are independent enough to be able to use any system that can be learnt individually. On the other hand, the high school students stated that they were familiar with technology and eBooks prior to evaluations. However, the evaluation results did not prove so, only 62% admitted to having used eBooks before while 100% had used eBooks at university level. But for educational purposes, only 21% had used eTextbooks while 85% had used eTextbooks at the tertiary level. High school students do not have vast experience with using electronic books for learning. This may be attributed to the culture of high school learning which is still teacher centred as opposed to tertiary education which is more student centred.

The fact that students in high schools have no advanced experience in discussion forums, they were relevant for analysing the two systems without bias to one system. They had the chance to choose from both platforms without being influenced by previous experiences. On the other hand, the previous experience might have been an advantage for tertiary students as they could quickly analyse and provide critical analysis of the provided systems, especially the internal forum platform which was new to them. Prior experience in using forums affected the findings because the participants showed an easy understanding of what they needed from the system. Although students in high schools also had a high percentage of choosing the internal forum system at 68%, their evaluation design when compared to that of students in tertiary environments showed that there is a challenge in the use of forums for learning. As Collazos et al. (2007) explained, tertiary students were at a level of collaborating to learn. High school students, however, required first to learn to collaborate before collaborating to learn. The tertiary students found a way to understand and use the system. The high

school students on the other hand were scared to use the system and ended up having a second experiment where they learnt how to collaborate. Much therefore still needs to be done to ensure that students at high school level adopt technological advances that may assist with their learning, especially in an independent way. Some challenges were identified where high school students were concerned. The students felt that their workload had been increased. As a result, it demotivated them to work independently on the system as it was not the norm nor was it a requirement at their level. Teachers still act as a significant support and influential system in high school.

The study appears to support the argument that a problem that may be solved through the creation of technology does not necessarily guarantee that the technology will be successful. Tertiary students rely on LMSs for learning in most universities; hence students have no choice but to understand the content of those LMSs including the use of forums. However, for students in high school, particularly those in developing countries, because many do not utilise LMSs for learning, their experience with discussion forums for learning is limited, which presents challenges of utilising the two forum systems easily. Students also in high schools seem to be afraid of technology. This is shown in the findings by having students who had a fear of sharing comments on the presented forums resulting in a change of the evaluation method. Students were lurkers on the system and only logged online to view but not to make comments. A lurker is a person who looks at the forum but does not actively participate. The fact that in the first experiment with the high school students, there were no interactions, it shows how high schools students have to be constantly assisted when performing technological tasks until they can be independent. They highly depend on the teachers while at tertiary level students are more explorative and are in charge of their learning. Although high school students still depend on teachers, students are being encouraged to be responsible for their learning especially in informal setups. The learning period for such a learning system with high school students needs to be longer for it to be adopted fully. This training and step by step guidance has to be done until users are confident in using the system without requiring support from others.

Seethamraju (2014) suggested two ways of conducting a content analysis of discussion forums: a qualitative analysis of the discussion and focus on responses related to the posts of the questions. This is especially relevant for tertiary students who formulated their responses as opposed to high school students who were given responses and questions to post. Asking the students to post predetermined posts or answers made it an exchange of information as opposed to a volunteer discussion, which is what occurs in the natural settings of social media systems. As a result, the experiences of the university participants and the high school participants could not be compared equally because of the

different methodologies followed in evaluating the systems. The responses of the university users indicated evidence of peer to peer learning, collaborative learning, content-focused interactions, textbook reading and referencing, sharing of different ideas and building on one another's contributions in knowledge construction.

The responses from varsity students showed that collaborations usually occurred in the evenings presumably that is when the students had free time to self-study. According to the results, almost all the posts were related to the content being discussed at that time. The student's responses were mostly detailed, and only a few responses had distinct answers like "I agree, I disagree, yes and no". Also, students were building posts from one another as many posts were related to each other or were a continuation of other posts. That showed they were reading each other's posts and some of their questions were derived from what others were asking. The number of posts also increased with time on the system as students got used to the system and became even more confident. Participants also showed that they were now engaging with the system as some posted more than the required number of posts a day. In MOOCs forums, various studies address the issue of overload and chaos of unprofitable posts on the forums. They develop models for assessing whether posts are related to course content in order to bring order by identifying and removing pointless threads. The strategic positioning of discussions within the text was deliberate to encourage students to discuss what is around them. The environment became educational which in turn caused them to focus. Both groups, tertiary and high school students, favoured the internal forum more especially when evaluating simplicity, speed, few steps to conducting tasks and the pleasure of using the system. Hence why it was chosen as the best platform to use by many participants. In comparing the results, high school students seemed to struggle with the system compared to tertiary students. There were very high percentages of 90s when it came to understanding how to post, comment and just use the system where tertiary students were concerned but only about 40s, where high school students were concerned.

When it comes to the major difference in the two applications of having forums within text or outside text, only a few felt it was convenient to separate text to the forums. However, 72% of university students felt combining text to forums was convenient and 42% of high school students felt the same. Even when it came to easy referencing of content, diagrams, questions and other subject matters, 78% at university students felt it was better with the internal forum than the external forum while 44% also felt it was better with the internal forum than the external forum with high school participants. 44% of university students felt the embedded discussions were not interruptive

compared to 21% for high school students. All these results show an interest in the concept of combining text with its relevant forums for encouraging discussions and co-reading.

Our findings suggest that the presentation of discussion forums may be an important factor in increasing and improving discussions. Generally, participants observed that using the forums in the textbook encouraged them to interact more and better. The findings show that the system enabled the students to converse with one other with their focus on the content placed around them. The results from the previous sections, evaluation of high school students and evaluation of tertiary students, show that the integration of textbooks with discussion forums may encourage adoption by students. They stated that it encouraged discussions on the content especially when using the internal forum platform. The internal forum increased collaborations among students as there were many posts following each other hence the easy build-up of conversations. However, the traditional forum is created such that people go there to obtain answers. As a result, the conversations have very few responses, and once an answer is given, the forum is closed. The posts were not organised to encourage distinct topic discussions whereas for the experimental forum the embedded discussions encouraged interest in a particular topic. Even if there is no evidence that the internal forum discussions improved learning, the type of posts observed that were linked to content contributed to the students' understanding of content. Students highlighted the relevance of having such a forum while learning the same subject in class. It promoted their understanding better than if they had been learning something else at the time. This suggests that such a system can be adapted to be used concurrently with class lessons even to encourage class lesson discussions that can be revised as one was reading the textbook.

6.5 Summary

This chapter has elaborated on the results that were derived from evaluating the system. Results have compared the system and experience of high school students and tertiary students. A discussion of the results has shown that the possibility of embedding discussions within the text may be feasible. The chapter that follows describes these results as related to the research questions.

7 Conclusion and Future Work

In this concluding chapter, the main findings are discussed, and a summary of this work is presented concerning the research questions and the contributions of this work. General conclusions based on the findings of the studies presented in this thesis are described. Furthermore, limitations and possible further research are presented. This chapter also highlights recommendations that resulted from evaluating the experimental compared to the traditional forums of the system created.

7.1 Purpose of the Research

The main purpose of this study was to determine the importance of representing forums for encouraging co-reading of common objects of interest like the textbook. To accomplish that goal, it became necessary to study the current platforms used for discussions. Forums are important for promoting collaborative learning and this study sought to find out how they may be improved to encourage more collaboration. Related to that effort, it became necessary to reach an understanding of the different ways of presenting forums to users. To provide for the possibility that forums can be presented within the subject of text to be discussed, it was essential to develop a model to test this.

Two versions of a forum system were developed and evaluated with two groups of students varying in their level of learning, i.e. high school students and tertiary students. One version of the forum was the traditional forum that is a standalone application with links to relative information. The second version was that of forums embedded within the relevant text of discussion common to the forum subscribers. All respondents were asked to utilise both versions and, through surveys, they were then asked to provide a comparison of the two platforms. Afterwards, they were asked to choose between the platforms that they felt was more suitable for their educational needs. Finally, they were asked to state the reasons for their preferences. Through the survey instruments developed for this study, data was collected that addressed the research questions posed in the first chapter of this dissertation. The following section explains and answers the research questions, thereby concluding the research work.

7.2 Addressing the Research Questions

7.2.1 In what ways can mobile phones be used to support collaborative interactions embedded in textbook content? (RQ1)

The answer to the first research question is YES, mobile phones may be channelled to support collaborations within textbooks. The results have shown that students at all levels use their mobile phones to study and sometimes even to read and refer to textbooks. The results also showed that a majority use their mobile phones for educational purposes than other devices despite the small screen

sizes compared to desktops. Students in developing countries depend on mobile phones. As a result, the educational systems should be designed to work on devices that they can afford. At the tertiary level, students buy expensive phones which have larger screens and can store much information. Although the majority use mobile phones, students also have other alternatives like laptops and desktop computers. At high school, students buy smartphones primarily to be able to install a system that enables communication with others. Almost all students depend on mobiles only. This question had sub-questions to determine better how the mobile devices should enable such collaborations.

How can textbook content be represented on a mobile phone in a navigable way that is deemed usable by students in promoting interactions?

The design of the system was influenced by the students as they stated that reading the large PDF files was tiring hence if the system could divide the book into chapters and maybe even further into sections it would be more appealing to read. Results showed that the students liked having the broken down chapters to read in sections. Also, the fact that collaborations were per section in each chapter further helped students to group their discussions such that they could focus on particular areas of the textbooks without distractions. This made the eTextbook easy to navigate and read with less scrolling.

Which platform do students consider to be more effective for their needs: embedding discussions within the content or separating discussions from content?

For both groups of participants preferred the experimental (internal) platform that embedded discussions within the textbook as already explained in the results. After using both systems in a series of tasks, 68% of the high school students and 63% of the university students selected the internal forum over the external forum when asked to choose the platform they would prefer to use. The high school students, however, liked the external forum better by 5% more. The reason for not selecting the platform they stated they liked was the convenience and quickness to execute tasks on the internal forum. This showed that efficiency is a key factor in the use of learning platforms. They felt it was more efficient to reference, it was faster and required little movement when one was discussing and reading. The internal forum platform enabled co-reading with other students and analysing text through questions to one another where they did not understand. However, results also show that even though a majority liked the internal forum platform, the external forum platform with separate discussion forums was also beneficial for times when one wanted to focus on reading and did not want any distractions from ongoing discussions. The university students and the high school students both agreed that the benefits of using the traditional external platform was the ability to focus on questions only and also shift to the textbook to focus on it without interruptions. Due to that important point, we conclude that taking the benefits of both platforms would yield more effective results. A

combination of both the internal forum and external forum platform features would allow students to converse with others whenever they want to read with others and also allow students to read on their own should they need to. However, participants would require the liberty to decide when they wanted the combined textbook and discussions and when they did not. The broken-down chapters, however, were considered useful for easy readability of the chapters. Students have different reading styles and all should be considered important for easy understanding of what they are studying.

7.2.2 What is the effect of embedding discussions within the textbook content? (RQ2)

The results show the high feasibility of integrating forums to textbooks to encourage co-reading. There is a difference in collaborations when they are found within the text and when they are found outside text content. The assumption at the beginning of this work was that minimising the distance between the forum and the information to be studied may encourage more discussions as well as improve more content related posts. The results showed a high selection of the internal forum for both groups of students. As such the supposition was true. This poses alternative considerations that perhaps forums should be designed to be included within textbooks. The following sub-questions were answered to help determine the exact effects of combining text with discussions in the internal forum platform.

Does embedding discussions within content encourage more content related collaborations?

The results and collaborations observed from the internal forum platform answer this research question positively. Shortening the distance between the information being discussed and the discussions enables more discussions, and because the discussions are next to the textbook content, the discussions promoted are almost always content related. The results showed that students highly trusted the responses as they could easily refer to the text for clarifications. Since the text was divided into sections, the students did not have to read large paragraphs to do so. Compared to the controlled forum that had few response posts that are not always building to each other, the internal forum promoted more discussions among students. As already shown in the results, this is shown by the number of posts made on each platform with the internal forum having an average of 40 posts each per section while the external forum had about three responses each.

What distractions do embedded discussions within content bring and how can they be mitigated?

Although mixing text and discussions seems favourable, it comes with its challenges. A majority of the students who selected the internal forum platform did not consider it a distraction to read while viewing discussions. However, the other students who selected the external forum rejected the internal forum platform because they felt it was distracting to read while seeing comments. The students stated that the distractions came about because as one reads, they can easily see an

interesting question and then focus on the discussions and stop reading. However, if one can decide when it is time to read and when it is time to revise, then that would be more manageable. Since this was largely the reason for rejection, the solution to this was to enable users to toggle between reading the textbook individually or co-reading with others. This means that users can be able to switch off discussions and just read the text on its own. However, they should also be able to switch the discussions back on should they want to read and revise with others.

7.2.3 How does mediated privacy of users on academic networking platforms affect user interaction? (RQ3)

The user identity on academic networking platforms affects user interaction. The results have shown a strong relationship between participation in forums and that of user identity on the forums. The following two sub-questions helped us answer this question in detail.

Does the use of anonymous profiles increase the level of interaction?

The results have shown that anonymous user profiles through alias names affect the participation in discussion forums hence should be highly considered when designing forums for students. The results discussed showed that those who used alias names felt they participated more and became more confident in using the systems. Both groups agreed that the use of alias names was important, with high school students having 74% of users using alias names and with 69% of university students choosing alias names. When using real user identity, students are reluctant to post on discussion forums. This reduces the number of interactions and limits knowledge sharing. Students prefer to be lurkers and read what confident users post. However, the use of anonymous profiles enables shy students to be also confident to participate and also create posts, thereby participating in the construction of knowledge with others. The non-threatening environments may potentially increase interactions thereby, enhancing the user experience on the platforms. Students stated that when they are using alias names, they participate more on the forums. Because this is a preference feature, users who want to use real identities can continue to do so as that may be what inspires them.

What concerns around privacy do students have in revealing their identities on online discussion systems?

From the results, the major hindrances of using real identities on educational systems for students both in tertiary level and in high school levels include the lack of confidence to share meaningful ideas, the abuse by other students in ridiculing them, judgemental comments when students do not fit into a particular circle, culture or status in life. These hindrances profoundly affect students, yet they are ignored by most LMSs. The results show that the level of education is not relevant when it comes to the comfortability of users when asking questions on forums. Both groups felt the same way about

revealing their identity on the system. It is, therefore, crucial to explore the feasibility of using anonymous identities on a long-term basis. Testing this for a more extended period of a semester would help determine more challenges that can develop and find ways of how to minimise them without dismissing the need for students to work anonymously. Also, it can determine the feasibility of the anonymous identity usage before fully adopting it on academic platforms.

7.3 Discussion and Conclusion

The responses from the participants have highlighted the importance of collaborations for learning. Technology provides spatial ground for individuals to share knowledge. The fragmentation of individuals through face to face collaborations is reduced by the affordances of mobile technology. The conclusion drawn from this research shows that the presentation of forums should be explored to identify more opportunities for improvements. The results of this work agree with Coetzee et al. (2014b) that embedding tools on artefacts provide greater communications than if the tools and artefacts are separated. The main point of forums is to encourage participation among learners. It is, therefore, essential to explore how they can be designed to generate more interactions. Rather than focus on the traditional presentation of forums as a standalone application, this study has explored presenting forums differently. This research is, therefore, important to designers of interactive systems as well as researchers as it gives a basis to explore further the innovative concept presented here. Instead of researchers only focusing on how to improve participation on forums without changing the structural presentation of forums, more should be done to consider other ways of presentation. In this research, minimising the distance between users and the information being discussed is one way of encouraging more participation. Not only does this experiment show more participation, but it shows it can promote more content related interactions, which has been a significant challenge for most LMSs and even MOOCs. A major drawback highlighted in literature is that of ensuring that discussions remain on-topic, hence the embedding of discussions to a textbook can be a huge consideration from the results observed in the experiments of this study. Placing discussions around content puts boundaries that force students to discuss the content; it gives an impression of the seriousness of the content being discussed. Non-content related discussions are therefore minimised.

The research severely underestimated one crucial factor: motivation when presenting new systems and even existing ones to students. The lack of results in the first experiment conducted with high school students shows that motivation for utilising a system is key to its success no matter how usable it is. For high school students the act of reading a text or studying is often under a teacher's

supervision, and it is almost obligatory for students to answer any questions posed by the teacher. However, for this project, registration was voluntary, as was the reading of the textbook together with answering exercises in the textbook. That means there were no mandatory tests or formal evaluations by the users as students who participated in this project did so of their own volition. As a result, this appears to have lowered the participation on the forums. It is evident that only students who are generally motivated to learn through technology may continue to participate in the future. It is, therefore a formidable challenge how such projects can maintain student motivation. Learning is therefore not only being able to collaborate but is affected by other external forces like the value of using those tools that enable collaborations and the benefits they ultimately provide.

As we have noted, for tertiary students, the need for constant monitoring seems not necessary as students managed to communicate on their own as they would when having discussions with peers after school lessons. There is suggestive evidence that similar experiments and similar platforms should follow different methodologies to ensure relevance to the group of students. What worked for high school students did not work for tertiary students in our experiments. Although the two groups of students were presented with a system that was closely similar (differing in a few features and the content to collaborate), the system substantially worked for tertiary students. However, because the university used in this experiment is considered one of the best on the educational ratings in Africa, we cannot state that their intellectual abilities did not affect the results. The high school students required a more focused evaluation that guided the students through a step by step process to allow for contributions on the forums. They were, therefore, more concerned with the two processes and how they are presented while tertiary students were more focused on analysing the systems and observing differences that led to their choices. The fact that in the second experiment for high school posts were encouraged by giving users content to post on the site shows the need to educate students about the benefits of social networks for learning. The analysis, therefore, shows distinctive differences between young learners and more advanced learners when using similar technology. Alternatives include creating systems that meet each groups needs and yet users should find it easy to migrate to the tertiary level platforms when the time comes.

From the research work, many theories come about after using different methodologies with the two groups of students. A technology that is not usable by a group of students does not mean it cannot be meaningful to another group of students. The same experiment was conducted for tertiary and high school students. However, high school students failed to yield results, while tertiary students yielded useful results. Also, the second experiment with high school students yielded results even after failing

at first. This indicates that when a user does not use a technology, it does not mean that the system is not usable but that other methodologies may be tested to generate more useful information. Students in high school need constant guidance and patience. They may take longer to adjust and adopt new technology. The educational sector should consider incorporating technology to its curriculum such that services and instruction are partly conducted through it and students are also rewarded for using it. Finally, the availability of devices that can enable the use of technology cannot guarantee adoption. Literature has stated that phones are merely enablers of technology. The demographic results show that students have mobile phones and they are using technology. While a lot of time is spent by students socialising on phones, if an activity is less rewarding, it is not likely to be adopted. Given that the current generation of students has a vast amount of online experience through social media it does not necessarily mean they may find educational forums easy to use. Academic platforms must, therefore, engage students on a level that can compete with the common social media platforms.

7.4 Contributions

The main contribution of this work is both theoretical and practical. The successful testing of the proposed system informs more effort to be put in researching work related to building learner-centred collaborations around shared content. Currently, the discussion forums are standalone applications, and this is how they have always been designed. The practical prototype provides one working example of how such systems would look like. Considering participants selected the new proposed system over the traditional ones, this suggests that if more work is put to it, this would be a welcome idea. This work therefore suggests that the design of discussion forums be embedded within textbooks to create communications centred on information thereby encouraging collaborations. As times change, designs also improve and can be altered. With the introduction of eTextbooks, more interactivity can be incorporated into the books. This research is proposing the extensive exploration of embedding discussions within relevant text as a form of encouraging content-related discussions, a major challenge for most forums.

Sub-contributions

The thesis provides a proof of concept prototype that shows that placing discussion forums inside eTextbooks yields better and more focused interactions for students. Putting discussions within the relevant text is not practically explored much, however, in this research, the system was designed to test its feasibility. Seethamraju (2014) states that even though evidence shows that collaborative learning is critical to active learning and that technology is said to be an effective enabler, using forums for enhancing learning is not yet fully explored and lacks sound evidence. As results have shown,

embedding discussions within the text are one practical way of testing if discussions may be routed to direct educational posts and promote more discussions on academic platforms.

Although social networking has always been considered to be a platform to relax and play, its successes can be channelled to the learning sector. This work has shown that a large group of people can be put together to create a hub of knowledge that can be shared amongst users while creating more content. The power of social media is in the connection of people to things they are interested in and this work has shown that this is possible even with connecting students to eTextbooks they are studying.

This study provides empirical evidence that a methodology that works on tertiary students might not necessarily work on high school students even when evaluating almost the same system with both groups. Different approaches must be used to evaluate the system. The fact that the first system that worked for tertiary students did not work for high school students is evidence enough that not all usable systems guarantee results. Also, when a methodology fails, it does not mean that the system is not usable and has failed. The second experiment with the high school students strengthened this argument as the students performed the experiments without much trouble the second time. Different methodologies should, therefore, be tried for different levels of students. Should a system fail, perhaps another methodology should be tested to evaluate the system and generate useful results. The result show no complaints about usability, but this system is more certain for adoption by tertiary students than it is for high school students who usually require guidance from teachers to conduct tasks before becoming independent.

The study also shows empirical evidence that the liberty to choose user identity is important to students at all levels of collaborative learning platforms. Both groups, the tertiary and high school students, should have the choice of anonymous posts on discussion forums or LMSs to encourage more interactions. The fact that students chose alias names over real names shows that anonymous identity is important in educational environments.

The findings of this study contribute to the literature on co-reading within books in academic setups, an area where existing literature is limited. It addresses the impact of co-reading by combining textbooks with forums. This permits users to read together and ask each other questions that are related to the common text of interest. This concept is usually prevalent for reading novels, however, for academic textbooks, it is scarce.

7.5 Limitations

The challenges that affected this work included having access to students at high school levels is very challenging. Not only does the challenge begin at the department of education but, also the headmasters and teachers consider these studies as disruptive. One of the schools approached even said:

> *"Maybe come after 5 years as at the moment this kind of project is not going to be adopted soon".*

This shows the level of their understanding of technology and how they perceive it to reach schools as opposed to embracing the technology. In South Africa, having access to high school students is also a challenge. The process of being given the go-ahead is so long such that one may not be able to obtain good results within the short space of time of conducting the work for a PhD student.

One of the other major challenges of this research was that of obtaining authorisation to test the system with the actual textbooks that students at high schools use. Even though the authorisation was for a few pages, the request to use them was an endless cyclical process that delayed the commencement of the project. This led to us using similar books. Even though the equivalent books are excellent and published, students are more familiar with the books they use at schools. The concern by publishers or writers is that of moving their textbooks to a digital format, which may be readily accessible to students at no cost hence they may miss out on sales. On the other hand, it limits students from having alternatives that may counter the challenges they encounter every day by buying expensive textbooks.

Providing free data websites is also necessary for conducting such studies to promote free use of the application at any time. However, Econet and other Zimbabwean network providers were not responding, hence students had to rely on the data given that they could then easily re-route and use for other things based on life pressures.

Due to many cultural and age related issues, some of the RQs were not fully answered for stronger conclusions. As such, the two groups of students were different and could not be compared at the same level, however from the few similarities of the groups a few patterns are drawn. Another limitation of the study is in the details of the artefacts. The internal forum did not have images or mathematical notations when posting questions or commenting. However, the external forum had images and mathematical notations. This was due to the functional deficiencies of Web2py where plugins were concerned. However the focus of the experiments was on collaboration and in results it

was observed if any of the students required or made use of these features. It is however noted the importance of having other media utilised on both systems for a full overview and comparison of the two systems at the same level. Again, the possibility of biasness when allowing participants to choose a platform they like could have been influenced by learners agreeing with each other before making any selections since they were in one class. However, this is an assumption considering university students conducted the study after hours in the comfort of their homes and high school students were each given time to do the experiment without communications with others other than through the application.

7.6 Recommendations for Future Research

Based on the rigidity of the experimental design used in this study, similar experiments may be conducted using the same methodology but with various groups of learners to test the use of embedded systems on eTextbooks and analyse the interactivity of users. Given the same type of students the same results would be expected. Also, given different groups of students, who have all experienced similar learning at some point in time, almost similar results would also be expected unless otherwise educational curriculums are vastly different. However, this is an assumption based on the results of this study which used two different groups, may other experiments would need to be conducted to conclude this theorem. The study is internally valid in that care was taken to avoid any biases or errors in the experimental research approach for the intended research motivation. The study however, may not be externally valid as more settings may be required to be tested to demonstrate applicability to other setups which may include different types of students or different eTextbook subjects to be used as text on the system.

The following recommendations are therefore offered for future research in the field of collaborative reading for learners:

Conducting evaluations with students at high schools for social media platforms may be challenging, therefore, as a way of improving the outcomes of this study, other methodologies may be adopted to elicit as much information as one can on the inexperienced users. The students at high schools require more time and more training for understanding technologies before they can utilise them. Therefore, one may use a few students but make use of approaches that can obtain much information about the student expectations and general feelings about the work being presented to them.

Now that the feasibility of embedding discussions within textbooks has been established, it is recommended that future work focuses on testing if such a platform may improve learning outcomes for learners. A series of longitudinal studies can be conducted by testing the application with various groups of students over longer periods. Experiments may, therefore, take note of the grades before using the system and that of grades after using the system, to observe if students perform better when using such an academic forum. This might help determine how effective the system is for learning. Testing how social media affects academic performance is beneficial to the success of social media for learning. Future exploration must design ways in which to test the effectiveness of learning on social media as well as the best facilitation of assessment strategies on such platforms.

Learners have various textbooks they are interested in reading at a particular time. Also, once they have read that book, they usually recommend those books to their juniors in the courses. It might be a challenge to create textbook-based forums for all the textbooks available for students at varsity or school. Other research may, therefore, focus on building customisable software that can automatically generate the forums within given textbooks. Further work may also consider other alternatives for encouraging co-reading of eTextbooks. For example, using QR codes to reference texts, video conferencing around common content and more.

Considering the benefits of collaborations among people with objects of interest, and the fact that students at high schools now have smartphones, hence access to technology, more research should be conducted in encouraging the adoption of collaborative systems, especially among students at high school levels, particularly in developing countries for such devices.

Given that this study provides a basis for concluding that co-reading within textbooks is an alternative way of presenting forums that may encourage content-based collaborations among learners, future research may focus on building an educationally focused social media platform that may encourage learners with similar goals to participate as they would on other social media platforms like Facebook and Twitter. Currently, LinkedIn has a platform for professionals, the same may be conducted for learners that have similar interests. This would add to the field of technology education. Despite the different schools or varsities, a hub of knowledge may exist to encourage further construction of knowledge.

The findings of this research are relevant to Mathematics and Computer Science only and hence cannot be generalised for all learning subjects, nor can they be generalised for all institutions. As a

result, more subjects can be tested with various students from various institutions and of various study levels for comparison.

Further work may be channelled towards adding other features that can encourage usage of the application, for example, tagging, notifications, subscriptions and other social media features may encourage user visitations to the site. Other media like videos and annotations may also be added to the eTextbooks to act as support material that may be appealing and encouraging to readers.

The use of alias names requires more exploration of educational platforms to improve interactions. It can be tested with a group of students for an extended period to identify challenges of presenting them on educational forums and finding suitable ways to minimise those problems. The results of this study show that using real identity on educational platforms affects students and so should not be ignored. Another consideration in this regard is that of allowing login to the application using any other platform credentials besides Facebook or using multiple login options from various common platforms to access the academic site.

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9 Appendices

Appendix 1: Preliminary Study Questionnaire

The following questionnaire has been developed by a student from the University of Cape Town. It is mainly to help understand the learning challenges that high school students face and obtain insight into any possible solutions. Your co-operation in completing this study by responding to the following questions would be greatly appreciated. Please do not put your name on the questionnaire since all the responses are confidential. Choose **ONE** answer from the round dots and **tick** one/more relevant answers on the square blocks.

1. Do you always have books or other resources to revise for tests or exams at home?
   - The school gives us books to use at home
   - I use the notes that I write in class
   - I buy my own books

   Other……

2. How do you feel about asking questions or answering questions in class? Please state a reason for your answer.
   - Very easy…….
   - Challenged ……

3. I have friends at school that I can turn to if I have questions about homework.
   True: False:

4. Do you ever revise or study some topics/ subjects with students in your grade but from other schools? Please state why
   - **Yes ……**
   - **No…….**

   If yes, explain how you revise (group work at home, Facebook, etc.)
   ……

5. Do you attend extra lessons? Please state a reason for your answer?
   - **Yes…….**
   - **No……**

6. Do you have any study group discussion with your friends after school? If **YES** for how long, state a reason why you do or don't have group discussions?
   - **Yes: ……..**
   - **No: ……**

   In what subjects are the study group discussions?
   ……

7. How helpful are the study group discussions?

   Very beneficial: Somehow beneficial: Not beneficial at all:

8. What are some of the problems that hinder you from having group discussions?
   - ☐ Asking for permission from parents
   - ☐ Finding group mates
   - ☐ Communication
   - ☐ Getting feedback from the teacher on topics discussed

Other**……..**

9. Do you own a cell phone or tablet or IPad?

   Yes: **No:**

   What type of phone do you own……

10. Do you have the internet on the mobile phone or computer that you use?
    - Yes, on a mobile phone
    - Yes, on a computer
    - No, I have never used the internet

    If you answered yes above, how often do you use the internet?

    Always: **Sometimes:** **Never:**

    What limits your internet usage?

    Cost: **Time:** **Social pressure:** **Other……**

    For what purpose do you use the internet?

    Facebook: **WhatsApp:** **Google:** **Other ……**

11. Do you use the internet at home to research school work? What are some of the challenges that you encounter when studying at home?
    ……

12. In detail state some of the challenges that you face when learning in class and how you think you can be assisted to reach your maximum potential.
    ……

    ……

Appendix 2: Focus Group Session Questions

- What is your opinion of textbook reading on a mobile phone
- Do you ever discuss questions or content in textbooks with friends using chartrooms
- If so what exactly do you refer to
- Suppose you had a textbook info on your mobile phone what information would be important to see (figures, tables, references?)
- What functionality would you need?
- What information should the interface display?
- How would you breakdown the textbook to easily represent it on a mobile phone application
- What if you only wanted to refer to the content of a textbook, how would you refer to a figure in a book to a friend using a mobile phone application?
- What requirements would you find necessary when representing a textbook on a mobile phone

Appendix 3a: Pre-task Questionnaire

(Tick or circle where appropriate)

Gender:

Female: Male:

Age: **……**

Type of Phone you use: **……**

	Question	Yes	No
1.	Have you ever used a discussion platform online using your mobile phone?		
2.	Have you ever liked a Facebook page		
3.	Do you belong to any Facebook Discussion groups		
4.	Have you ever used Twitter for discussing before		
5.	Have you ever used to a WhatsApp group for discussing before		
6.	Have you ever belonged to any other discussion platform which is not named above: If yes which one ……..		
7.	Do you participate actively in the discussion forums? If yes, how often do you participate and on which platform (Facebook, Twitter, etc.) Platform name: …… Daily: Weekly: Monthly: Rarely: Never: Platform name: …… Daily: Weekly: Monthly: Rarely: Never:		
8.	Do you discuss education-related material (like hard questions) in mathematics on social networks like Facebook, WhatsApp, and Twitter? If yes explain what and how you discuss ……..		
9.	Have you ever belonged to a discussion forum specifically created for educational discussions before? If yes, which one: ……..		
10.	Have you ever used an electronic Book before If yes, name one: ……..		
11.	Have you ever used an electronic Textbook before? (An electronic textbook is a computer version of Textbooks used for learning. You can read the eTextbook on your computer or mobile phone or any other device.		

Appendix 3b: Pre-task Questionnaire (UCT)

(Tick or circle where appropriate)

Gender:

Female: Male:

Age: ……

Type of Phone you use: ……

1. Do you belong to any social media Discussion groups (Facebook, Twitter, WhatsApp, Instagram, etc.?) name the ones you belong to
   ……
2. Explain in a few words what you understand by a discussion forum
   ……
3. How long have you been using discussion forums (e.g. months/years)
   ……
4. Do you discuss education-related material (like hard questions) in mathematics on social networks like Facebook, WhatsApp, and Twitter? If yes explain what you discuss and how you do so
   ……
5. Have you ever participated in any educational based discussion platforms, e.g. Stack Overflow, Cousera, MOOCS, etc? If yes state which ones and how long you have been using those platforms
   ……
6. Which device (e.g. desktop, mobile, etc.) do you normally use for educational related discussions with peers?
   ……
7. Give any 2 educational platforms you use the most for educational discussions and state how often you participate in them

   Platform name: ……
   Daily: Weekly: Monthly: Rarely: Never:

   Platform name: ……
   Daily: Weekly: Monthly: Rarely: Never
8. How often do you use the discussion forum, which is linked to your current CS1015F course, for asking challenging Python questions related to your course content?
   ……
9. Have you read an eBook (e.g. novels) before?
   ……
10. Have you ever used an electronic school Textbook before (An electronic textbook is a computer version of Textbooks used for learning. You can read the eTextbook on your computer or mobile phone or any other device).
    ……
11. How often do you use the CS1015F Python pdf electronic textbook? Why do you or don't you use them
    ……
12. Have you ever read an eBook or eTextbook with collaborations within it? If so explain
    ……

Appendix 4: Instructions for the eTextbook experiment (Week 1/ task 1, UCT)

- Log onto the system by clicking the following link or typing the URL below https://Web9.husseinsspace.com/collaborate
- You might encounter a safety precaution page because of UCT security. Just click advanced and proceed to the husseinsspace.com link
- You will then be directed to Facebook to log in. Log in using your credentials. This is only for tracking purposes, your posts will not appear on Facebook.
- Once you log in, you will be taken to a registration page where you choose to use a dummy alias name (so others don't see who you are) or continue with your Facebook name.

  Should you not be taken to that page after login, just go to settings before you post and change your name there.

  Take note that even if you change your name later in the experiments, all your previous posts will be changed to that new name.
- On submission of the register page (or settings page), you will be taken to the home page of the system ("Topics") with the two platforms (A and B). Platform A is the usual textbook with a linked discussion forum to it. Platform B is a textbook with discussions within it.

  There are two topics, for this week, click on the first Python topic, ("**Loop Control Statements"**). For next week you will focus on the second Python topic "Strings".
- Read through the chapter and ask any two questions related to the content. On platform A, you go to the discussion forum to ask a question. On Platform B, you will see "**Discussion comments**" buttons, click on them to open the dialogue box and type your question/comment to post.

  You are expected to:
  - Ask **two** random questions related to the chapter content on **each** of the two Platforms A and B every day.
  - Answer or comment on **two** questions posted by others on **each** Platform A and B every day

    !!! This will be monitored through computer logs, please comply to secure the R200 token of appreciation.
- On Friday, 4th of March, we will send a link to an online questionnaire to record your experiences when using the system for this week. Further instructions for week 2 will be given as well.
- Should you have any questions or challenges at any stage of the experiments, contact ncbsin004@uct.ac.za or sns.ncube@gmail.com

Appendix 5: Tasks Survey Questions (Week 1/ task 1, UCT)

(Tick or circle the appropriate box)

Logging onto the system

1. Did you use an alias name to login?
   YES: **NO:**

   Give reasons for choosing an alias name or not choosing one when you logged onto the system
   ……

   Did you have to change from real name to alias name or vice versa in the "Settings" page during this experiment?
   YES: **NO:**

   If yes, changing an alias name in settings page was easy

   What was your reason for changing? ……

2. If you were to use your real name on the system what would be your greatest challenge
   ……

3. Using an alias name made me safer

4. Using an alias name made me participate more

5. Did you complete all your tasks this week?
   YES: **NO:**

   If not, why were you not able to finish them?
   ……

6. I **understand** posting or commenting on this platform better than when I use forums

7. This platform is easier to use than a separate discussion forums

8. It is a **simpler task** to post a question or comment related to the textbook on this platform than on a separate discussion forum

9. Posting on this platform is much **faster** than posting questions on separate discussion forums

10. Posting on this platform has **fewer** steps to follow than going to a separate discussion forum

11. Posting on this platform **interrupted my reading** of the textbook **more** than if I was using a separate discussion forum

12. Moving to a separate discussion forum to ask or comment on questions is **inconvenient**

13. Overall, I **like** posting on this platform as opposed to a separate discussion forum

14. When posting or commenting on a question, I found this platform **frustrating** to use

15. What do you like the **most** about posting a question on **this platform as opposed to the usual forums you use**?
    ……

16. What do you like the **least** about posting a question on **this platform as opposed to the usual forums you use**?
    ……

17. Given a choice, which platform would you prefer to use when discussing questions online ((1) this platform with discussions embedded in the eTextbook or (2) Using an eTextbook with a link to a separate discussion forum. State reasons
    ……

18. I would recommend such a platform to a friend

Appendix 6: Instructions for the eTextbook Experiment (Week 2/ task 2, UCT)

1. Similar to last week, log onto the system by clicking the following link or typing the URL below

   https://web9.husseinsspace.com/collaborate

2. You will be taken to the home page of the system ("Topics") with the two platforms (A and B). There are two topics, this week you will focus on the second Python topic **"Strings".**

3. You are expected to **choose only one** platform that you prefer to use for the whole of this week.
   - **Platform A** is the eTextbook plus a linked discussion forum to it.
   - **Platform B** is the eTextbook with discussions embedded within it.

4. Read through the chapter and make posts related to the content. You are expected to:
   i. Ask **two** random questions related to the chapter content on **your chosen platform.**
   ii. Answer or comment on **two** questions posted by others on **your chosen platform.**

   Note: You should actively participate in the experiments as required!!!
   Again…this will be monitored through computer logs, please comply to secure the R200 token of appreciation.

5. On Friday 11th March, we will send a link to a final online questionnaire to record your experiences when using the platform that you have chosen for this week.

6. On Friday, you will also receive instructions on how to collect your R200 from the ICT4D lab. Please bring a student card along for verification purposes.

7. If you have any questions or challenges at any stage of this week's experiments, contact xxxx@uct.ac.za or xxxx@gmail.com

Appendix 7: Task 3 (high school) / week 2 (university) Survey Questions

1. Which group do you belong to?
   Group X: **Group Y:**

2. What platform did you choose for this task
   Platform A: **Platform B:**

3. Why did you choose the platform you selected above for task 3 over the other one (Tick all relevant answers)

Reason	Tick
It was easier to post questions on the Platform I chose	
It was easier to answer posts on the Platform I chose	
After trying both platforms in task 1 and task 2, I enjoyed using the platform I chose better	
It is simpler to use the platform I chose	
It is easy to understand the platform I chose compared to the other	
The platform I chose is much faster than the other platform	
Performing tasks on the platform I chose was easy	
It was difficult to follow the long steps of the platform I rejected	

4. Are there other reasons that made you choose the platform? Please write them below
   ……

5. Give reasons why you did not choose the other platform
   ……

6. I would recommend the platform I chose to a friend

7. List the most negative aspect(s) of Platform A:
   ……

8. List the most positive aspect(s) of Platform A:
   ……

9. List the most negative aspect(s) of Platform B:
   ……

10. List the most positive aspect(s) of Platform B:
……

11. Any other comments about the choice of your platform
   ……

Appendix 8: User Experience Questionnaire post task questionnaire

(Tick or circle the appropriate box)

Logging onto the system:

1. Did you use an alias name to login?
   YES: **NO:**

2. Give reasons for choosing an alias name or not choosing one when you logged onto the system
……

3. Did you have to change from real name to alias name or vice versa in the "Settings" page during this experiment?
   YES: **NO:**

   - If yes, changing an alias name in settings page was easy

4. If you were to use your real name on the system what would be your greatest challenge
   ……

5. Using an alias name made me safer

6. Using an alias name made me participate more (adopted UEQ)

	Overall impression of the platforms	**3**	**2**	**1**	**0**	**-1**	**-2**	**-3**	
1	Enjoyable								Annoying
2	Good								Bad
3	Unlikable								Pleasing
4	Friendly								Un-friendly
5	Attractive								Unattractive
6	Not satisfying								Satisfying
	Familiarity with the platforms	**3**	**2**	**1**	**0**	**-1**	**-2**	**-3**	
7	Not understandable								Understandable
8	Easy to learn								Difficult to learn
9	Complicated								Simple
10	Clear								Confusing
11	Use of words throughout the system was consistent								Use of words throughout the system was inconsistent

12	The buttons to show or hide the discussions in the Textbooks were helpful								The buttons to show or hide the discussions in the Textbooks were **not** helpful
	Efficiency in performing tasks	**3**	**2**	**1**	**0**	**-1**	**-2**	**-3**	
13	Fast								Slow
14	Inefficient								Efficient
15	Impractical								Practical
16	Effortless								Too much effort
17	The pages were organised								The pages were disorderly
18	Performing three tasks was straight forward								Performing the three tasks was difficult
19	Task 3 was now easier because I had learnt the system through task 1 and 2								Task 3 was not any easier even after I had learnt the system through task 1 and 2
	User control of the system	**3**	**2**	**1**	**0**	**-1**	**-2**	**-3**	
20	Unpredictable								Predictable
21	Frustrating								Supportive
22	Confident								Not confident
23	Meets expectations								Does not meet expectations
	Motivation to use the platforms	**3**	**2**	**1**	**0**	**-1**	**-2**	**-3**	
24	Valuable								Not valuable
25	Boring								Exciting
26	Not interesting								Interesting
27	Motivating								De-motivating
	Creativity of the platforms	**3**	**2**	**1**	**0**	**-1**	**-2**	**-3**	
28	Creative								Dull
29	Common								Not common
30	Traditional								Innovative
31	Viewing votes on questions helped me identify important questions								Viewing votes was not helpful at all
32	Viewing votes on comments made me trust the answers								Viewing votes on comments did not make me trust the answers

7. Any other general comments about all the activities you conducted today?

……

Appendix 9: Questions and Answers for Task 1 and Task 2

(adopted from everything maths)

Question	Answer
• What formula did they use for the table? (discussion comments A)	1x + 2y <=8 (discussion comments A)
• Why can we not use: 5x + 3y (discussion comments A)	Because sometimes they give extra information that can confuse you. In this case, the number of Roadees and Mountees are insignificant, but the profits not (discussion comments A)
• I still do not understand why we cancelled the 4 items in the table (discussion comments B)	These combinations have been excluded as possible answers since they make technicians to be more than what is allowed, which is 8. For example, (5, 3) gives 5+2(3)=11 technicians. (discussion comments B)
• Do we use the same procedure of technicians with profits (discussion comments B)	Yes because the technician represents a completed Roadee or Mountee. So we use the same formula used before but substitute with profit numbers (discussion comments B)
• The answer is derived from looking at the highest number in the table? (discussion comments C)	Yes and that is 8800 at (2, 3) (discussion comments C)
• What do the red dash lines represent (discussion comments D)	They show the maximum, eliminate the dots on top because the equations states that it should be less than (discussion comments D)
• So if the equation was x+2y >=8 then we would eliminate everything at the bottom of the line (discussion comments D)	Exactly (discussion comments D)
• For graphs we use all the data we are given? (discussion comments D)	Yes dots show number of roadees or mountees and then the line shows the technicians (discussion comments D)
• In 2 ways right? (discussion comments E)	Yes but which ones name them (discussion comments E)
• 3 notebooks and 5 pencils for the first way (discussion comments E)	Yep, and (discussion comments E)
• 4 notebooks and 3 pencils? (discussion comments E)	Yep, we also got that (discussion comments E)
• Yes the second way, it gives 12c change. Who else got 12c? (discussion comments F)	Which formula did you use for this question? (discussion comments F)
• 3x + 3y <= 3.60 (discussion comments F)	Ok I understand the two ways now, I have used tables to solve this question and not the graph (discussion comments F)
• X <= 10 and y <= 10 for the max number of questions per section and x >= 4 for the minimum number of algebra questions? (discussion comments G)	2x + 3y <= 30 for the time taken to answer each question (discussion comments G)
• Is this the formula: T= 5x + 10y? (discussion comments H)	Yes, T = (5 marks) × (algebra questions answered) + (10 marks) × (geometry questions answered) (discussion comments H)

• X <= 300 for the burgers meat? (discussion comments I)	Yes and Y <= 400 for the burgers chicken (discussion comments I)
• Since the number of chicken burgers sold is at least half the number of hamburgers sold. The equation should be: Y >= 0.5x? (discussion comments I)	X + y <= 500 for the total number of packets (discussion comments I)
• To calculate profit I followed: P = 3x + 2y? (discussion comments J)	I agree, Profit=(profit per hamburger)×(number of hamburgers sold)+(profit per chicken burger)×(number of chicken burgers sold) (discussion comments J)
• The maximum possible profit **R 1300** can be made if 300 hamburgers and 200 chicken burgers are sold? (discussion comments K)	That's what I got too (discussion comments K)
• I think for this question its best to use a graph (discussion comments K)	I agree (discussion comments K)

Appendix 10: Task 1 Instructions

Posting on Platform A

- Go to the topics home page of the system. This is the page you see after logging in.
- The page shows "1. Linear programming" with three options
- The first two options are:
- Platform A: Textbook
- Platform A: Discussion forum
- Click on the **textbook link (Platform A: Textbook)** on the system and **read** a clip of Linear Programming will show (This should take you about 5minutes).
- Go back to topics page and this time click on the discussion forum **(Platform A: Discussion Forum)**
- A page will open up to show a list of questions under this topic, click on "post a question" button
- On the page that opens up, type the question that you have been given in the form and submit to post to the forum. You can also add a relevant picture if you like.
- Go back to the topics page then click on the discussion forum to view the questions you have just posted. You might see what others have also posted on this page.
- Repeat steps 7 and 8 to type and ask the second question that you have been given.
- Ask any other questions you may want to ask that are related to what you have read in the textbook **(Optional, remember there is a prize for extra work)**

Posting on Platform B

- Go back to the topics page
- Below Platform A and the two options, the page shows Platform B of Linear Programming
- Click on the **Platform B (Platform B: Embedded discussions in Textbook)** link and a textbook chapter of Linear Programming will open.
- Read through the chapter and as you read you will see buttons written **"discussion comments"** under a chapter paragraph section.
    - Click the button open and type the two given questions in the specified "discussion comments" sections of the textbook
- Ask any other questions you may want to ask that are related to what you have read in the textbook **(Optional, remember there is a prize for extra work)**

Complete the given "Survey 1" questionnaire to finish.

Appendix 11: Task 1 Survey Questions

Platform A: Textbook + Discussion Forum

Platform B: Textbook with discussions in it

1. Which group do you belong to?
   Group X: **Group Y:**

2. Did you complete task 1?
   YES: **NO:**

   If not, why were you not able to finish task 1?
   ……..

3. I **understand** posting a question on Platform A better than Platform B

4. Platform A is easier to use than Platform B

5. It is a **simpler task** to post a question related to the textbook on Platform B than Platform A

6. Posting a question on the Platform B is much **faster** than posting questions on Platform A

7. Posting a question on Platform B had **fewer** steps to follow than Platform A

8. Posting on Platform B **interrupted my reading** of the textbook **more** than Platform A

9. Moving to a separate discussion forum to ask questions on Platform A was **inconvenient**

10. Overall, I **like** posting on Platform A as opposed to Platform B

11. When posting a question, I found Platform A **frustrating** to use

12. When posting a question, I found Platform B **frustrating** to use

13. What do you like the **most** about posting a question on **Platform A**?

……

14. What do you like the **most** about posting a question on **Platform B**?

……

15. What do you like the **least** about posting a question on **Platform A**?

……

16. What do you like the **least** about posting a question on **Platform B**?

……

17. Any other comments about task 1

……

Appendix 12: Task 2 Instructions

Commenting on Platform A

- Go to the topics page of the system
- The page shows the first topic 1. Linear programming and there are three options.
- The first two options are for Platform A, shown as:
- **Platform A: Textbook**
- **Platform A: Discussion forum**
- Click on the textbook link **(Platform A: Textbook)** and **READ** a clip of the Linear Programming textbook (This should take you about 5minutes)
- Go back to topics page and this time click on the discussion forum **(Platform A: Discussion Forum)**
- A page will open up to show a list of questions under this topic, search for the first given following question.
- When you find the question, click on the "**comments**" link of the question you just searched for. It will open a new page showing the question and a place to enter a comment.
- Type the given answer in the comment box and click on the **"answer question"** button.
- Go back to topics then click on the discussion forum **(Platform A: Discussion Forum)** again to view the posted questions. You might see what others have also posted on this page.
- Repeat steps 6 above and this time search for the second given question.
- Repeat step 7 and then type the answer to the question
    - You can search for the answer in the textbook section by going back to the topics page and then clicking the textbook link **(Platform A: Textbook).** If you find the answer go back to topics, discussion forum **(Platform A: Discussion Forum)** and type it into the comments box and click the "answer question" button
    - If you do not find the answer to the question in the textbook, you can answer the question by typing "I did not find the answer" or anything similar in the comment box.
- Answer any other questions you may want to answer that are related to what you have read in the textbook **(Optional, remember there is a prize for extra work)**

Commenting on Platform B

- Go back to the topics page
- Under the first topic, 1. Linear programming, there are three options.
- Below Platform A (and its two options), the page also shows
    - **Platform B: Embedded discussions in the Textbook**
- Click on the Platform B link and a clip of the textbook chapter of Linear Programming will open
- **READ** through the chapter and as you read you will see buttons written **"discussion comments"** under various paragraph section.

- Click the button open, and you will see a comment box, answer two questions in the given “discussion comments” sections of the textbook
- Answer any other questions you may want to answer that are related to what you have read in the textbook **(Optional, remember there is a prize for extra work)**
- **Complete the given survey 2 questionnaire to finish.**

Appendix 13: Task 2 Survey Questions

Platform A: Textbook + Discussion Forum
Platform B: Embedded discussions in Textbook

1. Which group do you belong to?
   Group X: **Group Y:**

2. Did you complete task 2?
   YES: **NO:**

   If not, why were you not able to finish task 2?
   ……..

3. I **understand** commenting on Platform A better than Platform B

4. Platform A is easier to use than Platform B

5. It is a **simpler task** to comment on a question related to the textbook on Platform B than on Platform A

6. Commenting on questions on Platform B is much **faster** than commenting on questions on Platform A

7. Commenting on a question on Platform B had **fewer** steps to follow than Platform A

8. Commenting on Platform A questions **interrupted reading** of the textbook **more** than Platform B

9. Referring to the textbook to find answers to questions in Platform A was **burdensome** than in Platform B

10. Moving to a separate discussion forum to comment on questions on Platform A was **inconvenient**

11. Overall, I **like** commenting on Platform A as opposed to Platform B

12. When commenting , I found Platform A frustrating to use

13. When commenting , I found Platform B frustrating to use

14. What do you like the **most** about commenting on a question on **Platform A**?
    ……..

15. What do you like the **most** about commenting on a question on **Platform B**?
    ……..

16. What do you like the **least** about commenting on a question on **Platform A**?
    ……..

17. What do you like the **least** about commenting on a question on **Platform B**?
    ……..

18. Any other thoughts about task 2
    ……..

Appendix 14: Questions and Answers for Task 3

(adopted from everything maths)

Question	Answer
• In the first worked out problem in the textbook, Is it the same thing if I prove by showing that (discussion comments A)	Yes because any two opposite angles must be a total of 180degrees if it's a quadrilateral (discussion comments A)
• In EXAMPLE 1 of the given textbook How do I know that angle '**a'** is 90 degrees (discussion comments B)	Because as it says in the book, it's a triangle that fits a semi-circle (discussion comments B)
• The textbook shows three methods of proving a quad. What reason did they use to show that is a cyclic quad in the first method? (discussion comments C)	The reason is that **o**pposite interior angles in a quadrilateral supplement each other (discussion comments C)
• The second method of proving a quad. Is a cyclic quadrilateral because angles are in the same segment? (discussion comments D)	Yes that's the reason (discussion comments D)
• Is a cyclic quadrilateral because angles are in the same segment? (discussion comments E)	External angle is always equal to the interior opposite angle (discussion comments E)
• a + 87 should equal to 180 because opposite angles of a quadrilateral supplement each other. This means that A = 93 degrees? (discussion comments F)	b + 106 should equal to 180 because opposite angles of a quadrilateral supplement each other. This means that b = 74 degrees (discussion comments F)
• Since a = HIJ because external angle in a quad is always equal to the interior angle. In this case 114? (discussion comments G)	I now understand better the rule that external angles should be equal to interior angles for it to be a quadrilateral (discussion comments G)
• XUV + XWV = 180 (opposite angles of a quad are equal to 180 degree) XWV = 180 – 86, XWV = 74 (discussion comments G)	Then angles of a triangle equal 180 degrees so 180 – (74 + 57) gives us 49 degrees which represents the angle A (discussion comments G)
• By the rules of quadrilaterals, DBC should be equal to DAC because the angles are in the same segment? (discussion comments I)	True, but to prove this we can also check if indeed DBC is 40 degrees. (discussion comments I)
• How do we check that from the given diagram? (discussion comments I)	Since we also know the rule that the external angle of a triangle is equal to the sum of the two opposite interior angles, this means that AMB = 32 + DBC. AMB is 72 as given. So 72= 32 + DBC which makes DBC 40 degrees. Now we have proven that it is a quad because from the previous comment we know that if it is a quad it should be 40 (discussion comments I)
• What I know is that triangle ABD is an isosceles triangle hence ABD and ADB are equal making them both 35 degrees? (discussion comments J)	If ADB is also 35 degrees as you have explained, then DAB = (180 – 35 – 35) because sum of a triangle = 180 degrees. So DAB= 110 degrees (discussion comments J)
• Ok then this means that DAB + DCB should add up to 180 if it's a quad because opposite angles of a	Yes, So 110 + 70 = 180 making this a quad (discussion comments J)

quad supplement each other? (discussion comments J)	
• Do tangents have their own rules? (discussion comments K)	Yes they do but they also follow all the other rules we have learnt too (discussion comments K)
• HI = HJ because they are tangents from the same point. This makes GJ and IJ equal also because the radius is perpendicular to the tangent? (discussion comments N)	Using Pythagoras theorem, d^2 = 8^2 + 5^ 2 D is the square root of 89 making it 9.4cm (discussion comments N)
• Let us break this down, LM and LK are equal (tangents from same point) so they are both 6cm? (discussion comments O)	Since LN = 7.5cm and we now know that LM = 6cm then MN is = 1.5cm (discussion comments O)
• OM = radius = 2 cm? (discussion comments O)	Yes because the radius is perpendicular to the tangent (discussion comments O)
• Can we use Pythagoras theorem to find e using the small angle? (discussion comments O)	Yes, this means that 2^2 + 1.5^2 = e^2 Therefore e^2 = 6.25cm making e = 2.5cm (discussion comments O)
• This one is easy, 3cm? (discussion comments P)	What theorem did u use? (discussion comments P)
• I used the rule that RS = QS because they are tangents from the same point (discussion comments P)	Ok was just checking that's what I thought too (discussion comments P)

Appendix 15: Task 3 Instructions

- Go to **Topic 2: Circle geometry** on the **topics** page
- Choose either Section A or Section B (**choose only one!**) where you would like to post your questions and comments. There are three sections to the textbook chapter clip (just like when you did task 1 and task 2). It is shown as follows:
    - 1. Circle Geometry
        - Section A :Textbook
        - Section A: Discussion forum

      And:
        - Section B: Embedded discussions in Textbook
- You can choose to use Platform A **OR** Platform B. Post two of the following questions on the platform you have chosen. You can refer to the Task 1 instructions if you have forgotten how to ask a question on the platform you have chosen.
    - If you have chosen Platform A post the given two questions:
    - If you have chosen Platform B, post the two given questions on the specified "discussion comments" sections of the textbook.
- Answer two of the following posted questions on the platform you chose and posted questions on. You can refer to the task 2 instructions if you have forgotten how to answer a question
    - If you have chosen Platform A search and answer the two given questions:
    - If you have chosen Platform B, answer the given two questions on the specified sections of the textbook.
- Vote for at least 2 of the posted questions or answers of a post you like or dislike
- (Optional) Ask any other questions or answer any other post you like or dislike

Fill in the survey questions