MEASURING MOBILE COLLABORATIVE LEARNING (MCL) AND ACADEMIC ACHIEVEMENT: WHATSAPP AND STUDENTS IN SOUTH AFRICA

by

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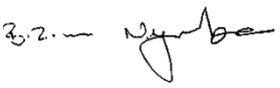
Declaration Statement

I declare that "Measuring Mobile Collaborative Learning (MCL) and Academic Achievement: WhatsApp and Students in South Africa" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis/dissertation to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

Bangisisi Zamuxolo Mathews Nyembe, 54830222, 	15/01/2021
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Abstract (Limited to 150 words per Unisa policy)

Mobile learning has developed into an essential component within the education landscape and, with two billion users worldwide, the social media platform WhatsApp has become a prominent feature in this domain. Nevertheless, with ambiguity in the literature about the effects of WhatsApp on teaching and learning and especially a paucity of research measuring collaboration on WhatsApp in relation to students' academic achievement. The purpose of the study was to explain and predict WhatsApp's effect on academic achievement using a quantitative questionnaire. The results suggest that increased collaboration on WhatsApp may improve academic achievement. Additionally, improving other aspects, such as active learning, trust, support, formality, interaction and interdependence, may enhance collaboration and, in turn, improve academic achievement. The study has value by providing measurable scientific evidence about the effects of WhatsApp on learning that can be incorporated into the design of teaching and learning activities with WhatsApp to improve academic achievement.

Uhlelo lokufunda uhamba (Mobile learning) selikhule ladlondlobala laba yisigaba esibalulekile ngaphansi komkhakha wemfundo kanti, lolu hlelo selunabasebenzisi abangamabhiliyoni amabili emhlabeni wonke jikelele, uhlelo lwenkundla yezokuxhumana komphakathi lwe-WhatsApp seluyinkanyezi egqamile kulesi sizinda. Yize-kunjalo, kukhona okungacaci kahle mayelana nombhalo wobuciko kwimiphumela yohlelo lwe-WhatsApp mayelana nokufundisa kanye nokufunda, kanti ikakhulu, uhlelo lwezocwaningo olulinganisa izinga lokusebenzisana kohlelo lwe-WhatsApp okumayelana nokuphumelela kwabafundi kwizifundo zabo. Inhloso yalolu cwaningo kwaye kuwukuchaza kanye nokuhlahla umphumela wohlelo lwe-WhatsApp kwezemfundo, ngokusebenzisa uhlelo locwaningo lwemibuzo egxile kumanani (quantitative questionnaire) . Imiphumela iphakamisa ukuthi izinga lokusbenzisana ohlelweni lwe-WhatsApp lungathuthukisa umphumela wezemfundo. Ngaphezu kwalokho, lungathuthukisa ezinye izinhlaka, ezinjengohlelo lokufunda olumatasa. Lungaletha ukwethembana, ukuxhasana, ukwenza izinto ngendlela esemthethweni, lungaletha ukuxoxisana kanye nokusebenzisana kwangaphakathi, lungaqinisa ukusebenzisana, kanti ngakolunye uhlangothi, lungaletha impumelelo kwezemfundo. Ucwaningo lubalulekile ngoba lunikeza ubufakazi bezesayensi obulinganisekayo mayelana nemithelela yohlelo lwe-WhatsApp ohlelweni lokufunda, okuwuhlelo olungafakwa ngaphansi kohlelo lokudizayina imisebenzi yohlelo lokufunda nokufundisa ku-WhatsApp ukuthuthukisa ukwenza ngcono imiphumela yezemfundo.

Mobiele leer het in ’n noodsaaklike komponent van die onderwyslandskap ontwikkel en met twee miljard gebruikers wêreldwyd, het die sosiale mediaplatform WhatsApp ’n prominente kenmerk van hierdie domein geword. Nogtans bestaan daar dubbelsinnigheid in die letterkunde oor die uitwerking van WhatsApp op onderrig en leer, en is daar veral ’n gebrek aan navorsing wat die samewerking op WhatsApp in verhouding tot die studente se akademiese prestasies meet. Die doel van hierdie studie was om WhatsApp se uitwerking op akademiese prestasie aan die hand van ’n kwantitatiewe vraelys te verduidelik en te voorspel. Die resultate stel voor dat ’n groter mate van samewerking op WhatsApp akademiese prestasie kan verbeter. Dit kan ook ander aspekte soos aktiewe leer, vertroue, ondersteuning, formaliteit, interaksie en onderlinge afhanklikheid verbeter en kan samewerking verhoog, wat op sy beurt akademiese prestasie kan verbeter. Die studie is waardevol in die sin dat dit meetbare, wetenskaplike bewyse oor die uitwerking van WhatsApp op leer verskaf het, wat by die ontwerp van onderrig- en leeraktiwiteite geïnkorporeer kan word om akademiese prestasie te verbeter.

Keywords (in alphabetical order): Academic achievement, Analysis of Variance (ANOVA), education and technology, Information Systems (IS), Information Technology (IT), Mobile Collaborative Learning (MCL), Mobile Learning (M-Learning), positivism, quantitative research, social media, structural equation modelling (SEM), students, WhatsApp.

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List of Academic Outputs Based on this Research

- Nyembe, B.Z.M., & Howard, G.R. (2019). The utilities of prominent learning theories for mobile collaborative learning (MCL) with reference to WhatsApp and m-learning. *Paper **presented and published** at the International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD 2019).* Winterton, South Africa: IEEE. ISBN: 978-1-5386-9236-3.

- Nyembe B.Z.M., & Howard G.R. (2020). Development of a quantitative instrument to measure mobile collaborative learning (MCL) using WhatsApp: The conceptual steps. In M. Hattingh, M. Matthee, H. Smuts, I. Pappas, Y. Dwivedi, & M. Mäntymäki (Eds.), Responsible Design, Implementation and Use of Information and Communication Technology. I3E 2020. *Lecture Notes in Computer Science (LNCS) vol 12066* (pp. 507-519). Cham, Switzerland: Springer. ISSN 0302-9743. doi: https://doi.org/10.1007/978-3-030-44999-5_42.

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Glossary of Key Terms

E-learning: E-learning is related to distance learning, it refers to the usage of digital tools and media or computer network technologies to support learning through the internet or intranet, making learning material accessible to users (learners and teachers) (Denk, 2007; Hewagamage & Wickramasinghe, 2012; Welsh et al., 2003).

Learning: A process in which an individual acquires knowledge that has an impact on or changes an individual's behaviour, thinking and skills (Bhuttoo et al., 2017).

Learning theories: These are the theories that explain how learning occurs, including the constructs involved and their interrelationships (Schunk, 2012).

M-learning: Learning at anytime and anywhere, informal and formal, enabled via mobile devices, mobile networks and typically wireless transmissions, and involving social interaction, content creation and sharing (de Waard, 2014; Gikas & Grant, 2013; Hewagamage & Wickramasinghe, 2012; Jairak et al., 2009; Pivec et al., 2003).

Mobile Instant Messaging (MIM): MIM is a messaging service that uses instant messaging on mobile devices, such as tablets and smartphones, to transmit messages using technologies such as Long-Term Evolution (LTE), General Packet Radio Service (GPRS) and Fourth Generation mobile network technology (4G) (Pimmer et al., 2019).

WhatsApp: It is an instant messaging application using the internet to transmit messages and has broad use on smartphones (Ahad & Lim, 2014). It also allows users to chat as individuals or in groups.

Chapter 1: Research Introduction

1.1 Chapter introduction

The study aims to explain and predict WhatsApp's effect on academic achievement by gathering data from students using a questionnaire survey to measure collaboration on WhatsApp in relation to their academic achievement. The goal of Chapter One is to provide a foundation for the study. In order to achieve this goal, the chapter has the following objectives, to present background information and context for the study, to define the research problem, research objective and research questions, and to provide a summary of the research design.

The layout of the sections in this chapter is as follows: The next section is the background and context section, which introduces the study. The researcher then defines the research problem, research objective and research questions. Subsequently, a research design summary is provided and then the study's scope and limitations are discussed. Thereafter, the layout of the entire dissertation is presented and lastly, the chapter summary and conclusions are provided.

1.2 Background and context

Technology has progressed rapidly in recent years (Georgiev et al., 2006). This progress has resulted in frequent changes to many aspects of everyday life (Dragana et al., 2015). In particular, technological progress has resulted in handheld, portable communication devices (Chinnery, 2006), namely mobile technology, that has undergone enormous growth, including in African countries (Brown, 2003).

Typically, mobile technologies are easily transportable, wireless and handheld (Chinnery, 2006). These wireless technologies have replaced wired telephones and computers since the beginning of the current century (Brown, 2003). Mobile technologies are not only used for telecommunications, but also for data transmission and connecting to the internet (Brown, 2003). Thus, mobile technologies are also mobile computing devices. Furthermore, it has been claimed that there are now more mobile computing devices in use than desktop computers and a great many people own at least one of these devices (Bhuttoo, Soman, & Sungkur, 2017; Chinnery, 2006; Holzinger, Nischelwitzer, & Meisenberger, 2005; Herrington et al., 2009). Nevertheless, even though mobile computing devices have a portability advantage over desktop computers, desktop computers or other bigger computing devices have their own advantages, such as better visual, sound, memory, speed and safety features (Chinnery, 2006).

Another notable and complementary technological development is social media. Social media has become part of everyday life for many people (de Waard, 2014). Mobile computing devices

together with social media enable communication, collaboration and content creation using Web 2.0 features (Brown, 2003; de Waard, 2014; Gikas & Grant, 2013; Herrington et al., 2009).

These technological developments have extended to the education sector with the potential to improve education (Georgiev et al., 2006). Many researchers have recommended that the technical strengths of mobile computing devices be linked to pedagogy in learning environments and implementing these recommendations has resulted in the concept of m-learning (Jeng et al., 2010). M-learning is based on the idea of anywhere, anytime learning (Denk, 2007). With m-learning, a learner and his/her entire learning environment is considered to be mobile. M-learning can be regarded as e-learning using mobile computing devices, where the features of mobile computing devices enable mobility to support learning (Garcia-Cabot et al., 2015; Jairak et al., 2009; Jeng et al., 2010).

In relation to M-learning Theory, the study focuses on the mobile and social media technology called WhatsApp and the important M-learning Theory aspect that WhatsApp was designed to support and facilitate, namely collaboration. Thus, the study concentrates on collaboration specifically instead of the development of M-learning Theory in general, to address the study's research problem and answer the study's research questions.

Specifically, within the broad ambit of m-learning, the social media application called WhatsApp has become prominent. It has been reported that as of October 2018, WhatsApp had approximately 1.5 billion active users, which places it behind Facebook and YouTube only as the most popular social network worldwide (Statista.com, 2018). WhatsApp is described as an internet-based cross-platform instant messaging and Voice over Internet Protocol (VoIP) service for mobile devices (WhatsApp, 2018). Some of the important features of WhatsApp include, as at October 2018, free messaging for sharing text, photos and videos, group creation and management with up to 256 people simultaneously, free voice and video calls even across countries, a built-in camera to send photos instantly, a built-in voice recorder to send recorded voice messages, document transfer of documents up to 100 megabytes (MBs) in size and end-to-end encryption so that messages and calls are secured and cannot be read or listened to by any other parties including WhatsApp personnel. Notably, WhatsApp users still have to pay their internet data providers to use the internet and to send and receive data across the internet, but WhatsApp users do not pay WhatsApp for any of the WhatsApp features.

In particular, WhatsApp enables anonymous, asynchronous collaborative learning, which is reported to improve and increase the productivity and participation of less confident, shy learners (Rambe & Bere, 2013). Furthermore, WhatsApp is an instant messaging tool, in other-words, it sends messages real-time and it is one of the most popular communication applications in South Africa (Bere & Rambe, 2016) and globally (Ahad & Lim, 2014).

Notably, many prominent learning theories have been applied in various ways to study WhatsApp, even Collaborative Learning Theory but it was not evident in the literature that the core features of collaboration had been explicitly measured for learning anywhere and anytime with WhatsApp.

1.3 Problem definition, research objectives and research questions

Against this background of widespread WhatsApp use, especially by students, understanding WhatsApp in relation to learning is an important topic. In particular, many students and, possibly, educators invest time and resources into WhatsApp for collaborative learning without there being sufficient evidence about the effects of such investment, which could be either negative or positive. For example, there is research reporting that WhatsApp can improve learning (Pimmer *et al.*, 2019) and research reporting that WhatsApp may not (Alkhalaf et al., 2018). In addition, in relation to the concept of collaboration alone, there is research indicating that collaboration for learning can be positive or it can be negative when extraneous cognitive loads are introduced (Kirschner et al., 2018).

Due to this ambivalence about the possible effects of WhatsApp for collaborative learning, the literature was further reviewed to find out the extent and nature of prior research about students and their learning with WhatsApp. This review occurred during December 2018 and January 2019 and returned fifty recent and relevant peer-reviewed articles on the topic. The analysis of these articles is presented in Appendix A.

The articles reviewed in Appendix A exposed research about WhatsApp and teaching and learning from many different perspectives. However, one of the core features of WhatsApp is its facilitation of collaboration amongst users, and this feature had not been measured in relation to students' academic achievement. This presented the research problem, which was the lack of research measuring collaboration on WhatsApp in relation to students' academic achievement.

Furthermore, only nine of the articles reviewed were conducted in Africa, and of those, three were in Nigeria and six were in South Africa. So, this study is significant because it furthers knowledge about WhatsApp and learning generally, and in South Africa specifically, to offer an original contribution to the academic body of knowledge. Additionally, the study provides researchers with a foundation from which to measure informative constructs involved in the mobile collaborative learning (MCL) processes on WhatsApp and potentially other mobile and social media platforms. The study uses the concept of mobile collaborative learning (MCL) to denote learning collaboratively using WhatsApp (Caballéa, Xhafab, & Barolli, 2010). The study also presents a positivistic research and epistemology to further the acquisition of objective and precise scientific knowledge and such deductive research promotes theory testing and development.

In addition, this study has value for educators trying to leverage or facilitate learning by providing measurable evidence about the effects of WhatsApp. Moreover, MCL theory testing and development provides educators and students with scientific evidence about learning with MCL applications such as WhatsApp, from which both curriculum and learning design can be informed and benefited. In the age of connected mobility this is a necessity.

Consequently, the research objective is to explain and predict WhatsApp's effect on academic achievement by gathering quantitative data using a questionnaire survey from students using WhatsApp to measure collaboration on WhatsApp in relation to their academic achievement. Subsequently, the research questions follow and collectively answer the overarching research question, namely can WhatsApp improve academic achievement?

1) What constructs and measurement items are appropriate for measuring MCL on WhatsApp in relation to academic achievement?

2) How do the relevant constructs involved in MCL on WhatsApp interrelate and relate to academic achievement?

3) What guidelines and recommendations can be made to educators and tertiary institutional management to improve MCL and academic achievement?

1.4 Research design summary

The study followed a quantitative research design. Research data was collected using a quantitative survey questionnaire and analysed using statistical procedures and structural equation modelling (SEM). Quantitative research explains phenomena by collecting numeric data that can be analysed by mathematical methods (Muijs, 2004). Furthermore, quantitative designs are suitable for testing hypotheses (Muijs, 2004), which are formulated in the study for providing answers to the study's research questions. In addition, a quantitative survey is suitable for gathering data from a large group of people and incorporates quantitative analysis to identify patterns using statistics (Oates, 2006).

1.5 Scope and limitations

For reasons of accessibility, the study was limited to the Free State province of South Africa. The participants were students from a university and a technical and vocational education and training (TVET) college. While the study was limited to these institutions, they still provided enough data and demographic diversity to address the research problem and develop valuable insights.

1.6 Layout of the dissertation

Chapter One is the foundation of the study and includes the background and context of the study, the research problem, research objective, research questions, scope and limitations and research design summary. Chapter Two is the literature review, which analyses and synthesises past research studies that relate to the research problem. In addition, Chapter Two analyses relevant literature for applicable theories, frameworks and models to answer Research Question One.

Chapter Three provides the study's research methodology, which is guided by the study's research problem and objective. Chapter Three details all aspects of the study's research methodology, including sampling and data collection. Chapter Four provides the presentation and discussion of the data gathered, based on the implementation of the research methods detailed in Chapter Three. In addition, Chapter Four explains the findings and hypotheses measures to answer Research Question Two. Chapter Five is the study's conclusion. It summarises the study's findings, how the research questions were answered, presents the study's limitations and contributions to the field. Furthermore, recommendations are provided for improving MCL and academic achievement, which answers Research Question Three.

1.7 Chapter summary and conclusions

Chapter One exposed the relevance and importance of mobile devices, m-learning, social media, and WhatsApp to education and learning. The chapter also exposed the lack of research measuring collaboration on WhatsApp in relation to students' academic achievement, which justifies the study.

Chapter One achieved its objectives, which were to present background information and context for the study, define the research problem, research objective and research questions and to provide a summary of the research design. Thus, Chapter One achieved its goal, which was to provide a foundation for the research. In addition, the chapter discussed the study's scope and delimitations, presented the layout of the dissertation and defined key terms.

In conclusion, Chapter One emphasises the importance of WhatsApp and substantiates the requirement for further research to measure collaboration on WhatsApp in relation to students' academic achievement, which provides value for academics and offers an original contribution to knowledge. This chapter also has value for teaching practice by emphasising the potential of WhatsApp and the need for careful consideration of its implementation to ensure effective learning by students. The next chapter is Chapter Two, being a comprehensive literature review and synthesis of past research relating to the research problem**.**

Chapter 2: Literature Review

2.1 Chapter introduction

Chapter One provided the foundation for the study, which included the study's background and context, research problem, research objective and research questions. Chapter Two is the study's literature review and proceeds to synthesise past research relating to the research problem. The goal of the literature review is to analyse and synthesise past research studies that relate to measuring collaboration in relation to students' academic achievement and present an initial research model and measurement items to answer Research Question One. To achieve this goal, Chapter Two has the following objectives, detailing the literature review process to demonstrate a rigorous literature review, revealing key theories, models, frameworks and phenomena in the domain, clarifying the contribution of the research and specifying the initial research model, measurement items and hypotheses.

Chapter Two continues by detailing the literature review process, comprising the literature search process and literature analysis process. Thereafter, each theme emerging from the literature analysis process is presented as a synthesis. Subsequently, the constructs are clarified, the initial measurement items are presented and the initial research model and hypotheses are specified. The last section of the chapter is the conclusion and summary section.

2.2 Overall literature review process

This section presents the steps that were followed in the literature review. In any academic research, the reviewing of literature is an important phase to create a firm foundation for knowledge creation by learning what was done previously by other researchers. A literature review is a critical analysis of the applicable research literature. One of the goals of a literature review is to expose relevant knowledge in the literature on the topic and to create a foundation for substantiating the current investigation (Cronin et al., 2008). A literature review helps to identify areas that require further research, uncovers areas that have a plethora of research and helps to develop theory (Webster & Watson, 2002).

A quality literature review covers applicable literature on a topic and is not limited to a single research methodology or a single journal or one geographical area (Oates, 2006; Webster & Watson, 2002) and the literature sources are legitimate sources (Oates, 2006). It is recommended that a structured approach is followed when reviewing literature (Cronin et al., 2008; Webster & Watson, 2002). The structured approach used in this study comprises three stages. Stage One is the inputs phase and is detailed in Section 2.3. Stage Two is the processing phase, detailed in

Section 2.4, which produces the concept-centric literature matrix presented in Appendix B. Stage Three is the outputs phase, which is the written literature review presented in the literature review subsections under Section 2.5.

2.3 Literature search process

2.3.1 Keywords

Keywords or search terms were used to search for relevant literature (Oates, 2006). Keyword searches are the most common method to find literature, however, special attention was given to the wording variances in American English compared to British English (Cronin et al., 2008). The initial keywords that were used stem from the research problem statement and include collaboration, WhatsApp and academic achievement. Thereafter, different combinations and derivatives of these were used. The researcher also used a dictionary and a thesaurus to develop keywords (Oates, 2006).

2.3.2 Databases and search engines

Numerous scientific papers are published in many databases, so it is important to know which of these databases are relevant for searches (Chadegani et al., 2017). Two popular databases were the Web of Science and Scopus databases. These databases ranked journals in terms of their productivity and number of times they were cited (Chadegani et al., 2017). Web of Science had been running longer than Scopus which was introduced by Elsevier Science, however, Scopus was the largest searchable citation and abstract source for academic literature and was continually growing and being modified (Chadegani et al., 2017). These databases were expensive to access, however, the University of South Africa (Unisa) subscribed to these databases and others and the researcher had access to them by virtue of being a Unisa student. So, relevant articles from these databases were searched for via the Unisa e-library.

In addition, the web has become an extensive resource with several search engines for information gathering (Spink et al., 2002). The researcher scrutinised the search engine results pages to check which results were relevant and valid for usage. In summary, the following search engines and databases were used to search for literature: Google Scholar, Science Direct, Scopus and the Unisa e-library databases. Nevertheless, only journals accessible through the Unisa e-library were included regardless of the initial search engine used. This was to ensure only peer-reviewed journals were included.

2.3.3 Search strategy

The study, while in the IS field involved another discipline, namely learning. As a result, the researcher searched across both these disciplines. In addition, backward searches were conducted on some of the relevant articles by reviewing the references in these articles. Forward searches were also done by using the electronic version of the social sciences citation index with the objective to find articles that cited the relevant articles that were found (Webster & Watson, 2002).

2.3.4 Assessing the quality of the literature

The researcher took into consideration the importance of assessing the credibility of the material used to conduct the literature review. This was achieved by referring to literature quality criteria suggested by Oates (2006). Where journal articles were used, the following criteria applied: Is the audience of the journal academics or practitioners? In the study, the researcher focused on academic journals. What is the lifespan of the journal? The longer the lifespan, the more reliable the journal is and more established it is. However, this did not mean newer journals were invalid and were to be excluded from the study. Hence the next question was: Is there a list of the journal's editorial board and advisors and do they have prominent profiles in the field? Lastly, the researcher checked if the journal had a policy for reviewing articles and whether the articles were peer-reviewed articles. Only peer-reviewed articles were used in this study.

Where conference and workshop articles were used, the following criteria applied: Is the focused audience of the conference academics or practitioners? In the study, the researcher focused on academic articles. Is it a well-established conference/workshop, has it been going on for many years? The number of times a conference is held and the lifespan of a conference gives confidence that articles derived from these conferences can be trusted, however, this did not mean newly established conferences were untrustworthy (Oates, 2006). The next question was: Is there a list of the committee members for the conference and do the members of the committee have prominent profiles in the field? Lastly, the researcher checked if the conference has a policy for reviewing articles and whether the articles were peer-reviewed articles. Only peer-reviewed articles were used in this study.

The researcher limited the use of website-based sources since these were not always reliable and trustworthy in the sense that almost everyone can post anything (Oates, 2006). However, this did not mean that all web-based sources were invalid. While the Google Scholar search engine was used to search for articles, upon downloading an article, the researcher would check if the article existed in the Unisa electronic e-library to ensure that the article was published in a valid, peer-reviewed journal.

2.4 Literature analysis process: Concept-centric literature matrix

To analyse the literature, the researcher used a concept-centric literature matrix. A literature review should focus on concepts for a literature review that is concept centric (Webster & Watson, 2002). This assisted the researcher to identify the relevant concepts associated with the topic to be researched and enabled the researcher to determine which concepts were vital and which articles may have usable content (Klopper & Lubbe, 2001). Having identified relevant articles or literature material, the researcher identified concepts relevant to the study and recorded these concepts in the concept-centric literature matrix, which is presented in Appendix B. The researcher mapped each article to emergent concepts to show which papers addressed which concepts.

2.5 Literature review

The following sub-sections are syntheses of the themes that emerged from the literature analysis as presented in the concept-centric literature matrix in Appendix B. Each sub-section is a synthesis of the literature relating to that theme.

2.5.1 Learning, e-learning and m-learning

Learning has been defined as a change in behaviour or the ability to behave in new ways because of practice or other forms of experience (Ertmer & Newby, 1993). Another definition of learning is a process through which experience and knowledge are acquired that has an impact on an individual's behaviour, skills and ability (Bhuttoo et al., 2017). Historically, learning has been discussed from two positions, namely empiricism and rationalism. According to empiricists, experience is the basic source of knowledge, in other words, knowledge is obtained through the senses (Ertmer & Newby, 1993). Rationalists, on the other hand, believe that knowledge is attained through reason and not through the senses. This study sees merit in both views and considers knowledge obtainable through both the senses and reason.

Learning has also been classified into categories, such as formal learning, non-formal learning and informal learning (Bhuttoo et al., 2017). Formal learning is what a learner experiences at a learning institution (Bhuttoo et al., 2017). Notably, in the traditional way of learning, learning is conducted in the classroom (de Waard, 2014) and knowledge is conveyed to learners from an instructor (Brown, 2003). Thus, formal learning and traditional learning often refer to the same concept. In contrast, non-formal learning does not occur at a learning institution, but occurs within any other type of organisational setting, such as a community centre or sports club (Bhuttoo et al., 2017).

Both formal learning and non-formal learning are intentional on the part of the learner. In contrast, informal learning takes place through everyday experiences and is unintentional (Bhuttoo et al., 2017).

With advances in technology, learning methods have changed (Ibrahim & Walid, 2014). Six types of learning methods are evident, namely traditional learning, distance learning (d-learning), technology-enhanced learning (te-learning), electronic learning (e-learning), wireless learning (w-learning) and mobile learning (m-learning) (Georgiev et al., 2006). These different methods often complement one another (Georgiev et al., 2006). Of these, e-learning appears to have been the biggest change since the introduction of the chalkboard (Welsh et al., 2003). Higher education institutions frequently come under pressure to use more than one of these learning methods (O'Flaherty & Phillips, 2016). The technology-based learning methods offer several benefits if effectively used, including reductions in time, costs and location (Hewagamage & Wickramasinghe, 2012).

In particular, e-learning was introduced in the 1990s as a learning method because of new technological developments, such as the internet. It grew and was adopted globally (Brown, 2003; Garcia-Cabot et al., 2015; Ruiz, Mintzer, & Leipzig, 2006). Terms such as web-based learning, online learning, distributed learning, internet-based learning or computer-assisted instruction are often synonyms for e-leaning (Lister, 2014; Ruiz et al., 2006; Shuib et al., 2015).

E-learning can be defined as the usage of computer network technologies, through the internet or an intranet, with the objective of making learning material accessible to learners and teachers (Welsh et al., 2003) or learning supported by digital electronic tools and media (Denk, 2007; Hewagamage & Wickramasinghe, 2012; Shuib et al., 2015). It is evident that Information and Communications Technology (ICT) plays an essential role in e-learning.

The addition of e-learning to education was to support learning in the traditional learning environments of classrooms and laboratories (Costabile et al., 2008). Previous studies have shown the effectiveness of e-learning (Ruiz et al., 2006). Indeed, the introduction of e-learning helped to partially remove location and time boundaries in learning, however, some of the ICT devices such as desktop computers were not very mobile (Welsh et al., 2003).

The combination of mobile computing technologies and e-learning resulted in m-learning, thereby making learning available anywhere at any time (Bhuttoo et al., 2017; Denk, 2007; He & Ueno, 2012; Yousafzai et al., 2016). As such, e-learning's limitations include that it is not always location independent and this is where m-learning improves on e-learning (Holzinger et al., 2005). Also, the technologies that are used in m-learning are different to those used in e-learning (Georgiev et al., 2006). Mobile technologies are used in m-learning, whereas wired technologies are often used in e-learning. Wired technologies have disadvantages such as local access only and limited

mobility (Kim et al., 2006). In addition, some researchers are of the view that m-learning should not be considered as e-learning on mobile devices (Bhuttoo et al., 2017), while others view m-learning as an extension of e-learning (Brown, 2006; Garcia-Cabot et al., 2015). Furthermore, e-learning typically does not allow students to interact whereas this is accommodated by m-learning. Indeed, mobile computing devices are mobile devices (Gikas & Grant, 2013), which typically connect to networks wirelessly (Gikas & Grant, 2013; Welsh et al., 2003) and include mobile phones, laptops, PDAs and tablets/iPads (Brown., 2003), just to name a few. Mobile computing devices have the ability to make learning more accessible and easily available compared to the traditional means of learning (Brown, 2003) In addition, mobile computing devices make learning possible for learners who do not have access to traditional infrastructure (Brown, 2003; Ishtaiwa, 2014). Many learners have a positive perception of m-learning (Ishtaiwa, 2014).

Mobile computing devices create opportunities for new ways of learning beyond the walls of formal learning institutions (de Waard, 2014). These learning opportunities include interaction, collaboration, communication and content creation (Gikas & Grant, 2013). Content creation can occur using, for example, blogging systems (Jeng et al., 2010) that enable collaboration among learners, instructors and field experts (Jeng et al., 2010) so that learning is facilitated (Madaio et al., 2016). M-learning is claimed to improve learning and m-learning itself has improved over the years (Traxler, 2007) resulting in an increasing interest in m-learning (Attwell, 2010).

Furthermore, mobile computing devices and social media technologies are becoming part of our everyday lives (Bhuttoo et al., 2017; de Waard, 2014; Jeng et al., 2010) and social media have had a profound impact on education (de Waard, 2014), enabling content creation and knowledge generation (de Waard, 2014). As a result, it has become important to find ways to use mobile computing devices and social media technologies to improve learning. An example of the potential of mobile computing devices and social media technologies is a study that involved Web 2.0 social applications enabling dispersed learners to access course content and form a support structure for their studies (Chinnery, 2006).

M-learning can be regarded as learning that is formal, informal, context aware and authentic (Gikas & Grant, 2013). M-learning is not meant to replace learning done in the classroom, but complements learning in a formal setting (Costabile et al., 2008). M-learning technologies further broaden the boundaries of traditional learning in the classroom by making learning more effective and possibly as effective as face-to-face learning (Kennedy, 2014). M-learning is a form of learning with legitimate nomadic learners (Herrington et al., 2009).

With m-learning an instructor may be less responsible for content management and may play more of a supervisory role, giving leaners more responsibility to learn in their own time, at any place and at their own pace. Content may be created by learners, stored on a network and accessed using

any compatible computerised device connected to the internet such as mobile phones, PDAs or laptops. Unlike e-learning, m-learning enables peer-to-peer interaction, collaborative learning and conversation learning. M-learning also supports learning that takes place in the workplace in a way that has not been possible before (Attwell, 2010; Pimmer & Pachler, 2010; Sharples, 2006; Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009; Wingkvist & Ericsson, 2011).

Nevertheless, there are challenges associated with m-learning. One of the challenges related to m-learning is language (Pham et al., 2017). Apps, which are software programs or often small, specialised programs downloaded onto mobile computing devices, built for m-learning are typically not built in the native languages of many non-English users. They mostly come in English and, therefore, non-English literate users may not be able to use these apps effectively. Other challenges associated with m-learning are technological challenges, which include the diversity of devices and content output problems; geographical challenges, which include network reception problems; digital divide challenges, which include some people with access and others without access; and target audience challenges, which include instructors not knowing their audience of students (de Waard, 2014).

Other challenges include that some instructors struggle to use m-learning and resist the technology (Gikas & Grant, 2013), financial constraints involved in buying the needed resources and their implementation (Denk, 2007), and theft and trust concerns. Furthermore, mobile devices are normally small, which can make it difficult for users to adapt to using them (Costabile et al., 2008) and these devices have a relatively short battery lifespan (Chinnery, 2006). Also, mobile devices may have a negative impact on human behaviour since it was reported that people can become addicted to their smartphones, negatively affecting their mental health and well-being (Samaha & Hawi, 2016) and smartphones have been found to be a distraction and result in poor academic performance (Kumar et al., 2014).

Yet, m-learning makes learning possible from anywhere at any time (Costabile et al., 2008; Denk, 2007; Ishtaiwa, 2014) with fewer limitations in comparison to e-learning, presenting opportunities for improved learning (Brown, 2003).

2.5.2 Prominent learning theories and mobile and social media technologies

Since mobile and social media technologies are a relatively recent development, prominent learning theories are reviewed in this section to assist in understanding how learning may occur with these technologies. The literature included many applicable learning theories, namely Activity Theory, Behaviorism, Cognitivism, Collaborative Learning, Communities of Practice, Connectivism, Constructivism, Context Awareness Learning, Conversation Theory, Experiential

Learning Theory, Information Processing Theory, Multiple Intelligences Theory, Neuroscience, Problem-based Learning, Situated Learning Theory, Social Learning Theory, Socio-cultural Theory and Transformative Learning Theory. Each theory is reviewed next.

Activity Theory dates back to the 19th century (Kaptelinin et al., 1995; Mwanza-simwami & Keynes, 2016) with the main contributors being Lev Vygotsky, Alexei Leont'ev and Sergei Rubinstein (Kaptelinin et al., 1995; Mwanza-simwami & Keynes, 2016). Activity Theory is a framework or conceptual lens that can provide insight about learning and the practices or activities learners undergo to obtain knowledge in particular contexts (de Waard, 2014). Activity Theory involves people using mediating artefacts or tools to achieve their learning goals. In addition, Activity Theory considers environmental variables such as the rules of an activity, the community and division of labour. Activity Theory aims for insight about how mental processes and physical activities relate in the context of these environmental variables (Keskin & Metcalf, 2011; Mohamad & AlAmeen, 2014; Mike Sharples, Taylor, & Vavoula, 2005; Mwanza-simwami & Keynes, 2016; Greenhouse, 2013; Mohamad & AlAmeen, 2014). Activity Theory can provide insight into m-learning based on a view that learning activities are mediated by mobile and social media technologies (Parsons, 2014; Pimmer & Pachler, 2010; Motta et al., 2015).

Behaviorism appeared in the early 20th century (Demirezen, 1988), but seemed to gain traction in education around the 1950s. Pioneer researchers of Behaviorism include J.B. Watson, O.N. Mowrer, L. Bloomfield, B.F. Skinner and A. Staats (Demirezen, 1988). Behaviorism typically concerns the learner, the environment and the stimulus that the learner is exposed to for developing the required response. (Cooper, 1993; Louw & Louw, 2007; Siemens, 2013). Behaviorism could have application in studying how learning is achieved through required responses to visual and audio stimuli from mobile and social media technologies (Keskin & Metcalf, 2011).

Cognitivism followed Behaviourism and one of the pioneers was Jean Piaget (Louw & Louw, 2007; Schunk, 2012). Cognitivism, in contrast to Behaviourism, focuses on the mental processes involved in receiving, processing and acquiring knowledge (Ertmer & Newby, 1993; Deegan, 2015; Proctor & Urcuioli, 2016). Cognitivism could provide insights into how mobile and social media technologies enable information and concepts to be received, processed and structured in the mind.

Collaborative Learning is a 20th century theory (Roberts, 2014). Collaborative Learning explains how learning takes place among a group of learners working together to achieve particular learning outcomes (Bishnoi, 2017; Dillenbourg, 1999; Roberts, 2014; Zheng, Li, & Huang, 2017). Collaborative Learning improves learning by enabling learners to exercise, verify, solidify and improve their mental models by working with other learners and discussing and sharing information during problem-solving (Keskin & Metcalf, 2011; Parsazadeh, Ali, & Rezaei, 2018).

Communities of Practice was developed by Jean Lave and Etienne Wenger in the late 1980s and early 1990s (Lave & Wenger, 1991). In Communities of Practice, a group of people learn and attain skills through engaging in a common activity (Kaschak & Letwinsky, 2015). Communities of Practice goes beyond a club of friends or a group of people connected in a network, it has a defined identity within a common domain of interest. As a result, to be a member, an individual needs to commit themselves to the domain (Wenger, 1998; Evnitskaya & Morton, 2011). Online communities also exist, where people from across the globe learn and interact through platforms such as Web 2.0 (Rosenbaum & Shachaf, 2010; Anohah, Oyelere, & Suhonen, 2017; Herrington & Herrington, 2007; Kukulska-Hulme, 2006; Mohamad & AlAmeen, 2014; Nordin, Amin, & Yunus, 2010). Communities of Practice can be useful for understanding how learning occurs collectively and how learning practices are developed in groups with shared interests, using mobile and social media technologies (Traxler, 2007).

Connectivism is reported to have been developed around 2005 by Stephen Downes and George Siemens (Clarà & Barberà, 2013). Connectivism aims at explaining how knowledge is acquired when individuals contribute, process and receive information through information networks (Maccallum et al., 2017; Ng, 2013). Connectivism is suited to learning environments where individuals are connected over the internet and involved in learning. As such, Connectivism offers insight into learning by connecting to networks of learners with mobile and social media technologies that send, process and receive information irrespective of location (Baggaley, 2012; Clarà & Barberà, 2013).

Constructivism is believed to originate during the time of Socrates (469-399 B.C.), who emphasised that learners and teachers create and interpret new knowledge through communication (Amineh & Asl, 2015). Since then, Constructivism has taken various forms, with contributors such as Jean Piaget, Lev Vygotsky, Ernst von Glasersfeld, Alexei Leont'ev and Jerome Bruner (Amineh & Asl, 2015; Jones & Brader-araje, 2002; Swan, 2014). Constructivism explains that learning occurs as a learner constructs new knowledge and meaning from past and present knowledge and experiences (Pivec et al., 2003). A central principle of Constructivism is active learning where learners create new concepts, ideas or knowledge from their prior knowledge (Brandon & All, 2010). Constructivism can assist with explaining learning using mobile and social media technologies as knowledge construction through active participation.

Context Awareness Learning was put forward by Bill N. Schilit and Marvin M. Theimer in about 1994 (Perera et al., 2013). Context Awareness Learning involves consideration of a learner's environmental context and then adapting learning materials to match the context (Hwang et al., 2008; Lu et al., 2014; Traxler, 2011b). Context Awareness Learning fits m-learning where learning can be adapted by mobile technologies for learners' particular contextual characteristics, including

personal characteristics and situation (Benzekki et al., 2018; Gómez et al., 2014; Kismihók & Szabó, 2012). Context Awareness Learning may better support and accommodate learners with differences, since different learners learn differently (Syvänen et al., 2005). Context Awareness Learning can explain how learning can be personalised and learners can learn in ways that are most comfortable for them from anywhere at any time using mobile and social media technologies.

Conversation Theory was developed by Gordon Pask in 1975 (Scott, 2001). Generally, Conversation Theory is a theory of human communication and social interaction. When applied to learning, Conversation Theory explains learning through conversing, typically between the teacher and learner (Baggaley, 2012; Kim, 2002; Tegos & Demetriadis, 2017). Conversation Theory can assist to explain learning with mobile and social media technologies as learning through communication and discourse with others.

Experiential Learning Theory began during the 1970s and was developed by David Kolb based on work by John Dewey, Kurt Lewin and Jean Piaget (Lee, Barker, & Kumar, 2016; Miettinen, 2010; Kolb, 1984). Experiential Learning Theory concerns the process of learning through experience and learning through reflection on experiences (Lee et al., 2016). Experiential Learning Theory refers to reflective observation, concrete experience, active experimentation and abstract conceptualisations (Lee et al., 2016). Experiential Learning Theory may be applicable to mobile technologies where mobile and social media technologies are used to interact with the environment and enable reflection on those actions.

Information Processing Theory was founded in the 1950s by George A. Miller, whose works also contributed towards cognitive psychology (Miller, 1956). Information Processing Theory explains how information is processed, remembered, perceived and thought about by a learner (Mohamad & AlAmeen, 2014). Information Processing Theory involves sensory memory where information is acknowledged, short-term memory where information temporarily stays to be processed and permanent memory where information is stored permanently (Louw & Louw, 2007). Information Processing Theory may provide insight about learning with mobile and social media technologies from an environmental stimuli processing and interpretation perspective.

Multiple Intelligences Theory was proposed in the 1980s by Howard Gardner (Baş, 2016; Gardner & Hatch, 2010; Gardner & Moran, 2006; Leshkovska & Spaseva, 2016; Chand & Darolia, 2017). Multiple Intelligences Theory takes into consideration various capacities and talents a learner possesses and states that there is more than one way to measure intelligence and that humans learn in different ways depending on their particular mode of intelligence, such as artistic intelligence or logical-mathematical intelligence (Dekhane & Tsoi, 2012). Multiple Intelligences Theory offers understanding about learning with mobile and social media technologies when these technologies adapt to fit the appropriate intelligence domain of a learner.

Neuroscience dates back in time to when people first started studying the human brain. Neuroscience helps educators to understand how learning occurs in the brain (Aldrich, 2013; Aldrich, 2014; Dolphens et al., 2014; Schunk, 2012) and how individual physiological differences can cause different learning abilities. Neuroscience can expose how learning is achieved with mobile and social media technologies when they accommodate individual differences.

Problem-based Learning was introduced by Howard Barows in the 1970s (Hashim et al., 2017; Savery & Duffy, 1995). Problem-based Learning develops learners' critical thinking skills by exposing them to ill-defined problems similar to what they may encounter in real-life (Keskin & Metcalf, 2011). Problem-based Learning also focuses on case-centred activities, problem-solutions and collaborative social interactions. Problem-based Learning enables students to think critically, creatively and laterally (Savery & Duffy, 1995; Schunk, 2012). Problem-based Learning could be evident with mobile and social media technologies where learning is focused on resolving meaningful problems in groups enabled by these technologies.

Situated Learning Theory was developed in the 1980s by Jean Lave and Etienne Wenger (Reder et al., 1996). Situated Learning Theory explains learning as specific to the context or situation of the learning, including the creation of meaning from actual daily activities (Anderson, 2008). Situated Learning Theory has relevance for learning with mobile and social media technologies when real-life scenarios can be simulated.

Social Learning Theory began in the 1960s with Albert Bandura (Maccallum et al., 2017; Rosenstock et al., 1988). Social Learning Theory involves learning by observing, imitating and modelling other people in social contexts (Louw & Louw, 2007). Social Learning Theory explains a triadic reciprocal causation between a person, his/her environment and his/her behaviour (Bandura, 2001b). Social Learning Theory can help to explain learning with mobile and social media technologies where there is social interaction and observation.

Socio-cultural Theory was proposed by Lev Vygotsky in the early 1900s (Nouri, Cerratto-pargman, Eliasson, & Ramberg, 2011; Lantolf, 2000). Socio-cultural Theory focuses on the contribution that culture makes in the development of a person (Lantolf, 2000; Keskin & Metcalf, 2011). Socio-cultural Theory views learning as a social process that is based on the relationship between the social world and cognitive development (Zhou & Brown, 2015). Important parts of Socio-cultural Theory are language, culture and social relations (Engin, 2011). Socio-cultural Theory provides understanding about learning with mobile and social media technologies when these technologies facilitate cultural authenticity, collaboration and personalisation.

Transformative Learning Theory was developed in 1978 by Jack Mezirow (Illeris, 2009; Izmirli & Yurdakul, Kabakçi, 2014; Kucukaydin & Cranton, 2012). Transformative Learning Theory states that learning is acquired through experience, which results in new understanding and

changed behaviour in the future (Izmirli & Yurdakul, Kabakçi, 2014; Klobučar, 2016). Transformative Learning Theory exposes the relationship between cognitive experience, creation of understanding and autonomous thinking (Izmirli & Yurdakul, Kabakçi, 2014). Transformative Learning Theory may explain learning with mobile and social media technologies where these technologies enable deep changes in perspectives.

The prominent learning theories reviewed offer different perspectives about how learning may occur with mobile and social media technologies. In particular, Collaborative Learning, Communities of Practice, Connectivism, Conversation Theory and Social Learning Theory appear to relate well to learning with mobile and social media technologies. Nevertheless, researchers have begun developing new learning theories to specifically explain learning with mobile and social media technologies, such as M-learning Theory.

2.5.3 Mobile Learning (M-learning) Theory

M-learning has become a popular field globally and has attracted the attention of many researchers across various fields who acknowledge the potential of applying mobile and social media technologies to improve learning (Keskin & Metcalf, 2011). M-learning practices have been applied in many sectors, including education, business and military. This has led to the development of a learning theory to explain how learning occurs with mobile and social media technologies, namely M-learning Theory. M-learning Theory does not seek to replace traditional learning theories; instead, it complements traditional learning theories. M-learning Theory also supports informal learning and workplace learning (Sharples et al., 2005). M-learning Theory views the mobility of learning as the object of analysis and this gives a better understanding about how learning is acquired across various contexts, where people are always on the move and how learning can be managed across the transitions of life (Sharples et al., 2005). M-learning Theory takes into consideration learning that happens at home, work, outdoors, places of leisure, places of worship, cafes, stores and when travelling (Sharples et al., 2005).

Three key constructs of M-learning Theory have been identified as personalisation, authenticity and collaboration, which occur outside of the traditional learning time and space constraints (Kearney et al., 2012). Personalisation is based in Socio-cultural Theory and Motivational Theory and involves learner choice, agency, self-regulation and customisation, enabled by mobile and social media technologies. Authenticity refers to the real-world relevance, practices and personal meaning created by using mobile and social media technologies in everyday life situations. Collaboration involves participating in rich learning interactions with other people, typically mediated by mobile and social media technologies. Nevertheless, M-learning Theory continues to

be researched, defined and evolved with the continued development of new mobile hardware and software technologies.

In relation to M-learning Theory, the study focuses on the mobile and social media technology called WhatsApp and the important M-learning Theory aspect that WhatsApp was designed to support and facilitate, namely collaboration. Thus, the study concentrates on collaboration specifically instead of the development of M-learning Theory in general, to address the study's research problem and answer the study's research questions.

2.5.4 WhatsApp and learning

This section reviews the literature on WhatsApp to highlight the extent of research about WhatsApp and learning and further substantiate the study's research problem and significance.

It has been reported that WhatsApp has the potential to develop collective, supportive, collaborative communities of practice, enabling interactions amongst participants (Gachago et al., 2015). WhatsApp is a mobile technology or application that is used for communicating and has evolved into a powerful educational tool that promotes interaction and has the potential to enhance student participation during learning activities (Andujar, 2016). These interactions can be through WhatsApp groups (Gachago et al., 2015), which provide functionalities such as, communication among participants, nurturing of the social environment, encouraging sharing among learners and a learning platform (Bouhnik & Deshen, 2014). WhatsApp supports m-learning, that is, it allows learning from anywhere at any given time (Gon & Rawekar, 2017).

In particular, WhatsApp enables anonymous, asynchronous collaborative learning, which is reported to improve and increase the productivity and participation of less confident, shy learners (Rambe & Bere, 2013). Furthermore, WhatsApp is an instant messaging tool, in other-words, it sends messages real-time and it is one of the most popular communication applications in South Africa (Bere & Rambe, 2016) and globally (Ahad & Lim, 2014). WhatsApp enables learners to communicate with one another and with their teachers, to express ideas and to share information in various formats from anywhere at any time (Aburezeq & Ishtaiwa, 2013), therefore, in learning, WhatsApp can be used for discussions and sharing information that is course related (Ahad & Lim, 2014).

In addition, WhatsApp has the ability to create and enhance interaction between students, students-and-content and students and facilitators (Aburezeq & Ishtaiwa, 2013). WhatsApp helps to create immediacy and connection in informal learning, formal blended learning and open distance learning contexts (Gachago et al., 2015). WhatsApp enables insightful learning processes, for making and taking learning outside of the classroom (Gachago et al., 2015).

However, despite the benefits that exist, there are some challenges associated with WhatsApp, such as, extra workload, distraction from learning, less commitment to participate, exposure to unregulated messages or false information, addiction and expenses (Aburezeq & Ishtaiwa, 2013; Ahad & Lim, 2014), and it has been documented to negatively impact the performance of tertiary students (Gan et al., 2015). In addition, the use of WhatsApp can cause stress, lack of privacy and difficulties managing responsibilities, especially for more mature students (Gachago et al., 2015). Married students also find WhatsApp disruptive in the sense that it collides with their family time and as a result they prefer traditional classroom learning over WhatsApp (Bansal & Joshi, 2014; Rambe & Bere, 2013). So, there are mixed reports about the effects of WhatsApp use for learning. For example, one study shows that WhatsApp negatively impacted student performance (Gan et al., 2015), while another argues that it improved student performance (So, 2016).

Nevertheless, there is research indicating that students find learning through WhatsApp interesting and educationally convenient (Bansal & Joshi, 2014) and increases their motivation for learning (Awada, 2016). It can be argued that WhatsApp is affordable to use and increases the chances of learners participating in learning activities (Ahad & Lim, 2014; Bere & Rambe, 2016; Bouhnik & Deshen, 2014). Also, students have the ability to control or anticipate when information is false or unregulated when broadcasted on WhatsApp (Ahad & Lim, 2014), which adds an element of quality to the learning process.

Furthermore, WhatsApp has accessibility features, which makes it user-friendly so that even disabled individuals can use it (Calvo et al., 2014). WhatsApp also gives immediacy to learning (Bouhnik & Deshen, 2014). It is advised that WhatsApp be used in blended learning, integrated with face-to-face and mobile learning (Barhoumi, 2016) and can be an ideal tool for m-learning when used in a blended learning course strategy. It is further advised that WhatsApp in learning be encouraged as a supportive tool (Awada, 2016) and that WhatsApp be adopted as a collaborative learning tool (Kufre & Abe, 2017). WhatsApp can add fun to the learning process (Hanisi et al., 2018). WhatsApp can create equal learning opportunities for all genders (Kufre & Abe, 2017).

Research shows that several learning theories have been applied in WhatsApp studies. Socio-cultural Theory was involved in a study where WhatsApp was used for learning English as a second language (Andujar, 2016). It focused on the role of social interaction to develop cognition and took into consideration the technical aspects of mobile devices as well as the social and personal aspects of learning. In another study, Activity Theory was used to analyse learner interactions on WhatsApp for improving critique writing skills of English as a foreign language (Awada, 2016). Activity Theory was also used in a study to identify factors that influence students' participation in mobile learning activities and online discussions on WhatsApp (Barhoumi, 2015).

In another study, Activity Theory, Situated Learning Theory and Communities of Practice were applied to study the use of WhatsApp for supporting teaching and learning in higher education (Gachago et al., 2015). In addition, Experiential Learning Theory was applied in a study where WhatsApp was used to improve the standard of primary health care education (Willemse, 2015). In another study where Mobile Collaborative Learning was studied, the following theories were applied, Constructivism, Behaviorism, Situated Learning Theory, Context Awareness Learning, Collaborative Learning and Social Learning (Caballéa, Xhafab, & Barolli, 2010).

Thus, many of the prominent learning theories reviewed in the study have been applied in various ways to study WhatsApp, even Collaborative Learning Theory, which is a 20th century theory and, therefore, originally a classroom-based theory. Also it was not evident in the literature that the core features of collaboration had been explicitly measured for learning anywhere and anytime with the modern mobile and social media technology called WhatsApp. Thus, the study's problem statement, which is the lack of research measuring collaboration on WhatsApp in relation to students' academic achievement, was supported by the reviewed literature. Subsequently, to address the research problem, the study continued to search and review literature that specifically related to the general measuring of collaboration and associated constructs to guide the study's instrument development.

2.5.5 Measuring collaboration

The study reviewed and evaluated instruments that related to the measurement of collaboration from various fields based on their appropriateness and construct validity and reliability measures (Ariola, 2006; Straub, 1989). The study included those that had applicability, established construct validity and high reliability measures as inputs into the instrument development process, shown in Table 1. Descriptions of the included instruments and the studies that researched those instruments follow.

In the study by Roberts, van Wyk and Dhanpat (2017), various collaboration instruments were reviewed and it was reported that there was not yet an instrument developed and validated in South Africa for measuring collaboration. Of the various collaboration instruments reviewed in that study, the Thomson, Perry and Miller Collaboration Instrument (Thomson A et al., 2009), which was a five factor model of collaboration, was selected and applied it in a South African context resulting in the Thomson, Perry and Miller (2007) Collaboration Instrument in the South African Context for collaboration.

In another study, five prominent instruments were selected to be reviewed as instruments for measuring nurse and physician collaboration. The instrument that was accessible and relevant was

the Collaboration with Medical Staff Scale of the Nurses Opinion Questionnaire (CMSS-NOQ) (Dougherty & Larson, 2005). The CMSS-NOQ was developed to determine the physical and social aspects of acute hospital environments and measures perceived collaboration, autonomy, independent actions and outcomes.

Further applicable instruments include the Collaboration and Trust in an Education Context (Hoy & Tschannen-Moran, 1999; Tschannen-Moran, 2001), which is an instrument used to measure collaboration between principals, teachers and parents, the Wilder Collaboration Factors Inventory (Townsend & Shelley, 2008), which is used for a general measure of collaboration, the Collaboration Index, which is a measure for supply chain collaboration between supply chain participants (Simatupang & Sridharan, 2005), the Collaborative Culture Scale (López et al., 2004), which is an instrument used to measure collaboration through values attributed to a collaborative culture, and the Assessment of Inter-professional Team Collaboration Scale (Orchard et al., 2012), which is an instrument used to measure collaboration between health professionals.

Another study introduced the Collaboration Assessment Tool (CAT), which is an evaluation tool and a seven-factor model of effective collaboration, to evaluate collaboration (Marek et al., 2015). This tool and model provides an instrument for building collaborative efforts in an international, comprehensive and effective manner and can be used in various disciplines (Marek et al., 2015). In addition, the Transdisciplinary Tobacco Use Research Centres (TTURC) Researcher Survey is an instrument for measuring collaborative processes and transdisciplinary integration and is based on Rosenfield's conceptualisation of transdisciplinary scientific collaboration which explains a continuum of collaborative research in various ranges (Mâsse et al., 2008). The Index of Interprofessional Team Collaboration for Expanded School Mental Health (IITC-ESMH) (Mellin et al., 2010) is used to measure the functioning of interprofessional teams and focuses on the collaboration of various communities such as schools, family and society where learning is conducted and promotes mental health strategies.

The Teacher Collaboration Assessment Survey (TCAS) (Woodland et al., 2013) operationalises and measures four elements, namely, dialogue, decision making, action and evaluation and it has been used to measure the quality of teacher collaboration (Woodland et al., 2013). The Distance Education Learning Environment Survey (DELES) is used for researching and measuring psychosocial learning in distance learning environments and addresses six domains, namely, personal relevance, student interaction and collaboration, authentic learning, instructor support, active learning and student autonomy (Walker & Fraser, 2005). The Index of Interdisciplinary Collaboration (IIC) was developed to measure interdisciplinary collaboration between social workers and other professionals and is made up of five components, namely, newly created

professional activities, interdependence, collective ownership of goals flexibility and reflection on process (Bronstein, 2002).

The Expanded School Mental Health Collaboration Instrument [School Version] is an instrument that was developed to measure collaboration amongst school-employed professionals (Mellin et al., 2016). The Collaborative Practice Assessment Tool (CPAT) was developed to assess collaboration practice in interprofessional teams (Schroder et al., 2011). The tool includes nine domains, namely leadership, mission and goals, role responsibilities and autonomy , relationships, communication, community linkages and coordination, decision-making and conflict management, patient involvement and perceived effectiveness (Schroder et al., 2011). The aforementioned instruments were analysed further in Table 1:

Table 1: Analysis of the included instruments measuring collaboration

#	Instrument Name	Main Factors / Constructs Measured	Reported Construct Validity	Reported Reliability
1	Thomson, Perry and Miller Collaboration Instrument (Thomson A et al., 2009)	1. Governance	Established using a validity coefficient (standardised lambda coefficient)	$R^2 = 0.87$
		2. Administration		$R^2 = 0.87$
		3. Autonomy		$R^2 = 0.49$
		4. Mutuality		$R^2 = 0.93$
		5. Norms (Trust)		$R^2 = 0.94$
2	Thomson, Perry and Miller (2007) Collaboration Instrument in the South African Context (Roberts et al., 2017)	1. Governance	Established using Principal Component Analysis (PCA)	Cronbach's alpha = 0.95
		2. Mutuality		Cronbach's alpha = 0.92
		3. Norms		Cronbach's alpha = 0.90
		4. Autonomy		Cronbach's alpha = 0.85
3	Collaboration with Medical Staff Scale of the Nurses Opinion Questionnaire (CMSS-NOQ) (Dougherty & Larson, 2005)	1. Leadership	Established using Factor Analysis	Cronbach's alpha = 0.86 and test-retest Pearson correlation coefficient = 0.83
		2. Practice		
		3. Relationships		
		4. Influence		
4	Collaboration and Trust in an Education Context (Hoy & Tschannen-Moran, 1999; Tschannen-Moran, 2001)	1. Collaboration with the principal	Established using Principal Component Analysis (PCA)	Cronbach's alpha = 0.93
		2. Collaboration among teacher colleagues		Cronbach's alpha = 0.97
		3. Collaboration with parents		Cronbach's alpha = 0.95

#	Instrument Name	Main Factors / Constructs Measured	Reported Construct Validity	Reported Reliability
		4. Faculty trust in the principal	Established using Factor Analysis	Cronbach's alpha = 0.98
		5. Faculty trust in colleagues		Cronbach's alpha = 0.98
		6. Faculty trust in clients		Cronbach's alpha = 0.97
5	Wilder Collaboration Factors Inventory (Townsend & Shelley, 2008)	1. Community	Established using Factor Analysis	Cronbach's alpha = 0.66 to 0.86
		2. Membership		
		3. Purpose		
		4. Resources		
6	Collaboration Index (Simatupang & Sridharan, 2005)	1. Information sharing	Established using Factor Analysis	Cronbach's alpha = 0.86
		2. Decision synchronisation		Cronbach's alpha = 0.88
		3. Incentive alignment		Cronbach's alpha = 0.72
7	Collaborative Culture Scale (López et al., 2004)	1. Collaborative culture	Established using Factor Analysis	Reliability coefficient = 0.85
8	Assessment of Inter-professional Team Collaboration Scale (Orchard et al., 2012)	1. Partnership	Established using Factor Analysis	Cronbach's alpha = 0.97
		2. Cooperation		Cronbach's alpha = 0.94
		3. Coordination		Cronbach's alpha = 0.80
9	Collaboration Assessment Tool (CAT) (Marek et al., 2015)	1. Context	Established using Factor Analysis	Cronbach's alpha = 0.86
		2. Membership		Cronbach's alpha = 0.91
		3. Process / Organisation		Cronbach's alpha = 0.86
		4. Communication		Cronbach's alpha = 0.85
		5. Function		Cronbach's alpha = 0.84
		6. Resources		Cronbach's alpha = 0.79
		7. Leadership		Cronbach's alpha = 0.92
10	Transdisciplinary Tobacco Use Research Centers (TTURC) Researcher Survey (Mâsse et al., 2008)	1. Satisfaction with the collaboration	Established using Factor Analysis	Cronbach's alpha = 0.91
		2. Impact of collaboration		Cronbach's alpha = 0.87
		3. Trust and respect		Cronbach's alpha = 0.75
11	Index of Interprofessional Team Collaboration for	1. Reflection on process		Cronbach's alpha = 0.91

#	Instrument Name	Main Factors / Constructs Measured	Reported Construct Validity	Reported Reliability
	Expanded School Mental Health (IITC-ESMH) (Mellin et al., 2010)	2. Professional flexibility	Established using Factor Analysis	Cronbach's alpha = 0.91
		3. Newly created professional activities		Cronbach's alpha = 0.84
		4. Role interdependence		Cronbach's alpha = 0.80
12	Teacher Collaboration Assessment Survey (TCAS) (Woodland et al., 2013)	1. Dialogue	Established using Principal Component Analysis (PCA)	Item reliability of separation = 0.98
		2. Decision making		
		3. Action		
		4. Evaluation		
13	Distance Education Learning Environment Survey (DELES) (Walker & Fraser, 2005)	1. Instructor support	Established using Principal Component Analysis (PCA)	Cronbach's alpha = 0.87
		2. Student interaction and collaboration		Cronbach's alpha = 0.94
		3. Personal relevance		Cronbach's alpha = 0.92
		4. Authentic learning		Cronbach's alpha = 0.89
		5. Active learning		Cronbach's alpha = 0.75
		6. Student autonomy		Cronbach's alpha = 0.79
14	Index of Interdisciplinary Collaboration (IIC) (Bronstein, 2002)	1. Interdependence	Established using Factor Analysis	Cronbach's alpha = 0.77
		2. Newly created professional activities		Cronbach's alpha = 0.76
		3. Flexibility		Cronbach's alpha = 0.56
		4. Collective ownership of goals		Cronbach's alpha = 0.76
		5. Reflection in process		Cronbach's alpha = 0.82
15	Expanded School Mental Health Collaboration Instrument [School Version] (Mellin et al., 2014)	1. Collaboration with community mental health professionals	Established using Factor Analysis	Cronbach's alpha = 0.91
		2. Collaboration with school colleagues		Cronbach's alpha = 0.73
		3. Collaboration with families		Cronbach's alpha = 0.84
		4. Outreach and approach by mental health professionals from collaborating agencies		Cronbach's alpha = 0.94
		5. School administrator support		Cronbach's alpha = 0.91

#	Instrument Name	Main Factors / Constructs Measured	Reported Construct Validity	Reported Reliability
		6. Interpersonal processes		Cronbach's alpha = 0.93
		7. School outreach to communities and families		Cronbach's alpha = 0.72
		8. Improved family–school relationships		Cronbach's alpha = 0.88
		9. Support for students and teachers		Cronbach's alpha = 0.89
		10. Increased mental health programming		Cronbach's alpha = 0.88
		11. Improved access for students and families		Cronbach's alpha = 0.84
16	Collaborative Practice Assessment Tool (CPAT) (Schroder et al., 2011)	1. Mission, meaningful purpose, goals	Established using Factor Analysis	Cronbach's alpha = 0.78
		2. General relationships		Cronbach's alpha = 0.81
		3. Team leadership		Cronbach's alpha = 0.84
		4. General role responsibilities, autonomy		Cronbach's alpha = 0.73
		5. Communication and information exchange		Cronbach's alpha = 0.74
		6. Community linkages and coordination of care		Cronbach's alpha = 0.73
		7. Decision-making and conflict management		Cronbach's alpha = 0.74

Table 1 provides a comprehensive set of collaboration instruments for inclusion in the study. However, not every factor and/or construct in every instrument in Table 1 was applicable and relevant to the study's research problem. Thus, for each instrument in Table 1, each factor and/or construct was subjectively evaluated by the researcher for inclusion, adaptation into or exclusion from the study. The evaluation was guided by the researcher's knowledge and familiarity of the subject domain and evaluation of importance to the research problem, parsimony and falsifiability (Weber, 2012). Thus, the study proceeded to develop a new instrument, since a single suitable one was not evident in the literature, to address the research problem by measuring the effects, if any, of the various relevant constructs involved during learning on WhatsApp on collaboration and academic achievement as central concepts, based on the research problem.

Based on the evaluation, the included and adapted relevant constructs were Interaction (IA), Support (S), Information Exchange (IE), Sense of Community (SC), Interdependence (ID), Trust (T), Active Learning (AL), Formality (F) and Collaboration (C). In addition, the construct

Academic Achievement (AA) was included since it was essential for addressing the research problem. In the study, these relevant constructs were applied to students/learners who used WhatsApp for academic learning and these constructs are clarified in Section 2.6.

2.6 Construct clarification

Interaction (IA) is defined as the amount of reciprocal action and engagement, such as discussing, sharing, chatting and meeting, between two or more learners using WhatsApp for academic learning. Support (S) is defined as the amount of help and assistance that is provided to a learner, who is experiencing learning difficulties, by other learners using WhatsApp for academic learning. Information Exchange (IE) is defined as the amount of information exchanged as part of the learning processes using WhatsApp for academic learning. Sense of Community (SC) is defined as a learner's feeling of belonging to a group with shared interests, goals and needs, using WhatsApp for academic learning. Interdependence (ID) is defined as the contingency or condition that other learners are part of a learner's learning process, using WhatsApp for academic learning. Trust (T) is defined as the level of confidence that a learner has in other learners using WhatsApp for academic learning. Active Learning (AL) is defined as being opposite to passive learning and comprises meaningful learning activities and applied learning on WhatsApp for academic learning. Formality (F) is defined as how casual and relaxed or academically correct and serious the engagement is between a learner and the other learners by virtue of the language they use, using WhatsApp for academic learning.

Collaboration (C) is defined as the amount of working and contributing together that takes place in a group of learners to achieve the common goal of learning using WhatsApp. Collaboration (C) differs from Interaction (IA) by focusing on the achievement of learning activities by working together while Interaction (IA) focuses only on learning activities requiring reciprocal action and engagement without the need for achievement of any learning goals. It is conceivable that Interaction (I) could occur without any working together to achieve learning goals or outcomes. Their difference is subtle but useful for the addressing the research problem. The difference between Collaboration (C) and Support (S) is clearer, based on the definitions, where Support (S) refers to experienced difficulties and help provided to overcome those difficulties. Information Exchange (IE) differs from Collaboration (C) because it relates to the amount of course/module material and information exchanged alone and does not refer to working together to achieve learning goals. It is conceivable that Information Exchange (IE) could occur without any working together to achieve learning goals or outcomes. Sense of Community (SC) is distinct from Collaboration (C) since it is mostly an emotion where the feeling of belonging is experienced while

Collaboration (C) mostly refers to activities. Interdependence (ID) is different to Collaboration (C) as it relates to a learner's reliance on other learners in order to learn instead of working together to achieve learning goals or outcomes. Trust (T) is distinct from Collaboration (C) because it refers to the confidence that a learner has in other learners. Active Learning (AL) is also different to Collaboration (C) since it relates to the type of learning that occurs and Formality (F) differs from Collaboration (C) as it refers to the nature of communication used.

In addition, it was necessary to measure student academic achievement in an acceptable way to address the research problem. Actual student grades are variables that measure academic achievement after writing a test or examination (Allen, 2005). However, the study did not have access to the participants' grades, thus, a construct called Academic Achievement (AA) was defined as a learner's self-reported academic achievement.

2.7 Initial measurement items for each construct

Subsequent to the conceptual definitions of the selected constructs, a set of items representing the conceptual domain of each construct was generated (MacKenzie et al., 2011). The items for each construct were generated by adapting measurement items from the corresponding constructs in the instruments reviewed in Table 1. The generated measurement items were then assessed for their content validity, which relates to how well a construct's items represent all aspects of that construct (MacKenzie et al., 2011). The study's researcher, a postgraduate university educated student conducted the assessments, since university-educated students are adequately representative of the intended generalised population. Qualitative subjective assessments were performed by the researcher guided by the researcher's knowledge and familiarity of the subject domain and the MacKenzie et al. construct measurement framework (MacKenzie et al., 2011), which required, for each item, assessing whether the item represented the content of the construct that it was assigned to measure, and for each construct, whether all the items assigned to measure that construct represented the entire content of that construct. After three iterations and changes, the initial measurement items stabilised and are presented in Table 2.

In addition, six items per construct were generated to balance adequate domain sampling and parsimony for construct and content validity and response bias and fatigue (Hinkin, 1995). Each item was measured using a five-point Likert measurement scale from 1 to 5, where 1= "strongly disagree", 2= "disagree", 3= "neither disagree nor agree", 4= "agree" and 5= "strongly agree" (Sekaran & Bougie, 2013). The higher the aggregate value for each item the more of that construct would be evident on WhatsApp for academic learning.

Table 2: Initial measurement items for each construct.

#	Construct	Measurement Items
1	Interaction (IA)	***When I am on WhatsApp with other students:*** 1. We have discussions to learn from each other. 2. We participate with each other to learn. 3. We have chats to learn from each other. 4. We share with each other to learn. 5. We have meetings with each other to learn. 6. We communicate with each other to learn.
2	Support (S)	***When I am on WhatsApp with other students:*** 1. They help me on my courses/modules. 2. They reduce the stress from my courses/modules. 3. They assist with difficult parts of my courses/modules. 4. They aid me when I am stuck on my courses/modules. 5. They lend a hand so I can figure out my courses/modules. 6. They encourage me to keep going on my courses/modules.
3	Information Exchange (IE)	***When I am on WhatsApp with other students:*** 1. We send and receive course/module information. 2. Course/module material gets passed around. 3. We swap course/module information. 4. Course/module material is spread around. 5. We distribute course/module information. 6. Course/module knowledge is circulated.
4	Sense of Community (SC)	***When I am on WhatsApp with other students:*** 1. I feel that I belong to a learning group. 2. I matter to my learning group. 3. My learning group matters to me. 4. My learning group benefits our learning. 5. My learning group has shared interests in learning. 6. My learning group has similar academic goals.
5	Interdependence (ID)	***When I am on WhatsApp with other students:*** 1. I rely on other students to learn. 2. Other students rely on me to learn. 3. My learning requires other students. 4. I need other students to learn. 5. Other students need me to learn. 6. My learning is conditional on other students.
6	Trust (T)	***When I am on WhatsApp with other students:*** 1. Other students provide honest course/module advice. 2. I believe in what other students say to me about courses/modules. 3. I have faith in the course/module communication from other students. 4. The course/module discussions with other students are sincere. 5. The course/module conversations with other students are genuine. 6. I am certain that other students provide truthful information.
7	Active Learning (AL)	***When I am on WhatsApp with other students:*** 1. I learn by having debates with other students. 2. I learn by working on questions with other students. 3. I learn by doing activities with other students.

#	Construct	Measurement Items
		4. I learn by solving study problems with other students. 5. I teach other students learning material. 6. I show other students how to figure out their courses/modules.
8	Formality (F)	***When I am on WhatsApp with other students:*** 1. We use academic language only when talking about courses/modules. 2. Messages about courses/modules contain academic content only. 3. When learning, we use correct wording only. 4. When learning, we discuss academic content only. 5. During course/module communication, we use scientific language only. 6. We use textbook wording only when chatting about courses/modules.
9	Collaboration (C)	***When I am on WhatsApp with other students:*** 1. We work together to understand our courses/modules. 2. We learn collectively to solve course/module problems. 3. We contribute jointly to learn our courses/modules. 4. When preparing for tests or exams we learn together. 5. We study as a group. 6. We learn our courses/modules together.
10	Academic Achievement (AA)	***Since I started using WhatsApp for learning:*** 1. My courses'/modules' marks have improved. 2. I do better in tests and exams. 3. I am able to achieve better success in my assignments. 4. I have had more success in my courses/modules. 5. I understand my courses/modules better. 6. My courses/modules are easier to do.

2.8 Specifying the initial measurement and basic structural model

Measurement model specification involves the focal constructs, their interrelationships and how the items relate to those constructs. Figure 1 provides the initial measurement and basic structural model which shows all of the constructs as unidimensional or reflective constructs and without sub-dimensions or conceptually distinguishable facets (Petter et al., 2007). At this conceptual stage it is not known how each of the constructs IA, S, IE, SC, ID, T, AL and F could interrelate. Nevertheless, based on the instruments and literature reviewed, it is evident that they are important when measuring C and influence C. Therefore, only a general relationship is specified between all those constructs and C. In addition, the relationship from C to AA is specified since it is the central focus of the study. These relationships are specified as the following alternate hypotheses (HA_{1-n}). The corresponding null hypotheses ($H0_{1-n}$) specify that there are no associations among each set of constructs.

1. IA positively influences C,
2. S positively influences C,

3. IE positively influences C,
4. SC positively influences C,
5. ID positively influences C,
6. T positively influences C,
7. AL positively influences C,
8. F negatively or positively influences C, and
9. C positively influences AA.

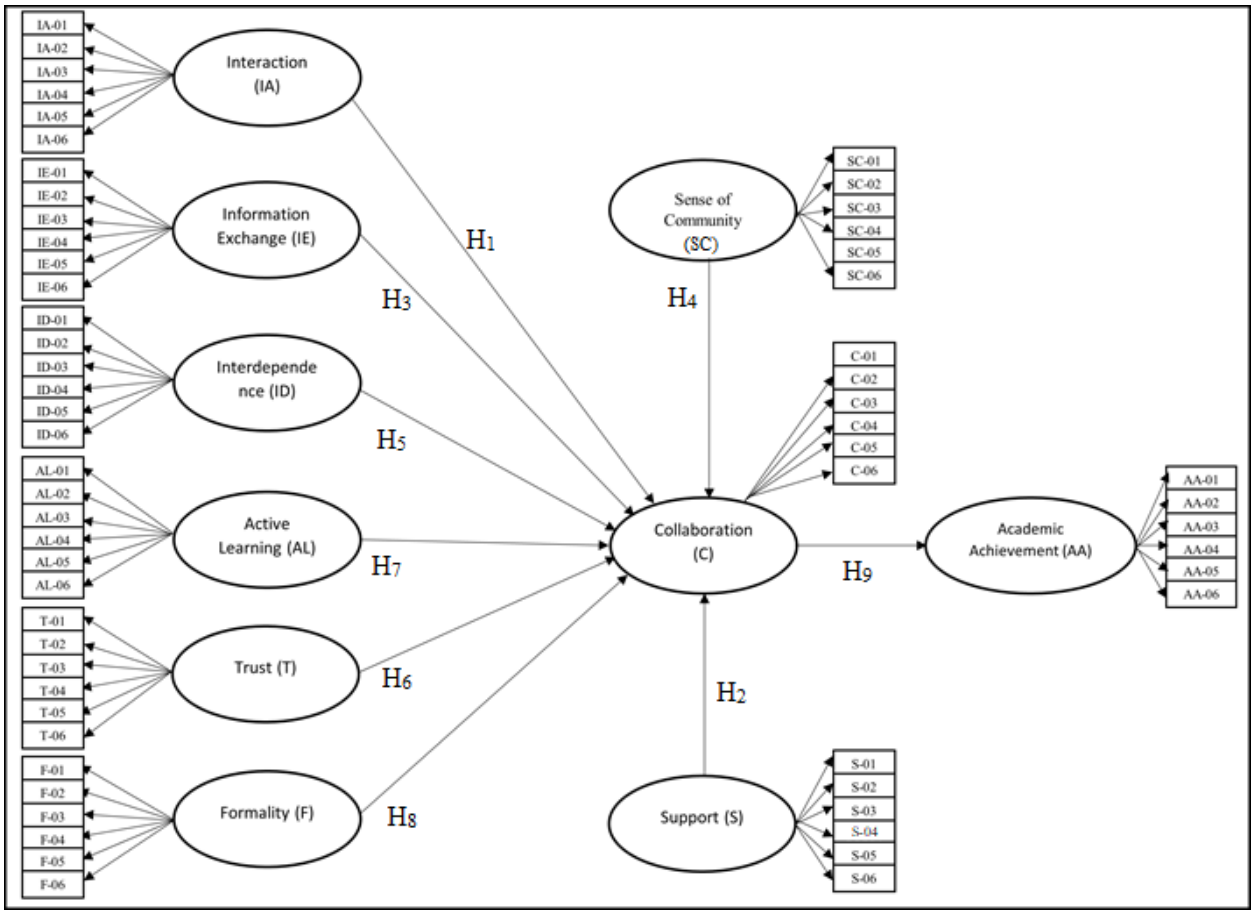

Figure 1: Initial measurement and basic structural model

2.9 Chapter summary and conclusions

The literature synthesised in Chapter Two demonstrated how learning has changed over time with technology and eventually moved outside of the classroom with m-learning. The relevant, prominent learning theories evident in the literature and the current explanations and definitions of m-learning theory were also explained. Chapter Two demonstrated the research requirement for the study to measure collaboration on WhatsApp in relation to academic achievement.

Subsequently, Chapter Two used the literature to develop relevant constructs, initial measurement items and the initial research model and hypotheses.

Chapter Two achieved the following specified objectives, namely it detailed the literature review process to demonstrate a rigorous literature review, revealed key theories, models, frameworks and phenomena in the domain, clarified the contribution of the research and specified the initial research model, measurement items and hypotheses. As such, the chapter achieved its goal, which was to analyse and synthesise past research studies that relate to measuring collaboration in relation to students' academic achievement and provide an answer to Research Question One.

In conclusion, Chapter Two exposed the relevant and appropriate constructs in the research domain for addressing the research problem and achieving the research objective and provides the basis for measuring collaboration on WhatsApp in relation to students' academic achievement. The chapter presented its process for conducting a literature review, which includes searching, analysing and synthesising. In addition, Chapter Two discussed prominent learning theories and justified the initial research model and measurement items for the study's specific research problem and objectives. The chapter also has value for teaching practice by exposing prominent learning theories, M-learning Theory and WhatsApp for learning to support curriculum and learning design.

Chapter Three, details the study's research methodology. Chapter Three justifies the study's methodological choices, provides the processes involved in gathering and analysing the empirical data and explains how rigour is maintained.

Chapter 3: Research Methodology

3.1 Chapter introduction

The previous chapter presented the literature review. Chapter Three provides the design for the empirical work. The goal of Chapter Three is to clarify and substantiate the research methodology for answering Research Question Two. To achieve this goal, Chapter Three has the objectives of substantiating the research strategy in relation to the study's research problem, objective and questions, explaining the sampling and data collection methods, detailing how bias was mitigated, discussing research quality, rigour and research ethics and providing the data analysis method.

The next sections include the research philosophy, the methodological choice and research strategy. Thereafter, the sampling and data collection procedures are described. Following are the bias types and mitigation, research quality, rigour and research ethics. Then, the data analysis-principles and processes and the summary and conclusion sections are provided.

3.2 Research philosophy and methodological choice

Research philosophy relates to a researcher's worldview and how knowledge is acquired in that worldview (Saunders & Tosey, 2013). A general dichotomy in research philosophies is often presented by referring to interpretivism and positivism (Saunders & Tosey, 2013). Interpretivism is a worldview of subjective experience where knowledge is socially constructed. Subsequently, interpretivist research often involves qualitative data and interviews to obtain rich, in-depth information about the subjective, social experiences of a small number of people involving non-numeric data such as images, words, sounds and videos (Oates, 2006). Interpretivism is also associated with inductive theory building. In contrast, positivism is a worldview of objective experience where knowledge is acquired through direct observation and measurement. In positivism, data collection and analysis are typically quantitative where the same closed-ended questions are put to many people to obtain numeric data about a limited set of concepts. Positivism is associated with deductive theory testing. To effectively address the research problem and answer the research questions, the study adopts a positivistic approach and collects quantitative data using closed-ended questions from gathered from a large number of people.

3.3 Research strategy

The selection of the study's research strategy follows from the philosophical perspective and the purpose of the research (Shepard et al., 1993). Positivism is associated with quantitative research

strategies and methods such as experiments and surveys (Bhattacherjee, 2012; Shepard et al., 1993) and based on the study's research problem, questions and objective, a questionnaire survey is the appropriate research strategy for the study. In addition, the survey method is a method that fits the operational rules for a positivist study (Shepard et al., 1993) and is appropriate where individuals are the unit of analysis (Bhattacherjee, 2012).

Surveys became formal research methods in the 1930-1940s and have been a prominent research method, especially for quantitative research in social sciences (Bhattacherjee, 2012). Data collection using questionnaires is often used with this research strategy to systematically collect data about people and their thoughts, preferences and behaviours (Bhattacherjee, 2012). Questionnaires typically require that participants respond in writing and may be done using the modes of mails, group-administered or online, and using multimode of data collection may increase the response rate (Healey et al., 2002).

Some of the benefits of surveys when compared to other methods include that surveys are useful for measuring a broad range of unobservable data such as individuals' traits, preferences, beliefs, attitudes and behaviours or factual information (Bhattacherjee, 2012). Surveys are also useful for studies where there are large groups of participants and mails, emails and telephones can be used to contact participants. Surveys can be unobtrusive in nature and enable respondents to participate at their own convenience, making questionnaire surveys favourable amongst participants (Bhattacherjee, 2012). Surveys enable detection of small effects even while analysing multiple variables and enable comparative analysis of population subgroups. Furthermore, surveys are cost, time and effort efficient for researchers compared to many other research strategies.

There are also some challenges associated with surveys, which have to be balanced against the benefits since no single method is risk free or without limitations. Surveys can create room for biases in research such as non-response bias and sampling bias (Bhattacherjee, 2012). These biases and the study's mitigation plans are discussed in Section 3.6. Further limitations of surveys include common methods variance mitigated in the study by conducting exploratory factor analysis and establishing construct validity, respondents not providing honest and accurate answers, respondents providing answers that they feel will make them look good, respondents interpreting the response scales differently and lack of depth of answers where it is not possible to discover additional information about why a respondent answered in a particular way or ask a new set of questions. However, balancing these limitations against the benefits to the study, including cost-effectiveness, generalizability, reliability and versatility and the potential for addressing the research problem and answering the research questions, the benefits outweighed the limitations with their mitigation plans and it was appropriate to proceed with the survey method.

Positivist surveys commonly use quantitative statistical analysis for data analysis (Shepard et al., 1993). Two statistical analysis categories are descriptive analysis and inferential analysis (Bhattacherjee, 2012). Descriptive statistics describe aspects of a sample or population and use measures of central tendency and variability or spread. In contrast, inferential statistics enable inferences and predictions to be made about a population from a sample of data taken from that population and can be used to test theory (Bhattacherjee, 2012). A flow diagram depicting the study's overall empirical process is presented in Figure 2.

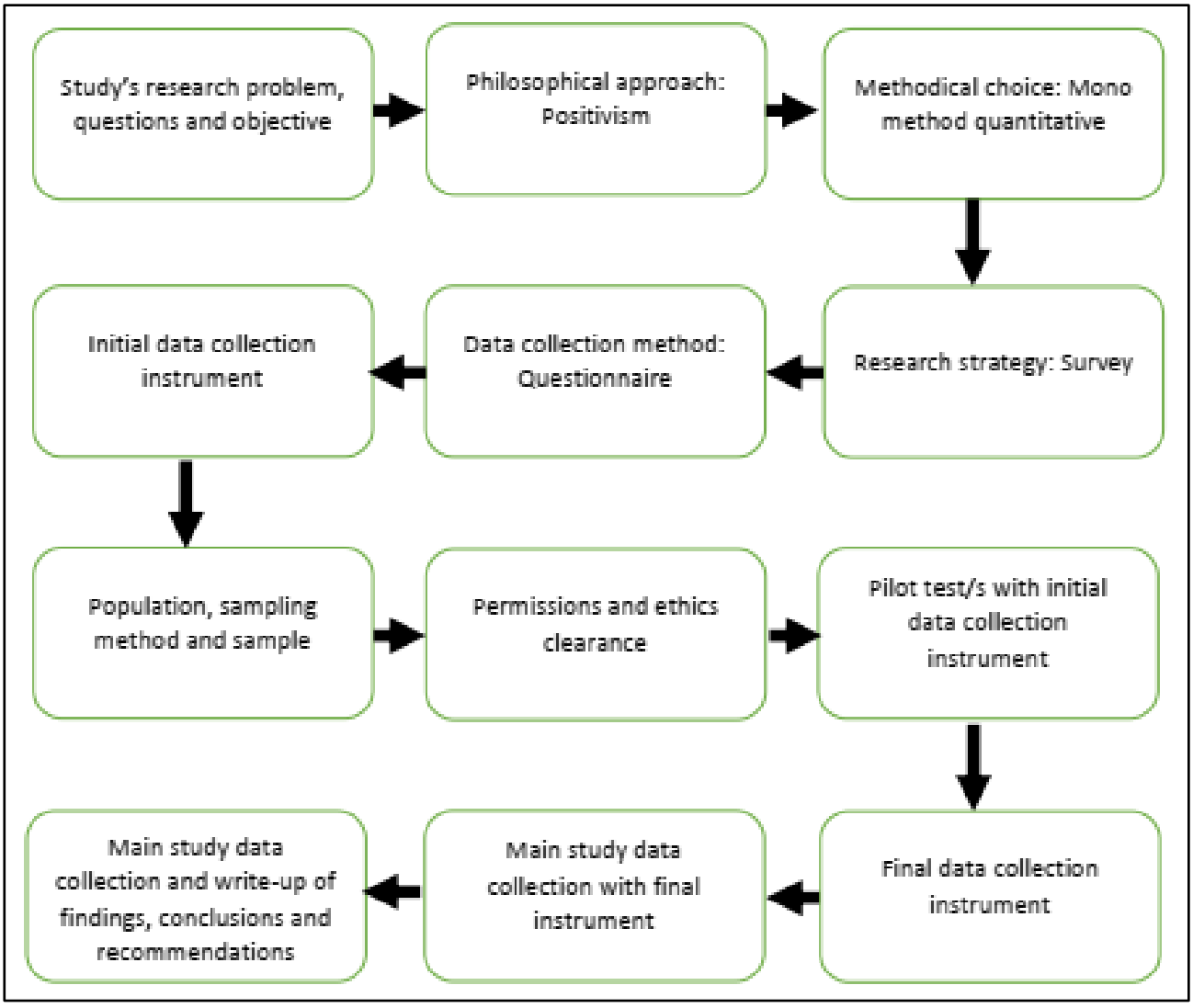

Figure 2: Flow diagram of the overall empirical process

3.4 Sampling and data collection

3.4.1 Sampling

A population involves the totality of elements such as people, events or objects that are of interest to a researcher that can provide answers to research questions and address research problems (Sekaran & Bougie, 2013). Based on the research problem, questions and objective, the population could be considered every student globally where a student in the study is defined as a person formally registered at a tertiary educational institution. However, it is practically impossible to access every single person in such a population and more so when considering that the study has time and resource constraints. However, common research practice is to access a sample or a subset of the population instead, which is an efficient practice and one that can still provide answers to the research questions, address the research problem and contribute to knowledge generation.

Selecting such a sample requires careful consideration of the sampling method applied (Tongco, 2007). The sampling method specifies the process of selecting the right people, events or objects (Sekaran & Bougie, 2013). There are different types of sampling methods, namely, probability sampling which includes simple random sampling, stratified random sampling, systematic sampling, area sampling, double sampling and cluster sampling, and nonprobability sampling which includes judgement/purposive sampling, convenience sampling and quota sampling (Sekaran & Bougie, 2013). The main difference between probability sampling and nonprobability sampling is that in probability sampling all the sample units in the population have an equal chance of being chosen and any findings are more likely to correctly reflect that population while in nonprobability sampling people are selected based on criteria such as their appropriateness or unique characteristics or ease of access. Each sampling method presents certain advantages and disadvantages for any study as presented in Table 3.

Table 3: Probability and nonprobability sampling designs

Sampling Design	Description	Advantages	Disadvantages
Probability sampling			

Sampling Design	Description	Advantages	Disadvantages
Simple random sampling	Every element of a population is taken into account, as a result, none of the elements are more favourable over other elements. In addition, every element is eligible to be used.	This method yields a generalisable finding.	Need a sample frame. It is less effective compared to stratified sampling.
Systematic sampling	A random point in the sample frame is chosen, then every nth element is selected.	This method is easy for usage provided there is a sample frame.	Systematic biases may occur. Need a sample frame.
Stratified random sampling	Elements are organised in ratio to the initial population sizes after the population is separated into segments.	It is the most effective probability design method. This method allows every group to be effectively sampled, in addition, evaluations can be conducted among these groups.	Need a sample frame. This method requires more time as compared to random sampling and systematic sampling.
Cluster sampling	The first step of this method identifies groups with diverse participants, groups are then randomly selected. Further, every element of the selected group is studied.	Low data collection costs in geographic clusters.	Need a sample frame. Subsections of clusters are less diverse, as a result, it is the least reliable and inefficient probability sampling method.
Area sampling	This is an extension of cluster sampling where sampling occurs within a certain area.	It is a less expensive method. It is a useful method for decisions related to a specific location.	Need a sample frame. This method requires a lot of time in order to collect data from an area.

Sampling Design	Description	Advantages	Disadvantages
Double sampling	The selected sample or subsection of the sample is investigated twice.	This method yields comprehensive knowledge around the studied area.	Need a sample frame. There are possibilities that initial biases may exist in both investigations. Participants may not find it pleasant to participate in repeatedly.
Non-probability sampling			
Convenience sampling	Selected elements or participants are those that are easily accessible.	This method is quick, inexpensive and convenient to use.	This method is not generalisable.
Judgment/ purposive sampling	Participants are selected based on their expertise or unique characteristics in relation to the subject investigated.	This is sometimes the only way to answer research questions.	The generalisability of research findings and conclusions is likely to be questionable. The outcomes of the investigation are not generalisable to the entire population.
Quota sampling	Elements are chosen expediently from a targeted group based on a predetermined number.	It is effective in studies where lesser elements are to be used for a study.	It does not easily give a true reflection of what occurs in the entire population.

Given that it is not practically possible for the study to access or to obtain a complete list or sample frame of every student across the globe or even across South Africa to draw a random sample, the study proceeds with judgement/purposive sampling. The literature (Tongco, 2007) indicates that judgement/purposive sampling can be used effectively in quantitative research designs where the sample is representative of or fits the profile of the participants to which the research problem relates and enables the research problem to be addressed. Other quantitative studies such as Grover and Segars (2005) and Chu, Hsiao, Lee and Chen (2004) have effectively used purposive sampling. Furthermore, purposive sampling can be used to produce research that is replicable, rigorous and

relevant. Purposive sampling is efficient and accesses people who are relevant, knowledgeable about and applicable to the research topic. Purposive sampling also does not restrict sample size, which is relevant to the study's application of structural equation modelling (SEM).

Nonetheless, purposive sampling is an inherently biased sampling method and requires caution when applied in quantitative research (Tongco, 2007). In purposive sampling, selection bias may occur where participants with characteristics important to the study are omitted intentionally or unintentionally. The result is that conclusions and inferences from the study cannot be applied beyond the actual purposive sample, which limits the study's external validity (Sekaran & Bougie, 2013). External validity relates to the generalisability of the results to a wider population. However, it can be argued that a study using purposive sampling exhibits external validity on the sample and contributes to theory because it can be replicated for confirmation in broader populations (Tongco, 2007). To mitigate selection bias in the study, specific criteria were used when selecting participants, which related directly to the research problem, questions, and objective, to enable to study to make a theoretical and empirical contribution to the field. The research problem focuses on measuring collaboration on WhatsApp in relation to students' academic achievement.

Thus, the sampling was guided by the study's research problem, which related directly to students in tertiary education institutions. The researcher was required to purposively gather data from a wide variety of students in tertiary education institutions. To this end, the researcher had practical access to two tertiary education institutions, being tertiary education institutions conveniently located within the researcher's geographical area (*the participant institution names have been removed to maintain participant anonymity*). These two tertiary education institutions were a good choice to address the research problem and answer the research questions because these institutions would provide enough data and demographic diversity to address the research problem and develop valuable insights. In addition, the sample covered undergraduate and honours level students as it is expected that these students would be more likely to use WhatsApp given their relatively younger age than older postgraduate students. Furthermore, the sampled students would provide relevant data from both academic and vocational qualifications and several different qualification types to improve the breadth of student characteristics and representativeness.

So, the study purposively selected tertiary education students and, within this broad scope, the study narrowed the sample to two accessible tertiary institutions, namely a university and a technical and vocational education and training (TVET) college both located in the Free State province in South Africa.

In addition to the sampling method, the sample size required careful consideration. To address the research problem the study used structural equation modelling (SEM) for data analysis. So, the

sample size needed to be adequate for SEM analysis. SEM enables multiple variables and their interrelationships to be measured simultaneously (Hoe, 2008). Thus, it is said to be more versatile compared to other multivariate techniques (Hoe, 2008). For effective SEM analysis, as a rule of thumb, it is said that at least two-hundred participants should be used (Hoe, 2008). Nonetheless, comparable studies since 2012 that used SEM were referenced to assess the rule of thumb in terms of how many participants were accessed for their SEM analyses. Table 4 presents nineteen prior comparable studies.

Table 4: WhatsApp and relevant social media studies that used SEM

Reference	Study Title	Sample Size Used
(Ahani et al., 2017)	Forecasting social CRM adoption in SMEs: A combined SEM-neural network method	360
(Hajli, 2014a)	A study of the impact of social media on consumers	800
(Kang & Schuett, 2013)	Determinants of sharing travel experiences in social media	1048
(Schreiner & Hess, 2015)	Examining the role of privacy in Virtual Migration: The case of WhatsApp and Threema	251
(Lee & Ma, 2012)	News sharing in social media: The effect of gratifications and prior experience	210
(Chaturvedi, 2017)	SEM modelling approach for studying the social impact of WhatsApp usage	201
(Hajli, 2015)	Social commerce constructs and consumer's intention to buy	1000
(Stibe, 2015)	Towards a framework for socially influencing systems: Meta-analysis of four PLS-SEM based studies	101
(Shambare, 2014)	The adoption of WhatsApp: Breaking the vicious cycle of technological poverty in South Africa	350
(Jin, 2012)	The potential of social media for luxury brand management	143
(Hajli, 2014b)	The role of social support on relationship quality and social commerce	68

Reference	Study Title	Sample Size Used
(Putro & Lee, 2017)	The structural equation modelling of reading interest psycho-behavioural constructs: How are they related across different modes of reading?	993
(Owoseni & Twinomurinzi, 2018)	Mobile apps usage and dynamic capabilities: A structural equation model of SMEs in Lagos, Nigeria	1162
(Gámez-Guadix et al., 2013)	Evaluation of the cognitive-behavioral model of generalised and problematic Internet use in Spanish adolescents	1021
(Hidayat & Rohana, 2019)	The perception on technology acceptance to the behaviors on the use of social media for marketing and its implications on the turnover of creative industry SMMEs in villages	78
(Ramadhani & Ilona, 2018)	Determinants of web-user satisfaction: Using technology acceptance model	53
(Halpern et al., 2016)	"Selfie-ists" or "Narci-selfiers"?: A cross-lagged panel analysis of selfie taking and narcissism	303
(Yi et al., 2019)	Sustainable construction safety knowledge sharing: A partial least square-structural equation modelling and a feedforward neural network approach	134
(Gnambs, 2015)	What makes a computer wiz? Linking personality traits and programming aptitude	1695

The minimum sample size was 53 and the maximum sample size was 1695. The arithmetic mean was 525 and the median was 303. Considering the accessible participants in the study, the plan was to exceed the median of 303. Table 5 presents the planned sample.

Table 5: Initial sample plan

Institution	Estimated Number of Respondents (Sample Size)	Main Qualification Types	Qualification Level
University	> 150	Bachelor's degrees students (various qualifications)	Undergraduate, Honours
TVET college	> 150	National certificate (vocational) students (various qualifications)	Undergraduate, Honours
TOTAL	> 303		

3.4.2 Data collection method

Following the research strategy in Section 3.3, the study made use of a questionnaire as the data collection instrument. Questionnaires are research instruments made up of questions related to the research question(s) and research problem (Bhattacherjee, 2012; Sekaran & Bougie, 2013). Furthermore, questionnaires are efficient in circumstances where the researcher knows what variables to measure and are used to capture responses from participants in an academically acceptable manner (Sekaran & Bougie, 2013).

The questions in a questionnaire are typically called items. These items can be structured or unstructured. Structured items or closed-ended items are where the respondent is given a limited list of responses to choose from, whereas unstructured items are where the respondent answers using his/her own words. The study appropriately made used of structured or closed-ended items. Closed-ended items assist respondents to answer quickly and help the researcher to code information for subsequent analysis (Sekaran & Bougie, 2013).

There are three common ways to conduct questionnaire surveys, namely, self-administered e-mail questionnaires, online questionnaires and group-administered questionnaires. With self-administered e-mail questionnaires, the questionnaires are e-mailed to the participants. One of the advantages is that the respondents can complete the questionnaire in their own time and in the comfort of their homes, however, using this way yields a low response rate. Online questionnaires are administered online or via the internet. Respondents are provided with a link to the questionnaire. Advantages of online questionnaires are that they are considered the most inexpensive way to administer questionnaires, can be modified easily when necessary and the results are recorded instantly in an online database (Bhattacherjee, 2012). As much as there are advantages, there are disadvantages such as online security issues, necessary access to computers

and the internet and possible exclusion of older respondents (Bhattacherjee, 2012). With group-administered questionnaires, respondents are grouped into one venue where they complete the questionnaire. Some of the advantages are that there is a high response rate and the respondents can get clarification when needed (Bhattacherjee, 2012). The study conducted both an online version of the questionnaire and a paper-based group-administered version of the questionnaire.

In addition, respondents tend to be very sensitive to question content and wording (Bhattacherjee, 2012). Question content and wording refers to factors such as the appropriateness of question content, question structure and language usage, the arrangement of the questions, the type of questions asked and personal data required from the respondents (Sekaran & Bougie, 2013). Thus, the study took into consideration designing the items for readability and understanding (Bhattacherjee, 2012) and the questions were asked in simple language, in a simple manner, positively worded to avoid double negatives, carefully scrutinised to avoid bias, no double barrel questions since double barrel questions have multiple answers, no general questions and no imaginary questions (Bhattacherjee, 2012). Additionally, all the items in the questionnaire were worded positively as recommended in the literature since negatively worded items reduce a questionnaire's validity, typically lower the Cronbach alpha due to poor correlations with the summated score and can misrepresent concepts (Roszkowski & Soven, 2010).

3.4.3 Measurement scale and item structure

There are four generic data measurement scales, namely nominal, ordinal, interval and ratio (Bhattacherjee, 2012). Nominal scales provide labels for variables and do not have any quantitative value, for example, the province where you live. Ordinal scales provide an order of importance, but the differences between each are unknown, for example the rank of a person in an organisation. Interval scales are numeric and provide both order and the difference between each value, for example the Celsius temperature scale. Ratio scales are the most useful data for statistical analyses since they communicate order, the exact value between units and they have an absolute zero, for example age and height.

Based on the four generic data measurement scales, there are many specific rating scales that can be implemented on a questionnaire for research. These include paired comparisons, forced choice and comparative scales, category scale, dichotomous scale, semantic differential scale, Likert scale, itemised rating scale, numerical scale, staple scale, fixed or constant sum rating scale, consensus scale and graphic rating scale (Sekaran & Bougie, 2013). For the study, a 5-point Likert scale was selected (Bhattacherjee, 2012).

The Likert scale was selected because it is designed to measure how strongly a respondent agrees or disagrees with a statement (Sekaran & Bougie, 2013) and subsequently, the responses can be aggregated into a composite scale for statistical analysis (Bhattacherjee, 2012). Thus, the Likert scale enables a researcher to determine an aggregate value for each item where the higher the aggregate value for an item the more of that construct is evident. In addition, Likert items provide fine-tuned responses when compared to binary items and also allow a respondent to be neutral about a statement (Bhattacherjee, 2012). Another advantage of the Likert scale is that it has anchors, namely 1 to 5, where 1= "strongly disagree", 2= "disagree", 3= "neither disagree nor agree", 4= "agree" and 5= "strongly agree", which remain constant (Bhattacherjee, 2012).

3.5 Data collection instrument

Table 2 in Section 2.7 provides the initial measurement items for all the constructs to be measured. In addition to the items in Table 2, the initial data collection instrument comprised several preceding questions that provided useful information and analyses about a respondent's characteristics. These characteristic questions included gender, home language, age range, qualification, year level of qualification, if the respondent used WhatsApp with other students for learning (if not, then reasons were requested and no further questions were available), hours spent on WhatsApp every week with other students for learning, type of devices used when learning with other students on WhatsApp, what places WhatsApp was used for learning with other students and obstacles preventing WhatsApp being used more often or in more places for learning with other students.

3.6 Bias-types and mitigation

As mentioned in Section 3.3, surveys can create room for biases in research such as non-response bias and sampling bias (Bhattacherjee, 2012).These biases and the study's mitigation plans are discussed in this section. In general, biases are damaging to research because they can distort data, measurements, observations, results, conclusions and interpretations (Sekaran & Bougie, 2013).

Non-response bias is a result of selected participants not responding to a survey (Bhattacherjee, 2012). Non-response bias mostly occurs in mail surveys (Armstrong & Overton, 1977). If there is a high non-response rate, a study's results may be questionable. There are numerous ways that can be used to mitigate non-response bias such as advance notification, relevance of content, respondent-friendly questionnaire, endorsement, follow-up requests, training, monetary and non-monetary incentives, confidentiality and privacy where the participants were assured that their data would be kept secret and not be made accessible to third parties (Bhattacherjee, 2012).

To mitigate non-response bias, the study used advanced notification where lecturers were informed of the survey and politely requested to allow access to their students. The information included the purpose of the study, the importance of the study, the mode of data collection and appreciation of their participation in the study. In addition, the study ensured relevance to the participants as a measure to control non-response bias, provided respondent-friendly questionnaires by limiting the number of questions and by using easy to understand language. The researcher was also physically present when the respondents completed the questionnaire (Oates, 2006).

Sampling bias can result from the sampling method or even the sampling medium (Bhattacherjee, 2012). For example, when using a telephone sampling medium, those without telephones would be omitted or when using the internet, it could be likely that older participants may be left out. If this is not controlled, relevant and important categories of respondents may be missed. To mitigate sampling bias, the study accessed all sampled students in their usual classrooms as they attended lectures and gave them the questionnaires on paper to complete or the option of completing it online. In addition, Section 3.4.1 explains how the study mitigated the inherent bias associated with its sampling method, namely purposive sampling.

3.7 Research quality and rigour- procedures and measures

3.7.1 Reliability

Reliability contributes and plays a significant role in ensuring good quality research (Morse et al., 2002). Reliability of a study is attributed to the accuracy of data and the reproducibility of the results over a period of time (Golafshani, 2003; Krippendorff, 1989). Reliability gives a researcher the assurance that the applied procedures are trustworthy and that the instrument used consistently measures the attributes (Devon et al., 2007).

The study used Cronbach's alpha to measure reliability. Cronbach's alpha is an efficient and widely used measurement for reliability in social and organisational sciences (Bonett & Wright, 2015). The internal consistency among the different items that measured each construct was assessed using Cronbach's alpha (Sekaran & Bougie, 2013). Cronbach's alpha indicates how well the items measuring each construct positively correlate using the average intercorrelations among the items for each construct. The Cronbach's alpha ranges from zero to one, where zero is no internal consistency reliability and one is complete internal consistency reliability. Generally, a Cronbach's alpha value of 0.90 to 0.95 is recommended only where very high risk impact exists and a value of 0.70 or more is considered acceptable (Nunnally, 1978). Notably, most of the Cronbach's alpha values in Table 1 in Section 2.5.5, being the instruments from the literature measuring collaboration that were used in the study to develop the study's questionnaire, are over

0.70. The study measured Cronbach's alpha for each construct during the pilot study and implemented the required changes until the Cronbach's alpha values reached acceptable values, then the main study was conducted.

3.7.2 Validity

Validity relates to whether or not the research measures what it intends to measure and therefore aims to give assurance that the findings of a study are acceptable (Devon et al., 2007; Golafshani, 2003; Krippendorff, 1989),. There are different types of validity such as face validity (Mosier, 1947; Nevo, 1985), construct validity (Cronbach & Meehl, 1955; Leary-kelly & Vokurka, 1998), content validity (Cronbach & Meehl, 1955) and external validity (Bracht & Glass, 2019; Calder et al., 1982; Lynch, 1999).

Face validity is usually associated with research instruments such as questionnaires and can be measured by asking people to subjectively rate the extent to which a questionnaire covers the concepts it claims to measure (Mosier, 1947). To improve face validity, the study's questionnaire items were adapted from validated research instruments.

Construct validity assesses the extent to which the measure of a construct effectively measures the concept studied (Leary-kelly & Vokurka, 1998; Rubio et al., 2003). Construct validity involves a series of empirical tests to examine the measurement properties of the indicators and how well they fit the theory they are developed from. There are three types of construct validity, namely, factorial, convergent and discriminant validity (Rubio et al., 2003). Factorial validity can be conducted in two ways, exploratory factor analysis or confirmatory factor analysis and by making use of structural equation modelling (Rubio et al., 2003). Convergent validity is evident when a construct is measured with different instruments and the scores from the instruments show a high correlation. Discriminant validity is evident when scores of theoretically different constructs show a low correlation (Rubio et al., 2003). The study adapted items to measure constructs from instruments measuring collaboration in Table 1, that have been validated, which promotes construct, convergent and discriminant validity.

Content validity evaluates the conceptual representativeness of a set of measurement items on a questionnaire with reference to the conceptual domain of the concept that is being measured by those items (Rubio et al., 2003). Content validity is usually determined by a panel of judges (Lawshe, 1975). Content validity enhances trust of an instrument for readers and researchers (Yaghmaie, 2003). Content validity helps to prove that the empirical indicators are logically and theoretically related to the construct (Leary-kelly & Vokurka, 1998). Content validity was supported by the use of items from various research instruments that have evaluated the same

constructs (Comer & Kendall, 2013). Sufficient construct domain coverage for content validity was provided through the use of items from different and applicable research instruments that measured the same constructs.

External validity determines whether observations and findings could be generalised to and across different persons, settings and times (Calder et al., 1982). The study used purposive sampling as detailed in Section 3.4.1, which decreases external validity. Thus, conclusions and inferences drawn from the study may not be applied beyond the purposive sample. However, it could be argued that studies based on purposive sampling may show external validity on the purposive sample and still contribute to theory because they can be replicated for confirmation in broader populations (Tongco, 2007).

3.7.3 Pilot Study

Testing is a vital feature of instrument development and typically requires running a pilot study (Rattray & Jones, 2007). A pilot study is a means for assessing whether a survey can be practically administered and obtain accurate data. A pilot study also guides refinement of item wording, item content, appropriateness of questionnaire and item length and identification of ambiguous items. According to the literature, pilot study respondents should be representative of those expected in the main study but be a small number. Importantly, ethical clearance from the Unisa School of Computing was obtained prior to the pilot study and main study. The pilot study was conducted in early April 2020 with data from sixteen students that were representative of the main study respondents.

Importantly. the reliability of the collected pilot data was tested, which involved calculating the Cronbach's alpha using the statistical software package called JASP, which is a free multi-platform open-source statistics package implemented in R and a series of R packages and developed and continually updated by researchers at the University of Amsterdam (Love et al., 2019). The Cronbach's alpha values, before any changes, from the pilot study data are presented in Table 6.

Table 6: Cronbach's alpha values for each construct, before any changes, from the pilot study data

Construct	Cronbach Alpha
Interaction (IA)	0.827
Support (S)	0.862
Information Exchange (IE)	0.791
Sense of Community (SC)	0.771

Construct	Cronbach Alpha
Interdependence (ID)	0.896
Trust (T)	0.870
Active Learning (AL)	0.860
Formality (F)	0.892
Collaboration (C)	0.641
Academic Achievement (AA)	0.872

The pilot study data was analysed using JASP's reliability analysis reporting that provided a calculation of the resulting construct's Cronbach's alpha value if each measurement item was removed. Based on this report, questionnaire items were amended and/or removed so that the highest Cronbach's alpha value and reliability resulted. The outcome was improved Cronbach's alpha values and questionnaire reliability. The analysis resulted in reducing the items per construct from six to four, with improved Cronbach's alpha values as explained in Section 3.7.1, and the final set of questionnaire items for the main study is provided in Appendix C. The Cronbach's alpha values, after the changes, from the pilot study data are presented in Table 7.

Table 7: Cronbach's alpha values for each construct, after the changes, from the pilot study data

Construct	Cronbach Alpha
Interaction (IA)	0.837
Support (S)	0.860
Information Exchange (IE)	0.864
Sense of Community (SC)	0.837
Interdependence (ID)	0.907
Trust (T)	0.879
Active Learning (AL)	0.897
Formality (F)	0.927
Collaboration (C)	0.759
Academic Achievement (AA)	0.915

3.8 Research ethics

Ethics in research concerns acceptable ways of conducting research (Sekaran & Bougie, 2013). Ethical conduct should be demonstrated by the researchers, the participants, the analysts and those involved in interpreting the research results and proposing solutions (Sekaran & Bougie, 2013). Ethics also applies to information handling to protect participants and secure their privacy and ensure that confidential information about participants is protected and does not end up in the hands of unauthorised people.

In the study ethical issues were addressed, such as obtaining permissions from the institutions which are provided in Appendix D, treating participants' information confidentially and protecting their privacy, explaining the purpose of the study to the participants and obtaining informed consent before they participated, avoiding personal or intrusive information, not violating the self-esteem and self-respect of the participants, not forcing anyone to participate, respecting the decision of those who did not want to participate, ensuring that participants were not exposed to any harm, whether physically or psychologically and reporting the collected data accurately. In addition, ethical clearance was obtained from the Unisa School of Computing and the signed ethical clearance certificate is provided in Appendix E with ethics clearance reference number 2020/CSET/SOC/001.

3.9 Data analysis-principles and processes

Structural equation modelling (SEM) is a multivariate analysis method and has been used often in Information Systems research (Gefen et al., 2000; Ringle et al., 2012) and is popular in social science studies (Hajli, 2014a). SEM is a flexible and comprehensive approach for research design and analysis (Hoyle & Smith, 1994). There are two important benefits pertaining to SEM (Hoyle & Smith, 1994). The first involves measurement error, which is considered a latent source of variability in the data. The second benefit involves the operationalisation of dependent and independent variables. SEM is a powerful tool for theory creation and is good for construct validation (Hajli, 2014b).

To address the research problem, answer the research questions and achieve the research objective, data analysis in the main study is required to test the hypotheses specified in Section 2.8, determine the associations among the constructs and assess the research model in Figure 1. SEM techniques fulfil these requirements. In particular, SEM makes use of hierarchical structural equations to reveal unclear variable associations and SEM provides measurements of the relationships between multiple constructs or variables simultaneously (Gefen et al., 2000). Furthermore, SEM provides confirmatory factor analysis and provides multivariate analyses which are used to evaluate and

inspect measurement models. SEM has advantages in comparison to other regression tools that provide multivariate analysis, for instance SEM evaluates structural models, establishes associations among dependent and independent variables and constructs, assesses measurement models comprising latent variables, performs factor analysis and tests hypotheses all within the same data analysis process (Gefen et al., 2000).

Structural equation modelling comprises a measurement and structural model. The depiction of the relationships among the latent and observed variables derives from the measurement or confirmatory model, which is defined before the structural model is specified so that the latent variables are correctly measured. The relationships between the latent variables are specified by the structural model.

3.10 Chapter summary and conclusions

Chapter Three presented the research design of the study. It presented the plan for how the empirical work was carried out. In addition, the methods and techniques that were applied were detailed. The research strategy, data collection techniques and data analysis were discussed and the reasons why they were selected were explained. In addition, the importance of the alignment of the selected research design with the research questions was emphasised. Importantly, Chapter three explains the research strategy to demonstrate that the research problem and questions could be effectively dealt with.

Chapter Three accomplished its objectives, namely substantiating the research strategy in relation to the study's research problem, objective and questions, explaining the sampling and data collection methods, detailing how bias was mitigated, discussing research quality, rigour and research ethics and providing the data analysis method. Therefore, Chapter Three accomplished its goal of clarifying and substantiating the research methodology to answer Research Question Two.

In conclusion, the chapter provides researchers with a methodological basis from which to measure informative constructs involved in the mobile collaborative learning (MCL) processes on WhatsApp and potentially other mobile and social media platforms. In addition, an appropriate data collection instrument was presented, and an applicable method was detailed for testing the study's hypotheses.

This chapter also has value for educators by detailing a suitable way for measuring learning with MCL applications such as WhatsApp, from which both curriculum and learning design can be informed and benefited. Chapter Four succeeds Chapter Three with the presentation, discussion and analysis of the data collected.

Chapter 4: Analysis, Presentation and Discussion of the Data

4.1 Chapter introduction

Chapter Three set the foundation for the empirical work by detailing and explaining the study's research methodology. The goal of Chapter Four is to analyse, present and discuss the collected data and answer Research Question Two. This goal is achieved by accomplishing the objectives of explaining the data collection and handling, describing the characteristics of the respondents, exposing the data's reliability and validity, assessing the dimensionality of the data, analysing any effects of the respondent characteristics, testing the hypotheses and measuring the research model. Chapter Four proceeds with a thorough account of the data collection process, measurement of the data reliability, an examination of the validity and dimensionality of the data using exploratory factor analysis (EFA), a presentation of the respondent characteristics, an analysis of the effects of the respondent characteristics and measurement of the research model and testing of the hypotheses using structural equation modelling (SEM).

4.2 Data collection and handling

Data collection for the main study began in late April 2020 and ended in mid-October 2020 with completed and usable responses from the anonymous Google Forms online questionnaire. Due to the outbreak of the Coronavirus (Covid-19), participants were only recruited electronically, since regulations and ethics did not allow for the use of paper-based and/or face-to-face questionnaires to be distributed. Participants were contacted electronically through Facebook, WhatsApp, email and SMS. The researcher got access to the participating and permitting institutions' WhatsApp and Facebook student groups and invitation messages were broadcasted to these groups. However, there was a low response from students in these groups. As a result, the researcher then sent students in these groups direct messages and stated that students must be from the participating institutions only.

As explained and justified in Section 3.4, the sampling criteria were tertiary education students from two accessible tertiary institutions that used English as the medium of instruction, namely a university and a technical and vocational education and training (TVET) college both located in the Free State province in South Africa. These institutions were expected to provide enough data and demographic diversity to address the research problem and develop valuable insights. In addition, the sample covered undergraduate to honours students only as it was expected that these students would be more likely to use WhatsApp given their younger age in contrast to older postgraduate students. Furthermore, the sampled students would provide relevant data from both

academic and vocational qualifications and several different qualification types to improve the breadth of student characteristics and representativeness.

Once collected, the data was analysed and cleaned accordingly. Data cleaning was done to detect and correct inconsistences and errors due to corrupted data or inaccurate data entry (Osbone, 2013). Once such data was detected, it was either modified or deleted or replaced. The data cleaning was conducted in the Microsoft excel file that was automatically downloaded from the Google Forms questionnaire.

Only four responses were removed entirely from the dataset. These were two respondents that entered master's degrees since these students were outside of the sampling scope of the study, and another two respondents that indicated "Med" and "MBChB" which relate to Bachelor of Medicine and Bachelor of Surgery degrees since the institutions sampled did not offer medical degrees. The result was a useful dataset of 393 responses, which provided sufficient data to proceed with factor analyses and SEM.

Thereafter, within the dataset of 393 responses, the only inconsistences and/or errors detected were in the respondent characteristics section or Section A of the questionnaire. Specifically, one respondent selected "Other" for "My home language is" and entered "Isizulu" and another respondent selected "Other" for "My home language is" and entered "Sesotho". This question on the questionnaire provided for the eleven official languages as "Ndebele", "Swazi", "Northern Sotho", "Sotho", "Tswana", "Tsonga", "Venda", "Zulu", "Xhosa", "Afrikaans", "English". However, these two students appeared to provide the more correct terminology for the languages, which was supported by the South African government's website about South Africa's people (South African Gorvernment, n.d.). Therefore, the data for this question was changed as follows: "Swazi" to "siSwati", "Ndebele" to "isiNdebele", "Sotho" to "Sesotho", "Northern Sotho" to "Sesotho sa Leboa", "Tswana" to "Setswana", "Tsonga" to "XiTsonga", "Venda" to "Tshivenda", "Zulu" to "isiZulu" and "Xhosa" to "isiXhosa".

In addition, the item titled "This year, I am registered for the qualification" was an open item that each respondent could complete and it resulted in many different versions of the same qualification names. For example, "B. ed", "B. Ed", "B. Ed FET phase", "B. Ed in intermediate phase", "B. Ed.", "B Edducation" and "B. Education" were used to describe a Bachelor of Education (BEd) degree. For subsequent statistical analysis, all the entries for this response item were changed to standardised descriptions. For example, the aforementioned entries were replaced with "Bachelor of Education (BEd)". In addition, where a response was not useful, for example one response was entered as "2020", it was changed to "Unknown".

Then, the item titled "This year, most of my subjects/modules/courses are:" provided closed options and an open option called "Other" where a respondent could enter a textual response. 21

respondents selected “Other” and entered responses such as "Year modules", "Post graduate", "Honours modules", "Postgrad subjects", "Postgraduate", “1 year course”, "Honours subjects with research", "Nated 6", "Last year" and variations of these. Given that the qualifications in item titled “This year, I am registered for the qualification” where all undergraduate and honours level qualifications, it was appropriate to set all these entered options to “Fourth year subjects/modules/courses”, except "Year modules" and “1 year course” that were set to “First year subjects/modules/courses”, "Nated 6" as “Second year subjects/modules/courses” which both equate to NQF level 6 courses typically, and "Last year" that was set to “Third year subjects/modules/courses” given the corresponding qualifications of these respondents.

Also, the item titled “What devices do you use when learning with other students on WhatsApp?” provided closed options and an open option called “Other” where a respondent could enter a textual response. Three respondents selected “Other” and entered the response “No phone”, which was changed to “Unspecified” since WhatsApp can only be used on an internet enabled device.

And, the item titled “Where or what places do you use WhatsApp for learning with other students?” provided closed options and an open option called “Other” where a respondent could enter a textual response. One respondent selected “Other” and entered the response “While im taking care of my fathers cattle in the velds and bushes”, which was changed to “While herding cattle in the fields” to improve phrasing and spelling.

Lastly, the item titled “What prevents you from using WhatsApp more often or in more places for learning with other students?” provided closed options and an open option called “Other” where a respondent could enter a textual response. 19 respondents selected “Other” and entered various textual responses, such as “Not feeling safe to use my phone freely in foreign places either than home”, “home chores” and “They take too long to respond”. In all these cases, the responses were changed, where possible, to concise phrasing without changing the apparent meaning. So, for example, for these three examples, they were changed to “Safety reasons”, “Other responsibilities” and “Slow internet connection”, respectively.

No further data changes were required and statistical analyses could proceed on the dataset of 393 responses. All subsequent statistical analyses were performed in JASP, which is a free multi-platform open-source statistics package implemented in R and a series of R packages and developed and continually updated by researchers at the University of Amsterdam (Love et al., 2019).

4.3 Reliability

Cronbach's alpha determines the internal consistency between each set of items measuring a construct in the research model and measured the reliability of the questionnaire items. Initially, a pilot study was conducted to improve the reliability of the questionnaire, as explained in Section 3.7.3. The Cronbach's alpha values for the main data collection for each construct in the research model are provided in Table 8. Constructs that have Cronbach's alpha values above 0.7 are generally regarded as reliable (Nunnally, 1976).

Table 8: Cronbach's alpha values for each construct in the research model

Construct	Cronbach Alpha
Interaction (IA)	0.884
Support (S)	0.927
Information Exchange (IE)	0.925
Sense of Community (SC)	0.923
Interdependence (ID)	0.821
Trust (T)	0.888
Active Learning (AL)	0.899
Formality (F)	0.862
Collaboration (C)	0.914
Academic Achievement (AA)	0.946

4.4 Exploratory factor analysis (EFA)

Exploratory factor analysis (EFA) was the method used to expose the underlying factor structure in the data and demonstrate whether the items in the questionnaire load onto the research model constructs (Costello & Osborne, 2005). In addition, EFA assists to assess construct, convergent, discriminant and face validity (Worthington & Whittaker, 2006).

Prior to conducting the EFA, a Kaiser-Meyer-Olkin (KMO) test was performed to determine the data's suitability for EFA (Gerber & Hall, 2018). KMO values range from zero to one and values greater than 0.5 would demonstrate a strong correlation structure among the items and justify proceeding with the EFA. The overall KMO value calculated was 0.950, which suggested proceeding with the EFA.

In addition, Bartlett's test of sphericity is another useful test to determine whether proceeding with EFA is appropriate. Bartlett's test of sphericity examined the null hypothesis that the initial correlation matrix of the dataset was an identity matrix, which has all the diagonal elements as one

and all the other elements as zero. The p-value was below 0.001, hence the null hypothesis was rejected meaning that continuing with EFA was appropriate.

Initially, Principal Component Analysis (PCA) with varimax rotation was used to evaluate how many principal components or "factors" there were in the data with eigenvalues greater than one or to ascertain which principal components accounted for the greatest portion of total variance. PCA was conducted as a widely used and variable-reduction technique, that reduces many variables into a concise set of principal components which account for the majority of the variance in the data (Costello & Osborne, 2009). Varimax rotation was selected since it maximises the variance of each component and simplifies interpretation. Table 9 presents the results of the PCA, where principal components with eigenvalues one or less were excluded (Reinard, 2006). The result was nine principal components.

Eigenvalues indicate the variation accounted for by a component (Gerber & Hall, 2018), and per the Kaiser Guttman rule, only components with eigenvalues one or higher should be used (Reinard, 2006) . There were nine components with eigenvalues over one, which indicated that those nine components should be used. In addition, the nine components explained just over 76% of the variance in the dataset and a cumulative percentage of variance over 60% is considered sufficient (Gerber & Hall, 2018).

Table 9: Principal component characteristics.

No.	Eigenvalue	Proportion var.	Cumulative
PC1	18.037	0.451	0.451
PC2	2.619	0.065	0.516
PC3	2.107	0.053	0.569
PC4	1.772	0.044	0.613
PC5	1.538	0.038	0.652
PC6	1.351	0.034	0.686
PC7	1.270	0.032	0.717
PC8	1.064	0.027	0.744
PC9	1.016	0.025	0.769

The PCA indicated that nine principal components accounted for most of the total variance in the data, instead of the expected ten per the initial research model. The PCA provided the loadings of each item onto the nine principal components. A factor loading of 0.4 is generally regarded as a

good loading (Howard, 2016), so only loadings greater than 0.4 were viewed. In addition, a value close to one indicates that an item loads highly on the factor. It was evident that all four items relating to the construct Sense of Community (SC) loaded onto both components PC1 and PC4. However, PC1 also had all four items relating to the construct Support (S) loaded onto it with higher loadings than any of the SC items, and PC4 also had all four items relating to the construct Active Learning (AL) loaded onto it with higher loadings than any of the SC items. This indicated that the SC items and SC construct could be removed since they did not load uniquely and had weaker loadings than the other construct items that loaded onto PC1 and PC4. Thus, the decision was to remove construct Sense of Community (SC) from the research model and remove all the data relating to the four items of construct Sense of Community (SC) from further analyses (Howard, 2016).

Thereafter, Principal Axis Factoring (PAF) with varimax rotation and loadings above 0.4 was conducted based on the nine principal components identified during PCA. The result showed that each construct's set of four questionnaire items loaded onto a separate factor as per Table 10. This provided support for using the nine-construct research model for all subsequent analyses.
Furthermore, the factor loadings in Table 10 provided support for the questionnaire measuring the intended constructs. This also provided support for construct validity and indicated that the questionnaire had face validity or made sense. Since there were no cross-loadings and mostly high loadings, there was support for discriminant and convergent validity, respectively.

Table 10: Principal Axis Factoring (PAF) with varimax rotation and loadings above 0.4 based on the nine principal components.

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
IA_1			0.803						
IA_2			0.794						
IA_3			0.730						
IA_4			0.545						
S_1					0.740				
S_2					0.689				
S_3					0.695				
S_4					0.624				
IE_1		0.724							
IE_2		0.724							

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
IE_3		0.835							
IE_4		0.771							
ID_1						0.596			
ID_2						0.676			
ID_3						0.824			
ID_4						0.615			
T_1									0.435
T_2									0.585
T_3									0.646
T_4									0.609
AL_1							0.586		
AL_2							0.666		
AL_3							0.695		
AL_4							0.641		
F_1				0.666					
F_2				0.750					
F_3				0.813					
F_4				0.688					
C_1								0.426	
C_2								0.646	
C_3								0.662	
C_4								0.709	
AA_1	0.793								
AA_2	0.832								
AA_3	0.850								
AA_4	0.741								

4.5 Summated scores per construct

To condense the analytic output and proceed with the analysis of variance (ANOVA) and SEM, within each response, the item scores per construct were added together for a summated score per construct.

In addition, the mean value per construct across all responses provided a concise view of the overall level of each construct present in the data as per Table 11. This view suggested that when the respondents were on WhatsApp with other students, they experienced, comparatively, Information Exchange (IE) more than the other constructs and Formality (F) the least.

Table 11: Mean and std. deviation of the summated construct scores sorted from the highest to the lowest mean value.

Construct	Mean	Std. Deviation
Information Exchange (IE)	15.318	4.209
Support (S)	15.219	4.326
Interaction (IA)	14.756	3.910
Trust (T)	14.481	3.525
Active Learning (AL)	14.303	3.867
Collaboration (C)	13.944	4.260
Academic Achievement (AA)	13.919	4.380
Interdependence (ID)	12.646	3.574
Formality (F)	11.298	3.811

4.6 Respondent characteristics

Table 12 provides a summary of the respondent characteristics and Table 13 provides additional contextual information about the devices used, places where WhatsApp was used and the barriers to using WhatsApp for learning. In summary, almost two-thirds of the students were female, the majority were between the ages of 19 and 24 years old, most of the respondents spoke Sesotho and isiZulu, over eighty percent were registered for bachelor's degrees and seventy percent spent from one to twenty hours per week on WhatsApp learning with other students. In addition, most students used smartphones at home to access WhatsApp and the most frequent barriers to WhatsApp use were the cost of data, places with no signal for internet connectivity, places without electrical plug points for charging their devices and places without a freely available Wi-Fi hotspot.

Table 12: Respondent characteristics.

Item	Variable description	Freq.	Percent
Gender	Male	143	36.4%
	Female	250	63.6%

Item	Variable description	Freq.	Percent
	Total	393	100.0%
Age Range	19 – 24 years old	309	78.6%
	25 – 29 years old	75	19.1%
	30 – 34 years old	3	0.8%
	35 – 39 years old	3	0.8%
	40 + years old	3	0.8%
	Total	393	100.0%
Home Language	Sesotho	172	43.8%
	isiZulu	171	43.5%
	isiXhosa	11	2.8%
	Sesotho sa Leboa	11	2.8%
	Setswana	10	2.5%
	siSwati	6	1.5%
	English	3	0.8%
	isiNdebele	3	0.8%
	Afrikaans	2	0.5%
	Tshivenda	2	0.5%
	XiTsonga	2	0.5%
	Total	393	100.0%
Qualification	Bachelor of Education (BEd)	110	28.0%
	Bachelor of Arts (BA)	61	15.5%
	Bachelor of Science (BSc)	52	13.2%
	Bachelor of Social Sciences (BSocSci)	52	13.2%
	Bachelor of Administration (BAdmin)	22	5.6%
	Postgraduate Certificate in Education (FET) (PGCE)	16	4.1%
	Bachelor of Commerce (BCom)	14	3.6%
	Bachelor of Community Development (BCmd)	8	2.0%
	Various other bachelor's and honours degrees, diplomas and certificates (VoDDC)	58	15.8%
	Total	393	100.0%
Course level	First year subjects/modules/courses	73	18.6%

Item	Variable description	Freq.	Percent
	Second year subjects/modules/courses	101	25.7%
	Third year subjects/modules/courses	127	32.3%
	Fourth year subjects/modules/courses	92	23.4%
	Total	393	100.0%
Hours on WhatsApp every week learning with other students.	0 – <1 hour	45	11.5%
	1 – <5 hours	137	34.9%
	5 – <10 hours	85	21.6%
	10 - <20 hours	53	13.5%
	20 - <40 hours	35	8.9%
	40+ hours	38	9.7%
	Total	393	100.0%

Table 13: Additional contextual information about the devices used, places where WhatsApp is used and the barriers to WhatsApp use.

Item	Variable description	Freq.
Devices used when learning with other students on WhatsApp.	Smartphones	373
	Tablets	14
	Laptop computers	88
	Desktop computers	7
Places where WhatsApp used for learning with other students.	At home	378
	At campus	134
	While travelling by car, bus, taxi, uber, etc.	103
	At any location with a freely available Wi-Fi hotspot	90
	At libraries, study centres or internet cafes	65
	While shopping	54
Barriers to using WhatsApp for learning with other students.	The cost of data	257
	Places with no signal for internet connectivity	251
	Places without electrical plug points for charging my device	118
	Places without a freely available Wi-Fi hotspot	83
	Places without a reliable electricity supply	4
	Places restricting smartphone/WhatsApp use	3

Item	Variable description	Freq.
	Places that are too noisy	2
	Other primary ways of learning	2

4.7 Analysis of variance (ANOVA)

4.7.1 Objectives and requirements

ANOVA was conducted to determine if there were any systematic variances present in two or more groups on a particular respondent characteristic, such as age or course level (Tredoux & Durrheim, 2005). For example, is there a statistically significant difference between students in first year and third year on their WhatsApp collaboration? Answers to these types of questions may provide valuable insights and could further inform educators about how to structure their teaching with WhatsApp.

Homogeneity of variance is an important assumption for ANOVA. To test for homogeneity of variance, the Levene's test of homogeneity of variances was conducted and where the significance (sig.) for this test was greater than or equal to 0.05, the homogeneity of variance assumption was not violated or the null hypothesis that the variances are equal was not rejected. However, where the significance (sig.) was less than 0.05, the assumption was violated or the null hypothesis was rejected, and the ANOVA was not interpreted for those constructs because the results could be misleading.

The ANOVA tables in JASP provided measures for the sum of squares, degrees of freedom (df), mean squares, F statistics and p-values. The p-value between zero and one inclusive is the probability value of obtaining the corresponding estimate when there are no differences between the group means or the null hypothesis is true. The null hypothesis is not rejected when the p-value ≥ 0.05. However, if the p-value is below the significance level of 5% or the specified alpha of 0.05 then the probability is very low that the estimate could be obtained if the null hypothesis was true, thus, the null hypothesis is rejected. So, when the p-value is < 0.05, there is a statistically significant difference between the groups in that respondent characteristic for a particular construct.

The sum of squares is the sum of the squared deviations of each item from its mean; the degrees of freedom (df) are the number of values in the calculation that are free to vary; the mean square is the sum of squares divided by the degrees of freedom and the F statistic is the ratio of the mean square between groups and the mean square within groups.

In addition, ANOVA is an omnibus test that simultaneously tests all possible comparisons to determine if a statistically significant difference exists between groups, but it cannot specify which

groups differ. To determine which groups actually differ, a post hoc test such as Tukey's Honestly Significant Difference (HSD) test should be conducted. Furthermore, even if the ANOVA shows a statistically significant difference, the Tukey's HSD may not, because Tukey's HSD controls the Type I error rate and needs a larger difference to determine significance. A Type I error arises when the null hypothesis is rejected although it is true.

4.7.2 Gender

Focusing on the gender of the respondents, the Levene's test indicated that ANOVA could proceed for constructs IA, S, ID, T, AL, IE, C and AA (sig. ≥ 0.05). However, the ANOVA indicated that there were no significant differences on any of those constructs for gender (sig. ≥ 0.05). Notably, since the respondents only entered either male or female for gender, an independent samples t-test could have been conducted for each construct to determine significant differences on any of the constructs for gender and this was done for completeness, and the t-tests confirmed that there were no significant differences on any of the constructs for gender (sig. ≥ 0.05).

4.7.3 Age range

Regarding the age range of the respondents, to mitigate misleading results from very small subgroups, all the data with age groups over 30 years old were combined into a grouped called 30+ years old. The Levene's test indicated that ANOVA could proceed for constructs IA, S, ID, T, F, IE, C and AA (sig. ≥ 0.05) and the ANOVA indicated that there was a significant difference (sig. < 0.05) on the construct T only.

For construct T, Tukey's HSD showed that there were significant differences (sig. < 0.05) between the groups 19 to 24 years old and 30+ years old and between the groups 25 to 29 years old and 30+ years old, which suggested that the 30+ years old age group trusted less on WhatsApp than the younger groups as was evident by their lower mean score for these constructs. Notably, the 30+ years old age group could be at any course level, from first year to fourth year, so these results are independent of the course level results.

4.7.4 Home language

For the home language of the respondents, to mitigate misleading results from very small subgroups, all the data with home languages other than Sesotho and isiZulu were combined into a grouped called Other_home_languages. The Levene's test indicated that ANOVA could proceed

for all constructs IA, ID, S, T, AL, F, IE, C and AA (sig. ≥ 0.05). Subsequently, the ANOVA indicated that there were no significant differences (sig. < 0.05) on any of the constructs.

4.7.5 Qualification

In terms of the qualifications, the Levene's test indicated that ANOVA could proceed for constructs IE, C and AA (sig. ≥ 0.05). However, the ANOVA indicated that there were significant differences (sig. < 0.05) in the constructs IE and AA only and Tukey's HSD showed significant differences for the construct IE only (sig. < 0.05).

Tukey's HSD significant differences for the construct IE were between each of Bachelor of Arts (BA), Bachelor of Education (BEd), Bachelor of Science (BSc), Bachelor of Social Sciences (BSocSci), Postgraduate Certificate in Education (FET) (PGCE) and the group Various other bachelor's and honours degrees, diplomas and certificates (VoDDC). This may have been suggestive of an information volume difference in VoDDC, since VoDDC had a lower mean construct score.

4.7.6 Course level

With reference to course level, the Levene's test indicated that ANOVA could proceed for constructs IA, S, ID, AL, IE and C (sig. ≥ 0.05). The ANOVA indicated that there were significant differences (sig. < 0.05) on the constructs IA, S, IE and C only and Tukey's HSD also showed significant differences on those four constructs (sig. < 0.05).

For the IA construct, Tukey's HSD showed a significant difference between first year subjects/modules/courses and third year subjects/modules/courses, with third year subjects/modules/courses having a higher mean construct score.

For the S construct Tukey's HSD showed significant differences first year subjects/modules/courses and third year subjects/modules/courses and between third year subjects/modules/courses and fourth year subjects/modules/courses, with third year subjects/modules/courses having the highest mean construct score.

For the IE construct Tukey's HSD showed a significant difference between first year subjects/modules/courses and third year subjects/modules/courses, with third year subjects/modules/courses having a higher mean construct score.

For the C construct Tukey's HSD showed significant differences between first year subjects/modules/courses and third year subjects/modules/courses, between first year subjects/modules/courses and fourth year subjects/modules/courses and between second year subjects/modules/courses and third year subjects/modules/courses, with third year

subjects/modules/courses having the highest mean construct score followed by second year subjects/modules/courses then fourth year subjects/modules/courses and finally, first year subjects/modules/courses. These results suggested that the more advanced third year students made more use of WhatsApp to interact, support, exchange information and collaborate.

4.7.7 Hours on WhatsApp every week learning

With reference to the hours spent on WhatsApp every week learning, the Levene's test indicated that ANOVA could proceed for constructs IA, ID, F, IE, C and AA (sig. ≥ 0.05), but the ANOVA indicated that there were significant differences (sig. < 0.05) on the constructs IA, ID, F, IE and C only and Tukey's HSD also showed significant differences for those five constructs (sig. < 0.05).
Tukey's HSD significant differences for the constructs IA and ID were between group 0 – <1 hour and group 10 - <20 hours and between group 0 – <1 hour and group 40+ hours, with the group 0 – <1 hour having the highest mean construct score.
Tukey's HSD significant differences for the construct F were between group 0 – <1 hour and group 20 - <40 hours and between group 0 – <1 hour and group 40+ hours, with the group 0 – <1 hour having the highest mean construct score.
Tukey's HSD significant differences for the construct IE were between group 0 – <1 hour and each of groups 1 – <5 hours, 5 – <10 hours, 10 - <20 hours, 20 - <40 hours and 40+ hours, with the group 0 – <1 hour having the highest mean construct score.
Tukey's HSD significant differences for the construct C were between group 0 – <1 hour and each of groups 5 – <10 hours, 10 - <20 hours, 20 - <40 hours and 40+ hours, with the group 0 – <1 hour having the highest mean construct score.
These results suggest that the students who spend only 0 – <1 hour on WhatsApp every week learning, experienced the most interaction, information exchange, collaboration, formality and interdependence.

4.7.8 Conclusion

It appeared that gender did not account for any significant differences on any of the constructs. Language also did not appear to have caused significant differences on any of the constructs. In addition, qualification seemed to have not accounted for any significant differences on any of the constructs, except information exchange, which may be suggestive of an information volume difference between the more traditional bachelor's degrees and the various other bachelor's and honours degrees, diplomas and certificates (VoDDC), since the VoDDC had a lower mean information exchange score.

Also, the 30+ years old age group appeared to have trusted less on WhatsApp. In contrast, at course level, the results suggested that the more advanced third year students, representing almost a third of the respondents, made more use of WhatsApp to interact, support, exchange information and collaborate.

In addition, it appeared that it may have been more constructive for students to spend only an hour per week on WhatsApp, learning with other students, instead of less constructive longer periods. So, short, focused learning on WhatsApp may be preferable for learning.

All significant results are detailed in Appendix I.

4.8 Structural equation modelling (SEM)

4.8.1 Objectives and software

SEM was conducted to test and evaluate the research model hypotheses, measure the relationships amongst the constructs and provide answers to Research Question Two. The SEM was also processed in JASP, whose SEM module was based on the lavaan package in R (Rosseel, 2012, 2020), which was a free open-source commercial-quality statistical package for latent variable modelling.

4.8.2 Initial SEM structural specification

To begin, the SEM structural model for the study's nine-construct research model was specified using the following hypothesised interrelationships and processed using the maximum likelihood (ML) method: Interaction (IA), Support (S), Information Exchange (IE), Interdependence (ID), Trust (T), Active Learning (AL) and Formality (F) positively influence Collaboration (C) and Collaboration (C) positively influences Academic Achievement (AA).

After running this structural model on the data, model fit indices were calculated. Model fit indices are necessary to support claims that the theoretical and structural relations adequately agree with the observed data (Schreiber et al., 2006). Table 14 indicates that several of the model fit indices were not at acceptable levels, which suggested that re-specification of the SEM structural model was necessary.

Table 14: Initial SEM structural model specification - model fit indices.

Model fit index	Recommended value	Value obtained	Interpretation
Absolute/predictive fit Chi-square (χ^2): Ratio of χ^2 to degrees of freedom (df)	≤ 3.0	4.93	Bad fit.
Standardised root mean square residual (SRMR)	≤ 0.8	0.040	Suggests an acceptable fit
Root mean square error of approximation (RMSEA)	< 0.06 to 0.08 with confidence interval	0.100 (90% confidence interval = 0.068-0.134)	Bad fit
Comparative fit index (CFI)	≥ 0.95	0.953	Suggests an acceptable fit
Tucker-Lewis index (TLI) or non-normed fit index (NNFI)	≥ 0.95 can be 0 > TLI > 1 for acceptance	0.900	Bad fit

Figure 3 shows the parameter estimates for the initial SEM structural model specification. The model in Figure 3 comprises latent variables or constructs displayed with ovals and lines with arrows, both solid and dashed, representing hypothesised relationships between the constructs. A dashed line signifies that the relationship is not statistically significant ($p \geq 0.05$), and a solid line signifies that there is a statistically significant relationship ($p < 0.05$). The direction of the single-headed arrows indicates the direction of an influence of one construct on another.

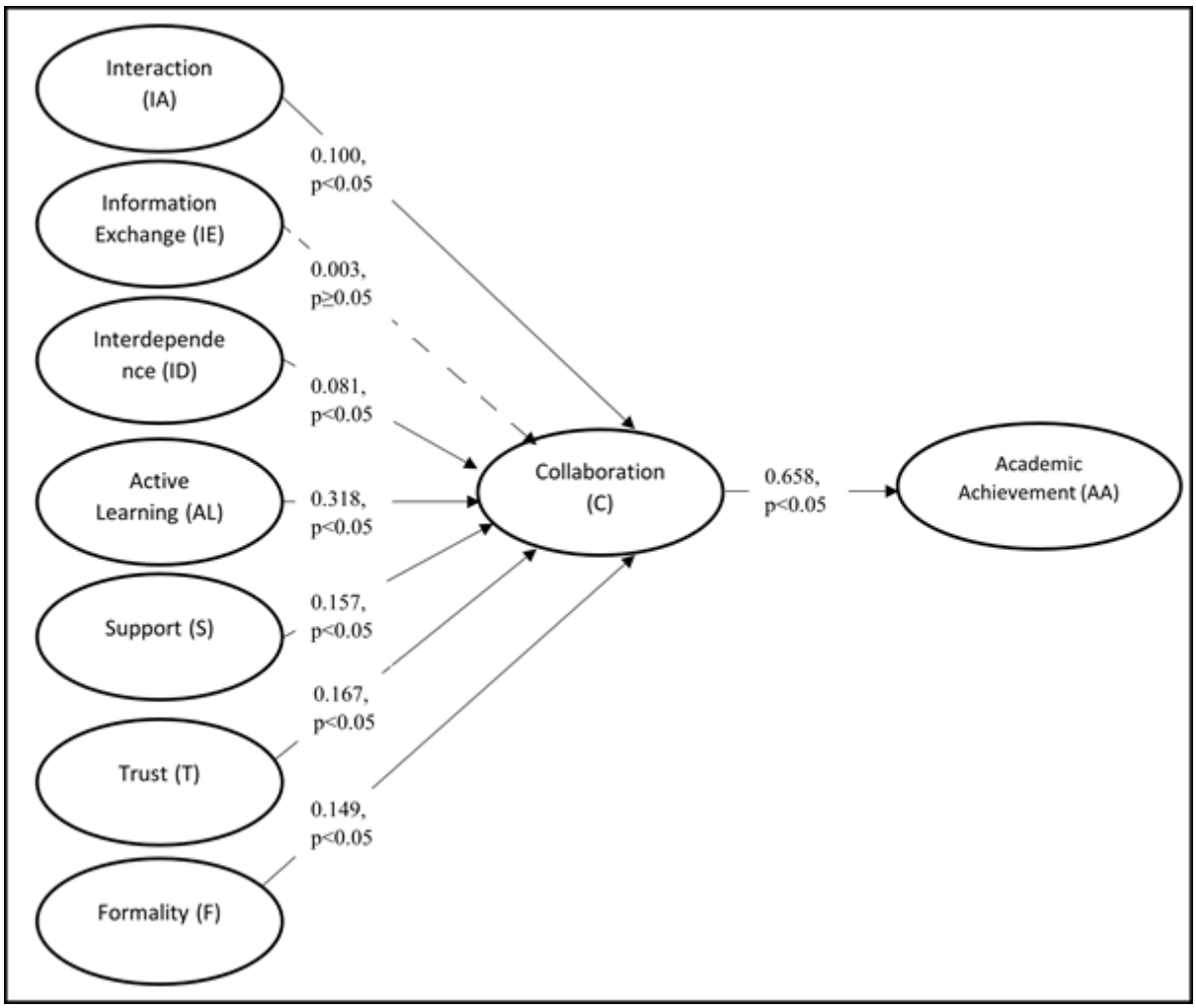

Figure 3: Initial SEM structural model specification.

4.8.3 Re-specified SEM structural model

Since a true model is typically an unknown in research, model re-specification should take place within meaningful and plausible theory (Whittaker, 2012), the study proceeded to re-specify the structural module within meaningful and plausible theory. Thus, the initial model specification was essentially only changed to specify and test the relationships amongst the constructs that were hypothesised to influence Collaboration (C), which was plausible given their interdependent conceptual involvement in learning on WhatsApp.

Therefore, since several of the initial SEM structural model specification's model fit indices were not at acceptable levels and the initial SEM structural model specification did not provide any information about the interrelationships among the constructs labelled Active Learning (AL), Formality (F), Interaction (IA), Support (S), Information Exchange (IE), Trust (T) and Interdependence (ID), re-specification of the SEM structural model was conducted using the modification indices calculated by JASP. Modification indices indicate whether changes such as

adding paths to a SEM structural model will result in improvements and is the Chi-square (χ^2) value by which the model fit would improve if the changes were made (Whittaker, 2012).

Table 15 provides the model fit indices for the re-specified SEM structural model following the changes made according to the modification indices and within theoretical reason.

Table 15: Re-specified SEM structural model - model fit indices.

Model fit index	Recommended value	Value obtained	Interpretation
Absolute/predictive fit Chi-square (χ^2): Ratio of χ^2 to degrees of freedom (df)	≤ 3.0	2.905	Suggests an acceptable fit
Standardised root mean square residual (SRMR)	≤ 0.8	0.045	Suggests an acceptable fit
Root mean square error of approximation (RMSEA)	< 0.06 to 0.08 with confidence interval	0.070 (90% confidence interval = 0.045-0.095)	Suggests an acceptable fit
Comparative fit index (CFI)	≥ 0.95	0.984	Suggests an acceptable fit
Tucker-Lewis index (TLI) or non-normed fit index (NNFI)	≥ 0.95 can be 0 > TLI > 1 for acceptance	0.961	Suggests an acceptable fit

Table 16 provides the parameter estimates for the re-specified SEM structural model, where "Estimate" refers to the unstandardised linear regression coefficients for each set of dependent and independent variable, "Std.Err" refers to the standard errors of the estimates that measure the accuracy of the estimates and lower values mean higher accuracy, "z-value" refers to how many standard deviations away from the mean of zero an estimate is and is based on the Wald test. "std(all)" refers to the standardised estimates having a mean of zero and a standard deviation of one. "P(>|z|)" is the probability value between zero and one of obtaining the corresponding estimate when the null hypothesis is true and when $p < 0.05$ the null hypothesis is rejected and the relationship between two constructs is statistically significant and represented by a solid line. Since it is only statistically significant relationships that are regarded as having an influence in the SEM structural model, all $p \geq 0.05$ relationships were omitted from Figure 4 and Figure 5 for visual ease.

Table 16: Re-specified SEM structural model – parameter estimates.

Dependent Variable	Independent Variable	Estimate	Std.Err	z-value	P(>|z|)	std(all)
Academic Achievement (AA)	Collaboration (C)	0.676	0.038	17.559	< 0.001	0.656
Collaboration (C)	Active Learning (AL)	0.351	0.063	5.608	< 0.001	0.319
Collaboration (C)	Formality (F)	0.167	0.044	3.777	< 0.001	0.150
Collaboration (C)	Interaction (IA)	0.109	0.044	2.508	0.012	0.101
Collaboration (C)	Support (S)	0.156	0.051	3.021	0.003	0.159
Collaboration (C)	Trust (T)	0.203	0.072	2.831	0.005	0.168
Collaboration (C)	Interdependence (ID)	0.097	0.049	1.986	0.047	0.082
Active Learning (AL)	Trust (T)	0.425	0.073	5.852	< 0.001	0.389
Active Learning (AL)	Formality (F)	0.140	0.044	3.215	0.001	0.138
Active Learning (AL)	Interaction (IA)	0.201	0.052	3.853	< 0.001	0.204
Active Learning (AL)	Interdependence (ID)	0.173	0.055	3.138	0.002	0.161
Support (S)	Trust (T)	0.287	0.075	3.845	< 0.001	0.234
Support (S)	Active Learning (AL)	0.211	0.071	2.991	0.003	0.189
Support (S)	Information Exchange (IE)	0.284	0.068	4.155	< 0.001	0.276
Support (S)	Interaction (IA)	0.244	0.059	4.116	< 0.001	0.221

Dependent Variable	Independent Variable	Estimate	Std.Err	z-value	P(>|z|)	std(all)
Interdependence (ID)	Trust (T)	0.492	0.046	10.762	< 0.001	0.485
Interdependence (ID)	Formality (F)	0.103	0.046	2.245	0.025	0.110
Information Exchange (IE)	Active Learning (AL)	0.244	0.059	4.178	< 0.001	0.224
Information Exchange (IE)	Interaction (IA)	0.261	0.060	4.351	< 0.001	0.243
Interaction (IA)	Trust (T)	0.609	0.051	11.881	< 0.001	0.549
Information Exchange (IE)	Trust (T)	0.380	0.069	5.498	< 0.001	0.319

Given the many significant relationships presented in Table 15, the re-specified SEM structural model is split into two diagrams for visual ease, namely Diagram One and Diagram Two. Diagram One is presented in Figure 4 and shows the constructs' influences on Collaboration (C) and the influence of Collaboration (C) on Academic Achievement (AA) only. Diagram One excludes the interrelationships among the constructs labelled Active Learning (AL), Formality (F), Interaction (IA), Support (S), Information Exchange (IE), Trust (T) and Interdependence (ID). Diagram One suggests that Collaboration (C) had a strong positive influence on Academic Achievement (AA), Active Learning (AL) had a moderate positive influence on Collaboration (C) and the other constructs had weak positive influences on Collaboration (C).

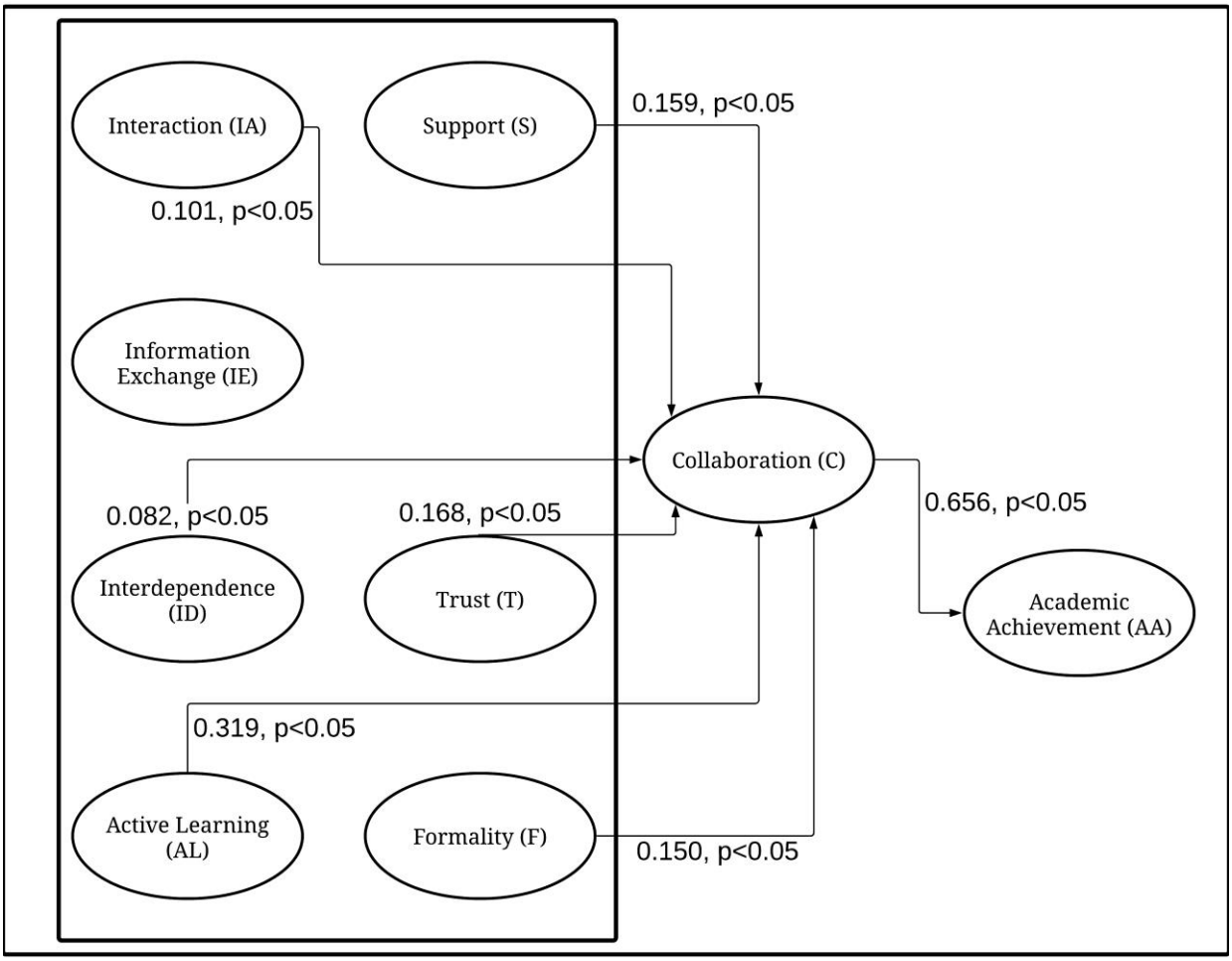

Figure 4: Re-specified SEM structural model – Diagram One.

Diagram Two is presented in Figure 5 and shows the influences amongst the constructs labelled Active Learning (AL), Formality (F), Interaction (IA), Support (S), Information Exchange (IE), Trust (T) and Interdependence (ID) only. Diagram Two highlights that Trust (T) and Formality (F) were antecedent constructs that positively influenced the other constructs. This seemed sensible since Trust (T) and Formality (F) were constructs relating to mental dispositions, in contrast to Active Learning (AL), Interaction (IA), Support (S) and Information Exchange (IE) that related to actions, and would be expected to be present to facilitate those actions. Diagram Two suggests that Trust (T) had a moderate to strong positive influence on Active Learning (AL), Interaction (IA), Support (S), Information Exchange (IE) and Interdependence (ID) while Formality (F) had a weak positive influence on Active Learning (AL) and Interdependence (ID). Thus, Trust (T) appeared to be an important requirement for all the constructs, while increased Formality (F) may have slightly improved Active Learning (AL) and Interdependence (ID).

Support (S) did not influence any other constructs but was moderately positively influenced by Trust (T), Information Exchange (IE) and Interaction (IA), and weakly positively influenced by Active Learning (AL).

Active Learning (AL) had relationships with all the other constructs, either being influenced by or influencing them, but apart from Trust (T), all the relationships were weak. Interaction (IA) had a weak positive influence on Active Learning (AL), Support (S) and Information Exchange (IE), Information Exchange (IE) had weak positive influences on Support (S), and Interdependence (ID) had a weak positive influence on Active Learning (AL).

Diagram Two supports the study's literature analysis and synthesis in Section 2.5.5 that suggests interrelationships amongst these constructs associated with collaboration. While the interrelationships exposed by the re-specified SEM structural model appeared complex, they were reasonable both at face value and in terms of the literature and construct definitions. The SEM provided evidence that all these constructs and their interrelationships should be considered when designing learning with WhatsApp.

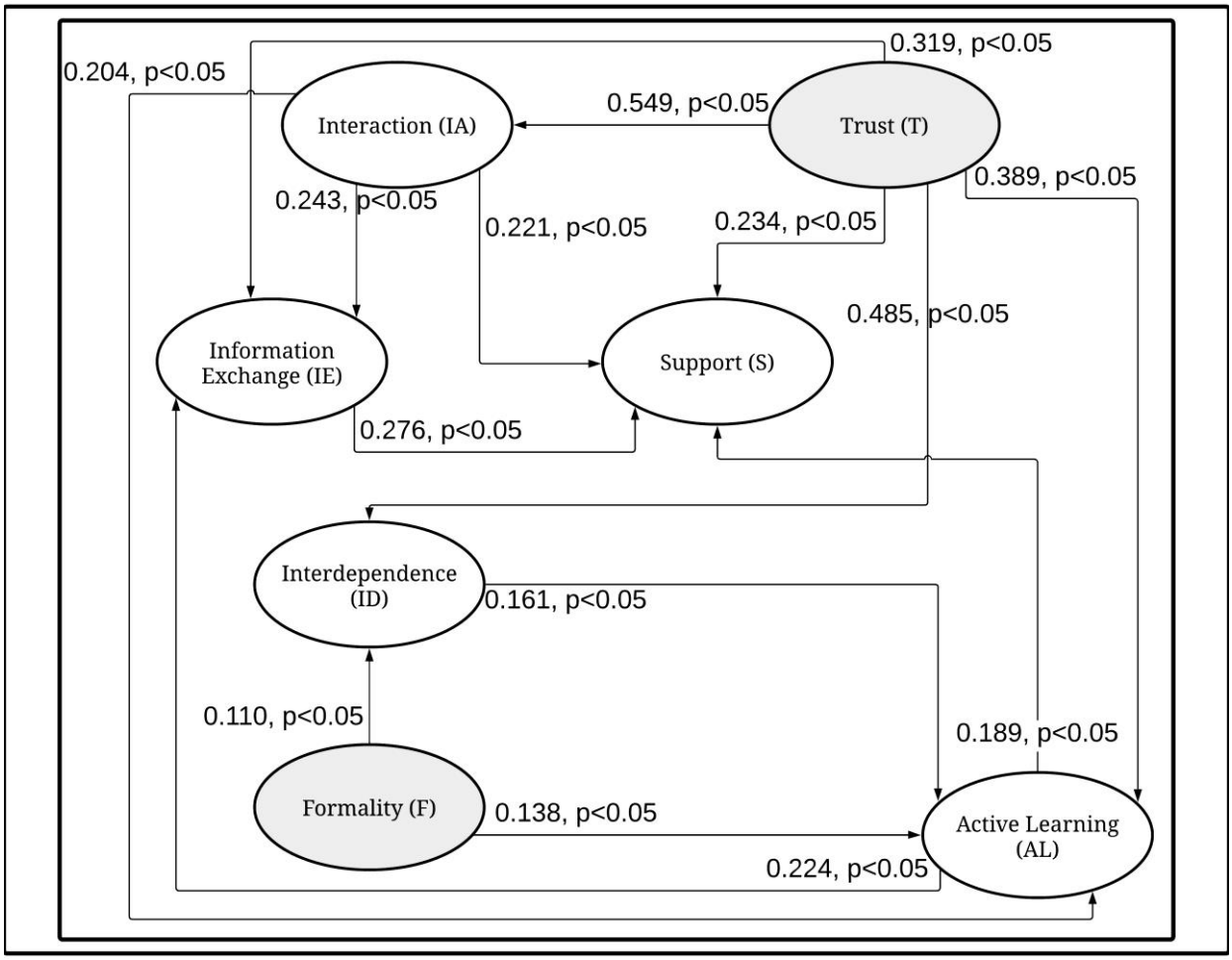

Figure 5: Re-specified SEM structural model – Diagram Two.

The SEM processing provided an efficient method for specifying and analysing the interrelationships among the constructs, which enabled the study to answer its second research question, namely how do the relevant constructs involved in mobile collaborative learning (MCL)

on WhatsApp interrelate and relate to academic achievement? In response, it was evident that collaboration had a strong positive influence on self-reported academic achievement, active learning a moderate positive influence on collaboration and trust a moderate to strong influence on all associated aspects including active learning.

4.9 Chapter summary and conclusions

Chapter Four presented the results from implementing the study's research methodology, which was detailed in Chapter Three. The Chapter Four objectives were accomplished by explaining the data collection and handling, describing the characteristics of the respondents, exposing the data's reliability and validity, assessing the dimensionality of the data, analysing any effects of the respondent characteristics, testing the hypotheses and measuring the research model. Thus, the Chapter Four goal of analysing, presenting and discussing the collected data and answering Research Question Two was achieved.

In conclusion, Research Question Two was answered by measuring how the relevant constructs involved in mobile collaborative learning (MCL) on WhatsApp interrelate and relate to academic achievement. This was demonstrated by the statistically significant positive influences of constructs Active Learning (AL), Formality (F), Interaction (IA), Support (S), Trust (T) and Interdependence (ID) on Collaboration (C) and, in turn, the statistically significant positive influences of Collaboration (C) on self-reported Academic Achievement (AA). In addition, there were statistically significant relationships among Active Learning (AL), Formality (F), Interaction (IA), Support (S), Information Exchange (IE), Trust (T) and Interdependence (ID).

Value for academics was demonstrated through the processes of rigorous data collection and handling, which facilitated the required analyses including EFA, ANOVA and SEM. In addition, value for educators in practice was demonstrated through the provision of scientific evidence of the key aspects requiring consideration when designing mobile collaborative learning (MCL) programs.

Chapter Five follows, clarifying how each research question was answered, the research problem was addressed and the research objective fulfilled. Chapter Five also presents the study's contribution, limitations and future research opportunities.

Chapter 5: Research Conclusion

5.1 Chapter introduction

Chapter Four analysed, presented and discussed the data collected and answered Research Question Two. Chapter Five's goal is to answer Research Question Three and present the study's conclusions and outcomes. To accomplish this goal, the following objectives need to be fulfilled, provide a summary of the findings, show that the research problem was addressed, the research questions were answered and research objective was attained, expose the study's limitations, present recommendations and guidelines for educators, explain the contribution of the study and propose future research opportunities.

Chapter Five proceeds with a summary of the Chapter Four findings and an explanation of how the research problem was addressed, research questions were answered and the research objective attained. Thereafter, the research limitations, recommendations and guidelines for educators, the study's contributions and proposals for future research are presented.

5.2 Summary of the data analysis, presentation and discussion

A survey in the form of an anonymous Google Forms online questionnaire was used to collect the data. Three hundred and ninety-three (393) complete and usable responses were collected and were adequate for EFA and SEM. Participants were from a university and a TVET college, both situated in the Free State province, South Africa. These institutions were expected to provide enough data and demographic diversity to address the research problem and develop valuable insights. In addition, the sample covered undergraduate to honours students only as it was expected that these students would be more likely to use WhatsApp given their younger age in contrast to older postgraduate students. Furthermore, the sampled students would provide relevant data from both academic and vocational qualifications and several different qualification types to improve the breadth of student characteristics and representativeness.

Cronbach's alpha was used to measure the reliability of the questionnaire items and values between 0.821 and 0.946 were obtained for all the constructs, thus the questionnaire was deemed reliable. Two constraints were taken into consideration and determined that it was acceptable to proceed with EFA, they were the KMO test and the Bartlett's test of sphericity. EFA began with PCA using varimax rotation to determine the number of factors and only nine factors had an eigenvalue of greater than one. Subsequently, the Sense of Community (SC) construct was removed from the constructs forming the initial research model because it did not load uniquely onto a component and loaded weakly when compared to the constructs that it shared factors with.

Thereafter, Principal Axis Factoring (PAF) with varimax rotation and loadings above 0.4 was conducted based on the nine principal components identified during PCA. The result showed that each construct's set of four questionnaire items loaded onto a separate factor. This provided support for using the nine-construct research model for all subsequent analyses.

Then, analysis on the respondent characteristics was done. In summary, almost two-thirds of the students were female, the majority were between the ages of 19 and 24 years old, most of the respondents spoke Sesotho and isiZulu, over eighty percent were registered for bachelor's degrees and seventy percent spent from one to twenty hours per week on WhatsApp learning with other students. In addition, most students used smartphones at home to access WhatsApp and the most frequent barriers to WhatsApp use were the cost of data, places with no signal for internet connectivity, places without electrical plug points for charging their devices and places without a freely available Wi-Fi hotspot.

ANOVA was done next on the respondent characteristics to determine the existence of systematic variances. It appeared that gender did not account for any significant differences on any of the constructs. Language also did not appear to have caused significant differences on any of the constructs. In addition, qualification seemed to have not accounted for any significant differences on any of the constructs, except information exchange, which may be suggestive of an information volume difference between the more traditional bachelor's degrees and the various other bachelor's and honours degrees, diplomas and certificates (VoDDC), since the VoDDC had a lower mean information exchange score.

Also, the 30+ years old age group appeared to have trusted less on WhatsApp than some of the younger age groups. In contrast, at course level, the results suggested that the more advanced third year students, representing almost a third of the respondents, made more use of WhatsApp to interact, support, exchange information and collaborate.

In addition, it appeared that it may have been more constructive for students to spend only an hour per week on WhatsApp, learning with other students, instead of less constructive longer periods. So, short, focused learning on WhatsApp may be preferable for learning.

Next, SEM was conducted to assess the research model hypotheses and measure the relationships between the constructs. The initial SEM structural model had to be re-specified because several of the initial SEM structural model specification's model fit indices were not at acceptable levels and the initial SEM structural model specification did not provide any information about the interrelationships among the constructs labelled Active Learning (AL), Formality (F), Interaction (IA), Support (S), Information Exchange (IE), Trust (T) and Interdependence (ID). Re-specification of the SEM structural model was conducted using the modification indices calculated by JASP.

The re-specified SEM structural model's model fit indices were at acceptable levels and suggested that Collaboration (C) had a strong positive influence on Academic Achievement (AA), Active Learning (AL) had a moderate positive influence on Collaboration (C) and the other constructs had weak positive influences on Collaboration (C).

In addition, the re-specified SEM structural model indicated that Trust (T) and Formality (F) were antecedent constructs that positively influenced the other constructs. This seemed sensible since Trust (T) and Formality (F) were constructs relating to mental dispositions, in contrast to Active Learning (AL), Interaction (IA), Support (S) and Information Exchange (IE) that related to actions and would be expected to be present to facilitate those actions. The re-specified SEM structural model suggested that Trust (T) had a moderate to strong positive influence on Active Learning (AL), Interaction (IA), Support (S), Information Exchange (IE) and Interdependence (ID) while Formality (F) had a weak positive influence on Active Learning (AL) and Interdependence (ID). Thus, Trust (T) appeared to be an important requirement for all the constructs, while increased Formality (F) may have slightly improved Active Learning (AL) and Interdependence (ID).

Support (S) did not influence any other constructs but was moderately positively influenced by Trust (T), Information Exchange (IE) and Interaction (IA), and weakly positively influenced by Active Learning (AL).

Active Learning (AL) had relationships with all the other constructs, either being influenced by or influencing them, but apart from Trust (T), all the relationships were weak. Interaction (IA) had a weak positive influence on Active Learning (AL), Support (S) and Information Exchange (IE), Information Exchange (IE) had a weak positive influence on Support (S), and Interdependence (ID) had a weak positive influence on Active Learning (AL).

The re-specified SEM structural model supports the study's literature analysis and synthesis in Section 2.5.5 that suggested interrelationships amongst these constructs associated with collaboration. While the interrelationships exposed by the re-specified SEM structural model appeared complex, they were reasonable both at face value and in terms of the literature and construct definitions. The SEM provided evidence that all these constructs and their interrelationships should be considered when designing learning with WhatsApp.

5.3The research questions answered

5.3.1 Research Question One

Research Question One was, what constructs and measurement items are appropriate for measuring MCL on WhatsApp in relation to academic achievement? This question was answered in Sections 2.5.5, 2.6, 2.7 and 2.8. The literature provided a comprehensive set of collaboration

instruments for inclusion in the study. However, not every factor and/or construct in every instrument was applicable and relevant to the study's research problem. Thus, for each relevant instrument in the literature, each factor and/or construct was evaluated by the researcher for inclusion, adaptation into or exclusion from the study. Based on the evaluation, the included and adapted relevant constructs were Interaction (IA), Support (S), Information Exchange (IE), Sense of Community (SC), Interdependence (ID), Trust (T), Active Learning (AL), Formality (F) and Collaboration (C). In addition, the construct self-reported Academic Achievement (AA) was included since it was essential for addressing the research problem. In the study, these relevant constructs were applied to students/learners who used WhatsApp for academic learning.

5.3.2 Research Question Two

Research Question Two was, how do the relevant constructs involved in mobile collaborative learning (MCL) on WhatsApp interrelate and relate to academic achievement? The SEM processing provided an efficient method for specifying and analysing the interrelationships among the constructs, which enabled the study to answer its second research question. In summary, it was evident that collaboration had a strong positive influence on self-reported academic achievement, active learning a moderate positive influence on collaboration and trust a moderate to strong influence on all associated aspects including active learning. In addition, there were statistically significant positive influences from constructs Active Learning (AL), Formality (F), Interaction (IA), Support (S), Trust (T) and Interdependence (ID) on Collaboration (C) and, in turn, the statistically significant positive influences of Collaboration (C) on self-reported academic achievement. In addition, there were statistically significant relationships among Active Learning (AL), Formality (F), Interaction (IA), Support (S), Information Exchange (IE), Trust (T) and Interdependence (ID).

5.3.3 Research Question Three – Guidelines and recommendations

Research Question Three was, what guidelines and recommendations can be made to educators and tertiary institutional management to improve mobile collaborative learning (MCL) and academic achievement? Based on the scientific evidence discovered by answering the preceding two research questions, important guidelines and recommendations can be made to educators and tertiary institutional management to improve mobile collaborative learning (MCL) and academic achievement.

In summary, WhatsApp is a valuable tool that educators can employ in their teaching, it is advisable for teachers to use it in addition to methods they have been using (Barhoumi, 2016). Educators can employ WhatsApp simultaneously with the traditional ways of teaching (Alsaleem,

2014). Based on this, the use of WhatsApp does not mean that the traditional ways of learning and teaching will be replaced, but rather, it will be an addition to the current way of learning and teaching. In addition, WhatsApp could create a positive learning environment since it could improve student-educator relationships, as well as creating an improvement in academic achievement (Hershkovitz et al., 2019). Educators should also set boundaries that would enable the platform to be used for educational purposes.

WhatsApp is an easy-to-use application and requires little training to use (Nedungadi et al., 2017). It further motivates learners to learn and increases their interest in learning modules. It also creates a sense of excitement in the learning process. Therefore, this will ease the work of a teacher and improve performance at the same time.

Specific guidelines and recommendations follow:

1) The results present implications for educators when designing learning programmes that involve WhatsApp. Firstly, it would be important to design for a high-level of collaboration since there appears to be a positive influence between collaboration and academic achievement. Since collaboration was defined as the amount of working and contributing together that takes place in a group of learners to achieve the common goal of learning using WhatsApp, it is recommended to design learning activities that require learners to learn in groups and the assessment should take into account both the effort by learners to work together and the contributions made by each learner to the common group goals via WhatsApp.
2) Then, the design should consider the development and maintenance of trust and formality during learning activities on WhatsApp as these aspects are indicated as vital for improving active learning, support, interaction and interdependence, all of which influence collaboration and, in turn, academic achievement. Trust seemed to be a central and vital aspect and may be developed by initially using very simple scaffolding activities on WhatsApp to develop trust before the core learning activities. Formality also seemed important and may be encouraged by setting out rules of engagement on WhatsApp to avoid casual and ineffective communication on WhatsApp.
3) In addition, design should include specific activities that require students to actively learn to enhance collaboration and, in turn, improve academic achievement. Active learning seems key to effective collaboration on WhatsApp and activities designed on WhatsApp such as group projects, role-playing, case studies, peer teaching and debates with the teacher as the facilitator would foster active learning on WhatsApp.
4) Support is also important for collaboration. Support was defined as the amount of help and assistance that is provided to a learner, who is experiencing learning difficulties, by other learners using WhatsApp for academic learning. It would be useful to design learning activities

on WhatsApp where students are encouraged to support one another, and the support could be assessed as part of an assessment rubric.

5) Interaction is another aspect needing consideration in learning activities. Interaction was defined as the amount of reciprocal action and engagement, such as discussing, sharing, chatting and meeting, between two or more learners using WhatsApp for academic learning. Collaboration differs from interaction by focusing on the achievement of learning activities by working together while interaction focuses only on learning activities requiring reciprocal action and engagement without the need for achievement of any learning goals. It is conceivable that interaction could occur without any working together to achieve learning goals or outcomes. Their difference is subtle but marked.
6) Interdependence also requires focus when designing learning activities involving WhatsApp. Interdependence was defined as the contingency or condition that other learners are part of a learner's learning process, using WhatsApp for academic learning. Interdependence is different to collaboration as it relates to a learner's reliance on other learners in order to learn instead of working together to achieve learning goals or outcomes. So, learning activities where learners are required to engage with other learners to learn and complete learning tasks would be necessary.
7) Furthermore, educators should design differently for different course levels so that first- and second-year level students are encouraged to interact, support, exchange information and collaborate more during their learning activities, as third year students appear to require less encouragement. Thus, WhatsApp learning activities would be required to be customised per course level especially, where significant differences were apparent in their interaction, support, information exchange and collaboration.
8) Also, it may be necessary to provide additional support to older students in the 30+ years old age group, who may not trust learning activities on WhatsApp than some of the younger groups. For these students introductory scaffolding learning activities on WhatsApp may be useful for developing their trust in learning via WhatsApp and their familiarity with learning with WhatsApp.
9) In addition, learning programmes making use of WhatsApp should design for short periods on WhatsApp only, such as an hour per week, as these time periods appear to be the most constructive with high levels of interaction, information exchange, formality, interdependence and collaboration. This also suggests that using WhatsApp exclusively for learning may not be constructive. So, course design should include WhatsApp in addition to many other learning methods where WhatsApp augments the learning processes within the one hour per week time allocation.

10) Although social networks enable learning though interaction and content creation by learners themselves, it is important that there is someone who oversees this process, in other words, someone who will ensure the validity and reliability of the content. This is where the educators fit in. Since learning through applications such as WhatsApp helps to improve student academic achievement, it is important for educators to familiarise themselves with these technologies since it is known that the use of mobile devices in learning has been a challenge (Elaish et al., 2017). It is also advisable that educators be members of their students' groups to observe, guide and contribute where necessary. It is advisable that educators in South Africa who have not started to explore these practices, begin to do so. In addition, WhatsApp not only enables collaboration between learners, but also between educators and enables communication and collaboration between educators and their management.

5.4 Research problem addressed and research objective achieved

After examining scientific academic articles, it was determined that there was a lack of research measuring collaboration on WhatsApp in relation to students' academic achievement, this was the research problem addressed in this study. Work done by other researchers was further examined to determine the relevant constructs to address the problem. Initially, ten constructs were identified, namely, Interaction, Support, Information Exchange, Sense of Community, Interdependence, Trust, Active Learning, Formality, Collaboration and Academic Achievement. After conducting EFA, Sense of Community was dropped. Following SEM, the results suggest that collaboration has a strong positive influence on academic achievement when WhatsApp was used for learning.

Thus, measuring collaboration on WhatsApp in relation to students' academic achievement was successfully conducted and the research problem addressed. In addition, given the limited research in this domain conducted in Africa and South Africa, this study is significant because it furthers knowledge about WhatsApp and learning generally and in South Africa specifically, and offers an original contribution to the academic body of knowledge. Additionally, the study provides researchers with a foundation from which to measure informative constructs involved in the mobile collaborative learning (MCL) processes on WhatsApp and potentially other mobile and social media platforms. Consequently, the research objective to gather quantitative data using a questionnaire survey from students using WhatsApp to measure collaboration on WhatsApp in relation to their academic achievement, was achieved.

5.5 Contributions to the field

The study advances the field of computers and education by creating original knowledge about MCL on WhatsApp in relation to self-reported academic achievement. In addition, the study presented a positivistic research methodology and epistemology, advancing objective and precise scientific knowledge and deductive theory testing and development. Furthermore, the study provided a foundation from which future researchers can proceed to measure informative constructs involved in MCL processes on WhatsApp and potentially other mobile and social media platforms. In addition, given the limited research in this domain conducted in Africa and South Africa, the study contributes knowledge about WhatsApp and learning generally and in South Africa specifically, and offers an original contribution to the academic body of knowledge.

For educators, the study has value by providing measurable scientific evidence about the effects of MCL applications such as WhatsApp on learning from which both curriculum and learning design can be informed and benefit. In the age of connected mobility this is an imperative.

5.6 Limitations and proposals for future research

The study had limitations which provide valuable opportunities for future research. While the study used a representative purposive sample guided by the literature and substantiated in the sampling section, it could present limitations due to subjective bias that negatively impact generalisability or external validity, and conclusions and inferences may not be applicable outside of the sample. Future research may benefit from pure random sampling designs to promote statistical generalisability if they are practically possible to implement. In addition, future research could replicate the study in other countries to test and verify the results and for advancing the theory.

There are also some general challenges associated with surveys, which include common methods variance mitigated in the study by conducting exploratory factor analysis and establishing construct validity, respondents not providing honest and accurate answers, respondents providing answers that they feel will make them look good, respondents interpreting the response scales differently and lack of depth of answers where it is not possible to discover additional information about why a respondent answered in a particular way or ask a new set of questions. However, balancing these limitations against the benefits to the study, including cost-effectiveness, generalizability, reliability and versatility and the potential for addressing the research problem and answering the research questions, the benefits outweighed the limitations with their mitigation plans and it was appropriate to proceed with the survey method. Nevertheless, future studies should consider the value provided by other empirical methods such as interview and experiments.

Also, an online data collection approach was used, and because of the COVID-19 pandemic, students who did not have access to the utilised online platforms were not reached or included in the study. Regulations did not allow any physical contact to be made with students.

Furthermore, the study was a cross-sectional study, where data was collected from respondents at one point in time and did not study the phenomena over time. Studying these phenomena over time periods on a longitudinal basis could expose new knowledge about the interactions amongst the research constructs and new patterns of student behaviour while learning on WhatsApp and similar social media platforms.

In addition, educators, syllabus developers and academic institution decision makers did not form part of the participants of this study. It can be recommended that in future studies interviews be conducted with these key informants.

5.7 Chapter summary and conclusions

Chapter Five provided the study's conclusions and outcomes. Chapter Five's objectives were fulfilled by providing a summary of the findings, showing that the research problem was addressed, the research questions were answered and research objective was attained, exposing the study's limitations, presenting recommendations and guidelines for educators, explaining the contribution of the study and proposing future research opportunities. Thus, the goal of Chapter Five was attained.

In conclusion, Chapter Five provided an answer to Research Question Three with guidelines and recommendations for educators that plan to incorporate social media applications like WhatsApp into their teaching and learning. Furthermore, Chapter Five explained how the study's research problem was addressed to make an original and relevant contribution to knowledge in the domain of mobile collaborative learning (MCL).

This chapter has value for academics by identifying the constructs and measurement items that are appropriate for measuring MCL on WhatsApp in relation to academic achievement and exposing how the relevant constructs involved in mobile collaborative learning (MCL) on WhatsApp interrelate and relate to academic achievement. This study furthers knowledge about WhatsApp and learning generally and in South Africa specifically to offer an original contribution to the academic body of knowledge. Additionally, the study provides researchers with a foundation from which to measure informative constructs involved in the mobile collaborative learning (MCL) processes on WhatsApp and potentially other mobile and social media platforms.

This chapter also has value for educators by presenting scientific evidence about the relevant aspects involved in MCL and especially using WhatsApp. It facilitates educators in incorporating

WhatsApp and related social media platforms into curricula and teaching and learning with guidelines and recommendations based on scientific evidence.

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Appendix A: Initial Mobile Collaborative Learning (MCL) Literature Search

The table below is sorted by “Social Media Used” descending order and then by “Pub. Year” in descending order. The search started with the search term "Mobile Collaborative Learning" and "WhatsApp" and then used different (broader such as "Mobile Collaborative Learning" only or narrower such as "Mobile Collaborative Learning" and "WhatsApp" and "South Africa") derivatives of these and other related terms. Articles were searched using the Google Scholar search engine and from the Google Scholar search results only those articles that could then be accessed from the University of South Africa’s (Unisa) e-library were used to ensure that only peer-reviewed, quality publications were included in the study.

#	**In-Text Citation & Publication Title**	**Pub. Year**	**Title of Article**	**Social Media Used**	**Conceptual Focus**	**Research Strategy & Method/s**	**Characteristics of Participants**	**Participants’ Location**
1.	(Pimmer et al., 2019) - *Computers & Education*	2019	Facilitating professional mobile learning communities with instant messaging	WhatsApp	• The use of mobile instant messaging (i.e. WhatsApp) by young professionals during their school-to-work transition, • WhatsApp group communications, • WhatsApp and socio-professional connectedness, • WhatsApp-based intervention	Quasi-experiment, online survey (qualitative)	Newly graduated nurses who were accredited by the Nursing and Midwifery Council of Nigeria (NMCN). Some participants work in rural areas, townships and a few in urban areas.	Nigeria

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
2.	(Baytiyeh, 2018) - *International Journal of Information and Communication Technology Education*	2018	Students ' use of mobile technologies: Motivational factors	WhatsApp	• The motivational factors behind WhatsApp • Four themes: simplicity for discussion and coordination, cost-effectiveness, immediacy and sense of belonging WhatsApp as a communication tool	Case study (Qualitative)	College students from three different institutions in major cities in Lebanon	Lebanon
3.	(Flores-Salgado & Castineira-Benitez, 2018) - *Journal of Pragmatics*	2018	The use of politeness in WhatsApp discourse and move 'requests'.	WhatsApp	• WhatsApp communication, • Politeness strategy selection, • Appropriate forms of language, • Watts' concepts of politic behaviour and politeness.	Observation (qualitative)	60 native speakers of Mexican Spanish which had 6 males and 54 females, and were divided into two groups, each having 30 members. One group had parents of preschool and the other, parents of third grade level pupils at two different schools	Mexico

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
4.	(Mursidi & Murdani, 2018) – *Proceedings of the 2nd International Conference on E-Society, E-Education and E-Technology (ACM)*	2018	Role of WhatsApp Application in Building the Interests of Students Literacy	WhatsApp	• WhatsApp as a communication tool • WhatsApp can increase student literacy interests if used properly, • WhatsApp can be used to enhance student literacy skills, • Collaboration learning,	Literature review	N/A	N/A
5.	(Pimmer et al., 2018) - *Nurse Education Today*	2018	Instant messaging and nursing students' clinical learning experience	WhatsApp	• The use of mobile instant messaging (i.e. WhatsApp) by nursing students, • Possible associations of WhatsApp and socio-professional indicators, • The use of WhatsApp during placement of nursing students, • Technology Acceptance Model (TAM)	Survey (Qualitative and quantitative)	196 final year nursing students	5 schools in Oyo State, Nigeria (South West Nigeria)
6.	(Rosenberg & Asterhan, 2018) - Jo*urnal of Information Technology Education: Research*	2018	"WhatsApp, Teacher?" - Student perspectives on teacher-student WhatsApp interaction in secondary schools	WhatsApp	• Secondary student-teacher interaction/communication, • Classroom WhatsApp groups, • Social networking technology	Survey (Qualitative)	Secondary school students between 13-18 years old, 43 males and 45 females	Israel

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
7.	(Andujar, 2016) - *System*	2016	Benefits of mobile instant messaging to develop ESL writing	WhatsApp	• Benefits of mobile instant messaging, • WhatsApp in second language learning, • Grammatical, verbal and mechanical accuracy, syntactic complexity in second-language learners' writing, • WhatsApp group interaction, • Vygotsky's social development theory, • Long's interaction theory, • Framework for the Rational Analysis of Mobile Education (FRAME).	Experimental (Qualitative and quantitative)	Spanish students enrolled for a B1 English course. Aged 20-26 years, made of 61 females and 19 males.	University of Almeria, Spain

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
8.	(Awada, 2016) - *Cogent education*	2016	Effect of WhatsApp on critique writing proficiency and perceptions toward learning	WhatsApp	• The effectiveness of WhatsApp on improving critique writing skills of English as foreign language (EFL), • WhatsApp in association with motivating learning, • Activity theory, • Community sharing framework,	Experimental (Quantitative and qualitative)	Average-English proficient students registered at two different English medium universities, in Sophomore Rhetoric classes, students are aged 19-22 years. All students are native Arabic speakers.	Lebanon
9.	(Bere & Rambe, 2016) - *Journal of Computing in Higher Education*	2016	An empirical analysis of the determinants of mobile instant messaging appropriation in university learning.	WhatsApp	• The acceptance of and capacity of mobile instant messaging (MIM) systems in improving student performance, • Social cognitive theory, • Mobile instant messaging (MIM; i.e. WhatsApp) in university learning, • Technology Acceptance Model (TAM), • Keller's ARCS model	Survey (Quantitative)	Tertiary students from the IT faculty enrolled for Internet programming (B. Tech students) and Information systems (3rd year National Diploma students) courses, Aged between 20-33 years, 111 were males, and 125 were females.	A South African University of Technology

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
10.	(Mahapatra et al., 2016) - *Proceedings of the 13th Web for All Conference (ACM)*	2016	LMS weds WhatsApp: Bridging Digital Divide using MIMs	WhatsApp	• Blended learning, • WhatsApp in association with Learning Managements System (LMS), • Learning, activity, leaner behaviour, and course status, • WhatsApp supports collaboration and learning, • WhatsApp compliments LMS based leaning and face-to-face learning, • WhatsApp group communication,	Observation (Qualitative)	Final year engineering (electronics and communications field) (undergraduates) students from a private higher education institution in India	Bengaluru, India

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
11.	(So, 2016) - *The Internet and Higher Education*	2016	Mobile instant messaging support for teaching and learning in higher education	WhatsApp	• Mobile instant messaging (MIM; i.e. WhatsApp) tools in supporting teaching and learning in tertiary education, • WhatsApp in Collaborative learning, • WhatsApp in informal learning and formal learning, • Technology Acceptance Model (TAM), • United Theory of Acceptance and Use of Technology (UTAUT).	Experimental (Quantitative)	61 undergraduate students at a teacher-training institution. One class was composed of in-service ICT students registered for mixed-mode courses, having either full-time teaching or non-teaching posts in primary or secondary schools. This class also had a few pre-service full-time student. The other class had full-time pre-service students either majoring or minoring in ICT.	Hong Kong
12.	(Barhoumi, 2015) - *Contemporary Educational Technology*	2015	The effectiveness of WhatsApp mobile learning activities guided by Activity Theory on students' knowledge management	WhatsApp	• The effectiveness of mobile technologies to compliment blended learning, • WhatsApp mobile learning, • Activity theory	Experiment (Qualitative)	University students enrolled for a blended learning course named Scientific Research Methods in Information Science.	Saudi Arabia

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
13.	(Gachago et al., 2015) - *Progressio*	2015	Crossing boundaries: lectures' perspectives on the use of WhatsApp to support teaching and learning in higher education	WhatsApp	• Mobile instant messaging (MIM; i.e. WhatsApp) in teaching activities, • Blended learning, • Informal learning, • Formal learning, • Open distance learning (ODL), • Activity theory, • Situated learning theory	Case study (Qualitative)	Lecturers from a tertiary institution.	University of Western Cape, South Africa
14.	(Sánchez-moya & Cruz-moya, 2015) - *Procedia - Social and Behavioral Sciences*	2015	WhatsApp, textese, and moral panics: discourse features and habits across two generations.	WhatsApp	• WhatsApp communications, • Communication practices, • Use of WhatsApp by people of two different generations, • Effect of instant messaging (IM) on language	Survey online questionnaire. (Qualitative)	15 Spaniard teens (secondary school students aged 13-18) and 15 Spaniard adults aged 28-33 who previously received higher education and are in the job market.	Spain
15.	(van Rooyen, 2015) - *Procedia - Social and Behavioral Sciences*	2015	Distance education accounting students ' perceptions of social media integration	WhatsApp; Facebook	• Social media for learning accounting, • Distance learning, • Social media apps (Facebook, Twitter, Blackberry Messaging (BBM), WhatsApp and MXit), • Holmberg's theory.	Online survey (Qualitative and quantitative)	Second year university accounting students.	UNISA, South Africa

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
16.	(Willemse, 2015) - *Curationis*	2015	Undergraduate nurses' reflections on WhatsApp use in improving primary health care education	WhatsApp	• Experience of undergraduate nursing students, • Primary Health Care (PHC) education, • Social media application (i.e. WhatsApp), • Positive practices using the WhatsApp group, • Helpfulness of WhatsApp for integrating theory and clinical practice, • The availability of resources for preparations of tasks, • Tech's steps of descriptive data analysis, • Learning using WhatsApp groups, • Mobile learning, • Experimental learning,	Experiment (Qualitative)	Undergraduate nursing students enrolled for Primary Health Care (PHC) module.	Western Cape, South Africa

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
17.	(Ahad & Lim, 2014) - *Procedia-Social and Behavioral Sciences*	2014	Convenience or nuisance?: The 'WhatsApp' dilemma.	WhatsApp	• Use of WhatsApp amongst young people, • WhatsApp as a communication tool, • WhatsApp as a distraction, • Undergraduate WhatsApp usage, • Domestication theory, • Mobile instant messaging (MIM; i.e. WhatsApp) in teaching activities.	Survey online questionnaire (Quantitative)	Undergraduate university students	University Brunei Darussalam
18.	(Bouhnik & Deshen, 2014) - *Journal of Information Technology Education: Research*	2014	WhatsApp goes to school: Mobile instant messaging between teachers and students	WhatsApp	• The effect of mobile instant messaging (MIM; i.e. WhatsApp) between teachers and learners, • WhatsApp as a learning tool, • Teacher-learner interactions, • Socialization, • WhatsApp group communication, • Academic and education processes, • Social media platforms,	Experiment (Qualitative)	Teachers (some homeroom class teachers and some were subject-matter teachers) and high school learners,	Not specified

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
19.	(Rambe & Bere, 2013) - *British Journal of Educational Technology*	2013	Using mobile instant messaging to leverage learner participation and transform pedagogy at a South African University of Technology	WhatsApp	• The effect of mobile instant messaging (MIM; i.e. WhatsApp) in education, • WhatsApp in association with psychology, • Collaborative learning, • Lecture-student and peer-peer interaction, • Formal learning, • Informal learning, • Koole's Framework for the Rational Analysis of Mobile Education (FRAME) model	Observations (Qualitative and quantitative)	Third-year information technology (IT) students at a University of Technology. IT lecturer	Central University of Technology, South Africa
20.	(Deng et al., 2016) - *Learning, Culture and Social Interaction*	2016	Interest-driven digital practices of secondary students: Cases of connected learning	Weibo	• Informal learning, • School-based learning, • Students' interest-driven practices outside the classroom, • Outside classroom learning meditated by digital technology, • Outside classroom connection to school-based learning, • Connected learning, • Interest-driven learning,	Mixed method research (Qualitative and quantitative)	Students in a junior secondary boarding school in a partial urban area in China	Guangdong, China.

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
21.	(Leow & Neo, 2015) - *Procedia - Social and Behavioral Sciences*	2015	Redesigning for collaborative learning environment: study on students' perception and interaction in Web 2.0 tools	Web 2.0 tools (Facebook closed group; web-based or mobile-based chat apps, such as LINE app, WhatsApp, Facebook Messenger, WeChat app; cloud-based storage software, such as DropBox or Google Drive.)	• Enhance learning, • Improve knowledge creation process, • Web 2.0 tools, • Peer interaction, • Constructivist learning environment (CLE), • Collaborative learning, • Gagne's instructional events, • Jonassen's model for designing CLE,	Survey (qualitative)	University IT students. Students were enrolled for seven different IT modules, 74.2 % were from Malaysia, 25.8% were from other countries across the world, around 79.9% were males and the rest were females.	INTI International University, Malaysia

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
22.	(Caballéa, Xhafab, et al., 2010) - *Mobile information systems*	2010	Using mobile devices to support online collaborative learning	Web 2.0 tools	• The connection between mobile technologies and collaborative learning, • Mobile technology supporting formal and informal learning, • Group learning, • Online collaborative leaning, • Mobile Collaborative learning • Constructivism, • Behaviorism, • Situated learning, • Problem-based learning, • Context-aware learning, • Social learning	Survey (Qualitative)	University students	Birkbeck, University of London
23.	(Carpenter & Green, 2017) - *Teaching and Teacher Education*	2017	Mobile instant messaging for professional learning: Educators' perspectives on and uses of Voxer	Voxer	• The use of mobile instant messaging (MIM), • Professional learning, • Social media, • Voxer (multimodal messaging tool), • Communication trough Voxer, • Collaboration, • Heutagogy	Survey (Qualitative and quantitative)	School teachers	Not specified

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
24.	(Veletsianos, 2011) - *Journal of Computer Assisted Learning*	2011	Higher education scholars ' participation and practices on Twitter.	Twitter	• Scholars naturalistic practices in social networks (i.e. Twitter), • Online social networks • Twitter in higher education • Collaborative learning,	Surveys, constant comparative method (qualitative)	Twitter using students and are active Twitter users with more than 2000 followers, who does both research and teaching as professionals, they hold PhD degrees, they are working for tertiary institutions	Universities across the globe
25.	(Al-samarraie & Saeed, 2018) - *Computers & Education*	2018	A systematic review of cloud computing tools for collaborative learning: Opportunities and challenges to the blended-learning environment	Social media applications in general, e.g. Facebook, Twitter, Skype, and WhatsApp	• Cloud computing in learning, • Collaborative learning, • Distance learning, • Blended learning, • Learning Management System (LMS) tools, • Social networking tools, • Study framework: Tranfield, Denyer, and Smart for conducting a review research	Literature review	N/A	N/A

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
26.	(Hernández-Lara et al., 2018) - *Computers in Human Behavior*	2018	Applying learning analytics to students' interaction in business simulation games. The usefulness of learning analytics to know what students really learn	Social media in general, e.g. Facebook, WhatsApp	• Learning analytics and data mining are used to study online discussion forums, • Learning analytics tools, • Data mining, • Collaborative learning activity, • Online learning, • Student interactivity, • Digital technology (i.e. online discussion forums), • Social constructivism,	Experiment (Mixed method)	Business students who are doing their bachelors and master's degrees.	Open University of Catalonia, Spain
27.	(Alakpodia, 2015) - *International Journal of Information and Communication Technology Education*	2015	Social networking among library and Information Science undergraduate students	Social media in general, e.g. Facebook, WhatsApp	• Use of social networking, • Facebook is the most popular social networking site, • How students to use social networks	Questionnaire	2000 Library and Information Science students,	Delta State University, Abraka, Nigeria

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
28.	(Pimmer et al., 2014) - *Nurse education today*	2014	Informal mobile learning in nurse education and practice in remote areas — A case study from rural South Africa	Social media applications in general, e.g. Facebook; WhatsApp	• Mobile phones used as learning tools, • Nursing students, • Mobile learning in rural, marginalised and distance areas, • Digital mobile technology in learning, • Mobile learning, • Distance learning, • Community of practice, • Situated learning, • Socio-cognitive, • Socio-cultural	Survey (interviews) (qualitative)	Participants were nurses who completed an advanced midwifery education program, facilitators and clinic managers from rural places in South Africa.	South Africa
29.	(Reychav et al., 2017) - *Computers & Education*	2017	The relationship between gender and mobile technology use in collaborative learning settings: An empirical investigation	Social media tools in general	• The relationship between gender and mobile technology, • Learning activities in relation to text/video content on a mobile device, • Gender factor, • Mobile learning, • Collaborative learning, • Social constructivism,	Experimental (Mixed method)	Secondary school students from five different schools who were given tablets that run on Windows 8.	Not specified

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
30.	(Järvelä et al., 2007) – *Journal of Educational Technology & Society*	2007	Structuring and regulating collaborative learning in higher education with wireless networks and mobile tools	Social media tools in general	• Examine new acceptable ways to structure and regulate individual and collaborative learning with smartphones in higher education, • Collaborative learning, • Mobile devices, • Cognitive learning, • Self-regulated learning, • Mobile lecture interaction tool, • Social software, • Smartphones,	Experiment (Qualitative)	Higher education students	Not specified
31.	(Ng'ambi et al., 2016) - *British Journal of Educational Technology*	2016	Technology enhanced teaching and learning in South African higher education–A rear-view of a 20 year journey	Social media applications in general	• The effect of technology in learning, • South African higher education, • Technology learning in South Africa for the past 20 years, • Learning and teaching practices, • Cloud computing, • Technology Enhanced Learning,	Literature review	N/A.	N/A

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
32.	(Alabdulkareem, 2015) - *Procedia - Social and Behavioral Sciences*	2015	Exploring the use and the impacts of social media on teaching and learning science in Saudi	Social media applications in general	• Teacher and student views, • Social media in learning and teaching, • Social media applications, • Social interactions, • Smartphones, • Social media learning tools, • Educational experiences, • Formal learning, • Informal learning,	Survey (Qualitative and quantitative)	Middle school science Saudi teachers and students.	Saudi Arabia
33.	(Mohammadi, 2015) - *Computers in Human Behavior*	2015	Social and individual antecedents of m-learning adoption in Iran	Social media applications in general	• M-learning, • Effects of m-learning in Iran, • Self-efficacy on user intention and satisfaction, • Individual mobility, • Perceived usefulness, • Technology Acceptance Model (TAM), • Expectation-Confirmation Theory (ECT)	Survey (Qualitative and quantitative)	Not specified	Iran

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
34.	(Reychav & Wu, 2015) - *Computers in Human Behavior*	2015	Mobile collaborative learning: The role of individual learning in groups through text and video content delivery in tablets	Social media applications in general	• Connection between learning process (group learning and self-cognitive absorption) and learning impact (performance, satisfaction and understanding), • Application of mobile technologies in supporting and facilitating collaborative learning, • Individual learning in Collaborative learning (group learning), • Learning content delivery (i.e. video and text), • Mobile learning, • Mobile collaborative learning (MCL), • Cognitive absorption (CA) theories, • Dual coding theory	Experimental (Qualitative and quantitative)	Students and teachers from secondary schools	Not specified

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
35.	(Gikas & Grant, 2013) - *Internet and Higher Education*	2013	Mobile computing devices in higher education: Student perspectives on learning with cell phones, smartphones & social media	Social media applications in general	• Use of mobile computing devices (i.e. cell phones and smartphones) in teaching and learning, • Higher education, • Mobile learning, • Social media, • Merriam's characterization and process of a general qualitative study.	Survey (Qualitative)	University students and teachers. These teachers have used and implemented mobile learning for at least a year. Public and private four-year tertiary institutions.	3 US universities, USA
36.	(Berjón et al., 2015) - *Computers in Human Behavior*	2015	SCHOM. A tool for communication and collaborative e-learning	SCHOM (SCHOlar Messaging)	• Introduction of SCHOlar Messaging (SCHOM) in collaboration e-learning, • Communication tool, • Mobile learning, • Computer meditated learning, • Mobile supported collaborative learning, • Software as a Service, • Cloud computing,	Design and creation	N/A	N/A

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
37.	(Fu & Hwang, 2018) - *Computers & Education*	2018	Trends in mobile technology-supported collaborative learning: A systematic review of journal publications from 2007 to 2016	N/A	• Collaborative learning supported by mobile technology, • Collaborative learning, • Social constructivism, • Student interactions	Literature review	N/A	N/A
38.	(Fakomogbon & Bolaji, 2017) - *Contemporary Educational Technology*	2017	Effects of collaborative learning styles on performance of students in a ubiquitous collaborative mobile learning environment	N/A	• Examine student performance in mobile learning, different collaborative learning styles and non-collaborative leaning styles, • Effectiveness of collaborative learning, • Mobile learning, • Collaborative learning, • Mobile learning of mole concept (MLMC)	Experimental (Qualitative)	Secondary school students who are enrolled for Chemistry course.	Not specified
39.	(Miguel et al., 2016) - *Computer standards & interfaces*	2016	A methodological approach for trustworthiness assessment and prediction in mobile online collaborative learning	N/A	• Trustworthiness, • Mobile online collaboration learning, • e-learning security issues, • Information security, • Trustworthiness and Security Methodology (TSM)	Conceptual	N/A	N/A

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
40.	(Lan et al., 2007) - *Language Learning & Technology*	2007	A mobile-device-supported peer-assisted learning system for collaborative early EFL reading	MPAL	• Observation of the weaknesses that exists in collaborative learning for teaching English as a foreign language, • Mobile learning, • Peer-assisted learning, • Collaborative learning, • Mobile-device-supported peer-assisted learning (MPAL)	Quasi-experimental, Observation (qualitative)	Third grade students from an elementary school, 14 were males and 12 were females, students were from Taiwan. They were doing beginning-level subjects and students have been taught English as a foreign language for two years.	Taipei, Taiwan
41.	(Y. Huang et al., 2009) - *Journal of Educational Technology & Society*	2009	An educational mobile blogging system for supporting collaborative learning	Mobile Blog	• Web 2.0 technologies, • Blogging, • Mobile blogging, • Mobile applications • Collaborative learning	Experimental (Qualitative and quantitative)	40 college students with engineering science as their major. All the involved students are second year college students who own mobile devices that are network communication enabled, further, they are computer literate.	National Cheng Kung University in Taiwan.

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
42.	(Cortez et al., 2004) - *Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04)*	2004	Teaching science with mobile computer supported collaborative learning (MCSCL)	Mobile Computer Supported Collaborative Learning (MCSCL) system	• Mobile learning, • Software design, • Examine the use of Mobile Computer Supported Collaborative Learning (MCSCL) in teaching science, • Computer Supported Collaborative Learning (CSCL), • Constructivism.	Experimental (Qualitative and quantitative)	High school learners and educators. The learners were doing their second year in high school, and were enrolled for science.	A public high school located in Santiago de Chile
43.	(Junco & Cotten, 2011) – *Computers & Education*	2011	Perceived academic effects of instant messaging use	Instant messaging tools (such as Facebook, MSN, AOL)	• Examining the impact of instant messaging and multitasking on learning, • Instant messaging (IM), • Multitasking, • Student performance, • Mayer and Moreno's theory of learning	Web-based survey (Qualitative and quantitative)	College students. Students were from public universities and a medium four year pubic university.	USA

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
44.	(Hou & Wu, 2011) – *Computers & Education*	2011	Analysing the social knowledge construction behavioral patterns of an online synchronous collaborative discussion instructional activity using an instant messaging tool: A case study	Instant messaging tools	• Computer mediated communication, • Collaborative learning, • Instant messaging (IM), • Learning activities, • Online discussions, • Social constructivism,	Case study (quantitative and a lag sequential analysis)	University students that were enrolled for Web design course in Taiwan	University in Taiwan.
45.	(Gan & Balakrishnan, 2017) - *Telematics and Informatics*	2017	Enhancing classroom interaction via IMMAP – An Interactive Mobile Messaging App	IMMAP	• Examine the effectiveness of Interactive Mobile Messaging App (IMMA) in higher education in a classroom setup, • Improving classroom teaching, • Student-teacher interactions, • Instant messaging (IM) applications, • Social media, • Interactive Mobile Messaging Acceptance (IMMA) model	Experimental (Qualitative and quantitative)	University students. They were divided into two groups, the first group were sophomore students enrolled for an IT course and the second group were third year students enrolled for business administration course. They were undergraduate students aged 20-24	Malaysia

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
46.	(Heflin et al., 2017) - *Computers & Education*	2017	Impact of mobile technology on student attitudes, engagement, and learning	HeadsUp	• Examine student learning in three different collaborative environments, • Environments: Common practice, intentional practice and mobile applications for group work (i.e. HeadsUp), • Mobile technology, • HeadsUp mobile application, • Mobile learning, • Student interactions, • Collaborative learning, • Gay, Rieger, and Bennington's model to develop a framework for understanding different types of mobile learning	Quasi-experimental research	6 intact classes of first year students who registered for a four year university program. There were 102 females and 57 males	Abilene Christian University, Abilene, Texas, USA

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
47.	(Santos et al., 2014) - *Pervasive and Mobile Computing*	2014	To be or not to be in situ outdoors, and other implications for design and implementation, in geolocated mobile learning	GPS applications	• Mobile learning designing factors, • Mobile learning, • Context awareness, • Mobile devices, • Global Positioning Service (GPS), • Outdoor learning, • M-learning, • Software application	Experimental (Qualitative and quantitative)	A teacher and learners with an average age of 17.	Spain
48.	(Gan et al., 2015) - *Computers in Human Behavior*	2015	Enhancing students' learning process through interactive digital media: New opportunities for collaborative learning	Edmodo	• Digital media, • Web applications, • Mobile devices, • Examine technology enabled systems, • Web-based teaching and learning, • Enhanced educational experience, • Edmodo site, • Mobile learning, • Collaborative learning	Case study/Observations (Qualitative)	Undergraduate students from an Asian higher learning institution (university)	An Asian institution of higher learning, Singapore

#	In-Text Citation & Publication Title	Pub. Year	Title of Article	Social Media Used	Conceptual Focus	Research Strategy & Method/s	Characteristics of Participants	Participants' Location
49.	(Calvo et al., 2014) - *Procedia Computer Science*	2014	Are all chats suitable for learning purposes? A study of the required characteristics	Chat applications (desktop, mobile and web chats)	• Examine the effectiveness of chatting in learning, • Social media applications, • Social media communication, • Computer meditated learning, • Mobile learning, • Commercial chats in learning and teaching, • Computer Supported Collaborative Learning (CSCL) Tool, • Universal Design for Learning (UDL) guidelines 2.0	Observation (Qualitative)	Not specified	Not specified
50.	(Ke & Hsu, 2015) - *Internet and higher education*	2015	Mobile augmented-reality artifact creation as a component of mobile computer-supported collaborative learning	AR tools	mine learning activities, ile computer supported collaborative ning (MCSCL), mented reality, nological pedagogical content wledge (TPACK), ile AR- and web-conferencing-orted mobile collaborative learning,	Mixed method (Qualitative and quantitative)	40 teacher education students from a college of education at a university in the US. 74% were females and the rest were males, and have been a median of 3.5 years in college.	A land-grant university in USA

Appendix B: Literature Review - Concept-Centric Literature Matrix

References / Concepts		Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
#	**Total sources per concept**		**225**	**160**	**29**	**17**	**12**
1	Worsley et al. (2015)	**1**	1				
2	Holzinger et al. (2005)	**1**	1				
3	Georgiev et al. (2006)	**1**	1				
4	Smith et al. (2015)	**1**	1				
5	Pham et al. (2017)	**1**	1				
6	Bhuttoo et al. (2017)	**1**	1				
7	Kim et al. (2006)	**1**	1				
8	Evans (2008)	**1**	1				
9	Welsh et al. (2003)	**2**	1	1			
10	Veletsianos (2011)	**2**	1	1			
11	de Waard (2014)	**2**	1	1			
12	Samaha et al. (2016)	**1**	1				
13	Kumar et al. (2014)	**1**	1				
14	Gikas et al. (2013)	**1**	1				
15	Denk (2007)	**1**	1				
16	Herrington et al. (2009)	**2**	1	1			
17	Jairak et al. (2009)	**2**	1	1			
18	Costabile et al. (2008)	**1**	1				
19	Chinnery (2006)	**1**	1				
20	Cheon et al. (2012)	**2**	1	1			
21	Ruiz et al. (2006)	**1**	1				
22	Jeng et al. (2010)	**1**	1				
23	Hein (1991)	**1**	1				
24	Taber (1965)	**1**	1				

	Concepts / References	Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
25	O'Flaherty (2016)	**2**	1	1			
26	Madaio et al. (2016)	**1**	1				
27	Garcia-Cabot et al.(2015)	**1**	1				
28	Ibrahim (2014)	**1**	1				
29	Yousafzai et al. (2016)	**1**	1				
30	Khan et al. (2015)	**1**	1				
31	Dragana et al. (2015)	**1**	1				
32	Althunibat (2015)	**2**	1	1			
33	Chang et al. (2016)	**1**	1				
34	Cheng (2015)	**2**	1	1			
35	Korucu (2011)	**1**	1				
36	Ertmer et al. (1993)	**2**	1	1			
37	Demirezen (1988)	**2**		1	1		
38	Cooper P.A. (1993)	**1**		1			
40	Laouris et al. (2005)	**2**	1		1		
41	Sharples et al. (2009)	**1**	1				
42	Traxler et al. (2005)	**1**	1				
43	Rossing et al. (2012)	**2**	1	1			
44	Zhou et al. (2015)	**2**	1	1			
45	Syvänen et.al (2005)	**2**	1	1			
46	Brown (2015)	**2**	1	1			
47	Sharples (2002)	**2**	1	1			
48	Brown T.H. (2006)	**2**	1	1			
49	Hewagamage et al. (2012)	**1**	1				
50	Attwell (2010)	**2**	1	1			
51	Vieira (2016)	**2**	1	1			

	Concepts / References	Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
52	Anohah et al. (2017)	**2**	1	1			
53	Cochrane et al. (2009)	**2**	1	1			
54	Pimmer et al. (2010)	**2**	1	1			
55	Viberg et al. (2013)	**2**	1	1			
56	Kismihók et al. (2012)	**2**	1	1			
57	Crompton et al. (2015)	**1**	1				
58	Traxler (2011b)	**2**	1	1			
59	Cochrane (2011)	**2**	1	1			
60	Wake et al. (2009)	**2**	1	1			
61	Buzzetto-More (2015)	**2**	1	1			
62	He (2014)	**1**	1				
63	Noce et al. (2014)	**2**	1	1			
64	Lister (2014)	**1**	1				
65	Richardson et al. (2014)	**2**	1	1			
66	Kennedy (2014)	**2**	1	1			
67	Smith P.K. et al. (2016)	**1**	1				
68	Maccallum et al. (2017)	**2**	1	1			
69	Palalas et al. (2015)	**1**	1				
70	Kalloo et al. (2011)	**2**	1	1			
71	Parsons (2014)	**2**	1	1			
72	Wingkvist et al. (2011)	**1**	1				
73	Ishtaiwa (2014)	**2**	1	1			
74	Alavi (1994)	**2**	1	1			
75	Eliasson et al. (2011)	**2**	1	1			
76	Andert et al. (2015)	**2**	1	1			
77	Kebritchi (2014)	**1**	1				

References		Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
78	Schrader et al. (2016)	**2**	1	1			
79	Ezell (2016)	**2**	1	1			
80	Dekhane et al. (2012)	**2**	1	1			
81	Clarà et al. (2013)	**2**	1	1			
82	Lu et al. (2014)	**2**	1	1			
83	Pollara et al. (2011a)	**2**	1	1			
84	Deegan (2015)	**2**	1	1			
85	Ng (2013)	**2**	1	1			
86	Pivec et al. (2003)	**2**	1	1			
87	Yau et al. (2009)	**2**	1	1			
88	Mwanza-simwami et al. (2016)	**2**	1	1			
89	Kukulska-Hulme et al. (2009)	**2**	1	1			
90	Motta et al. (2015)	**2**	1	1			
91	Nouri et al. (2011)	**3**	1	1	1		
92	Vavoula et al. (2009)	**1**	1				
93	Traxler (2009)	**1**	1				
94	Elmorshidy (2012)	**2**	1	1			
95		**2**	1	1			
96	Traxler et al. (2014)	**2**	1	1			
97	Traxler (2011a)	**2**	1	1			
98	Sharples (2006)	**1**	1				
99	Sharples et al. (2009)	**1**	1				
100	Pimmer et al. (2014)	**1**	1				
101	Kukulska-Hulme (2006)	**2**	1	1			
102	Traxler et al. (2005)	**1**	1				
103	Nordin et al. (2010)	**2**	1	1			

	Concepts	Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
References							
104	Shuib et al. (2015)	**2**	1	1			
105	Herrington A. et al. (2007)	**0**	1				
106	Parsazadeh et al. (2018)	**2**	1	1			
107	Chou et al. (2012)	**1**	1				
108	Dold (2016)	**2**	1	1			
109	Mohamad et al. (2014)	**3**	1	1	1		
110	Kukulska-hulme (2009)	**2**	1	1			
111	Hwang et al. (2014)	**1**	1				
112	Parsons et al. (2007)	**1**	1				
113	Motiwalla (2007)	**2**	1	1			
114	He et al. (2012)	**2**	1	1			
115	Kaptelinin et al. (Kaptelinin et al., 1995)	**2**	1	1			
116	Lau (2014)	**3**	1	1	1		
117	Keskin et al. (2011)	**3**	1	1	1		
118	Sharples (2005)	**3**	1	1	1		
119	Greenhouse (2013)	**2**	1		1		
120	Cleland et al. (2016)	**2**	1		1		
121	Siemens (2013)	**2**	1	1			
121	Louw et al. (Louw & Louw, 2007)	**3**	1	1	1		
122	Maccoby (1992)	**3**	1	1	1		
123	Schunk (Schunk, 2012)	**3**	1	1	1		
124	Anderson (Anderson, 2008)	**3**	1	1	1		
125	Illeris (Illeris, 2009)	**2**	1	1			
126	Pargament(1985)	**2**	1	1			
127	Yang et al. (2013)	**2**	1	1			
128	Powell et al. (2009)	**2**	1	1			

References		Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
Concepts							
129	Proctor et al. (2016)	**2**	1	1			
130	Roberts (2014)	**3**	1	1	1		
131	Bishnoi (2017)	**2**	1	1			
132	Dillenbourg (Dillenbourg, 1999)	**2**	1	1			
133	Zheng et al. (2017)	**2**	1	1			
134	Crook (1998)	**2**	1	1			
135	Lave et al. (Lave & Wenger, 1991)	**3**	1	1	1		
136	Kaschak et al. (2015)	**2**	1	1			
137	Curnow (2013)	**2**	1	1			
138	Wenger (Wenger, 1998)	**3**	1	1	1		
139	Evnitskaya et al. (2011)	**2**	1	1			
140	Rosenbaum et al. (2010)	**2**	1	1			
141	Traxler (2007)	**2**	1	1			
142	Baggaley (2012)	**2**	1	1			
143	Cochrane et al. (2009)	**2**	1	1			
144	Hogg et al. (2012)	**2**	1	1			
145	Pettenati et al. (2007)	**2**	1	1			
146	Amineh et al. (Amineh & Asl, 2015)	**3**	1	1	1		
147	Jones et al. (Jones & Brader-araje, 2002)	**3**	1	1	1		
148	Swan (Swan, 2014)	**3**	1	1	1		
149	Au (1998)	**2**	1	1			
150	Brandon et al. (2010)	**2**	1	1			
151	Perera et al. (Perera et al., 2013)	**2**	1	1			
152	Wan (2009)	**3**	1	1	1		
153	Yano et al. (2007)	**2**	1	1			
154	Hwang et al. (2008)	**2**	1	1			

References		Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
155	Gómez et al. (Gómez et al., 2014)	**1**	1				
156	Scott (Scott, 2001)	**3**	1	1	1		
157	Kim (2002)	**2**	1	1			
158	Tegos et al. (2017)	**2**	1	1			
159	Miettinen (Miettinen, 2010)	**2**	1	1			
160	Lee et al. (2016)	**2**	1	1			
161	Petrovic et al. (2014)	**2**	1	1			
162	Kolb (Kolb, 1984)	**3**	1	1	1		
163	Seaman et al. (2017)	**2**	1	1			
164	Miller (Miller, 1956)	**2**	1	1			
165	Durning et al. (2011)	**3**	1	1	1		
166	Rudolph et al. (2007)	**2**	1	1			
167	Offredy et al. (2005)	**2**	1	1			
168	Alshalabi et al. (2013)	**1**	1				
169	Baş (2016)	**2**	1	1			
170	Gardner et al. (2006)	**2**	1	1			
171	Gardner et al. (2010)	**2**	1	1			
172	Leshkovska et al. (2016)	**2**	1	1			
173	Chand et al. (2017)	**2**	1	1			
174	Karamikabir (Karamikabir, 2012)	**2**	1	1			
178	Gardner (2003)	**2**	1	1			
179	Aldrich (2013)	**2**	1	1			
180	Dolphens et al. (2014)	**2**	1	1			
181	Smeyers (2016)	**2**	1	1			
182	Hashim et al. (2017)	**2**	1	1			
183	Savery et al. (Savery & Duffy, 1995)	**2**	1	1			

References		Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
184	Çakıroğlu et al. (2017)	**2**	1	1			
185	Reder et al. (Reder et al., 1996)	**2**	1	1			
186	Oliver et al. (1995)	**2**	1	1			
187	Langer (2009)	**2**	1	1			
188	Kim et al. (2010)	**2**	1	1			
189	Curnow (2013)	**2**	1	1			
190	Rosenstock et al. (1988)	**2**	1	1			
191	Doustkam et al. (2017)	**2**	1	1			
192	Bandura (Bandura, 2001b)	**2**	1	1			
192	Bandura (Bandura, 2001a)	**2**	1	1			
193	Cooper (2014)	**2**	1	1			
194	Wilroy (2013)	**2**	1	1			
195	Lantolf (Lantolf, 2000)	**3**	1	1	1		
196	Engin (2011)	**2**	1	1			
197	Mukherjee et al. (2014)	**2**	1	1			
198	Wells (1999)	**3**	1	1	1		
199	Radford (1997)	**2**	1	1			
200	Izmirli et al. (2014)	**2**	1	1			
201	Kucukaydin et al. (2012)	**2**	1	1			
202	Cox et al. (2016)	**2**	1	1			
203	Christie et al. (2015)	**1**	1				
204	Ahad et al. (Ahad & Lim, 2014)	**2**	1			1	
205	Bere et al. (Bere & Rambe, 2016)	**2**	1			1	
206	Gachago et al. (Gachago et al., 2015)	**3**	1	1		1	
207	Andujar (Andujar, 2016)	**3**	1	1		1	
208	Bouhnik et al. (Bouhnik & Deshen, 2014)	**2**	1			1	

References		Total relevant concepts per source	Learning, e-learning and m-learning	Prominent learning theories and mobile and social media technologies	Mobile Learning (M-learning) Theory	WhatsApp and learning	Measuring collaboration and academic achievement
209	Gon et al. (Gon & Rawekar, 2017)	**2**	1			1	
210	Rambe et al. (Rambe & Bere, 2013)	**4**	1	1	1	1	
211	Aburezeq et al. (Aburezeq & Ishtaiwa, 2013)	**2**	1			1	
212	Gan et al. (Gan et al., 2015)	**2**	1			1	
213	Bansal et al. (Bansal & Joshi, 2014)	**4**	1	1	1	1	
214	Awada (Awada, 2016)	**3**	1	1		1	
215	So (So, 2016)	**3**	1	1		1	
216	Calvo et al. (Calvo et al., 2014)	**2**	1			1	
217	Barhoumi (Barhoumi, 2016)	**4**	1	1	1	1	
218	Kufre et al. (Kufre & Abe, 2017)	**3**	1	1		1	
219	Hanisi et al. (Hanisi et al., 2018)	**3**	1	1		1	
220	Caballéa et al. (2010)	**4**	1	1	1	1	
221	Strijbos et al. (Strijbos & Fischer, 2007)	**3**	1	1			1
222	Roberts et al. (D. Roberts et al., 2017)	**2**	1				1
223	Dougherty et al. (Dougherty & Larson, 2005)	**2**	1				1
224	Simatupang et al. (Simatupang & Sridharan, 2005)	**1**					1
225	Marek et al. (Marek et al., 2015)	**1**					1
226	Su et al. (Su & Beaumont, 2010)	**2**	1				1
227	Salmon (Salmon, 2002)	**2**	1				1
228	Gress et al. (Gress et al., 2008)	**2**	1				1
229	Rovai (Rovai, 2002)	**2**	1				1
230	Joiner et al. (Joiner et al., 2002)	**2**	1				1
231	Fraser et al. (Fraser & Treagust, 1986)	**2**	1				1
232	Moolenaar et al. (Moolenaar et al., 2012)	**2**	1				1

Appendix C: Anonymous Online Questionnaire (Excluding the Informed Consent Cover Letter)

Measuring Mobile Collaborative Learning (MCL) and Academic Achievement: A Study of Tertiary Education Students and WhatsApp in South Africa

Note to the respondent

VOLUNTARY QUESTIONNAIRE FOR STUDENTS

"Measuring Mobile Collaborative Learning (MCL) and Academic Achievement: A Study of Tertiary Education Students and WhatsApp in South Africa"

School of Computing
University of South Africa (UNISA)
Researcher: Bangisisi Zamuxolo Mathews Nyembe (student number 54830222)
Research Supervisor: Dr Grant Howard

Note to the respondent:

- I need your help to understand whether students use WhatsApp and, if they do, how their WhatsApp use affects their academic achievement.
- Although I would like you to help me, you do not have to take part in this survey.
- If you do not want to take part, just return the blank questionnaire or let me know. If I do not hear from you, I may send you a reminder.
- What you say in this questionnaire will remain private and confidential. No one will be able to trace your responses back to you as a person.

This questionnaire has two sections:

Section A: Asks general personal particulars like your age and gender.

Section B: Asks you to give your opinion about WhatsApp and related matters.

Thank you very much for filling in this questionnaire.

Section A: Please tell me a little about yourself

Directions for Section A: Please respond by selecting the appropriate option or filling in words or numbers.

1. I am: *

(Please only select one option for this question)

- ◯ Male
- ◯ Female
- ◯ Other: _____

2. My home language is: *

(Please only select one option for this question)

- ◯ Swazi
- ◯ Ndebele
- ◯ Northern Sotho
- ◯ Sotho
- ◯ Tsonga
- ◯ Tswana
- ◯ Venda
- ◯ Xhosa
- ◯ Zulu
- ◯ Afrikaans
- ◯ English
- ◯ Other: _____

3. I am: *

(Please only select one option for this question)

- ◯ 19 – 24 years old
- ◯ 25 – 29 years old
- ◯ 30 – 34 years old
- ◯ 35 – 39 years old
- ◯ 40 – 44 years old
- ◯ 45 + years old

4. This year, I am registered for the qualification called *

Your answer

5. This year, most of my subjects/modules/courses are: *

(Please only select one option for this question)

- ◯ First year subjects/modules/courses
- ◯ Second year subjects/modules/courses
- ◯ Third year subjects/modules/courses
- ◯ Fourth year subjects/modules/courses
- ◯ Other:

6. Do you use WhatsApp with other students for learning? *

(if you mark "No", then there are no further questions for you to answer, thank you for participating)

- ◯ Yes
- ◯ No

7. How many hours do you estimate that you spend on WhatsApp every week with other students for learning? *

(Please only select one option for this question)

- ○ 0 – <1 hour
- ○ 1 – <5 hours
- ○ 5 – <10 hours
- ○ 10 - <20 hours
- ○ 20 - <40 hours
- ○ 40+ hours

8. What devices do you use when learning with other students on WhatsApp? *

(You can select as many options as you want for this question)

- ☐ Smartphone
- ☐ Tablet
- ☐ Laptop computer
- ☐ Desktop computer
- ☐ Smart watch
- ☐ Gaming console
- ☐ Other: _____

9. Where or what places do you use WhatsApp for learning with other students? *

(You can select as many options as you want for this question)

- ☐ At home
- ☐ At campus
- ☐ While travelling by car, bus, taxi, uber, etc.
- ☐ While shopping
- ☐ At any location with a freely available Wi-Fi hotspot
- ☐ At libraries, study centres or internet cafes
- ☐ Other: _____

10. What prevents you from using WhatsApp more often or in more places for learning with other students? *

(You can select as many options as you want for this question)

- [ ] Locations with no signal for internet connectivity
- [ ] Locations without a freely available Wi-Fi hotspot
- [ ] The cost of data
- [ ] Locations without electrical plug points for charging my device
- [ ] Other: _____

Section B: *Please give me your opinion about WhatsApp for learning with other students*

Directions for Section B:

- *There are no right or wrong answers; we are only interested in your personal opinion.*
- *All the questions are in the same format and for each question you are required to read the question and then just click one of the radio buttons that best describes your opinion. If you are doing the paper-based questionnaire please put an "X" in the column that best describes your opinion*
- *Please **answer every question** otherwise the study may not be successful.*
- *Please **ONLY CHOOSE ONE ANSWER FOR EACH QUESTION** (never choose more than one answer on a question).*
- *Some of the questions may seem similar, but they do address slightly different aspects.*
- *Here is an example. In this example, the respondent has said that he/she agrees that books are important by marking the "agree" column with an "X":*

Statements about books	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Concept: Attitude toward books					
I think that books are important.				X	

When I am on WhatsApp with other students: *

Interaction (IA)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
1. We have discussions to learn from each other.	○	○	○	○	○
2. We participate with each other to learn.	○	○	○	○	○
3. We have chats to learn from each other.	○	○	○	○	○
4. We have meetings with each other to learn.	○	○	○	○	○

When I am on WhatsApp with other students: *

Support (S)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
5. They help me on my courses/modules.	○	○	○	○	○
6. They aid me when I am stuck on my courses/modules.	○	○	○	○	○
7. They lend a hand so I can figure out my courses/modules.	○	○	○	○	○
8. They encourage me to keep going on my courses/modules.	○	○	○	○	○

When I am on WhatsApp with other students: *

Information Exchange (IE)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
9. Course/module material gets passed around.	○	○	○	○	○
10. We swap course/module information.	○	○	○	○	○
11. Course/module material is spread around.	○	○	○	○	○
12. We distribute course/module information.	○	○	○	○	○

When I am on WhatsApp with other students: *

Sense of Community (SC)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
13. I feel that I belong to a learning group.	○	○	○	○	○
14. I matter to my learning group.	○	○	○	○	○
15. My learning group matters to me.	○	○	○	○	○
16. My learning group benefits our learning.	○	○	○	○	○

When I am on WhatsApp with other students: *

Interdependence (ID)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
17. Other students rely on me to learn.	○	○	○	○	○
18. I need other students to learn.	○	○	○	○	○
19. Other students need me to learn.	○	○	○	○	○
20. My learning is conditional on other students.	○	○	○	○	○

When I am on WhatsApp with other students: *

Trust (T)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
21. Other students provide honest course/module advice.	○	○	○	○	○
22. I believe in what other students say to me about courses/modules.	○	○	○	○	○
23. I have faith in the course/module communication from other students.	○	○	○	○	○
24. The course/module discussions with other students are	○	○	○	○	○

When I am on WhatsApp with other students: *

Active Learning (AL)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
25. I learn by working on questions with other students.	○	○	○	○	○
26. I learn by doing activities with other students.	○	○	○	○	○
27. I teach other students learning material.	○	○	○	○	○
28. I show other students how to figure out their courses/modules.	○	○	○	○	○

When I am on WhatsApp with other students: *

Formality (F)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
29. When learning, we use correct wording only.	○	○	○	○	○
30. When learning, we discuss academic content only.	○	○	○	○	○
31. During course/module communication, we use scientific language only.	○	○	○	○	○
32. We use textbook wording only when chatting about courses/modules.	○	○	○	○	○

When I am on WhatsApp with other students: *

Collaboration (C)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
33. We work together to understand our courses/modules.	○	○	○	○	○
34. When preparing for tests or exams we learn together.	○	○	○	○	○
35. We study as a group.	○	○	○	○	○
36. We learn our courses/modules together.	○	○	○	○	○

Since I started using WhatsApp for learning: *

Academic Achievement (AA)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
37. My courses'/modules' marks have improved.	○	○	○	○	○
38. I do better in tests and exams.	○	○	○	○	○
39. I have had more success in my courses/modules.	○	○	○	○	○
40. I understand my courses/modules better.	○	○	○	○	○

Appendix D: Permission Letters from Participating Institutions

The signed permission letters have been removed from this appendix to maintain participant anonymity

Appendix E: Unisa Ethics Clearance Certificate

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) ETHICS REVIEW COMMITTEE

18 February 2020

ERC Reference #: 2020/CSET/SOC/001
Name: Mr Bangisisi Zamuxolo Mathews Nyembe
Student #: 54830222
Staff #:

Dear Mr Nyembe

Decision: Ethics Approval from 18 February 2020 to 17 February 2023 (Humans involved)

RECEIVED
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College of Science, Engineering and Technology

Researcher(s): Mr Bangisisi Zamuxolo Mathews Nyembe
0720868910bzm@gmail.com, 058 718 1116

Supervisor (s): Dr Grant Howard
howargr@unisa.ac.za, 011 471 2273

Working title of research:

Measuring Mobile Collaborative Learning (MCL) and Academic Achievement: A Study of Tertiary Education Students and WhatsApp in South Africa

Qualification: MTech IT

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Ethics Review Committee for the above mentioned research. Ethics approval is granted for 3 years.

*The **low risk application** was expedited by the College of Science, Engineering and Technology's (CSET) Ethics Review Committee on 18 February 2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next Committee meeting for ratification.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

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2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology's (CSET) Ethics Review Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No field work activities may continue after the expiry date 17 February 2023. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.
8. Permission to conduct this research should be obtained from the University of the Free State Qwa-Qwa Campus and the Maluti TVET College prior to commencing field work.

Note

The reference number 2020/CSET/SOC/001 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Yours sincerely,

Mr C Pilkington
Chair of School of Computing Ethics Review Subcommittee
College of Science, Engineering and Technology (CSET)
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Appendix F: Research Data - Covariance/Correlation Matrix from JASP

Covariances (lower triangle) / correlations (upper triangle)										
		Academic_Achievement_AA	**Collaboration_C**	**Active_Learning_AL**	**Support_S**	**Interdependence_ID**	**Information_Exchange_IE**	**Interaction_IA**	**Formality_F**	**Trust_T**
Academic_Achievement_AA	observed	19.133	0.658	0.536	0.536	0.344	0.424	0.460	0.413	0.540
	fitted	19.055	0.656	0.445	0.394	0.305	0.333	0.334	0.311	0.426
	residual	0.078	0.002	0.091	0.142	0.039	0.091	0.126	0.102	0.114
Collaboration_C	observed	12.237	18.104	0.680	0.610	0.478	0.509	0.525	0.487	0.646
	fitted	12.121	17.932	0.679	0.601	0.465	0.507	0.510	0.474	0.649
	residual	0.116	0.171	0.002	0.009	0.013	0.001	0.015	0.013	-0.003
Active_Learning_AL	observed	9.058	11.180	14.913	0.608	0.485	0.557	0.514	0.439	0.650
	fitted	7.481	11.067	14.821	0.605	0.476	0.554	0.500	0.430	0.652
	residual	1.577	0.113	0.092	0.003	0.009	0.003	0.014	0.009	-0.002
Support_S	observed	10.135	11.211	10.150	18.670	0.420	0.639	0.593	0.378	0.643
	fitted	7.421	10.978	10.051	18.621	0.377	0.638	0.590	0.335	0.644
	residual	2.714	0.232	0.099	0.048	0.043	8.058e -4	0.003	0.043	-8.347e -4
Interdependence_ID	observed	5.366	7.255	6.687	6.485	12.743	0.347	0.345	0.340	0.537
	fitted	4.749	7.026	6.548	5.814	12.743	0.350	0.295	0.340	0.537
	residual	0.616	0.229	0.139	0.671	-1.460e -6	-0.003	0.050	2.317e -10	3.188e -7
Information_Exchange_IE	observed	7.792	9.099	9.036	11.605	5.207	17.667	0.533	0.314	0.598
	fitted	6.099	9.023	8.953	11.564	5.242	17.632	0.530	0.311	0.599
	residual	1.692	0.076	0.083	0.041	-0.036	0.035	0.003	0.003	-5.916e -4
Interaction_IA	observed	7.861	8.719	7.753	10.013	4.804	8.755	15.248	0.313	0.549
	fitted	5.698	8.430	7.523	9.948	4.111	8.698	15.248	0.260	0.549
	residual	2.162	0.289	0.230	0.065	0.693	0.056	-2.288e -5	0.053	4.103e -7
Formality_F	observed	6.882	7.895	6.459	6.215	4.617	5.017	4.650	14.489	0.474
	fitted	5.167	7.644	6.302	5.508	4.617	4.965	3.866	14.489	0.474

Appendix F: Research Data-Covariance Matrix from JASP

Covariances (lower triangle) / correlations (upper triangle)										
		Academic_Achievement_AA	**Collaboration_C**	**Active_Learning_AL**	**Support_S**	**Interdependence_ID**	**Information_Exchange_IE**	**Interaction_IA**	**Formality_F**	**Trust_T**
	residual	1.715	0.251	0.157	0.707	-2.614e -7	0.052	0.784	0.000	0.000
Trust_T	observed	8.317	9.676	8.842	9.783	6.748	8.850	7.550	6.345	12.392
	fitted	6.540	9.676	8.842	9.783	6.748	8.850	7.550	6.345	12.392
	residual	1.776	-9.202e -7	-1.013e -6	7.348e -7	3.620e -6	-8.356e -7	-2.325e -8	0.000	0.000

Appendix G: Language Editing Certificate

Kim N Smit Editorial Services

Declaration of Professional Editing

12 February 2021

This letter serves to confirm that Bangisisi Zamuxolo Mathews Nyembe submitted a thesis to myself for editing. The thesis is entitled, '**MEASURING MOBILE COLLABORATIVE LEARNING (MCL) AND ACADEMIC ACHIEVEMENT: WHATSAPP AND STUDENTS IN SOUTH AFRICA**'.

The following aspects were edited:

- Spelling
- Grammar
- Consistency of layout
- Sentence structure
- Logical sequencing
- References (Reference checking involves proofreading and perhaps some editing with regards to the simple formatting of the references into the referencing style required i.e. changing the order of the elements - author, date, title, series, place, publisher, journal, volume, issue, pagination etc.)

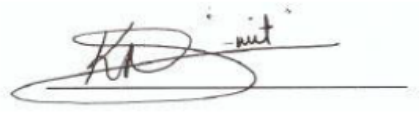
The following sections were excluded at the request of the student:

- All preliminary pages except the Abstract
- All Appendices

My involvement was restricted to language use and spelling, completeness and consistency, referencing style, and formatting of headings and captions. I did no structural re-writing of the content and did not influence the academic content in any way.

Should you have any further queries, please do not hesitate to contact me.

Kind regards,



Kim Smit

Tel: +27 (0)78 493 6554 Email: kimnsmit@gmail.com
Member of the Freelance panel for the University of South Africa
Member of the Freelance panel for the University of Pretoria
Full Member of the Professional Editor's Guild

Appendix H: Originality Report

Once all the chapters of the dissertation were completed, the dissertation was submitted to iThenticate, which was leading originality/plagiarism checking software that exposed content in the dissertation that matched text on the Internet, in academic and many other sources. The iThenticate similarity report was analysed without applying filters and after applying filters and no plagiarism was evident.

The following filters were used:

- The matches to the student's own publications directly from the dissertation, listed just before the table of contents in this document, were excluded.
- The matches to other Unisa student dissertations and theses that used the same headings and other document structures were excluded since these were unavoidable and mandatory and did not indicate plagiarism.
- The references filter was activated to exclude the bibliography since there were many typical individual reference matches only and no evidence of copying and pasting groups of references.
- The word filter was activated to exclude matches that are less than 9 words since this was the minimum value allowed by iThenticate for this filter, and it removed many of the matches on headings and other structural elements that did not indicate plagiarism.

The result was a 7% similarity index as shown in the Figure H.1 below:

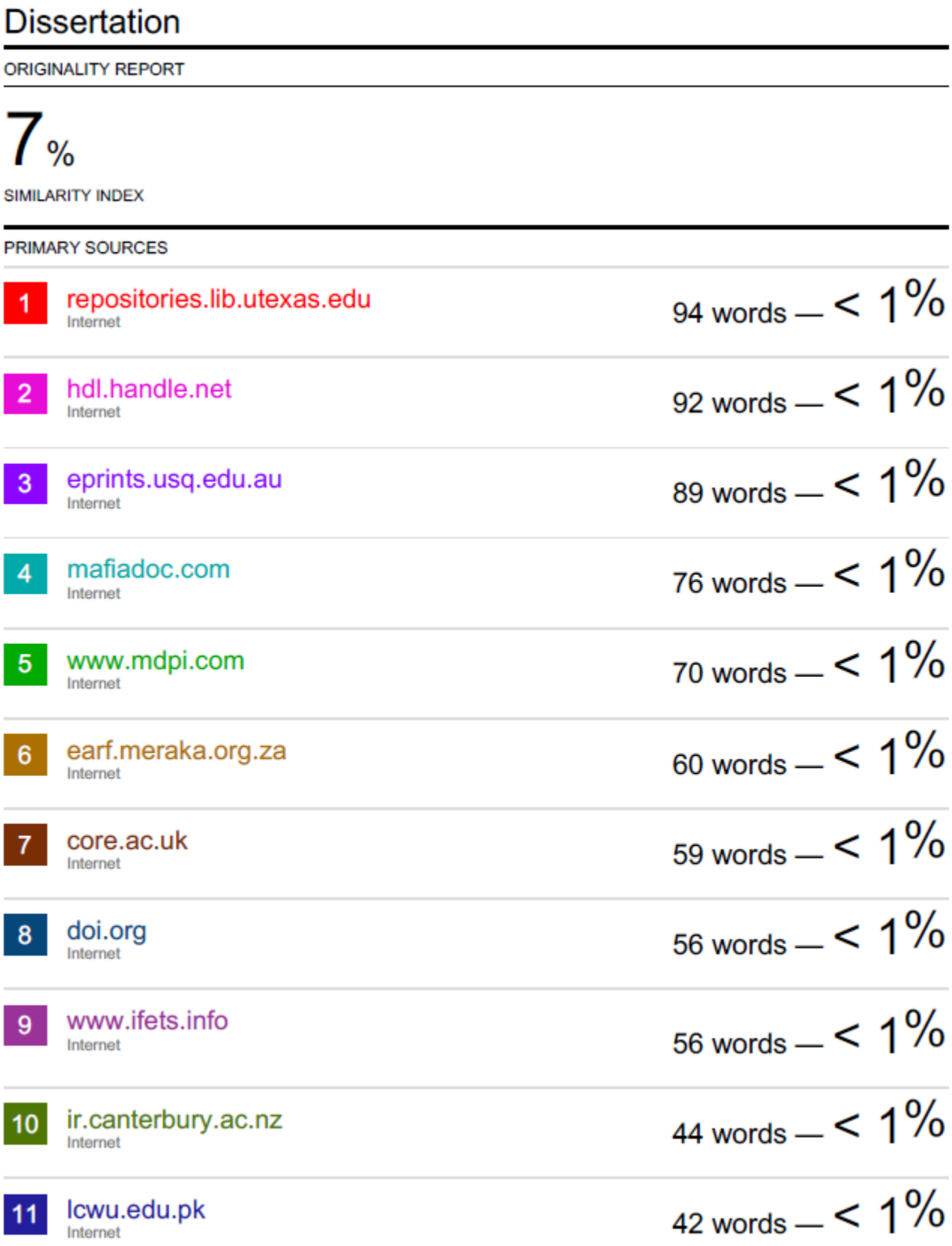


Figure H.1: Filtered similarity index

The full iThenticate report was excluded from this appendix due to it being longer than the entire dissertation. However, it was available during 2021 in electronic format for inspection by readers on request. If required, it should be requested via the Unisa School of Computing's examinations contact

person and a suitable repository provided to which it can be uploaded, such as Dropbox or Google Drive (since the file was about twenty-four megabytes in size, which was usually too big for e-mail) or a transfer service provided like WeTransfer.

Appendix I: Significant ANOVA Results

Age range:

ANOVA - Trust_T

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Age_Range	87.988	2	43.994	3.588	0.029	0.018
Residuals	4782.119	390	12.262			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
1.888	2.000	390.000	0.153

Post Hoc Comparisons - Age_Range

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	Cohen's d	p_{tukey}
19_to_24_years_old	25_to_29_years_old	-0.225	-1.286	0.835	0.451	-0.500	-0.065	0.871
	30+_years_old	3.064	0.278	5.849	1.184	2.587	0.873	0.027*
25_to_29_years_old	30+_years_old	3.289	0.383	6.195	1.235	2.662	0.902	0.022*

* $p < .05$

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the tukey method).

Qualification:

Appendix I: Significant ANOVA Results

ANOVA - Information_Exchange_IE

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Qualification	502.837	8	62.855	3.748	< .001	0.072
Residuals	6440.405	384	16.772			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
1.866	8.000	384.000	0.064

Post Hoc Comparisons - Qualification

		Mean Difference	95% CI for Mean Difference		SE	t	Cohen's d	p_{tukey}
			Lower	Upper				
Bachelor, of, Administration, (BAdmin)	Bachelor, of, Arts, (BA)	0.454	-2.723	3.631	1.018	0.446	0.119	1.000
	Bachelor, of, Commerce, (BCom)	1.935	-2.433	6.303	1.400	1.382	0.550	0.904
	Bachelor, of, Community, Development, (BCmd)	1.614	-3.661	6.888	1.691	0.954	0.396	0.990
	Bachelor, of, Education, (BEd)	-0.400	-3.384	2.584	0.956	-0.418	-0.104	1.000
	Bachelor, of, Science, (BSc)	0.325	-2.924	3.574	1.042	0.312	0.091	1.000
	Bachelor, of, Social, Sciences, (BSocSci)	0.287	-2.963	3.536	1.042	0.275	0.072	1.000

Appendix I: Significant ANOVA Results

ANOVA - Information_Exchange_IE

Cases	Sum of Squares	df	Mean Square	F	p	η²			
		Postgraduate, Certificate, in, Education, (FET), (PGCE)	-0.699	-4.897	3.499	1.346	-0.519	-0.173	1.000
		Various, other, bachelor's, and, honours, degrees, , diplomas, and, certificates	2.933	-0.266	6.132	1.025	2.860	0.668	0.102
Bachelor, of, Arts, (BA)		Bachelor, of, Commerce, (BCom)	1.481	-2.305	5.267	1.214	1.221	0.379	0.952
		Bachelor, of, Community, Development, (BCmd)	1.160	-3.644	5.964	1.540	0.753	0.279	0.998
		Bachelor, of, Education, (BEd)	-0.854	-2.893	1.186	0.654	-1.306	-0.217	0.929
		Bachelor, of, Science, (BSc)	-0.129	-2.540	2.283	0.773	-0.166	-0.034	1.000
		Bachelor, of, Social, Sciences, (BSocSci)	-0.167	-2.578	2.244	0.773	-0.216	-0.041	1.000
		Postgraduate, Certificate, in, Education, (FET), (PGCE)	-1.153	-4.741	2.436	1.150	-1.002	-0.279	0.986
		Various, other, bachelor's, and, honours, degrees, , diplomas, and, certificates	2.479	0.136	4.822	0.751	3.300	0.572	0.029*
Bachelor, of, Commerce, (BCom)		Bachelor, of, Community, Development, (BCmd)	-0.321	-5.984	5.341	1.815	-0.177	-0.072	1.000
		Bachelor, of, Education, (BEd)	-2.335	-5.960	1.290	1.162	-2.009	-0.597	0.538

Appendix I: Significant ANOVA Results

ANOVA - Information_Exchange_IE

Cases	Sum of Squares	df	Mean Square	F	p	η²			
		Bachelor, of, Science, (BSc)	-1.610	-5.457	2.237	1.233	-1.306	-0.440	0.929
		Bachelor, of, Social, Sciences, (BSocSci)	-1.648	-5.495	2.198	1.233	-1.337	-0.404	0.920
		Postgraduate, Certificate, in, Education, (FET), (PGCE)	-2.634	-7.309	2.042	1.499	-1.757	-0.610	0.710
		Various, other, bachelor's, and, honours, degrees, , diplomas, and, certificates	0.998	-2.807	4.802	1.219	0.818	0.220	0.996
Bachelor, of, Community, Development, (BCmd)		Bachelor, of, Education, (BEd)	-2.014	-6.692	2.665	1.500	-1.343	-0.496	0.918
		Bachelor, of, Science, (BSc)	-1.288	-6.140	3.563	1.555	-0.828	-0.327	0.996
		Bachelor, of, Social, Sciences, (BSocSci)	-1.327	-6.179	3.525	1.555	-0.853	-0.303	0.995
		Postgraduate, Certificate, in, Education, (FET), (PGCE)	-2.312	-7.845	3.220	1.773	-1.304	-0.455	0.930
		Various, other, bachelor's, and, honours, degrees, , diplomas, and, certificates	1.319	-3.499	6.137	1.545	0.854	0.274	0.995
Bachelor, of, Education, (BEd)		Bachelor, of, Science, (BSc)	0.725	-1.425	2.875	0.689	1.052	0.189	0.980
		Bachelor, of, Social, Sciences, (BSocSci)	0.687	-1.463	2.837	0.689	0.996	0.171	0.986

ANOVA - Information_Exchange_IE

Cases	Sum of Squares	df	Mean Square	F	p	η²			
		Postgraduate, Certificate, in, Education, (FET), (PGCE)	-0.299	-3.717	3.119	1.096	-0.273	-0.074	1.000
		Various, other, bachelor's, and, honours, degrees, , diplomas, and, certificates	3.333	1.259	5.406	0.665	5.015	0.791	< .001*
Bachelor, of, Science, (BSc)		Bachelor, of, Social, Sciences, (BSocSci)	-0.038	-2.544	2.467	0.803	-0.048	-0.010	1.000
		Postgraduate, Certificate, in, Education, (FET), (PGCE)	-1.024	-4.676	2.628	1.171	-0.875	-0.260	0.994
		Various, other, bachelor's, and, honours, degrees, , diplomas, and, certificates	2.607	0.168	5.047	0.782	3.334	0.615	0.026*
Bachelor, of, Social, Sciences, (BSocSci)		Postgraduate, Certificate, in, Education, (FET), (PGCE)	-0.986	-4.638	2.667	1.171	-0.842	-0.228	0.995
		Various, other, bachelor's, and, honours, degrees, , diplomas, and, certificates	2.646	0.206	5.086	0.782	3.383	0.593	0.022*
Postgraduate, Certificate, in, Education, (FET), (PGCE)		Various, other, bachelor's, and, honours, degrees, , diplomas, and, certificates	3.631	0.024	7.239	1.156	3.140	0.769	0.047*

* p < .05, ** p < .01, *** p < .001

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 9 estimates (confidence intervals corrected using the tukey method).

Course level:

ANOVA - Information_Exchange_IE

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Course_Level	142.345	3	47.448	2.714	0.045	0.021
Residuals	6800.897	389	17.483			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
1.639	3.000	389.000	0.180

Post Hoc Comparisons - Course_Level

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	Cohen's d	p_{tukey}
First, year, subjects/modules/courses	Second, year, subjects/modules/courses	-0.486	-2.144	1.171	0.642	-0.757	-0.113	0.874
	Third, year, subjects/modules/courses	-1.607	-3.191	-0.022	0.614	-2.616	-0.405	0.045 *
	Fourth, year, subjects/modules/courses	-1.064	-2.755	0.627	0.655	-1.624	-0.246	0.366
Second, year, subjects/modules/courses	Third, year, subjects/modules/courses	-1.121	-2.559	0.318	0.557	-2.010	-0.275	0.186
	Fourth, year, subjects/modules/courses	-0.578	-2.133	0.977	0.603	-0.960	-0.132	0.772
Third, year, subjects/modules/courses	Fourth, year, subjects/modules/courses	0.542	-0.935	2.019	0.572	0.947	0.133	0.779

* $p < .05$

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 4 estimates (confidence intervals corrected using the tukey method).

ANOVA - Interaction_IA

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Course_Level	153.398	3	51.133	3.406	0.018	0.026
Residuals	5839.152	389	15.011			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
1.325	3.000	389.000	0.266

Post Hoc Comparisons - Course_Level

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	Cohen's d	p_{tukey}
First, year, subjects/modules/courses	Second, year, subjects/modules/courses	-0.444	-1.980	1.092	0.595	-0.746	-0.116	0.878
	Third, year, subjects/modules/courses	-1.649	-3.117	-0.181	0.569	-2.897	-0.455	0.021 *
	Fourth, year, subjects/modules/courses	-1.050	-2.617	0.517	0.607	-1.729	-0.267	0.310
Second, year, subjects/modules/courses	Third, year, subjects/modules/courses	-1.205	-2.538	0.128	0.517	-2.333	-0.314	0.092
	Fourth, year, subjects/modules/courses	-0.606	-2.047	0.835	0.558	-1.085	-0.147	0.699
Third, year, subjects/modules/courses	Fourth, year, subjects/modules/courses	0.599	-0.770	1.967	0.530	1.129	0.153	0.672

* $p < .05$

Note. Cohen's d does not correct for multiple comparisons.

ANOVA - Interaction_IA

Cases	Sum of Squares	df	Mean Square	F	p	η²

Note. P-value and confidence intervals adjusted for comparing a family of 4 estimates (confidence intervals corrected using the tukey method).

ANOVA - Support_S

Cases	Sum of Squares	df	Mean Square	F	p	η²
Course_Level	204.267	3	68.089	3.713	0.012	0.028
Residuals	7132.914	389	18.337			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
2.207	3.000	389.000	0.087

Post Hoc Comparisons - Course_Level

			95% CI for Mean Difference				
		Mean Difference	Lower	Upper	SE	t	Cohen's d
First, year, subjects/modules/courses	Second, year, subjects/modules/courses	-1.038	-2.735	0.660	0.658	-1.577	-0.235
	Third, year, subjects/modules/courses	-1.781	-3.404	-0.159	0.629	-2.832	-0.444
	Fourth, year, subjects/modules/courses	-0.204	-1.936	1.528	0.671	-0.304	-0.044
Second, year, subjects/modules/courses	Third, year, subjects/modules/courses	-0.744	-2.217	0.729	0.571	-1.303	-0.184
	Fourth, year, subjects/modules/courses	0.834	-0.759	2.426	0.617	1.351	0.183
Third, year, subjects/modules/courses	Fourth, year, subjects/modules/courses	1.578	0.065	3.090	0.586	2.691	0.378

* $p < .05$

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 4 estimates (confidence intervals corrected using the tukey method).

ANOVA - Collaboration_C

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Course_Level	317.549	3	105.850	6.058	< .001	0.045
Residuals	6797.219	389	17.474			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
2.433	3.000	389.000	0.065

Post Hoc Comparisons - Course_Level

			95% CI for Mean Difference				
		Mean Difference	Lower	Upper	SE	t	Cohen's d
First, year, subjects/modules/courses	Second, year, subjects/modules/courses	-0.907	-2.564	0.750	0.642	-1.412	-0.201
	Third, year, subjects/modules/courses	-2.371	-3.955	-0.787	0.614	-3.862	-0.579
	Fourth, year, subjects/modules/courses	-1.988	-3.678	-0.297	0.655	-3.034	-0.467
Second, year, subjects/modules/courses	Third, year, subjects/modules/courses	-1.464	-2.902	-0.026	0.557	-2.627	-0.355
	Fourth, year, subjects/modules/courses	-1.081	-2.636	0.473	0.602	-1.795	-0.254
Third, year, subjects/modules/courses	Fourth, year, subjects/modules/courses	0.383	-1.094	1.860	0.572	0.669	0.098

* p < .05, ** p < .01, *** p < .001

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 4 estimates (confidence intervals corrected using the tukey method).

Hours on WhatsApp every week learning:

ANOVA - Interaction_IA

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Hours_on_WhatsApp	264.874	5	52.975	3.579	0.004	0.044

Appendix I: Significant ANOVA Results

ANOVA - Interaction_IA

Cases	Sum of Squares	df	Mean Square	F	p	η²
Residuals	5727.675	387	14.800			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
0.640	5.000	387.000	0.669

Post Hoc Comparisons - Hours_on_WhatsApp

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	Cohen's d	p tukey
Zero_to_under_one_hour	One_to_under_five_hours	-1.327	-3.221	0.566	0.661	-2.008	-0.329	0.339
	Five_to_under_ten_hours	-1.745	-3.776	0.286	0.709	-2.461	-0.451	0.139
	Ten_to_under_twenty_hours	-2.745	-4.978	-0.511	0.780	-3.520	-0.719	0.006**
	Twenty_to_under_forty_hours	-2.419	-4.902	0.064	0.867	-2.790	-0.623	0.061
	Forty_hours_and_over	-2.723	-5.150	-0.295	0.848	-3.212	-0.702	0.018*
One_to_under_five_hours	Five_to_under_ten_hours	-0.418	-1.939	1.104	0.531	-0.786	-0.106	0.970

ANOVA - Interaction_IA

Cases	Sum of Squares	df	Mean Square	F	p	η²	
Five_to_under_ten_hours	Ten_to_under_twenty_hours	-1.417	-3.200	0.365	0.622	-2.277	-0.362	0.206
	Twenty_to_under_forty_hours	-1.092	-3.178	0.995	0.729	-1.498	-0.276	0.666
	Forty_hours_and_over	-1.395	-3.415	0.625	0.705	-1.978	-0.353	0.357
Ten_to_under_twenty_hours	Twenty_to_under_forty_hours	0.326	-2.074	2.725	0.838	0.389	0.090	0.999
	Forty_hours_and_over	0.022	-2.320	2.364	0.818	0.027	0.006	1.000
Twenty_to_under_forty_hours	Forty_hours_and_over	-0.304	-2.885	2.278	0.901	-0.337	-0.084	0.999

* p < .05, ** p < .01

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 6 estimates (confidence intervals corrected using the tukey method).

Appendix I: Significant ANOVA Results

ANOVA - Interdependence_ID

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Hours_on_WhatsApp	210.093	5	42.019	3.389	0.005	0.042
Residuals	4797.744	387	12.397			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
0.575	5.000	387.000	0.719

Post Hoc Comparisons - Hours_on_WhatsApp

			95% CI for Mean Difference				
		Mean Difference	Lower	Upper	SE	t	Cohen's d
Zero_to_under_one_hour	One_to_under_five_hours	-1.347	-3.080	0.386	0.605	-2.227	-0.375
	Five_to_under_ten_hours	-1.025	-2.884	0.834	0.649	-1.579	-0.299
	Ten_to_under_twenty_hours	-2.551	-4.596	-0.507	0.714	-3.575	-0.710
	Twenty_to_under_forty_hours	-1.835	-4.108	0.438	0.794	-2.312	-0.506
	Forty_hours_and_over	-2.330	-4.552	-0.109	0.776	-3.004	-0.693
One_to_under_five_hours	Five_to_under_ten_hours	0.322	-1.070	1.715	0.486	0.663	0.092
	Ten_to_under_twenty_hours	-1.204	-2.836	0.427	0.570	-2.114	-0.333
	Twenty_to_under_forty_hours	-0.488	-2.398	1.422	0.667	-0.731	-0.134
	Forty_hours_and_over	-0.983	-2.832	0.866	0.646	-1.523	-0.280
Five_to_under_ten_hours	Ten_to_under_twenty_hours	-1.527	-3.291	0.238	0.616	-2.477	-0.440
	Twenty_to_under_forty_hours	-0.810	-2.835	1.215	0.707	-1.146	-0.233
	Forty_hours_and_over	-1.306	-3.273	0.662	0.687	-1.900	-0.396

Appendix I: Significant ANOVA Results

ANOVA - Interdependence_ID

Cases	Sum of Squares	df	Mean Square	F	p	η²	
Ten_to_under_twenty_hours	Twenty_to_under_forty_hours	0.716	-1.480	2.913	0.767	0.934	0.195
	Forty_hours_and_over	0.221	-1.923	2.365	0.748	0.295	0.064
Twenty_to_under_forty_hours	Forty_hours_and_over	-0.495	-2.858	1.867	0.825	-0.601	-0.144

* p < .05, ** p < .01

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 6 estimates (confidence intervals corrected using the tukey method).

ANOVA - Formality_F

Cases	Sum of Squares	df	Mean Square	F	p	η²
Hours_on_WhatsApp	169.333	5	33.867	2.372	0.039	0.030
Residuals	5524.835	387	14.276			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
0.831	5.000	387.000	0.528

Post Hoc Comparisons - Hours_on_WhatsApp

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	Cohen's d	p_{tukey}
Zero_to_under_one_hour	One_to_under_five_hours	-1.559	-3.418	0.301	0.649	-2.401	-0.402	0.158

ANOVA - Formality_F

Cases	Sum of Squares	df	Mean Square	F	p	η²		
	Five_to_under_ten_hours	-1.490	-3.485	0.505	0.697	-2.139	-0.397	0.269
	Ten_to_under_twenty_hours	-1.833	-4.026	0.361	0.766	-2.393	-0.456	0.161
	Twenty_to_under_forty_hours	-2.467	-4.906	-0.028	0.852	-2.897	-0.614	0.04*
	Forty_hours_and_over	-2.398	-4.782	-0.014	0.832	-2.881	-0.628	0.04*
One_to_under_five_hours	Five_to_under_ten_hours	0.068	-1.426	1.563	0.522	0.131	0.018	1.000
	Ten_to_under_twenty_hours	-0.274	-2.025	1.476	0.611	-0.448	-0.071	0.998
	Twenty_to_under_forty_hours	-0.908	-2.958	1.142	0.716	-1.269	-0.238	0.802
	Forty_hours_and_over	-0.840	-2.824	1.144	0.693	-1.212	-0.225	0.831
Five_to_under_ten_hours	Ten_to_under_twenty_hours	-0.343	-2.236	1.551	0.661	-0.518	-0.092	0.995
	Twenty_to_under_forty_hours	-0.976	-3.150	1.197	0.759	-1.287	-0.267	0.792

ANOVA - Formality_F

Cases	Sum of Squares	df	Mean Square	F	p	η²		
	Forty_hours_and_over	-0.908	-3.020	1.204	0.737	-1.232	-0.258	0.821
Ten_to_under_twenty_hours	Twenty_to_under_forty_hours	-0.634	-2.991	1.723	0.823	-0.770	-0.162	0.972
	Forty_hours_and_over	-0.566	-2.866	1.735	0.803	-0.704	-0.151	0.981
Twenty_to_under_forty_hours	Forty_hours_and_over	0.068	-2.467	2.604	0.885	0.077	0.019	1.000

* p < .05

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 6 estimates (confidence intervals corrected using the tukey method).

ANOVA - Information_Exchange_IE

Cases	Sum of Squares	df	Mean Square	F	p	η²
Hours_on_WhatsApp	371.102	5	74.220	4.370	< .001	0.053
Residuals	6572.139	387	16.982			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
0.211	5.000	387.000	0.958

Post Hoc Comparisons - Hours_on_WhatsApp

ANOVA - Information_Exchange_IE

Cases	Sum of Squares	df	Mean Square	F	p	η²		
			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	Cohen's d	p_{tukey}
Zero_to_under_one_hour	One_to_under_five_hours	-2.580	-4.608	-0.552	0.708	-3.644	-0.611	0.004*
	Five_to_under_ten_hours	-2.915	-5.091	-0.739	0.760	-3.837	-0.744	0.002*
	Ten_to_under_twenty_hours	-3.490	-5.882	-1.097	0.835	-4.178	-0.857	< .001*
	Twenty_to_under_forty_hours	-2.787	-5.447	-0.127	0.929	-3.001	-0.692	0.034
	Forty_hours_and_over	-3.244	-5.845	-0.644	0.908	-3.574	-0.819	0.005*
One_to_under_five_hours	Five_to_under_ten_hours	-0.335	-1.964	1.295	0.569	-0.588	-0.080	0.992
	Ten_to_under_twenty_hours	-0.910	-2.819	1.000	0.667	-1.364	-0.213	0.748
	Twenty_to_under_forty_hours	-0.207	-2.442	2.028	0.780	-0.265	-0.048	1.000
	Forty_hours_and_over	-0.664	-2.828	1.500	0.756	-0.879	-0.156	0.951
Five_to_under_ten_hours	Ten_to_under_twenty_hours	-0.575	-2.640	1.491	0.721	-0.797	-0.143	0.968
	Twenty_to_under_forty_hours	0.128	-2.243	2.498	0.828	0.154	0.032	1.000

Appendix I: Significant ANOVA Results

ANOVA - Information_Exchange_IE

Cases	Sum of Squares	df	Mean Square	F	p	η²	
Ten_to_under_twenty_hours	Forty_hours_and_over	-0.329	-2.633	1.974	0.804	-0.410	-0.084	0.999
	Twenty_to_under_forty_hours	0.702	-1.868	3.273	0.898	0.783	0.169	0.970
	Forty_hours_and_over	0.245	-2.264	2.754	0.876	0.280	0.060	1.000
Twenty_to_under_forty_hours	Forty_hours_and_over	-0.457	-3.222	2.308	0.965	-0.473	-0.113	0.997

Note. P-value and confidence intervals adjusted for comparing a family of 6 estimates (confidence intervals corrected using the tukey method).

Note. Cohen's d does not correct for multiple comparisons.

* p < .05, ** p < .01, *** p < .001

ANOVA - Collaboration_C

Cases	Sum of Squares	df	Mean Square	F	p	η²
Hours_on_WhatsApp	446.560	5	89.312	5.183	< .001	0.063
Residuals	6668.209	387	17.231			

Note. Type III Sum of Squares

Test for Equality of Variances (Levene's)

F	df1	df2	p
2.241	5.000	387.000	0.050

Post Hoc Comparisons - Hours_on_WhatsApp

				95% CI for Mean Difference	

ANOVA - Collaboration_C

Cases	Sum of Squares	df	Mean Square	F	p	η²		
		Mean Difference	Lower	Upper	SE	t	Cohen's d	p tukey
Zero_to_under_one_hour	One_to_under_five_hours	-1.889	-3.932	0.153	0.713	-2.649	-0.431	0.088
	Five_to_under_ten_hours	-2.787	-4.979	-0.595	0.765	-3.642	-0.650	0.004**
	Ten_to_under_twenty_hours	-3.403	-5.813	-0.993	0.841	-4.045	-0.728	<.001**
	Twenty_to_under_forty_hours	-3.337	-6.016	-0.657	0.936	-3.566	-0.737	0.005**
	Forty_hours_and_over	-3.606	-6.226	-0.987	0.915	-3.944	-0.804	0.001**
One_to_under_five_hours	Five_to_under_ten_hours	-0.898	-2.539	0.744	0.573	-1.566	-0.223	0.621
	Ten_to_under_twenty_hours	-1.514	-3.437	0.409	0.671	-2.255	-0.360	0.216
	Twenty_to_under_forty_hours	-1.447	-3.699	0.805	0.786	-1.841	-0.355	0.441
	Forty_hours_and_over	-1.717	-3.897	0.463	0.761	-2.256	-0.423	0.215
Five_to_under_ten_hours	Ten_to_under_twenty_hours	-0.616	-2.697	1.464	0.727	-0.848	-0.153	0.958
	Twenty_to_under_forty_hours	-0.550	-2.937	1.838	0.834	-0.659	-0.144	0.986
	Forty_hours_and_over	-0.820	-3.139	1.500	0.810	-1.012	-0.216	0.914

ANOVA - Collaboration_C

Cases	Sum of Squares	df	Mean Square	F	p	η²	
Ten_to_under_twenty_hours	Twenty_to_under_forty_hours	0.067	-2.523	2.656	0.904	0.074	0.016	1.000
	Forty_hours_and_over	-0.203	-2.730	2.324	0.882	-0.230	-0.050	1.000
Twenty_to_under_forty_hours	Forty_hours_and_over	-0.270	-3.055	2.515	0.972	-0.278	-0.072	1.000

* p < .05, ** p < .01, *** p < .001

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 6 estimates (confidence intervals corrected using the tukey method).