# From gimmick to game-changer: A study on the use smartphones to expand access to higher education in sub-Saharan Africa

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# ABSTRACT

Today, blended university courses are designed with an unspoken assumption that students will use desktop PCs and laptops for online learning. Recent studies regarding smartphone usage in educational settings explore ways to adapt desktop PC and laptop content for viewing on smartphones; however, the impact of these studies is limited. Smartphones are still subservient to conventional platforms. While this is not an issue in developed countries, it is problematic for developing countries in sub-Saharan Africa. Only 20% of the population in sub-Saharan Africa own desktop PCs and laptops compared to 80% smartphone ownership. The dearth of these conventional platforms means many learners in sub-Saharan Africa are excluded from the benefits of blended learning.

This research took the first steps to explore whether a student who owns a smartphone and does not have access to a desktop PC or laptop can successfully participate in a blended university course. Shaped by the pragmatist philosophical perspective, the research utilised a mixed-methods case study design. The case examined was Tom Mboya University College (TMUC), a Kenyan public university that exclusively offers on-campus courses. The research progressed in four phases: a feasibility study; survey with students (n = 114); interviews with lecturers (n = 17); and beta-testing of a smartphone-supported blended course with students.

Results indicate that smartphones could provide a viable learning platform. Key findings identify that TMUC students and lecturers value smartphone-supported learning due to its ability to enhance collaborative learning activities. Furthermore, the results led to the development of a novel framework entitled 'Smartphone Only Learning Environment'

(SOLE), that provides guidelines on how teachers can deliver blended university courses solely to smartphones.

The research implication is three-fold: First, it facilitates introduction of blended learning in extraordinarily resource-constrained public universities of sub-Saharan Africa. Second, it provides the foundations for critical discussions on smartphone-supported online learning policies; notably, discussions about supporting teachers by providing an institution LMS are necessary. Finally, underpinned by the collectivist culture of sub-Saharan Africa, this research showcases opportunities for educators around the world to uncover learning theories that focus on more collaborative forms of blended learning.

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Finally, this thesis is dedicated to the memory of my grandfather, Mzee Francis Odhiambo. He founded Ordharms Academy in Siaya district, Kenya and devoted his entire life to educating and supporting underserved, rurally based pupils. I drew my inspiration for this research from you, and I know you would be proud.

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# 1. INTRODUCTION

## 1.1 Background

### *1.1.1 University Education in Sub-Saharan Africa*

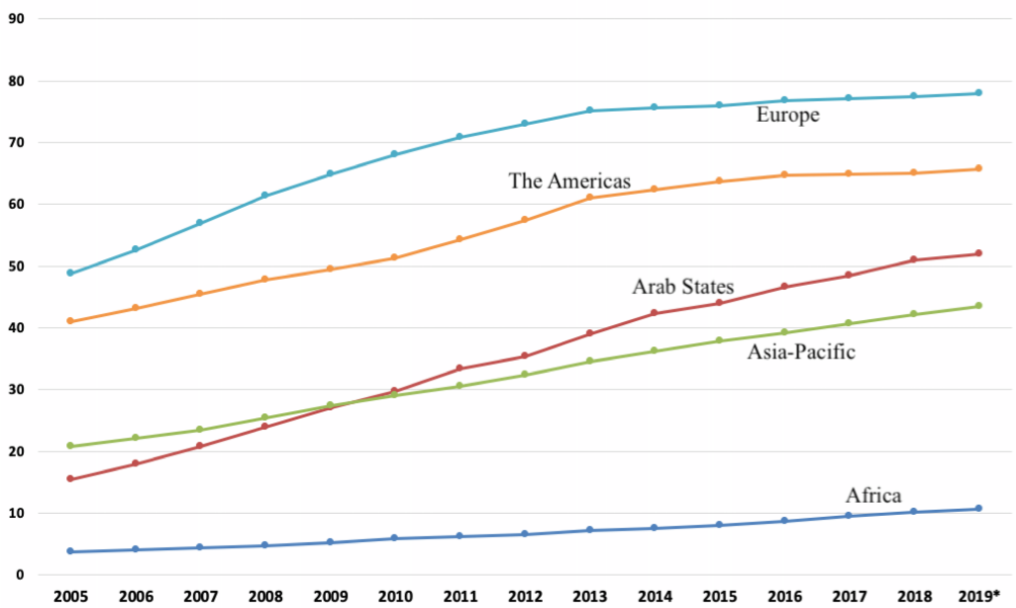
Technology-enhanced university education has had a long and successful history in the developed world; however, this has not been the case in the developing countries of sub-Saharan Africa. Public universities[1] in sub-Saharan Africa face significant budget cuts due to economic pressures (Spector et al., 2014; Trines, 2018) – this has led to a general lack of resources within the universities, notably, Information Technology (IT) infrastructure (Agbatogun, 2013). Personal computer[2] (PC) ownership in Sub-Saharan Africa, is extremely low (at 10%) and has hardly increased in the last fifteen years (see Figure 1.1) (ITU, 2019). Consequently, the paucity of technological resources (such as desktop PCs and laptops) limits the extent to which the public universities can explore other technology-supported teaching strategies namely, blended learning or e-learning (Adarkwah, 2021; Mbengo, 2014; Tagoe, 2012; Tarus et al., 2015). As such, these institutions primarily provide classroom-based courses (Agbatogun, 2013; Kashorda & Waema, 2014). Regretfully, owing to the ever-increasing enrolment rates, these public universities are few and overcrowded, and cannot adequately cater to the students' learning needs (Agbatogun, 2013; Gudo et al., 2011; Trines, 2018) – thereby diminishing their educational experience.

From the students' point of view, this limited learning experience can broadly be categorised as follows: The first category consists of students who involuntarily miss to attend some

[1] Sub-Saharan Africa being a predominantly lower income region (see reference (World Bank Group, 2018)), the focus of this present research is on public universities because they serve as the most affordable gateway to formal higher education.
[2] Personal Computer – comprises desktop PCs and laptops.

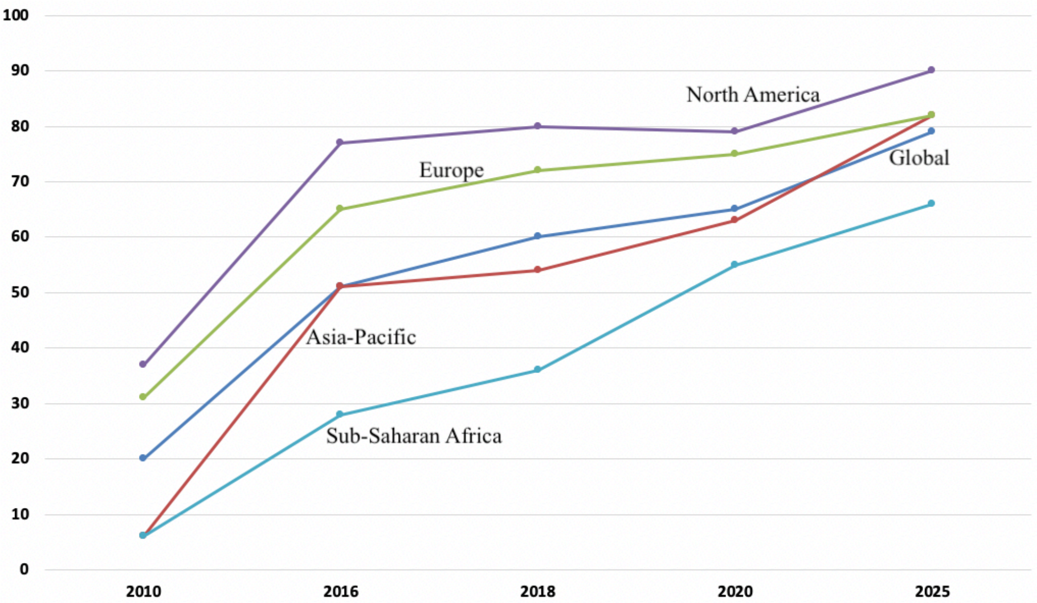
lectures because there is not enough space in the lecture halls (Gudo et al., 2011). The second category consists of students who, in a bid to avoid scuffling for seats, voluntarily opt out of attending some of the lectures (Gudo et al., 2011). The third category consists of students who come from low-income communities. For these students, the low purchasing power means they solely rely on government funded student accommodation. However, because of the overcrowding observed in public universities, these subsidised accommodations are few. Consequently, many of these learners are forced to commute from their homes to campus; but due to insurmountable travel costs, the students are unable to regularly attend lectures (Kaliisa & Picard, 2019). For another group of students, the rurally based learners, the classroom-based mode of learning limits their ability to fully participate in formal higher education, more so as a consequence of socio-economic barriers rather than the overcrowded lecture halls (Kaliisa & Picard, 2019). The collectivist culture of the rural population in developing countries (Eaton & Louw, 2000) means the rurally based students have a filial duty to contribute to the family's income (GSMA, 2014a; World Bank Group, 2018), hence are also unable to sufficiently complete the required lecture hours.

**Figure 1.1: Percentage of households with a personal computer (PC) from 2005 – 2019 (ITU, 2019)**



Considering the aforementioned, it is clear that technology-enhanced learning has the potential to enrich these students' educational experience, since it facilitates remote learning. Through technology, the delivery of course material is brought online and accessible by students in their own time, which will afford them flexibility and convenience when it comes to attending lectures. As pioneers of technology-enhanced learning, the developed world made the transition from classroom-based learning to online-based learning by way of PCs. However, I argue that on account of the significant scarcity of PCs in the developing countries of sub-Saharan Africa, emulating this trajectory is self-defeating. Figure 1.1 indicates a high possibility that PC ownership in sub-Saharan Africa will not increase significantly in the next few years, hence continuing to use PCs as the technology basis for online learning in this region is futile. Instead, I suggest the time is right to seriously look at building technology-enhanced university education in sub-Saharan Africa with smartphones as the primary devices for study. With more than 50% of the population having access to a smartphone (see Figure 1.2), these devices present an opportunity to accelerate the adoption of technology-enhanced education in the region (Trines, 2018). Published literature (Tossell et al., 2015) that dismisses smartphones as serious learning tools for university education stem from the developed world and are of limited relevance to the developing countries in sub-Saharan Africa. Here, it is important to point out that, the device replacement (smartphones instead of PCs) will be effectuated on the students' side – the teachers usually have access to at least one PC at their respective institution.

**Figure 1.2*:* Percentage of global smartphone penetration from 2010 – 2025 (GSMA, 2014b, 2015, 2017a, 2019)**




### *1.1.2 Smartphones' influence in the daily lives of the sub-Saharan Africa population*

Indeed, the proliferation of smartphones in developing countries and their impressive computing capabilities, suggests the device has a shot at progressing technology-enhanced learning in sub-Saharan Africa. However, it is futile to embark on new technology-driven interventions without taking stock of how the technology is already affecting the cultural ways of a community. The performance of the technology is highly influenced by the local situations and practices of the environment it operates in (Spector et al., 2014). While the affordances of the smartphone are globally recognised, in the developed world, the impact of these devices tends to be more surface felt, where the smartphone is largely used in the social context. However, in developing countries, especially those in sub-Saharan Africa, smartphones exert a far-reaching influence that goes beyond the social context (Wigginton et al., 2016).

In sub-Saharan Africa, smartphones have become a necessity for accessing basic amenities such as health, finance, and agriculture (GSMA, 2018). Specifically, financial inclusion stands out seeing as mobile money has become a lifeline for majority of the population. Mobile money, which is the transfer of monetary funds via mobile phones has provided access to financial services for the unbanked population (GSMA, 2018), thereby allowing these underserved communities to invest, save money and manage their expenses. For instance, in Uganda, NGOs funding the *Bidi Bidi refugee camp* use mobile money to deliver humanitarian cash transfers; in Kenya, *M-Akiba* application allows the population to buy government bonds via mobile money; in Senegal, *MaTontine* allows members to save money and build credit scores which can later be used to access small loans and insurances via mobile money; in Tanzania, *EdgePoint* provides access to health insurance policies for micro/small/medium enterprises via mobile money payments (GSMA, 2017c); and in Ghana, *Esoko* – a virtual market application, links smallholder farmers to suppliers and financial institutions and allows them to purchase farm inputs using borrowed funds or personal savings via mobile wallets (Esoko, 2018). Given that smartphones serve as the main hosts for mobile money, it is apparent that these devices play an integral part in the economic stability and by extension living standards of the population in sub-Saharan Africa.

Informal education is another area where the sub-Saharan African population is proactively using their smartphones. Taking Kenya as an example of a developing country in sub-Saharan Africa, the population is increasingly utilising smartphone-based applications to further life-long learning particularly in the area of agricultural education. Perhaps this is because about 80% of the population in Kenya rely on agriculture for their livelihood (FAO, 2018). For instance, the Kenyan government implemented a smartphone-supported programme, *E-extension*, that currently provides informal agricultural education to over seven million farmers (Gichamba et al., 2017).

### *1.1.3 Current Knowledge Gap and Need for Research*

As earlier outlined, technology-enhanced education, specifically online-based learning, promises to be highly beneficial for university students in sub-Saharan Africa. However, the current online university courses are still largely designed for laptops and desktop PCs. While universities have indeed acknowledged the potential the pocketable smartphone has in providing flexible learning environments, these devices still take on a supplementary role and institutions only use the devices to scaffold learning (Han & Yi, 2019). Recent studies into the use of smartphones in educational settings explore ways to adapt laptops or desktop PC content for viewing on smartphones but by far have not reached the depths possible (Cochrane & Farley, 2017; Farley et al., 2015; Pimmer & Pachler, 2014). Little innovative work has been done to customise learning content to fit the smartphone's capabilities (Parsons, 2014). For full participation in the online-based courses, students still have to access content on the conventional computing platforms – desktop PCs or laptops. Accordingly, given the general lack of these aforementioned resources in sub-Saharan Africa, many of the learners in the region are excluded from the affordances of online-based learning, which goes against the fourth[3] and ninth[4] sustainable development goals (SDGs) suggested by UNDP (World Bank Group, 2018).

Therefore, seeing as smartphones serve as the most practical gateway to online learning content for many students in sub-Saharan Africa (Deloitte, 2016; Karlsson et al., 2017), research is needed to examine how a student who owns only a smartphone and does not have access to a laptop or desktop PC can successfully participate in an online-based university course. To the best of my knowledge, a framework that provides guidelines on how to successfully deliver a

[3] Sustainable Development Goal 4: Equal access to quality education for all.
[4] Sustainable Development Goal 9: Enhanced access to ICT resources and services.

university course solely to a smartphone does not exist. Hence, this research attempts to identify the outstanding issues and requirements for developing such a framework. This research aims to expand access to higher education for learners in developing countries by inspiring a paradigm shift – from smartphones as informal, supplementary learning tools to smartphones as formal, primary learning tools.

Research indicates that sub-Saharan Africa has significantly low tertiary enrolment rates (Darvas et al., 2017; Kaliisa & Picard, 2019; Trines, 2018). A UNESCO (2010) report indicated that only 6% of the population in sub-Saharan Africa were enrolled in tertiary courses by the year 2010. Not much has changed since then; a report by The World Bank (2020) indicated 8.8% tertiary enrolment rate in this same population as of the year 2016. Granted these low tertiary enrolment rates are also a result of the drop-off enrolment rates at primary and secondary school (World Bank Group, 2018), World Bank's SDGs, suggest one way to fast track growth in the education sector as a whole, is through innovations in information and communication technology (ICT) infrastructure (United Nations, 2018). In my research, I demonstrate that smartphones could indeed provide a viable learning platform for university students in the developing countries of sub-Saharan Africa.

## 1.2 Research Question and Objectives

To guide the present research, the following research question was considered:

*What learning and teaching strategies are effective in facilitating the use of a smartphone as the sole device for formal study in university courses?*

Furthermore, to direct this inquiry, three research objectives have been developed, as listed in this section. A more detailed discussion on how these objectives are realised can be found in the methodology section (Chapter 3) of this thesis.

1. To determine the technical requirements for participating in an existing course solely on a smartphone.
2. To evaluate the appropriate roles of lecturers, students, and institutions in the delivery of a smartphone-based course.
3. To develop a framework that provides a set of guidelines on how to successfully deliver a university course solely to a smartphone.

## 1.3 Scope

Taking Kenya as an example of developing country in sub-Saharan Africa, the practical work of this research mainly targeted rural learners in Kenya. The rural regions of sub-Saharan Africa are characterised as being remote – typically located far away from basic amenities such as universities/schools; also, the population generally has a lower purchasing power compared to other areas (GSMA, 2016; World Bank Group, 2018). As such, there is a higher demand and need for cost-effective technology-enhanced education in rural Kenya, as it facilitates remote learning. Whilst the poverty level in this region is significant (World Bank Group, 2018), an increasing number of this population is now finding practical ways to afford low-cost smartphones (Karlsson et al., 2017). For example, in Kenya, the leading mobile service provider, Safaricom, has partnered with Google to allow low-income consumers to pay for 4G-enabled smartphones in daily instalments (GSMA, 2020). Hence, within this context, the research focus is on how smartphone-based technologies can be used to deliver the existing formal university courses.

Indeed, this research views technology as a key driver for educational change. However, it also acknowledges that work in educational technology cannot solely focus on technology; the technology should be led by pedagogy (Anderson & Dron, 2011; Kinchin, 2012; Njenga & Fourie, 2010). In this regard, the present research aims to build on existing pedagogies, specifically, blended learning – herein defined as a combination of classroom-based learning and off-campus online learning activities. Unlike e-learning – wherein all learning takes place online, blended learning is arguably more beneficial in sub-Saharan Africa, as it preserves the collectivist culture of the population. Through blended learning, educators will retain some of the on-campus social interaction craved by learners in this region but add the convenience and flexibility of online lectures.

## 1.4 Outline of this Thesis

This thesis consists of nine chapters. The present chapter has set the scene by providing a rationale for conducting research on smartphone-supported blended learning, stating the research question and explaining the research scope.

In Chapter 2, I review the literature on technology-enhanced learning strategies, with emphasis on blended learning and smartphone-based learning. First, the chapter distinguishes the current state of technology-enhanced education between developing and developed countries to demonstrate where sub-Saharan Africa lies in principle regarding the progression of blended learning. Next, a summary of the benefits and challenges of implementing blended learning is presented. Then, through a systematic review and a narrative review, the chapter presents noteworthy examples of smartphone-based projects that highlight the current global impact of smartphones in technology-enhanced learning. The salient barriers to the fast adoption of smartphones as formal devices for study in higher education are also discussed. I then present a conceptual analysis demonstrating how teachers can effectively integrate smartphone-supported blended learning into their pedagogy. The chapter concludes by exploring the role of the university management in leading the adoption of smartphones as the technology basis for blended learning in sub-Saharan Africa.

Chapter 3 looks at the methodology implemented in this research. Shaped by the pragmatist philosophical perspective, the chapter describes the mixed-methods case study design I used to investigate the research question and gain insights into the research objectives. I discuss the salient threats to the validity of the research conclusions and explain how ethical concerns were managed. Furthermore, a section of this chapter provides an overview of the research methods used, but detailed discussions of these methods are presented together with the findings in subsequent chapters because they facilitate interpretation of the findings. The chapter concludes with a description of the research setting.

Chapters 4, 5, 6, and 7 present the methods and findings of each of the four phases of research. The first phase (Chapter 4) is a feasibility study that evaluates the technical capabilities of the smartphone to assess whether the idea of 'smartphone-supported blended learning' can be shaped to be relevant and sustainable. Its findings are interpreted in this chapter as they inform the methods of the next phase. Chapter 5 presents a quantitative survey that examines TMUC students' attitudes to using smartphones for formal university learning. The survey findings, such as the students' most common educational smartphone habits, activities, and preferences, are also interpreted in this chapter. Chapter 6 focuses on the interviews with TMUC lecturers and the themes I interpreted about their perceptions on integrating smartphones into their formal teaching practices. Chapter 7 then presents Phase 4, which involves a pilot study of a smartphone-supported blended course. I elucidate how I collaborated with a lecturer at TMUC to restructure their course and make it smartphone-ready, then tested the redesigned smartphone-supported blended course with the students to evaluate user experiences. The findings of this study are also interpreted in this chapter.

In Chapter 8, the findings across all four phases are synthesised and situated with respect to a novel framework entitled *Smartphone-Only Learning Environment (SOLE)*. The SOLE framework provides practical guidelines to help educators in sub-Saharan Africa integrate smartphones into their formal teaching and learning processes.

Chapter 9 concludes the research by reflecting on the contributions and outlining the limitations. It also discusses the research implications and suggests future research directions.

# 2. LITERATURE REVIEW

At the onset of this PhD research, several topics resonated with me, paramount among them: the evolution of technology-enhanced learning; challenges and benefits of blended learning; barriers to- and exemplars of smartphone-based learning; mobile learning; and the current state of learning and teaching processes in public universities of sub-Saharan Africa. This chapter, therefore, presents some of the crucial literature that stood out and informed my initial interest in formal smartphone usage in higher education. The extensive literature I draw upon here has defined and refined my research question and objectives, shaped my research approaches and, as a result, informed the direction of the present study. Nevertheless, since research is an iterative process, throughout this thesis, I have continued to explore newly published literature and juxtaposed them with my own research findings.

Given the rapid advancement of technology, particularly smartphone technology, the literature included in this chapter needed to be contemporary. Having written this chapter in 2021, what I deemed as contemporary literature comprised studies conducted from 2017 onwards. Nonetheless, the reader will notice that some of the studies included in this literature review are older (i.e. published before 2017). The inclusion of these older sources is strategic and well-thought-out – my rationales for their inclusion are as follows:

- As mentioned in Chapter 1, presently, there exists very limited literature[5] that views the smartphone as a primary learning tool. The majority of the recent literature (2017 onwards) that I came across either viewed the smartphone as a source of distraction in studies or only viewed the smartphone as a supplementary learning tool and were

[5] Further evidence of the literature gap regarding smartphones as primary devices for study has been presented in Section 2.3.2 where I discuss the results of a systematic review and narrative review.

mainly from the developed world context. Since I could not readily find contemporary literature that viewed the smartphone as a primary learning tool, my focus in this chapter shifted to reviewing *any* literature that supported my thesis argument instead of the recency of the studies. In other words, the primary intention in this chapter was to include studies (even the old ones) that were significantly relevant to my research such that, if the reader decides to review the sources I have included, they could gain more insight into smartphone-based learning.

- Regarding the older literature I have included about technology-enhanced learning (i.e., blended learning), it is important to draw the reader's attention to the fact that educational technology research does not progress as fast as technology research. Meaning, what was remarked ten years ago is presumably going to be relevant today. This slower progress was evident in my literature search as I observed that many of the contemporary sources (e.g., those published between 2019 and 2021) were citing literature that had been written between 2011 and 2014 and some even earlier. As such, my strategy was to also review the original sources rather than only rely on the secondary sources. In reviewing the original (older) sources, I found useful information about blended learning that had not been cited in the secondary sources.

Notwithstanding the aforementioned rationales for including older sources in the literature review, the reader will notice that throughout this chapter, I have included recent sources that support (reiterate) the claims made in the older sources, which demonstrates that the information derived from the older sources is still valid today. Therefore, to the best of my knowledge, the present chapter is contemporary and reflects the current status of literature on technology-enhanced learning strategies (specifically, smartphone-based learning and blended learning).

## 2.1 Technology-Enhanced Learning: An Overview of its Evolution

The paramount aim of this research is to evaluate whether the smartphone can be used as the sole device for study in higher education. Yet, smartphone application in teaching and learning cannot be discussed without first discussing the evolution of technology-enhanced learning. Educational technology has had a long history; in this vein, Parsons (2014), Siemens et al. (2015) caution that, to avoid reinventing the wheel, it is essential to first take stock of what is already known about digital learning, before embarking on new technology-driven interventions in the classroom. Thus, a succinct account of the progression of technology-enhanced leaning is presented next.

### *2.1.1 History of the Three Generations: Mass Media, Web 1.0, and Web 2.0*

Technology-enhanced learning gained attention with the advent of personal computers towards the latter part of the 20th century. Since then, the discipline of educational technology has experienced several paradigm shifts (Spector et al., 2014). Anderson and Dron (2012) categorise these shifts into first, second and third generations of learning technology. Whilst the first-generation used mass media (television and radio) to broadcast learning content, it was the second-generation technologies (Web 1.0) that put technology-enhanced learning on the map. Web 1.0 instantly provided worldwide access to a plethora of educational resources in form of web pages. However, Web 1.0 content was static, meaning learners could not interact with the web pages of the other users within the website. This led to the third-generation technologies, which incorporated the highly interactive Web 2.0 (Anderson & Dron, 2012).

Web 2.0 allowed learners to dynamically comment, make contributions and receive feedback from existing online resources and other users, thereby creating a network of knowledge.

### *2.1.2 Current State of Technology-Enhanced Learning: Level of Adoption within Regions and the Impact of COVID-19 Pandemic*

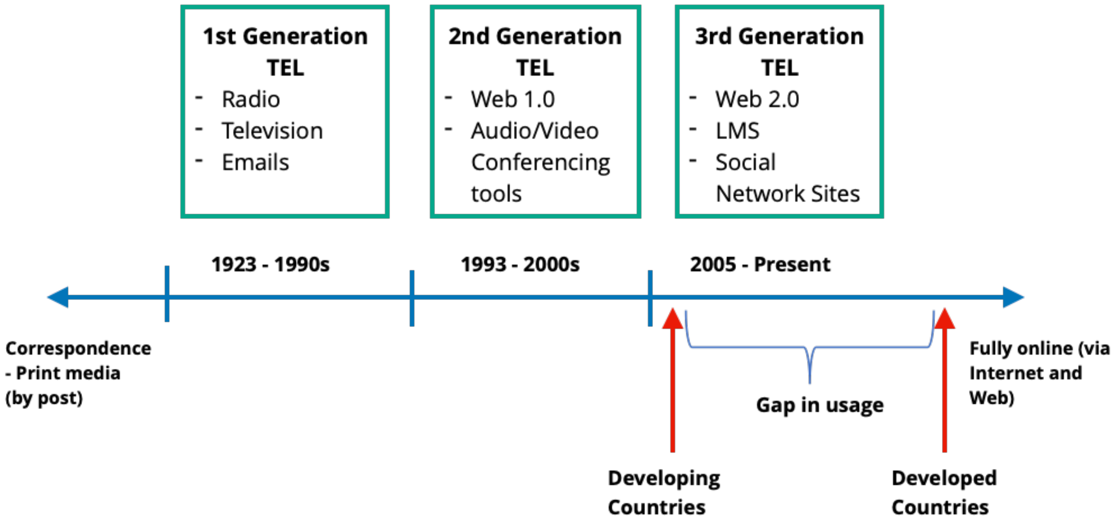
#### 2.1.2.1 Level of adoption in developing and developed countries

Although the three generations mentioned above are still in existence today, most institutions offering technology-enhanced courses are now predominantly in the third generation. This is because, a significant portion of learning takes place on the web (Siemens et al., 2015). Notably, there is increasing use of interactive web 2.0 technologies, particularly social network sites, to augment learning activities (Bouhnik & Deshen, 2014; Kim et al., 2015; Pimmer et al., 2012). However, it is imperative to point out that the level of adoption of third generation technology-enhanced learning varies between regions. As explained in the Chapter 1, the technologies commonly found in developed countries are not readily available in developing countries (especially those in sub-Saharan Africa). Consequently, developing countries fall behind in the implementation of technology-enhanced learning. Therefore, it is necessary to distinguish between the current state of technology-enhanced learning in developed countries and developing countries.

Higher education institutions in developed countries can be described as being in the advanced stages of the third-generation technology-enhanced learning. Majority of the institutions are progressively offering online courses. A study by Gaebel et al. (2014) concluded that out of the 249 European higher education institutions surveyed, 82% stated they offered online courses. This is influenced by the widespread ownership of PCs among the population (Baller et al., 2016) which has swayed universities to alter the way on-campus learning is provided. For example, the increasing use of learning management systems (LMS) like *Moodle* and *Blackboard*, means learners are able to access majority of the course materials online, thereby resulting in the reduction of classroom-based instruction. While the integration of LMSs enables most of these institutions to combine on and off-campus components and synchronous and asynchronous teaching, some institutions are now working towards fully online (off-campus) courses. For example, open education tertiary institutions like OERu (n.d.) and The Open University (n.d.) have already made great strides regarding offering fully online university certifications.

Upon shifting focus to developing countries, it can be argued that based on Figure 1.1 data (PC ownership), technology-enhanced learning in these regions is still in the early stages of the third generation. What has been done in terms of technology-enhanced learning is mostly basic with minimal use of multimedia, which is a consequence of the apparent scarcity of computing resources. Courses at the early stages of technology-enhanced learning are usually text-heavy and mostly digitised forms of print media (Siemens et al., 2015). Several scholars have demonstrated the nascent nature of technology-enhanced learning in developing countries. For instance, Tarus et al. (2015) aver that Kenyan public universities have only started incorporating technology in their curriculum. Tagoe (2012) points out that the University of Ghana has done very little in incorporating technology in teaching and learning – a sentiment later supported by Adarkwah (2021). Elsewhere, Mbengo (2014) asserts that technology integration is still in its infancy in Zimbabwean State Universities, while Agbatogun (2013) demonstrates that technology-enhanced pedagogies are yet to be explored in most Nigerian university classrooms. Figure 2.1 illustrates where my research places most developing countries in regard to the adoption of technology-enhanced learning. It can be observed that there is a significant gap between the developing region and the developed world. The rationale for the placement of developing countries in Figure 2.1 was derived from Figure 1.1 data, which illustrated that PC ownership in sub-Saharan Africa today is still nowhere near where the developed world was fifteen years ago. Accordingly, it is only sensible to assume that most technology-enhanced university courses in developing countries would follow the same trajectory. The dates on Figure 2.1 have been derived from Casey (2008).

**Figure 2.1*: Evolution of technology-enhanced learning (TEL) in developing and developed countries***




2.1.2.2 Impact of COVID-19 pandemic on technology-enhanced learning: Is the increased uptake of synchronous cloud-based collaboration tools the advent of the fourth generation?

The effects of COVID-19 on the higher education landscape cannot be ignored; the *'social distancing*[6]*'* policy radically accelerated the uptake of technology-enhanced education, as it compelled all universities to offer digital face-to-face lessons in order to remain connected to students and minimise the associated feeling of isolation (Pal & Vanijja, 2020). Accordingly, this social distancing policy increased the demand for virtual collaborative learning spaces (Almarzooq et al., 2020) and the need for video live meetings. Indeed, before the pandemic, universities already provided avenues for students to participate in collaborative discussions via the institutional LMS; nevertheless, to facilitate video live meetings, these LMSs needed

[6] In the COVID-19 context, social distancing means maintaining a spatial distance between oneself and other people who are not from one's household; it does not mean transactional distance.

to integrate with other platforms (e.g., Adobe Connect and Zoom). However, due to the rapid increase in the number of students synchronously collaborating in the digital-face-to-face (video live) lessons during the pandemic, traditional LMSs could not comfortably scale to meet the demand (Çankaya & Durak, 2020; Microsoft, 2019). This LMS limitation is evidenced by the staggering uptake of synchronous cloud-based collaboration tools like *Microsoft Teams* (Bozkurt et al., 2020; Francis, 2020). As previously stated, while these synchronous cloud-based collaboration tools were in use even before the pandemic, they were adjuncts to the institutional LMS. But, at the onset of the COVID-19 pandemic, many of these synchronous cloud-based collaboration tools, especially *Microsoft Teams*, *Google Meet*, and *Zoom,* were catapulted to the forefront due to their impressive proficiency at facilitating video live meetings (compared to traditional LMSs). Furthermore, the scalability of these synchronous cloud-based collaboration tools made it easier for IT support staff to quickly respond to the ever-changing user wants, needs and trends stemming from COVID-19 restrictions (Çankaya & Durak, 2020; Pal & Vanijja, 2020).

Undoubtedly, COVID-19 has impacted the technology integration gap between developed and developing worlds (previously depicted in Figure 2.1) (Bozkurt et al., 2020; Mpungose, 2020). For example, in the developed countries (such as Australia and South Korea) where online learning was already well-established pre-pandemic, universities gradually shifted (within a few weeks) to the online exclusive modality (Bozkurt et al., 2020). However, for the better part of 2020, nearly all public universities in sub-Saharan Africa that have long operated under the traditional classroom model were forced to suspend all forms of learning (Omanga, 2021; Osabwa, 2020). Even so, this pandemic has been a wake-up call for public universities in sub-Saharan Africa, which are now also rethinking alternatives to the traditional classroom and prioritising technology-supported learning (Bozkurt et al., 2020; Omanga, 2021). These universities are now increasingly leveraging synchronous cloud-based collaboration tools (notably *Zoom*) to extend the traditional classroom walls. For example, Omanga (2021) points out that at the onset of COVID-19, the Institute of Open and Distance Learning at Makerere University started to conduct graduate viva voce (oral defences) via *Zoom*, and the University of Ghana partnered up with telecommunication companies to waive all financial costs associated with online learning and used *Zoom's* collaboration tools to engage with their students. Moreover, the University of Nairobi achieved a milestone when more than 20 postgraduate students completed their first-ever online-based end-of-semester examinations via *Google Meet*, following intense weeks of teaching and learning conducted virtually via *Cisco WebEx* and *Zoom* (UoN, 2020). Elsewhere in India, Bozkurt et al. (2020) affirm that there was a sudden surge in online synchronous classes as many higher education institutions resorted to using *Google Meet*, *Cisco WebEx* and *Zoom* cloud-based collaboration tools.

In light of the aforementioned observations, one could argue that the COVID-19 era has ushered in the fourth generation of technology-enhanced learning, which comprises learning through synchronous cloud-based collaboration tools (Corey, 2020). This is in line with Çankaya and Durak (2020, p. 901) assertion that, *"according to today's emergency distance education applications, systems which do not allow live lessons [such as those supported by cloud-based collaboration tools like Microsoft Teams] but just include a learning management system, or vice versa, will not be regarded as complete systems".* Consequently, COVID-19 educational policies have prompted higher learning institutions to move beyond a focus on information delivery via the walled garden type LMS (a dominant feature of the third generation) to open environments such as *Microsoft Teams* and *Google Meet*. A shift espoused by Mpungose (2020). With emphasis being on collaboration tools, it is apparent that the fourth generation of technology-enhanced learning is heavily related to the socio-constructivist pedagogies where the main focus is on co-construction of knowledge and support of students in learning communities (Hickey, 1997). In essence, the fourth generation is an extension of what was already underway in the third generation which featured the use of social media tools such as Facebook and Twitter to enhance collaborative learning. However, the difference is that social media tools used in the third generation predominantly support asynchronous type of collaboration while the cloud-based collaboration tools in the fourth generation primarily aim to facilitate synchronous digital face-to-face collaborative activities (Bozkurt et al., 2020).

In summation, in this COVID-19 health crisis era which has forced many higher learning institutions to stop brick-and-mortar teaching and learning processes, technology-enhanced learning (that facilitates remote teaching and learning) is presently experiencing a radical transformation. Paramount in this transformation is the move from the dominant asynchronous LMS-based learning mode – that made online synchronous collaboration for large classes difficult, to a synchronous audio-visual live lesson format supported by cloud-based collaborative tools. In other words, the current state of technology-enhanced learning is one where communication by talking online has become indispensable (Çankaya & Durak, 2020). This shift to live lessons (i.e., digital face-to-face sessions) is appropriate seeing as the untimely pivot to online learning due to COVID-19 meant that many students who were used to the traditional brick-and-mortar learning mode were not adequately equipped with the self-directed learning skills typically associated with distance education (Bozkurt et al., 2020; Çankaya & Durak, 2020; Mpungose, 2020). Thus, the digital-face-to-face sessions potentially allow teachers to make this transition to 'emergency remote education' smoother for their students.

### *2.1.3 Common Technology-Enhanced Learning Strategies: E-learning, Blended Learning, Technology-Enhanced Brick-and-Mortar, and Mostly off-campus online learning*

Figure 2.2 demonstrates that technology-enhanced learning falls on a spectrum, classified into four strategies: *e-learning*, *blended learning*, *technology-infused brick-and-mortar*, and *mostly off-campus online learning*. Over the years, e-learning and blended learning have taken on several definitions. So, for the sake of clarity, in this research, e-learning is defined as instruction solely delivered via the Internet and Web, meaning the interactions between the students and the teachers are entirely online (off-campus). On the other hand, blended learning is defined as a combination of classroom-based learning and off-campus online learning activities. In blended learning, the shift to off-campus online learning typically results in a reduction in classroom time. While e-learning and blended learning are the more popular technology-enhanced strategies used, the other two strategies depicted in Figure 2.2 are fairly common in higher education. The technology-infused brick-and-mortar strategy involves the integration of online learning activities into a traditional classroom-based course. The introduction of online components does not result in a reduction in classroom time. Lastly, the mostly off-campus online learning strategy means that courses are primarily delivered via the Internet, and classroom-based learning is optional or need-based. Indeed, some educators perceive the technology-infused brick-and-mortar strategy and the mostly off-campus online strategy as blended learning. However, considering my definition of blended learning, the present research classifies them as separate modalities on the technology-enhanced learning spectrum. This is because, unlike the blended learning modality, the technology-infused brick-and-mortar modality does not involve off-campus online learning, and the mostly off-campus online modality does not require students to attend classroom-based lessons. Table 2.1 provides a summary of the definitions of each of the four technology-enhanced learning modalities discussed.

**Figure 2.2: Spectrum of common course-delivery modalities in higher education**

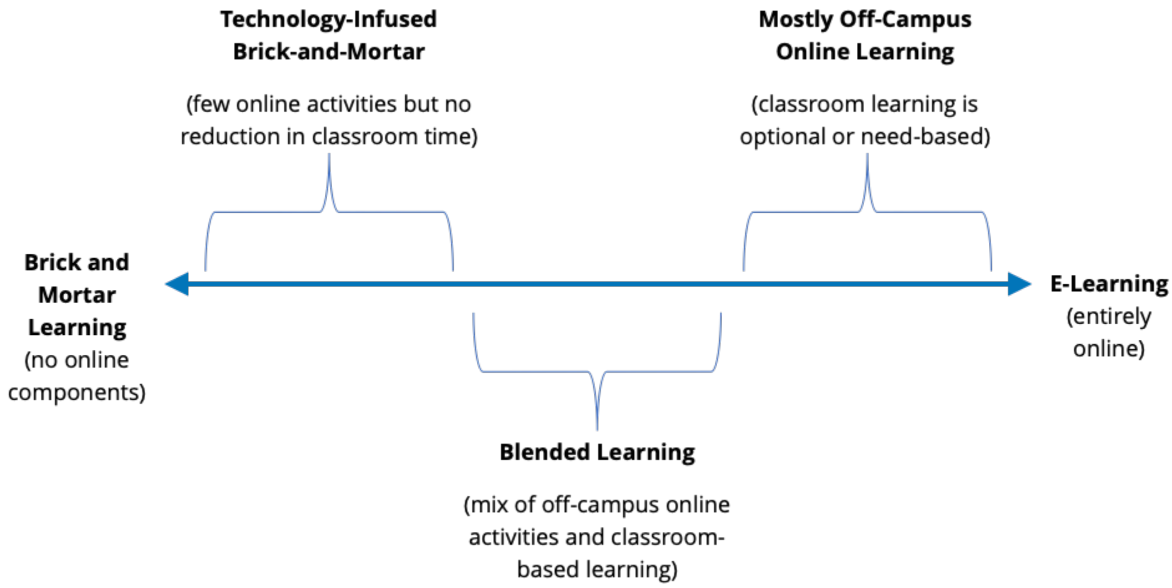



**Table 2.1: Description of common course-delivery modalities in higher education**

| Modality | Description |
|---|---|
| *Brick-and-Mortar Learning* | This refers to the traditional classroom-based (on-campus) learning. There are no online components. |
| *Technology-Infused Brick-and-Mortar Learning* | This refers to the integration of online learning activities into the traditional classroom-based course. The introduction of online components does not result in a reduction in classroom time. |
| *Blended Learning* | The combination of brick-and-mortar and off-campus online learning activities. The introduction of the online component typically results in a reduction in classroom time. |
| *Mostly Off-Campus Online Learning* | Courses are primarily delivered via the Internet; the classroom-based online learning activities are optional or need-based. |
| *E-Learning* | Courses are exclusively delivered via the Internet and Web (off-campus). There are no brick-and-mortar learning activities. |

Given that courses delivered via the e-learning modality are fully online, implementation of this strategy typically requires significant technological (and financial) investments on the institution's part. Thus, considering the financial constraints and general lack of conventional technological resources in most public universities of sub-Saharan Africa, e-learning will not be discussed further in this chapter. Instead, the ensuing discussions around technology-enhanced education in sub-Saharan Africa focus on blended learning, which, as previously discussed in Chapter 1, is the more feasible strategy to implement in this region.

## 2.2 Blended Learning: Other Definitions, Benefits, Design Models, and Challenges During Design

### *2.2.1 Other Definitions of Blended Learning and its Benefits*

The previous section (Table 2.1) states the definition of blended learning that I have adopted in this thesis – *a combination of classroom-based learning and off-campus online learning activities.* However, several other definitions exist. For example, Ross and Gage (2006, p. 156) described blended learning as a mode of delivering, "technology-enhanced courses, which add supplementary online components to a traditional course without changing the amount of time students spend face-to-face with instructors". Graham (2006, p. 5) defined blended learning as, "the combination of instruction from two historically separate models of teaching and learning: traditional F2F learning systems and distributed learning systems". Later on, Graham et al. (2013) described it as a combination of distinct online-based and classroom-based learning activities. Elsewhere, Garrison and Kanuka (2004, p. 96) described it as, "the thoughtful integration of classroom face-to-face learning experiences with online learning experiences". Furthering Garrison and Kanuka (2004) definition, Alammary et al. (2014, p. 443) described blended learning as, "courses that thoughtfully integrate different instructional methods such as: lecture, discussion group, self-paced activity; and contain both face-to-face and computer-mediated portions".

To the extent that there are many definitions of blended learning, there are also several reasons why over the years, blended learning has become a widespread teaching phenomenon. Osguthorpe and Graham (2003) list the following reasons: 1) pedagogical richness, 2) access to knowledge, 3) social interaction, 4) personal agency, 5) cost-effectiveness, and 6) ease of revision. Later on, Graham (2006, p. 9) stressed that blended learning's popularity in institutions of higher education is mainly attributed to its ability to: 1) improve pedagogy, 2) increase flexibility of and access to learning environments, and 3) increase cost-effectiveness.

In regard to improving pedagogy, the research study by Kenney and Newcombe (2011) presents a noteworthy example. The first author explains that due to increased class sizes, interaction in her educational psychology course drastically reduced as lectures became the predominant mode of teaching. She stated:

"*There was less time and it was more difficult logistically to provide classroom activities that required students to actively engage in the learning process… more students were coming to class less prepared and less willing to participate. Frequent comments from students were too many lectures and too much material to learn. For these reasons the decision was made to [adopt blended learning which] would promote more active student involvement in the learning process and more effective learning of the course material.*" (Kenney & Newcombe, 2011, pp. 45 - 46).

In the matter of increased access to and flexibility of learning environments as a benefit of blended learning, Graham (2006, p. 9) suggests that some programs, "would not be possible if students were not able to have a majority of their learning experiences at a distance from instructors and/or other students". Brandt et al. (2010) provide a notable scenario. In their paper, the authors describe how as a result of the rising demand for allied health workers throughout Minnesota, the University of Minnesota faced significant challenges in educating these professionals who were urgently needed at work. Ergo, to address Minnesota's allied health workforce needs, there was an increased urgency to incorporate distance learning solutions.

> *"[Therefore, the University developed a set of blended learning programs that combine] on-line learning technologies, classroom and laboratory teaching, and clinical skills assessments, all of which are supported by technology platforms – such as simulations, videoconferencing, or teleconferencing – to extend learning to the students no matter where they are or when they can access learning"* (Brandt et al., 2010, p. 168).

Considering increased cost-effectiveness as another benefit of blended learning, the case study by Napier et al. (2011) at Georgia Gwinnette College (GGC), a small public liberal arts college, is a good example. In their study, the authors explain that in a bid to more efficiently utilise the scarce resources, the school administration had to transition several sections of an introductory computer course from traditional face-to face format to a blended learning format. The authors stated:

> *"Like many other public institutions, GGC has faced dramatic budget cuts due to economic pressures. At the same time, the school anticipates increased enrollment and has to plan for rapid growth. Since this course is taught in a classroom which seats a maximum of 25 students, classroom space is at a premium. With the blended learning model, this space could be shared among multiple sections by adding a significant online component to coursework"* (Napier et al., 2011, p. 22).

### 2.2.2 Blended Learning Models

The lack of a common definition for blended learning over the last decade has seen teachers in higher learning institutions develop their own interpretations of the term – within the context of their courses or institutions; accordingly, a wide variance of design models have evolved (Alammary et al., 2014).

In some blended learning models, the *percentage of online learning activities* becomes the focus of the design. For example, Allen et al. (2007) propound that a blended course should be designed such that 30% to 79% of the program content is delivered online. The authors considered anything below that to be a course that uses web-based technology such as a course management system (CMS) to facilitate what is essentially a face-to-face course. In this case, the CMS and webpages are usually used to post the syllabus, course announcements, grades and/or assignments. Likewise, in their report, anything above 80% was considered to be an e-learning (fully online) course. Elsewhere, in the design of a third-year nursing degree blended course, Saiz-Manzanares et al. (2020) developed two blended learning environments that also factored in the percentage of online content: Blended Learning type 1, consisted of the students completing 80% of the coursework online through a learning management system (LMS) with 20% face-to-face interaction. The second learning environment, Blended learning type 2, consisted of 80% face-to-face interaction and 20% of the feedback was done through the LMS. On the other hand, in their study examining the differential impact of studying in a blended learning environment versus a traditional classroom and e-learning settings, Thai et al. (2017), implemented a 50% - 50% balance in their blend. The participants in their study were required to consume web-based video lectures in an online forum, then attend in-class sessions to complete guiding questions (individually) and get feedback from the teacher.

Next, Graham (2006) suggested that blended learning programs could be designed based on the *primary purpose of the blend* and came up with three model categories. The first category, enabling blends, focuses on convenience and flexibility. The design of the blended learning program is such that, it sufficiently satisfies the learners' educational costs and time constraints. For example, programs could be designed so that classroom-based activities are significantly reduced to minimise the travel related costs of on-campus learning and to also cater to learners who have work or family commitments. In the second category, enhancing blends, the blended learning programs are designed such that they augment the teaching and learning processes without radically altering the pedagogical style. The addition can occur either on the face-to-face and/or online component. For example, for large class sizes, to increase and make participation more efficient, instructors could add an online discussion forum (during face-to-face class) that requires students to post questions/comment on a particular topic. The third category, transforming blends, allows for a drastic change in the instructional delivery (pedagogy) of a course. For example, these blends require teachers to shift from being the 'sage on stage' to a facilitator. Likewise, the students move from passively absorbing content to a model where they are required to use technology to actively construct knowledge and engage in intellectual activities. For example, requiring biomedical engineering students to use mobile devices to facilitate *in situ* learning.

From another perspective, Graham (2006) suggested that blended programs are designed based on *curriculum structure*. The author identified four levels: 1) Activity level blending – which is when a single lesson activity contains both face-to-face and a technology mediated instruction. For example, administering an online quiz and then discussing the answers in a physical classroom. 2) Course level blending – this is blending that entails a combination of distinct face-to-face and online activities used as part of course. The emphasis here is that the blend involves multiple activities and that these activities can be independent of each other. The in-class and online activities can overlap each other in time or can be sequenced chronologically. 3) Program level blending – this is when the program (e.g., certificate, diploma or degree) is designed such that some courses are delivered face-to-face while other courses within the same program are completed online. 4) *Institution level blending* – in this model, the university makes a commitment to integrate blended learning across all of its programs (e.g., certificate, diploma or degree). For example, some universities implementing this model have a requirement that for a student to be allowed to graduate, they must experience and complete at least one online course.

Moving on to the work of Alammary et al. (2014), the authors put forward that blended courses can be designed based on the *potential changes to teaching practices and student learning experience*. They identified three distinct design approaches: 1) Low-impact blend – this is when extra online activities are added to an existing traditional face-to-face course without eliminating the existing activities. While the authors state this is a quick approach to producing a blended course, they caution that this approach if not well thought out, could lead to what Kaleta et al. (2007, p. 127) called "the course-and-a-half syndrome". Their advice is that teachers adopting this low-impact model should add the extra online activity as a result of a pedagogical need, rather than trying to keep up with a technological trend. 2) Medium-impact blend – in this model, a traditional course is redesigned such that some face-to-face activities are replaced with online components. The motivation behind this model is that some course objectives are better realised if the learning activities are facilitated online. For this medium-impact model, an LMS is an ideal platform. When considering this design, the authors recommend that the teacher has medium to long-term prior experience teaching the existing traditional course; this is because the model requires the teacher to identify the parts that do not work properly in the traditional format but would work better if shifted online. 3) High-impact blend – in this design approach, the blended course is developed from the outset using the course learning outcomes as the foundation. The authors state that while building from scratch has a higher risk of failure owing to the fact that the teacher would be introducing an untried course to the students, blending at the course learning outcomes level allows for a more effective integration of the online and face-to-face components. Afterall, according to Tabor (2007, p. 48), most adopters of blended learning even the experienced ones, "… struggle with the question of creating balance and harmony between the two formats".

### *2.2.3 Challenges of Designing a Blended Course*

As suggested by Garrison and Kanuka (2004), due to the differing requirements of course disciplines; institutional policies to change management; as well as availability of resources (financial, human and technical), blended learning is highly contextual and no two blended designs are identical. This gives a strong implication that the process of designing a blended learning environment is not an easy feat – it involves a great deal of planning and forethought (Alammary et al., 2014). Therefore, it is crucial for adopters of blended learning to be cognisant of the challenges that may ensue. Indeed, the contextual nature of blended learning environments means there is a wide array of challenges that need to be addressed during the design process. Nevertheless, there are a few prominent issues that have historically created roadblocks for blended learning initiatives across the multiple contexts. The present research identified four considerable challenges:

1) Balancing the Blend

Given the varying course learning goals, some courses will inherently tip the balance in favour on one of the two formats (online or in-class) while others will blend the two components equally. Still, finding the right blend of online and in-class activities is a challenge for most adopters of blended learning (Mestan, 2019; Tabor, 2007). It can be argued that this is due to the lack of a set of defined standards to guide decisions as to how much or what part of courses should be taught online versus in-classroom (Alammary et al., 2014, p. 446). For example, in an attempt to blend the two formats, some teachers add extra online activities without reducing the in-class time; however, Garrison and Vaughan (2011) perceive this as a poor integration because the students will likely regard this as a burden rather than a bonus – a situation which Kaleta et al. (2007) deemed the "course-and-a-half syndrome". Similarly, Hofmann (2006, p. 30) averred that some teachers unintentionally end up creating two separate courses (one online and another in-class) by, "stringing together stand-alone components into a learning path instead of truly weaving learning experiences together".

In order to find a harmonious balance, Alammary et al. (2014) suggest that the teachers attempting to integrate blended learning should have some experience teaching the traditional course. Prior knowledge of the course content allows the teachers to better identify the parts in their course that could be enhanced if shifted to an online platform while still ensuring there is a strong connection between the in-class media and online media. Furthermore, the authors advise that achieving a harmonious blend is gradual process and will require continuous review and evaluation. In other words, the replacement (or shifting) of existing activities from in-classroom to online mode should occur incrementally. In the same vein, Kenney and Newcombe (2011) suggest viewing the course as a "work in progress". For example, in the case of large classes where providing timely feedback is challenging, a teacher could decide to administer all quizzes online so as to automate the marking process and ensure feedback is more quickly obtained by students. Then, if there is positive feedback from students in regard to this online-based quiz, the teacher can proceed to deliver the content heavy sections of the course as video-based online lectures so as to free up classroom time for the practical bits of the course content. This scaling process should continue until a harmonious balance is achieved between the online and in-classroom components.

2) Time management

According to Vaughan (2007), developing a blended course can take two or three times longer than designing a similar course in the traditional format. This poses a challenge because more often than not, blended learning initiatives start off as individual experimental projects (Graham et al., 2013), which means teachers do not usually receive any workload reduction from management (Kenney & Newcombe, 2011). Finding this extra time for course development can be quite overwhelming for the teachers. In a bid to keep up with the workload, many teachers often end up redesigning an existing course as opposed to building a blended course from scratch. While both techniques are judicious, Hofmann (2006, p. 33) asserts that it is unwise to "assume that it's going to take less time to redesign an existing traditional program than it would to design a blended program from scratch".

As a general guide, some researchers have recommended allowing at least six months' lead time for designing a blended course (Alammary et al., 2014; Kenney & Newcombe, 2011; Ragan, 2007). Moreover, since an extra online activity in a traditional course is often not recognised or compensated by administration, to better manage the time constraints and overwhelming workload, Alammary et al. (2014) advise teachers to ensure that any online teaching resources added into a traditional course results in the reduction of in-classroom time or should be driven by a specific pedagogical need rather than a technological trend.

3) Support and Training

Most universities have adequate support services for the students' learning needs; however, unlike the students, these supports are often not at the desired level for the teaching faculty (Garrison & Kanuka, 2004; Kenney & Newcombe, 2011). Particularly, since most blended learning initiatives start as individual projects adopted by faculty members interested in using both online and traditional strategies (Graham et al., 2013), in universities that predominantly offer traditional courses, there is often a lack of policies to support online learning and teaching strategies (Kenney & Newcombe, 2011; Nyerere et al., 2012). In such scenarios, it is generally observed that, due to the globally pervasive presence of technology, training workshops for teachers on how to effectively utilise technology in their traditional teaching is often overlooked as institutions assume that teachers already know how to use the technology. However, Spector et al. (2014) aver that the way in which technology is used in non-school environments differs from their application in school settings. Failure to adequately prepare teachers to use this technology in a school setting could lead to what Kinchin (2012) refers to as "technology-enhanced non-learning" – which can be quite frustrating for the teacher whose main intention for adopting blended learning is to enhance their students' learning experience. Therefore, in an attempt to avoid technology-enhanced non learning, these teachers find themselves in a situation where "they often must seek out [professional] assistance on their own and at their own cost" (Kenney & Newcombe, 2011, p. 49).

Garrison and Kanuka (2004, p. 102) assert that, "the most effective support systems for teaching faculty are those that provide a course development team for the development of blended learning courses". The authors go on to explain that this team typically comprises of the teacher (content expert); educational designer (assists with course design, offers advice on proper use of educational technologies, and reviews the new course); and the media specialist (assists with the technical creation of course materials). Accordingly, Alammary et al. (2014, p. 448) propose that, "there must be a high-level institutional support in the form of time release, professional development, funding and technical support". Professional development is crucial as it helps teachers learn new teaching and technological skills that assist them in deciding the most suitable delivery mediums to achieve their blended course objectives (Vaughan, 2007). Regarding funding, since faculty interest to adopt blended learning is typically driven by the need to enhance students' educational experiences, Garrison and Kanuka (2004) propose that universities create an innovation fund that not only serves as financial support but also provides incentives to faculty and departments that initiate blended learning course transformations. According to Graham et al. (2013), faculty are more motivated to teach online if there is a possibility of material incentive. Considering time release, Kenney and Newcombe (2011) and Mestan (2019) suggest that faculty should have a reduction in workload, and given time to learn new technologies that are needed to prepare the blended course.

4) Learning Styles

Every student has a personal and preferred learning style which is usually influenced by their personality or former educational experiences (Ouda & Ahmed, 2016). Furthermore, Kearney et al. (2012) propound that the learning method employed is influenced by the learning technology used. Therefore, in the matter of designing blended learning courses, the multitude of delivery mediums that ICTs offer means teachers face the complex task and pressure of not only considering the wide array of learning styles but also evaluating the implication of the various technologies on these learning styles (Alammary et al., 2014). For example, some students have an obvious preference for visual (video) rather than auditory learning mode, while some prefer textual content and others learn best with a mixed mode. Moreover, some students prefer live online interactions while others favour asynchronous online interaction.

Indeed, it is impractical to assume that a blended course will support all learners' needs; however, Farley et al. (2015) suggest one way to accommodate the varying learning contexts is by using multiple media formats during content creation. There is a myriad of applications that can assist in automatic file conversions. Additionally, since building a blended course is an iterative process, *"it is worthwhile investigating students' opinions about the course components ... consistent and transparent communications with students about their opinions and expectations is essential for the success of the blended learning experience"* (Alammary et al., 2014, p. 445). This evaluative feedback allows teachers to ascertain whether the activities are assisting students in achieving their learning targets.

## 2.3 Smartphone-Supported Blended Learning: Is it a Conceivable Idea? Exemplars, Barriers to Adoption and a Conceptual Framework

### *2.3.1 Is it a Conceivable Idea?*

Indeed, the blended learning challenges described in section 2.2.3 have workable solutions. Yet, blended learning models that are cost-effective and address the needs of different populations with different socio-economic conditions are still scarce. For example, in Australia, Mestan (2019) demonstrated that due to the existing digital divide, rurally based students did not fully experience the benefits of the blended learning programs offered. According to the author, the rurally based students had difficulty learning off-campus because they relied on university computers to access online learning materials. Similarly, in sub-Saharan Africa, blended learning is often perceived as an approach favouring the economically advantaged (Mpungose, 2020; Spector et al., 2014) since the typically unaffordable desktop PCs and laptops presently serve as the main computing platforms for online learning.

However, this research argues that the pervasive presence of smartphones, even in less advantaged regions like rural sub-Saharan Africa (see Figure 1.2), presents a silver lining for the progression of blended learning in the region. State-of-the-art smartphones are now considered as pocketable computers rather than just mobile phones. Accordingly, these devices can now accomplish most tasks typically done on PCs. Sentio Superbook (Sentio, 2017), a recent crowdfunded research demonstrates that the smartphone's computing power is at par with laptops. The critical success factors underpinning the smartphone's powerful on-board computing capabilities include: extensive memory, open operating systems that allow application development and the smartphone's ability to support wireless mobile internet access (Boulos et al., 2011; Iqbal & Bhatti, 2020).

Therefore, this section discusses the smartphone's onboard computing capabilities (e.g., memory and storage, mobile apps, mobile internet and battery capacity) that could give it a shot at becoming a primary learning tool in blended university education. The discussion describes the specifications of low-mid value range smartphones with a price point of $150 (New Zealand Dollar (NZD)). But, before proceeding, it is imperative to mention that for the rural population in sub-Saharan Africa, $NZD 150 is still costly. However, as mentioned in Chapter 1, reports by Karlsson et al. (2017) and GSMA (2020) illustrate that an increasing number of this population is now finding practical solutions to afford these low-mid range smartphones. Additionally, the influx of low-cost smartphone brands (e.g., Tecno, Infinix and Xiaomi) has challenged the existing established brands (e.g., Apple and Samsung). This influx of low-cost brands has led to best consumer-price competition; hence affordable high-specification smartphones are now more widely available in sub-Saharan Africa (Oluwadara et al., 2020).

a) Memory and storage

Low-mid value range smartphones now come with at least 3GB RAM and a minimum of 16GB internal storage. High RAM capacities increase processing efficiency such as the launching of applications and this inevitably enhances the overall user experience. Regarding storage, Hawi et al. (2018) demonstrate that the smartphone can effectively store an entire semester's worth of content of a video-intensive online course. In the event a student needs to participate in multiple courses via their smartphone, affordable smartphone brands (e.g., Xiaomi, Infinix and Tecno) with a price point of $NZD150 have microSD slots that allow users to expand the storage capacity. These memory cards are very affordable; for instance in Kenya, 32GB and 64GB microSD cards cost $NZD9 and $NZD15 respectively (source: jiji.co.ke).

b) Mobile Applications (apps)

The smartphone's ability to integrate independent applications commonly known as '*mobile apps*' transforms it into a powerhouse (Parsons, 2014). Through *mobile apps*, smartphones can perform most tasks typically done on laptops (Pechenkina, 2017). For example, one major concern with integrating smartphones into formal education is the small screen size that may impede writing long text documents (Kim & Jin, 2015). However, with *Google Voice Typing* app, writing essays does not necessarily mean typing – the *app* translates speech-to-text. Additionally, *Google Keep* allows one to translate an image of a handwritten document into text. Therefore, it is possible for students to create learning content using their smartphones.

c) Mobile Internet

Globally, mobile internet is the most widely used mode of connectivity, and the smartphone is the most reliable device for providing continuous access to this connectivity (Cerwall et al., 2017; Deloitte, 2016; Karlsson et al., 2017; Wang & Liu, 2021). Needless to say, the Internet is a fundamental enabler for the currently employed technology-enhanced learning approaches (like blended learning). In their study, Hawi et al. (2018) demonstrate that mobile internet speeds supported by low-mid range smartphones can go as high as 15Mbps (for 3G/LTE/4G networks[7]) and on a very slow 2G network, 235Kbps. These speeds are more than sufficient to comfortably stream and download learning content via a smartphone (Hawi et al., 2018).

If we go by Hawi et al. (2018) evaluation that a 12-week video-intensive course will generate 5.5GB worth of learning content, then certainly, there are significant monetary costs associated with mobile internet access. For example, in Kenya, 5GB on the most popular networks costs between $6 - $12 New Zealand dollars (Airtel, 2020; Safaricom, 2020). Although much cheaper than what is seen in majority of the developed countries (Cable, 2020), for the lower-income population in sub-Saharan Africa, the aforementioned mobile data prices may indeed still be high. However, considering that this data will go towards consuming an entire semester's worth of course content, then the costs are worth it. A sentiment shared by students at a rural-based university in Kenya, who feel that the cost associated with using their smartphones for university education is worth it (Hawi et al., 2021). Moreover, the proliferation of smartphones in sub-Saharan Africa has seen mobile network providers offer more attractive data plans in order to reach a wider market (GSMA, 2017b).

[7] In 2019, 3G overtook 2G and is now the leading mobile broadband in sub-Saharan Africa with 70% coverage; 4G is set to overtake 2G by the year 2023 (GSMA, 2019a, 2019b).

d) Battery capacity

Although *"smartphone battery technology hasn't been able to keep pace with the rapid growth of the capacity and functionality of smartphones and apps, [and the short battery life] has always been a bottleneck of a user's daily experience of smartphones"* (Li et al., 2018, p. 1), recently, affordable smartphone brands (e.g., Xiaomi Redmi 9A) now come with a 5000mAh battery life, which can last 24 hours with extensive use. Using the GSMArena battery life tool, if a student uses their smartphone (with a 5000mAh battery) mainly for coursework and moderately for entertainment purposes, a single charge can last up to two days; if the smartphone is used extensively for entertainment in addition to accessing coursework, then a student would have to charge the smartphone once a day, which is still reasonable.

Concerning whether rurally based students have easy or stable access to power to charge their smartphones, I argue that they do. Leading mobile service providers in sub-Saharan Africa are now partnering up with solar power companies to provide affordable access to power to low-income households and the population living in remote rural areas where grid electricity is not readily available. For example, Safaricom, a leading mobile network provider in the region, launched a solar power project, M-Kopa, which allows its subscribers to purchase solar panels through a payment plan. M-Kopa is currently operating in Kenya, Tanzania, Uganda, Ghana and Nigeria and its subscriber base is burgeoning. Moreover, in the event a student does not have access to solar power in their home, charging stations in the town centres ask for a very small fee to charge smartphones – for instance, in Kenya, it only costs KSH10 (about 4 cents in New Zealand currency) to fully charge a smartphone (F. Osano, personal communication, March 22, 2022). Therefore, charging smartphones would not be a barrier to implementing smartphone-supported blended learning.

### 2.3.2 *Exemplars: A systematic review and a narrative review of research studies on smartphone-supported learning in higher education contexts*

In the previous section I have suggested that it is possible for a student to use their smartphone to: store an entire semester's worth of course content; create learning content (contribute to a course); and comfortably stream and download online course material. Certainly, smartphone-based learning is not a novel idea, higher learning institutions are indeed acknowledging the potential the pocketable smartphone has in providing convenient flexible learning environments, especially when compared to laptops which can be cumbersome to move around with. However, it should be noted here that the smartphone has found its niche only as a supportive learning tool rather than a primary one. In this vein, this section, in the format of 1) a systematic[8] review and 2) a narrative[9] review, endeavours to present noteworthy examples (both in the developing and developed regions) that highlight where the smartphone lies in principle with regards to supporting learning in higher education. A systematic review was deemed fit as it not only highlights examples of smartphone-use in higher education but also initiates an evidence-based discussion on the gap that still remains in literature when it comes to research on smartphones as the sole/primary devices for study. On the other hand, a narrative review is suitable as it captures other published works that were not represented in the systematic review (due to inclusion and exclusion criteria); hence helps to provide a more encompassing account of extant research studies on smartphone-supported learning. These two reviews are presented next.

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[8] Systematic review: the process of identifying existing research on a topic of interest using explicit, accountable rigorous research methods (meaning, the criteria used to identify, include and exclude studies in a review are clearly explained) Gough, D., Oliver, S., & Thomas, J. (2017). *An introduction to systematic reviews* (2nd ed.). SAGE Publications.

[9] Narrative review: presents research findings relating to a topic of interest without explaining the criteria used to identify or include those studies or why certain studies are described and discussed while others are not ibid.

2.3.2.1 A systematic review of research studies on smartphone-supported learning

This systematic review was guided by the overarching question, *what research has been conducted using smartphones as the technology basis for learning from the year 2012 to 2021*? This question was then broken into three sub questions:

- What is the research status of smartphone-supported learning? Is the number of articles concerning this topic increasing or decreasing?
- What are the learning contexts and geographical distribution of the research studies identified?
- What subject matter domains are adopted in the identified research studies?

a) Data sources

Using Google Scholar's five-year h-index and h-median metrics, 6 of the top 20 ranked education technology journals (as listed in Table 2.2) were selected for the search. These peer-reviewed journals are widely recognised as being on the leading edge and have high impact factors. For example, *Computers and Education* has a H5-index of 101 which means in the past five years, the journal has published 101 articles that have 101 or more citations each.

**Table 2.2: Title of the journals included in this search of the literature**

| Journal | H5-index | H5-median |
|---|---|---|
| Computers and Education | 101 | 148 |
| British Journal of Educational Technology | 59 | 101 |
| Journal of Educational Technology and Society | 52 | 71 |
| Educational Technology Research and Development | 41 | 62 |
| Journal of Computer Assisted Learning | 35 | 57 |
| Australasian Journal of Educational Technology | 35 | 44 |

b) Search strategy

Within each of the six journals' database, electronic searches were conducted using the following search terms: "smartphone" and "mobile learning". In line with the review's research question, the search was bound between the years 2012 and 2021. According to Cochrane (2014), smartphones became more accessible to the general public from the year 2012; hence provides a rationale for the selected start date of this review. Furthermore, to be counted in the review, each article needed to meet all the inclusion criteria and not match any of the exclusion criteria listed in Table 2.3. Peer-reviewed journal articles were the main focus of this review. Although peer-reviewed conference proceedings could have provided useful information about works in progress not yet published in journals, they were excluded since I aimed to inspect research articles included in the top-ranked educational technology journals listed in Table 2.2. Similarly, dissertations, government publications and organisational reports were also not included since these articles are typically not published in academic journals. Additionally, since books and book chapters are usually theory-oriented or cite empirical findings of other studies, they were also excluded from this review. As a last measure to ensure that no literature was obviously missed, an educational librarian at Massey University was consulted, and they assisted with checking and exploring other databases (particularly, Web of Science, Scopus and Google Scholar) using the specified search terms until all available literature was exhausted.

**Table 2.3: Inclusion and exclusion criteria**

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| ▪ Must use smartphones/mobile phones to facilitate learning. | ▪ Studies on other mobile devices (e.g., tablets, laptops, mp3 players, PDAs). |
| ▪ Must be involved in higher education settings. | ▪ Any study outside the university context. |
| ▪ Must include empirical findings with actual data. | ▪ Articles presenting personal opinions and/or theoretical argumentations. |
| ▪ Must be a peer-reviewed research article. | ▪ Books, book chapters, conference proceedings, dissertations, government publications, and reports. |
| ▪ Must be written in English for easy and quick analysis, given the author's linguistic background. | ▪ All other languages. |

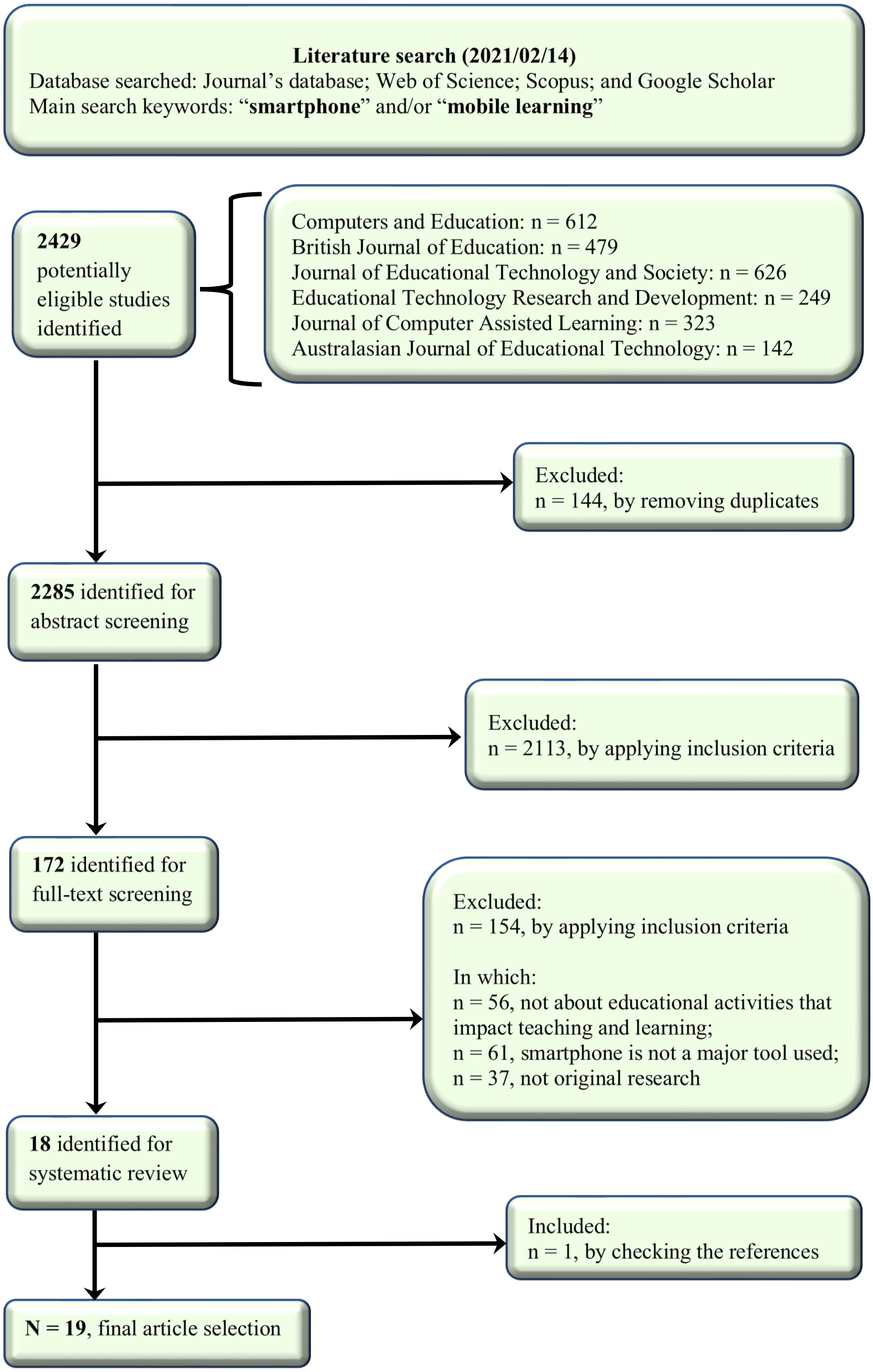
c) Search process and results

At first, a 'title search' was conducted using the term "smartphone". However, very few studies were retrieved. For example, Computers and Education (n = 11); British Journal of Educational Technology (n = 5); Journal of Educational Technology and Society (n = 1); Educational Technology Research and Development (nil); Journal of Computer Assisted Learning (n = 2); Australasian Journal of Educational Technology (n = 3).

Ergo, given the paucity of articles with the term "smartphone" in the title, to improve completeness and avoid missing any published literature relevant to this review, a broad systematic search using the term "mobile learning" was conducted. This is because mobile learning (sometimes m-learning) is usually the umbrella term given to research that utilises smartphones for educational purposes (Crompton & Burke, 2018; Shuler et al., 2012; Woodcock et al., 2012). As of 14th February 2021, the initial search produced a total of 2429 articles. From this, 144 duplicates were deleted and the abstracts of the remaining 2285 articles were prudently reviewed for any mention of the terms: "smartphone", "mobile phone", and/or “mobile device”. Consequently, a total of 172 articles (including the papers retrieved from using only the term “smartphone” in the title search) fit the inclusion and exclusion criteria recorded in Table 2.3.

Next, the selected 172 articles were further examined by full-text scrutinising and the reference sections of these articles were also inspected carefully to find any other studies that met the inclusion criteria. From this step, a further 154 articles were eliminated and 1 more study was identified, resulting in a final tally of 19 articles that fit the inclusion and exclusion criteria. Figure 2.3 shows a flowchart depiction of the literature search process, and later in this same section, Table 2.4 presents a summary of the studies reviewed.

**Figure 2.3: Flowchart of the literature search and filtering process during the systematic review of studies on smartphone-supported learning (from 2012 to 2021)**



d) Results and Discussion

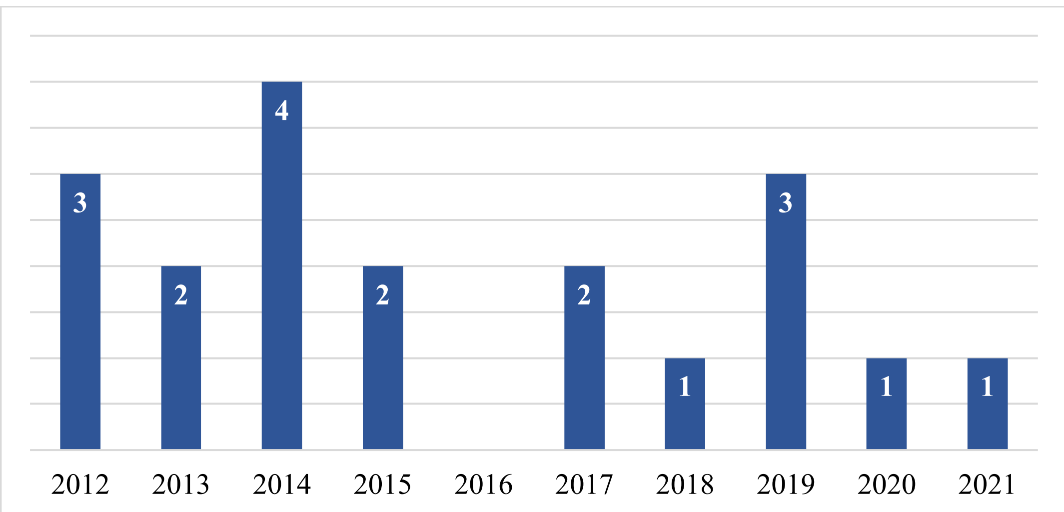
- *What is the research status of smartphone-supported learning? Is the number of articles and interest in this topic increasing or decreasing?*

This review yielded a total of only 19 research articles (see Table 2.4) concerning smartphone-supported learning within the university context. Given the inexorable progress of smartphone technology since the turn of the last decade, as well as the disruptive presence of smartphones in peoples' lives, especially university students (Crompton & Burke, 2018), one would assume that the number of studies would be bigger and that smartphones would play a more significant role in the evolution of educational research in higher education. Nonetheless, Kaliisa et al. (2019) opined that much of the research on learning supported by mobile technologies (such as smartphones) is currently dominated by studies conducted at primary and secondary school levels. This, therefore, could explain the low count of research studies on smartphone-supported learning within the university context.

Moreover, Figure 2.4 shows that, by dividing the search years into two periods (2012 to 2016 and 2017 to 2021), there is a slight decline in the number of studies – the first period (n = 11) and second period (n = 8). These results contradict the assertions of scholars such as Hwang and Tsai (2011) who, at the outset of the last decade predicted that as the years went by, more technology-based learning research would be focused on mobile devices (such as smartphones). But, it appears that nearly ten years later, there is still relatively little systematic knowledge available, especially regarding the use of mobile technology in higher education (Kaliisa et al., 2019). Perhaps the underlying reason for this downturn is due to the fact that most of the extant implementations on mobile-based learning are small-scale projects which are mainly explorative and experimental in their intent and design – hence many of them end at the pilot phase (Ally, 2013; Isaacs, 2012; Kaliisa & Picard, 2019; Sharples, 2013).

Regarding whether interest in this domain (smartphone-supported learning) is peaking, Figure 2.4 gives the impression that research interest started lagging after the year 2015. Hence, from the scant findings of this review, one could infer that generally, there is no considerable interest in exploiting the smartphone's full potential to facilitate university education – and in the event plenty more of these smartphone-based learning projects exist, then they are not well documented. This conclusion is sufficiently supported by the results obtained in the research by Kaliisa and Picard (2017). In their systematic review of mobile learning in higher education from the perspective of African countries, Kaliisa and Picard (2017), who had a more exhaustive scope (in terms of data sources), found only 31 empirical studies, with 24 of these studies focusing primarily on smartphones – a tally not far from the 19 studies derived from the systematic review I carried out. The scant findings in Kaliisa and Picard (2017) literature demonstrate that even in Africa, where mobile learning would be especially beneficial given the prevalence of smartphones and the extreme paucity of laptops and desktop PCs, there have been no concerted efforts towards furthering smartphone-supported learning research.

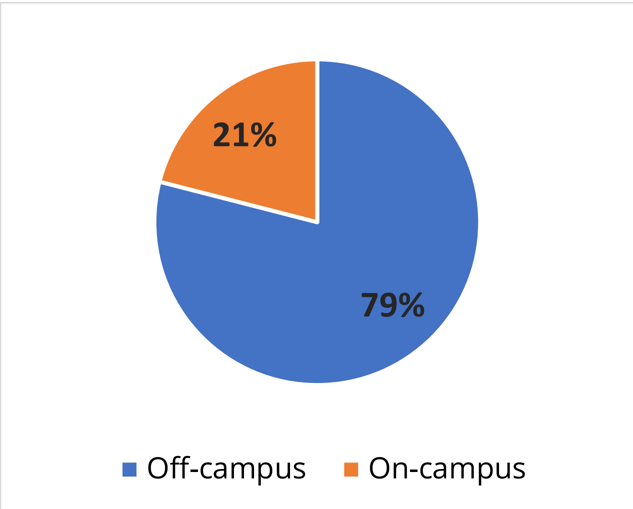
**Figure 2.4: Number of research studies from the findings of the systematic review on smartphone-supported learning from 2012 to 2021**



- *What were the learning contexts and geographical distribution of the research studies identified?*

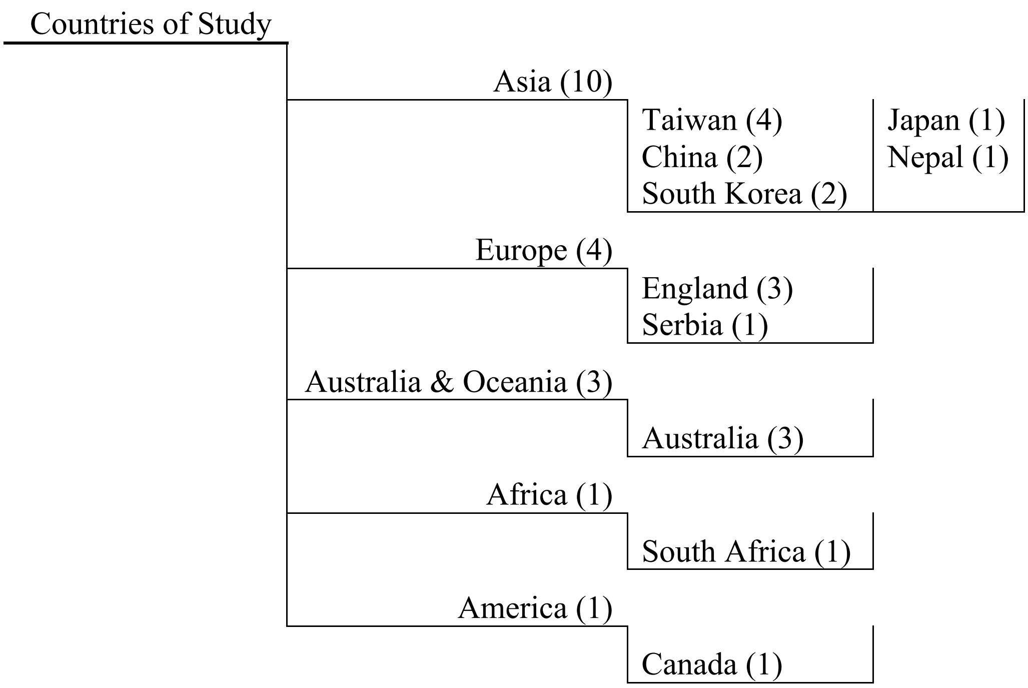
While all the studies identified were conducted in the context of higher education, the learning contexts were different. Figure 2.5 reveals that majority of the studies (n = 15) took place off-campus (i.e., where learning is intended but occurs outside of the classroom), while the on-campus studies (i.e., where learning is intended and occurs inside a physical classroom) accounted for only 4 articles (21%). The disparity between the on-campus context and off-campus contexts is not surprising. According to Tossell et al. (2015) since smartphones are inherently portable, teachers and/or researchers usually explore the use of these devices in contexts beyond the traditional classroom walls.

**Figure 2.5: Types of educational contexts identified from the findings of the systematic review**




The findings of this study (as seen in Figure 2.6) suggest that research is taking place globally but some countries are conducting more research from particular continents. For example, Asia was the continent with the highest percentage of studies (n = 10); more specifically, Taiwan conducted the most research. This result is expected as it correlates with the systematic reviews by Crompton and Burke (2018) and Hwang and Tsai (2011) who also report that Taiwan generally produces more research studies on the use of mobile devices for learning. What is interesting to note is that, only one article was retrieved from Africa. Yet, given the extreme paucity of desktop PCs and laptops in this particular region (review Figure 1.1), Africa potentially stands to benefit the most from mobile-based learning (Kaliisa & Picard, 2017). The absence of studies reporting on smartphone-supported learning in Africa further reflects the need to avidly encourage higher education faculty and researchers to explore this emerging field to enable the region to become an equal player in the competitive global knowledge economy.

**Figure 2.6: Countries where the research studies identified in the systematic review took place**

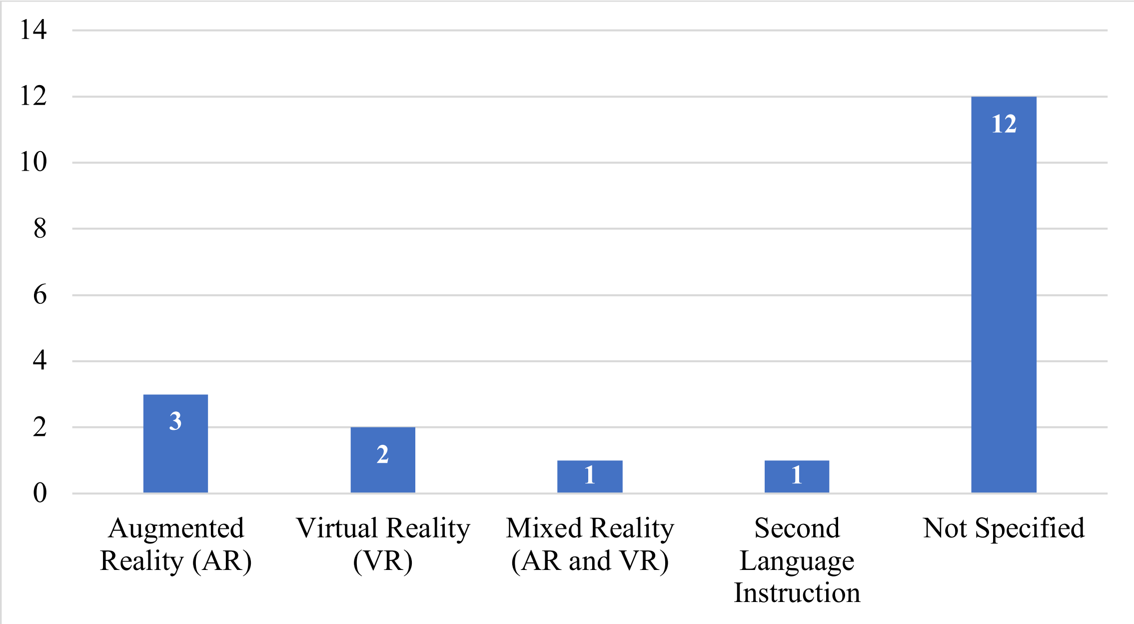


- *What subject matter domains are adopted in the identified research studies?*

It is observed that most of the studies (n = 12) did not involve any subject matter domain, instead, they mainly focused on using the smartphone to facilitate general learning processes such as: 1) administering formative assessments (e.g., quizzes) and 2) enhancing participation and feedback turnaround time in collaborative activities through mobile apps (e.g. WhatsApp, WeChat, Clickers, m-LMSs). Augmented reality (AR) and virtual reality (VR), as well as second language instruction were the only subject matter domains discussed in the reviewed studies, with AR and VR representing six articles and second language instruction appearing in only one article. The breakdown of the subject matter domains is provided in Figure 2.7.

In regard to AR and VR, it is not surprising that there is considerable interest in integrating these technologies in education. Research in this area is beneficial because through AR and VR environments, students are able to learn about real-world environments without the limitations of time and location, thereby facilitating more authentic learning experiences (Chin & Wang, 2021). Pre smartphone era, due to high acquisition costs, VR and AR technology were not readily available to the general population. However, the widespread adoption and highly portable nature of smartphones led researchers to explore new ways of making these cutting edge technologies mainstream. For example, the location aware AR uses GPS-enabled smartphones while vision-based AR leverages the smartphone's camera to scan and present additional digital information relevant to users' physical location or nearby objects. *Layar* and *Wikitude* are good examples of smartphone-based AR tools used in educational activities. On the other hand, VR headsets leverage the smartphone's in-built sensors such as the accelerometer, gyroscope and magnetometer, to immerse users in a 3D virtual world. A popular and affordable VR headset used to enhance students' learning experiences is *Google Cardboard*.

**Figure 2.7: Subject matter domains identified from the findings of the systematic review**




e) Limitations of the systematic review

Indeed, it is imperative to note that, despite all possible efforts made to present a true picture of the existing body of knowledge on smartphone-supported learning, the six journals reviewed herein may not provide a representation of all works published. The review was limited by a number of factors. The first limitation concerns data sources. Only peer-reviewed research articles were examined and included. Consequently, studies that could have been accessed from other sources such as books, book chapters, conference proceedings, government publications, reports and dissertations were excluded. Second, the search terms used: “smartphone” and “mobile learning” might exclude some studies that involved smartphone-based learning but defined it in other ways such as “technology-enhanced learning” or “ubiquitous learning”. Another limiting factor is that the review focused primarily on studies conducted within the higher education (university) context. Lastly, all the journals reviewed in this section were English language publications hence, it is possible more research may have been conducted in non-English speaking countries. Even so, this review, in principle, still provides reasonable evidence and useful insight on the current state of smartphone-supported learning in university settings.

**Table 2.4: Summary of studies (from the systematic review) on smartphone-supported learning as identified in six top-ranked educational technology journals (n = 19)**

| # | Study | Research objective | Uses of Smartphone | Takeaway | Country |
|---|---|---|---|---|---|
| 1 | Aljaloud et al. (2019) | To investigate the impact of smartphone clicker applications on the learning performance of male students. | Male computer science students were required to use a smartphone clicker application during peer group discussions and to respond to quiz/teacher questions. | Smartphones can function as 'student response systems' – thus help teachers to better monitor students' engagement in group discussions, especially in large classes. | Saudi Arabia |
| 2 | Birt et al. (2017) | To explore how mobile mixed reality (i.e., 3D printing, VR and AR) can be used to provide a more hands-on-skill practice to paramedic distance education students prior to attending mandatory residential schools. | Students were required to use their smartphones to interact with a *Task Simulation Trainer* application that assisted them in learning and practising airways management. | Smartphones provide a cost-effective platform upon which learners can experience the benefits of simulation learning. | Australia |
| 3 | Bogdanović et al. (2014) | To explore how mobile technologies (e.g., smartphone and mobile internet) can be effectively integrated into the e-learning process. | Students in a Business course were required to complete a quiz hosted on Moodle platform via their mobile phones. | Smartphones (through m-LMSs) provide a practical gateway to administer frequent formative assessments. | Serbia |

| # | Study | Research objective | Uses of Smartphone | Takeaway | Country |
|---|---|---|---|---|---|
| 4 | Broadbent et al. (2020) | To evaluate whether mobile-app learning diaries foster self-regulated learning behaviours. | During a self-regulated learning training program, students were required to use *Instant Survey* smartphone app to document and self-reflect on their learning strategies. | Smartphones conveniently support the development of e-Portfolios. | Australia |
| 5 | Chen et al. (2013) | To investigate the influence of timely constructive feedback on learning performance. | A *learning system* continuously recorded all student's learning activities carried out via their smartphone, and then used this learning portfolio to automatically generate personalised feedback for each student. | Smartphones have a great potential for facilitating just-in-time learning. | Taiwan |
| 6 | Chin and Wang (2021) | To investigate the effect of applying AR technology in mobile learning environments. | Through their Android-based smartphones, students undertaking a Cultural Heritage course were required to interact with an *AR-based mobile touring system* that enabled them to observe and learn key information regarding historical sites. | The highly portable nature of smartphones makes it a useful tool to facilitate authentic learning experiences. | Taiwan |
| 7 | Edmonds and Smith (2017) | To design location-based mobile learning games that facilitate active learning and authentic educational experiences. | During field excursions, undergraduates from various courses were required to interact with *Mobile Learning Academy* – a smartphone-based application that used AR and gamification strategies to present the learning content. | Smartphone technology is accelerating the integration of gamification in education. | Australia |

| # | Study | Research objective | Uses of Smartphone | Takeaway | Country |
|---|---|---|---|---|---|
| 8 | Gromik (2012) | To assess the feasibility of mobile-assisted language learning. | Students studying an English course were required to use their smartphones to produce weekly 30-second videos as a way to develop/improve their communication skills. | Smartphones can be used to not only consume but also produce audio-visual educational material. | Japan |
| 9 | Kim et al. (2014) | To investigate the effects of mobile instant messaging on collaborative learning processes and outcomes. | Through the popular smartphone-based application, *KakaoTalk*, students were required to hold discussions on a given topic, as part of their coursework in an Educational Technology course. | Smartphones serve as one of the quickest ways to foster ad-hoc online learning communities. | South Korea |
| 10 | Huang et al. (2012) | To evaluate the effectiveness of procedural scaffoldings in facilitating group learning. | Using the QR code functionality, the smartphone was used to integrate print and digital learning content to facilitate collaborative learning activities. | Smartphones can function as 'student response systems' – thus help teachers to better monitor students' engagement in group discussions, especially in large classes. | Taiwan |
| 11 | Lu et al. (2014) | To design a context-aware mobile educational game that retains students' interest overtime. | Students undertaking a Management Information System course were required to use smartphones to interact with popular I.T. companies in a *virtual science park* that automatically generated a series of story-based, role playing learning activities. | Smartphone technology is accelerating the integration of gamification in education. | Taiwan<br>Canada |

| # | Study | Research objective | Uses of Smartphone | Takeaway | Country |
|---|---|---|---|---|---|
| 12 | McFaul and FitzGerald (2019) | To evaluate and gain new insights on the use of VR technology to facilitate remote learning in legal education settings. | Law students were required to use their smartphones to access the *Open Justice VR* application that would enable them to practise their presentation skills in a simulated environment and receive automated feedback prior to their actual face-to-face presentations. | Smartphones provide a cost-effective platform upon which learners can experience the benefits of simulation learning. | England |
| 13 | Pimmer et al. (2012) | To explore how students and faculty use social networking sites in the setting of developing and emerging economies. | Medical students and faculty used their mobile phones to access, discuss and post educational content on *Facebook*. | Informal learning via mobile social media is becoming indispensable. | Nepal |
| 14 | Price et al. (2014) | To determine how mobile technologies (e.g., smartphones) can be used to initiate a geospatial approach to science teaching and learning. | Teacher trainees studying a postgraduate course in science education used a customisable smartphone-based AR application, *GeoSciTeach,* to design and teach a fieldwork-based learning activity on botany. | Smartphones enable *in-situ* learning. | England |
| 15 | Rambe and Bere (2013) | To explore the pedagogical influence of mobile instant messaging in the facilitation of collaborative learning across geographically disperse contexts. | Through *WhatsApp* mobile application, the smartphone was used to heighten lecturer-student and peer-based participation in an Information Technology course during and after hours. | Smartphones serve as one of the quickest ways to foster ad-hoc online learning communities. | South Africa |

| # | Study | Research objective | Uses of Smartphone | Takeaway | Country |
|---|---|---|---|---|---|
| 16 | Kim and Jin (2015) | To develop and validate guidelines on auditory information design for improving learning on mobile phones. | Using their smartphones, students were required to complete a short English course while in a public location (i.e., an uncontrollable learning environment such as a café). | Learning *on the move* is one of the most distinguishing characteristics of smartphone-based learning; therefore, auditory content are essential in this type of learning environment. | South Korea |
| 17 | Wang et al. (2018) | To assess the efficiency of mobile messaging-based case studies in improving clinical health literacy among pharmacy students. | Through the smartphone-based application, *WeChat,* students were required to post at least one care plan each week in response to a pharmacotherapy case study posted by their instructor in their respective group chats. | Although learning via instant messaging smartphone apps is highly susceptible to interruptions (e.g., impromptu non-educational messages/calls from peers), the *structured* use of these apps has been shown to have positive impacts on the learning process. | China |
| 18 | Wilkinson et al. (2019) | To evaluate whether mobile-app quiz games (as opposed to normal revision i.e., notes/books) increase student achievement. | Students undertaking an Anatomy course were required to use a smartphone-based quiz game as a revision tool immediately before completing an online formative assessment still on their smartphone. | Smartphone (through *mobile apps*) is accelerating the integration of gamification in education. | England |
| 19 | Yang et al. (2015) | To explore the effect of different presentation modes (video, audio, text and picture) on learner concentration when using smartphones for study. | Students in an Education course were required to study in 20 minutes, 8 concepts (delivered in multiple media formats) via their smartphones. | Due to the smaller screen size of the smartphone (compared to tablets/laptops), some learners may experience difficulties maintaining visual attention on the screen. | China |

#### 2.3.2.2 A narrative review of research studies on smartphone-supported learning

In light of the scant findings of the systematic review, an additional narrative review (unrestricted by the journal specific criterion previously listed in Table 2.2) was deemed appropriate, in order to gain a more holistic understanding of the research status of smartphone-supported learning. Accordingly, an additional 14 publications were retrieved. A brief account of these noteworthy studies that demonstrate smartphone usage in higher education contexts in developing and developed countries is presented next. Table 2.5 provides a summary of the studies inspected.

a) Developing world

*Dunia Moja Project* (Ryou, 2007; Steinbeck, 2009) is a large scale ongoing mobile learning project that cuts across two continents to connect faculty and students from Stanford University (USA), University of Western Cape (South Africa), Mweka College of African Wildlife Management (Tanzania) and Makerere University (Uganda). The project was started by Stanford University to pilot an international environmental course, aimed at designing global solutions to environmental issues. This is achieved through the use of smartphones that allow students from these institutions to exchange, contribute and discuss field related course content. Through *moblog* (the platform's online interactive mobile blog), students are expected to post multimedia content from their smartphones showcasing to other learners their fieldwork experiments in their local contexts. This exchange allows them to better design global collaborative activities and solutions.

In Kenya, tertiary agricultural education enrolments constitute only 7.4% of overall tertiary enrolments (Kanwar et al., 2015); however, about 80% of the population rely on agriculture for their livelihood (FAO, 2018). Therefore, in an attempt to improve agricultural education and foster food security, the Kenyan government started *E-extension* programme that is hinged on the smartphone. Through smartphones, the platform is able to reach over seven million farmers in the field to provide informal agricultural education. This is achieved through a combined approach of using mobile apps, social media, short message service (SMS) and agricultural websites, which provide tailor-made multimedia content on specific needs of the farmers. (Gichamba et al., 2017; Tata & McNamara, 2017)

In India, Ray and Deb (2016) leveraged the portability and affordability of smartphones to introduce virtual reality (VR) into an undergraduate course on micro-controllers and Arduino boards. In order to participate in the session, the students had to connect their smartphones to *Google's Cardboard* headsets, upon which they were presented with 3D content with embedded notes and panoramic views. The authors reported that the smartphone-based VR system was a success and led to a significant increase in student performance.

An orthodontist instructor in Iran (Golshah et al., 2020) recruited a group of fourth year dental students at Kermanshah University of Medical Sciences, to compare the efficacy of smartphone-based mobile learning versus lecture-based learning for instruction of cephalometric landmark identification. The students were expected to consume two hours' worth of theoretical lecture content (multimedia format) via an Android-based smartphone application. The findings of the two-week long intervention revealed that smartphone-based mobile learning had a comparable, and even slightly superior, efficacy to lecture-based learning instruction mode. For instance, the mean error rate in the identification of one of the landmarks examined was significantly lower in the smartphone group compared with the traditional lecture-based group.

According to GSMA (2014a), Philippines has more than six million youths who are excluded from education due to socioeconomic barriers. However, through the *Abot Alam* programme, the government partnered with leading mobile service providers to expand access to education. The mobile operators provide mobile-based educational materials via mobile phones – for instance, through their Alternative Learning System app, Smart Communications, a leading mobile operator in the country, partnered with the Open University of Philippines to deliver a MOOCs course via smartphones.

The University of Botswana School of Medicine (Chang et al., 2012; GSMA, 2011) noted that their trainee physicians located in the rural hospitals were having a difficult time accessing medical information and assistance from their remote mentors. Hence, the trainees were equipped with 3G enabled *Google myTouch* smartphones that came preloaded with applications with content on point-of-care and drug information, as well as a telemedicine app that allowed trainees to submit and discuss case information with their mentors. In this context, the use of smartphones enabled the trainees to mitigate the lack of connectivity issue as well as facilitate self-directed learning.

In Lesotho, *Sterio.me* (Reid & Pruijsen, 2015) an SMS and voice-based mobile education project allows student assignments to be created, shared and marked via a mobile phone. Initially launched in Nigeria, *Sterio.me* also allows teachers to pre-record lectures and quizzes which can then be accessed for free by the students via a specific SMS code. Once completed, teachers are prompted and can instantly provide feedback on performance or provide student tutoring.

In their research, Adedoja et al. (2013) explain how in order to encourage integration of resource-based pedagogies, and to ensure that distance learners dispersed in various geographical locations had affordable access to educational content anytime-anywhere, the Distance Learning Centre (DLC) at the University of Ibadan (Nigeria) explored the use of mobile phones to deliver tutorials as well as formative assessments for three courses. This short-term funded project yielded a positive outcome; however, it was observed that only students with smartphones (as opposed to basic feature phones) fully benefited from the intervention.

In a one-year long pilot project examining the perceptions of teachers on m-learning and the effects of m-learning on students, Central University College in Ghana integrated the mobile learning platform, *AD-CONNECT*, in 44 courses (Annan et al., 2012). The platform gave teachers the opportunity to publish simplified lecture notes, examinations, quizzes, questionnaires, assignments, poll and surveys with direct feedback to students with any kind of mobile device. Similarly, once logged in, students were able to read the lecture notes, complete assignments, quizzes, group work and exams in a ubiquitous environment with their mobile phones. The findings revealed that the automated learning processes facilitated by smartphones made it easier to handle large number of students and enabled just-in-time learning.

b) Developed world

Stanford University's *SMILE* application, requires students to use their smartphones to generate and share multiple choice questions to be answered by their peers during class. Each student is expected to take the quiz, which is generated from all the students' questions. The quiz results are then displayed immediately on the student's phone screen. Consequently, this increases interaction and engagement as it creates a game-like collaborative environment. (Stanford Graduate School of Education, 2016)

A Twitter-based response system used at a South Korean university by Kim et al. (2015) required students to use their smartphones to answer questions to a quiz. Results from the pilot study indicated that students preferred the smartphone-based quiz (on Twitter) to the conventional method of quizzing (paper or verbal). According to the authors, incorporating the smartphone which the learners already had a personal attachment to, improved learning efficiency and consequently contributed to an increase in student engagement.

*iPAC* used by Open University of Catalonia allows teachers to mark and correct PDF student submissions directly from their iPhone. By allowing annotations via a smartphone, *iPAC* obviates the need for instructors to use desktop PCs, laptops or paper to provide feedback to students. Once corrected, instructors simply upload the PDF still via their iPhone for the students to review. (Ferran-Ferrer et al., 2014)

Georgetown University School of Medicine requires its students to own a smartphone, which is to be used during clinical rotations (Georgetown School of Medicine, 2017). The students are expected to use the phones for clinical decision making as well as to answer clinical questions at point of care. After which, the acquired technical skills in applying handheld devices during medical care is tested still using the smartphone. This demonstrates how smartphones are used outside classrooms to support work integrated learning (Scott et al., 2017).

In an attempt to examine students' attitudes towards mobile education, a group of students studying an Information Technology course at British University of Nicosia were required to consume course lectures as well as complete two end of course exams via their smartphones (Tuncay, 2016). The intervention findings revealed that more than half of the participants agreed that using smartphones for education would increase their motivation towards learning. Also, the study found that mobile-based exams were efficient as there was no significant difference between the students' paper-based exam results and the smartphone-based exam results.

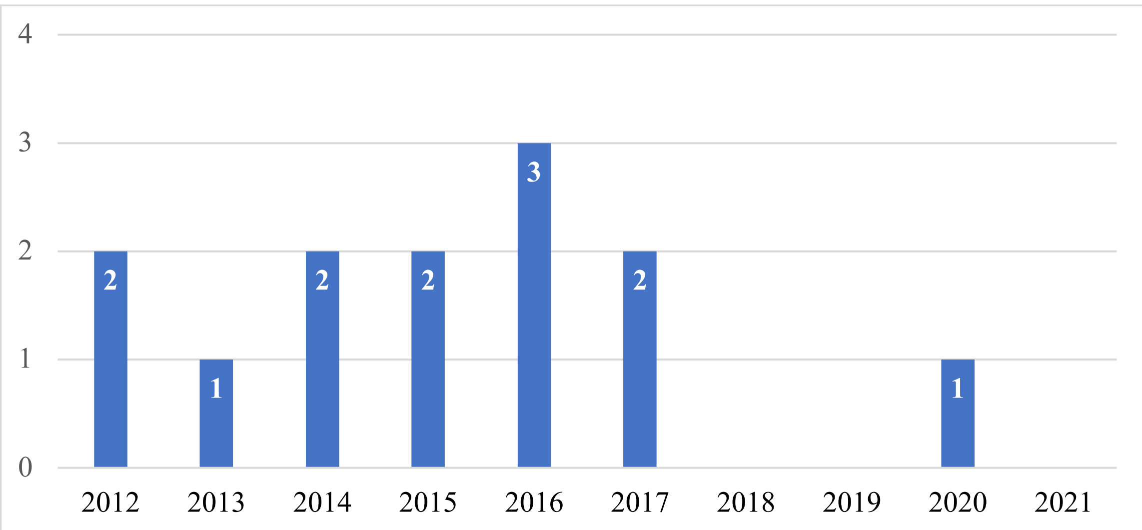
**Table 2.5: Summary of research studies (from the narrative review) that showcase the current impact of smartphones in higher education (n = 14)**

| Project | Smartphone's Potential |
|---|---|
| ▪ SMILE (USA)<br>▪ iPAC (Spain)<br>▪ Sterio.me (Lesotho, Nigeria)<br>▪ British University of Nicosia - Mobile Exams Project (Cyprus) | - Provision of mobile-based assessments. |
| ▪ Twitter-based smartphone response system (South Korea)<br>▪ Dunia Moja Project (USA, South Africa, Tanzania, Uganda) | - Global establishment of ad hoc peer-to-peer learning communities. |
| ▪ Abot Alam (Philippines)<br>▪ DLC Project at University of Ibadan (Nigeria)<br>▪ Cephalometric Landmark Identification intervention (Iran)<br>▪ AD-CONNECT (Ghana)<br>▪ Google Cardboard course (India) | - mEducation: delivery of educational resources via mobile learning content management systems (m-LCMS) and other mobile apps. |
| ▪ Georgetown University School of Medicine (USA)<br>▪ University of Botswana School of Medicine<br>▪ E-extension (Kenya) | - Supports work-integrated learning. |

c) Brief discussion on the findings of the narrative review

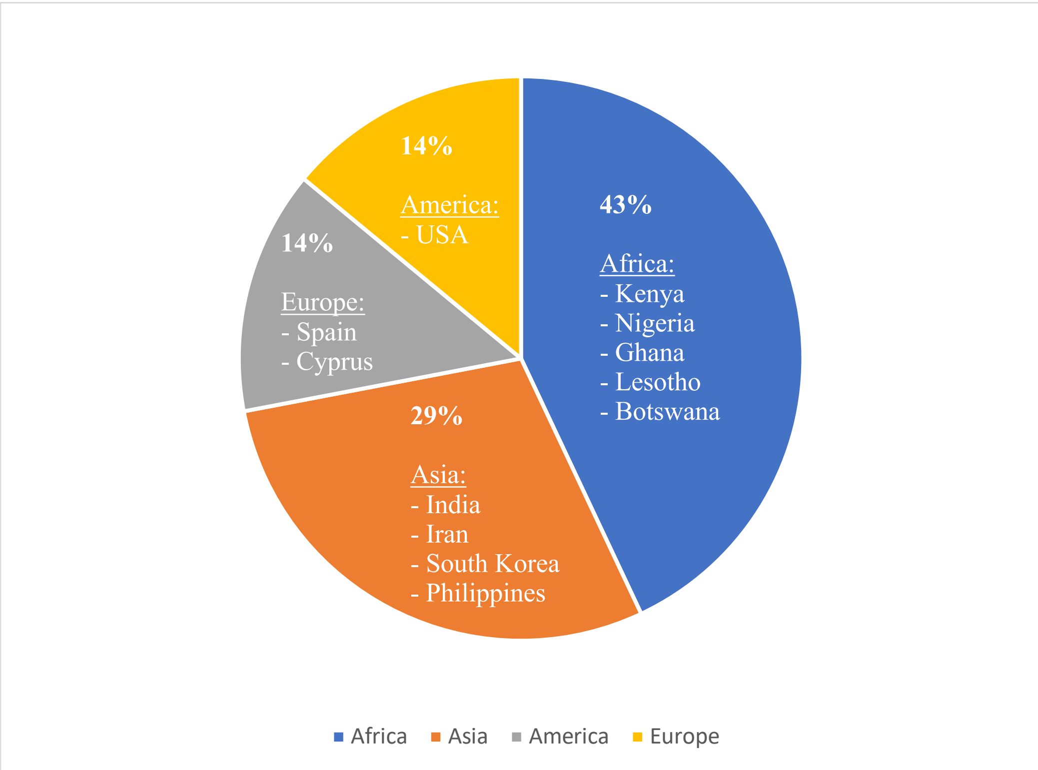
Acknowledging that a narrative review is predominantly subjective and the conclusions or findings rely heavily on the author's insight (Aromataris & Pearson, 2014), it is interesting to note that the conclusions drawn in this narrative review match well with what was revealed in the previously discussed systematic review in regard to the research question: '*What is the research status of smartphone-supported learning? Is the number of articles and interest in this topic increasing or decreasing?'* Figure 2.8 shows that research on smartphone-supported learning began with much initial interest in the first half of the last decade (2012 to 2021) but started waning after the year 2016. Therefore, even though today smartphone technology is advancing at an inexorable pace, it would not be unwise to state that much of the literature cited in this thesis in regard to implementation of smartphone-supported learning strategies will be skewed towards the first half of the last decade (i.e., between 2012 to 2016).

**Figure 2.8: Number of research studies from the findings of the narrative review on smartphone-supported learning from 2012 to 2021**




Moreover, although careful consideration went into ensuring that a global search of all relevant studies was conducted, it is observable that majority of the studies (n = 9; 64%) that emerged in this narrative review stem from developing countries; only 5 studies (36%) were conducted in developed countries. This is expected since, from a developed world's perspective, there is no need to rely heavily on smartphone-based learning as nearly all students have access to desktop PCs and laptops (Baller et al., 2016; Spector et al., 2014). Figure 2.9 shows the regional distribution of the studies inspected.

**Figure 2.9: Regional distribution of the research studies inspected in the narrative review on smartphone-supported learning**




Even though the developed world does not need to rely on smartphone-supported learning, Figure 2.9 illustrates that smartphone technologies, on a global scale, have the potential to enhance educational experiences. *SMILE*, *iPAC*, *Sterio.me* and *British University of Nicosia* projects indicate that it is possible to design smartphone-based assessments. Additionally, the *Twitter smartphone-based response system* and Stanford's *Dunia Moja* project demonstrate that smartphones can be appropriate tools for establishing global learning communities through social media sites. The *Abot Alam* programme, *AD-CONNECT*, *Cephalometric Landmark Identification intervention* and *DLC project at University of Ibadan* showcase the smartphone's ability to successfully deliver learning content (mEducation), while the *Google Cardboard* project demonstrates how smartphones can deliver learning content in an immersive way through VR environments, which consequently enhance the learning experience. Finally, the *Georgetown University* and *University of Botswana School of Medicine interventions*, as well as the *E-extension* programme in Kenya reveal that smartphones are capable of supporting work integrated learning.

### *2.3.3 Barriers to the Adoption of Smartphones as Sole Devices for Blended Learning*

Indeed, the case studies highlighted in section 2.3.2, while not exhaustive, still demonstrate that smartphones have great potential to serve as learning tools. But, it should be noted that the mentioned cases still position smartphone-based learning as an adjunct to traditional teaching and learning strategies. In light of this observation, it is not unreasonable to argue that little knowledge still exists on use of smartphones as sole/primary learning tools in university settings (Han & Yi, 2019; Iqbal & Bhatti, 2020). This leads to the question: *despite smartphones serving as the most affordable gateway to technology-enhanced learning strategies like blended learning, why does formal education in sub-Saharan Africa*[10] *not draw on smartphone technology?* In order to gain insights on this question, it is essential to discuss some of the well-established barriers that are seemingly preventing universities in developing countries from leveraging the smartphone's full potential in formal learning. Generally, these established barriers serve as the foundation upon which many other deterrents to the adoption

[10] The focus is on sub-Saharan Africa (a developing world) since, from the developed world's perspective, given the prevalence of PCs, there is no need to rely on smartphones as the technology basis for blended learning.

of formal smartphone-based learning emerge. This research identifies three salient impediments:

1) Conforming to the historical technological patterns of the developed world

As seen in Figure 1.1, the majority of the population in the developed world have access to a personal computer. Spector et al. (2014) aver that learning institutions in developed regions are economically stable regarding technology investments. On-campus facilities are up to date (upgraded regularly), and most learners in developed countries have access to at least one desktop PC on-campus. Concerning home access (off-campus), a comprehensive global survey by Baller et al. (2016) illustrates that at least 87% of the population in developed countries have a personal computer at home. For example, in Australia, Farley et al. (2015) point out that 91% of the learners interviewed stated they used their laptops to support their studies off-campus. This is not particular to Australia, a study by Clayton and Murphy (2016) indicates that 91% of learners in America own laptops. Given this high PC ownership, it is fair to say the developed world made the transition from classroom-based learning to blended learning by way of PCs. Accordingly, because of the apparent successful history of technology-enhanced learning in universities in the developed world, public universities in sub-Saharan Africa strive to follow the same trajectory used in developed countries. However, on account of the significant scarcity of PCs in sub-Saharan Africa, following the blended learning adoption patterns of the developed world is likely self-defeating.

2) Ever increasing capability of the smartphone is outpacing curriculum progression

The rapid and constant advancements in technology, particularly smartphones, is outpacing that of educational research (Cochrane & Farley, 2017; Crompton & Burke, 2018; Kaliisa et al., 2019; Pimmer et al., 2016). Consequently, there is a short supply of expertise on how to design and facilitate a technology-enhanced learning environment supported by smartphones (Biddix et al., 2016; Farley et al., 2015), which means the current curricula seemingly appear incompatible with the ever-increasing capability of smartphones. Indeed, as previously outlined, education should not be about the technology but rather what the technology does to enhance learning (Spector et al., 2014). However, even sceptics of techno-centrism in education like Njenga and Fourie (2010) argue that for the successful implementation of a technology-enhanced learning environment, the curriculum needs to be in harmony with the current technology practices. Parsons (2014) provides a plausible explanation for this by suggesting that today's students learn differently because of the affordances of various technologies namely social networks, augmented reality, virtual reality and other multimedia content. Kearney et al. (2012) correspond to this sentiment by suggesting that learning is influenced by the learning tool used and reciprocally, learning tools are modified by the learning methods employed. Nevertheless, Crompton (2013), Cochrane and Bateman (2010) point out that the pedagogical integration of smartphones into a course inevitably requires a gradual paradigm shift on behalf of the educators involved. Farley et al. (2015) attribute this slow-paced shift to two factors: firstly, the initial unwillingness of teachers to incorporate smartphone-supported learning due to time constraints – a sentiment more recently supported by Iqbal and Bhatti (2020) and Raghunath et al. (2018); and secondly, the lack of knowledge to support a multitude of smartphones on the existing university systems – a sentiment reiterated later by Kaliisa et al. (2019).

3) No clear guidelines on how to facilitate contextualised learning supported by smartphones

Technology-enhanced learning allows students to learn across varying contexts. Brooks (2011) stresses that the context in which learning occurs does matter and should be considered when designing learning resources. The portable nature of smartphones means learners can physically move their learning environments. However, this raises a series of important questions. For example: will smartphone-based learning lead to a fragmented learning experience (Tossell et al., 2015)? What can one really effectively learn anywhere anytime (Terras & Ramsay, 2012)? What is the impact of mobility on learning (Farley et al., 2015)? What cognitive processes do learners use when on-the-go (Ally, 2013)? The current university pedagogies do not fully support smartphone use; hence whilst the aforementioned questions have not been entirely neglected, they have not been fully explored in the university context (Tossell et al., 2015). Perhaps this could be why some studies still aver that smartphone-supported learning is more susceptible to interruptions than classroom-based learning (Iqbal & Bhatti, 2020; Tossell et al., 2015). It appears that over a decade later, Sharples et al. (2007) sentiment that there needs to be a theory for learning in a mobile society that takes into account learning facilitated by mobile devices as well as learning in a society where people and knowledge are constantly on the move, still stands true. A viewpoint also implied by Tossell et al. (2015, p. 10) in their statement:

> *"… the incompatibility between smartphones and higher education may not have to do with the technology per se but might rather be due to the fact that the current model of education does not require this type of [contextualised] learning. Smartphones support ubiquitous learning opportunities, but the educational model being used currently provides limited need for this beneficial activity."*

#### *2.3.4 Conceptual Framework: How to make it happen – extending the use of smartphones into the existing higher education sector*

In spite of the aforementioned barriers to the adoption of smartphones as primary learning tools, many students in sub-Saharan Africa are already using smartphones in almost all areas of their lives (Hawi et al., 2021). From the student's point of view, not incorporating smartphones in education can be seen as a step backwards (Crompton, 2013). Therefore, in the promotion of smartphone-supported blended learning, the focus ought to shift to the teachers and higher education institutions. What can instructors do now to make their courses blended with the smartphone as the technology basis for accessing the online content? What support systems can universities offer learners and instructors when it comes to smartphone-supported blended learning? Taking into consideration the concerns highlighted in sections 2.2.3[11] and 2.3.3[12], the suggestions raised in the following discussion can easily be integrated into existing courses (pedagogies); this helps to alleviate some of the time-related concerns educational practitioners may have about having to design new blended courses.

a) Role of Teachers

For the teachers, the first step is to determine what type of blended learning model will be employed. As discussed in section 2.2.2 of this thesis, there are several models. Some, like the *low-impact blend,* if not pedagogy-driven could easily lead to the 'course-and-a-half syndrome'. While some like the *program level blend* and the *high-impact blend* are quite complex and require extensive experience in implementing blended learning. Given the nascent nature of blended learning in sub-Saharan Africa and the experimental nature of the smartphone-supported blended approach, *medium-impact blend* (whereby only a few parts of a traditional course are replaced by an online learning activity) is an ideal starting point. According to Alammary et al. (2014), since the process is incremental, the approach is ideal for early adopters of blended learning and can help build the teacher's confidence in running a blended course. The following section explores other key decision points that will emerge as

[11] Section 2.2.3 – Challenges of blended learning
[12] Section 2.3.3 – Barriers to the adoption of smartphones as sole devices for study

the teachers attempt to make this transition to a smartphone-supported blended learning environment:

*Decision #1: What blended learning pedagogy is most suitable?*

Since learner flexibility and convenience (time and monetary) when it comes to attending lectures is one of the main reasons for encouraging blended learning in sub-Saharan Africa, teachers should adopt the flipped classroom pedagogy. In a flipped classroom, the lectures are delivered online (outside the class) and then during class time, the content is explored further through problem-solving techniques and group discussions (Long et al., 2016; Ouda & Ahmed, 2016; Thai et al., 2017). The term 'flipped' is based on the fact that, what typically took place in the traditional face-to-face classroom must now take place outside the classroom and, assessments (such as the problem solving activities and group discussions) which typically took place after-class, must then take place in-class (Al-Zahrani, 2015). Although the flipped classroom instructional model has been around for several years and its origins were in non-technology supported learning environments, nowadays, it is predominantly applied in blended learning environments (Al-Zahrani, 2015).

Here, it is important to emphasise the need for incorporating embodied face-to-face group discussions in the learning. The out-of-class learning experience facilitated by the flipped classroom pedagogy may lead to a psychological feeling of isolation (Croft et al., 2015). Needless to say, the effect of learner isolation will be greatly felt in the collectivist culture of sub-Saharan Africa. Graham (2006) asserts that culture to a large extent influences how learning occurs; hence, it is imperative to consider the local situations and practices of the students' environment in the learning and teaching process.

*Decision #2: How much of the course should be blended?*

Based on Figure 1.1 data, blended learning in sub-Saharan Africa is underdeveloped. Hence, in the early stages of implementation, it is better to start small and transition in stages (Alammary et al., 2014; Kenney & Newcombe, 2011). For example, in the redesign of a second-year political science course that was originally delivered via three one-hour lectures per week, Garrison and Vaughan (2011) demonstrate how an instructor transitioned into blended learning by reducing the lectures to two hours and replaced the third lecture with an online discussion. In another scenario presented in the study by Napier et al. (2011), an instructor opted to blend one week's worth of course content such that, the students were excused from lecture once a week.

*Decision #3: How will smartphone-supported blended learning affect the current teaching and learning styles?*

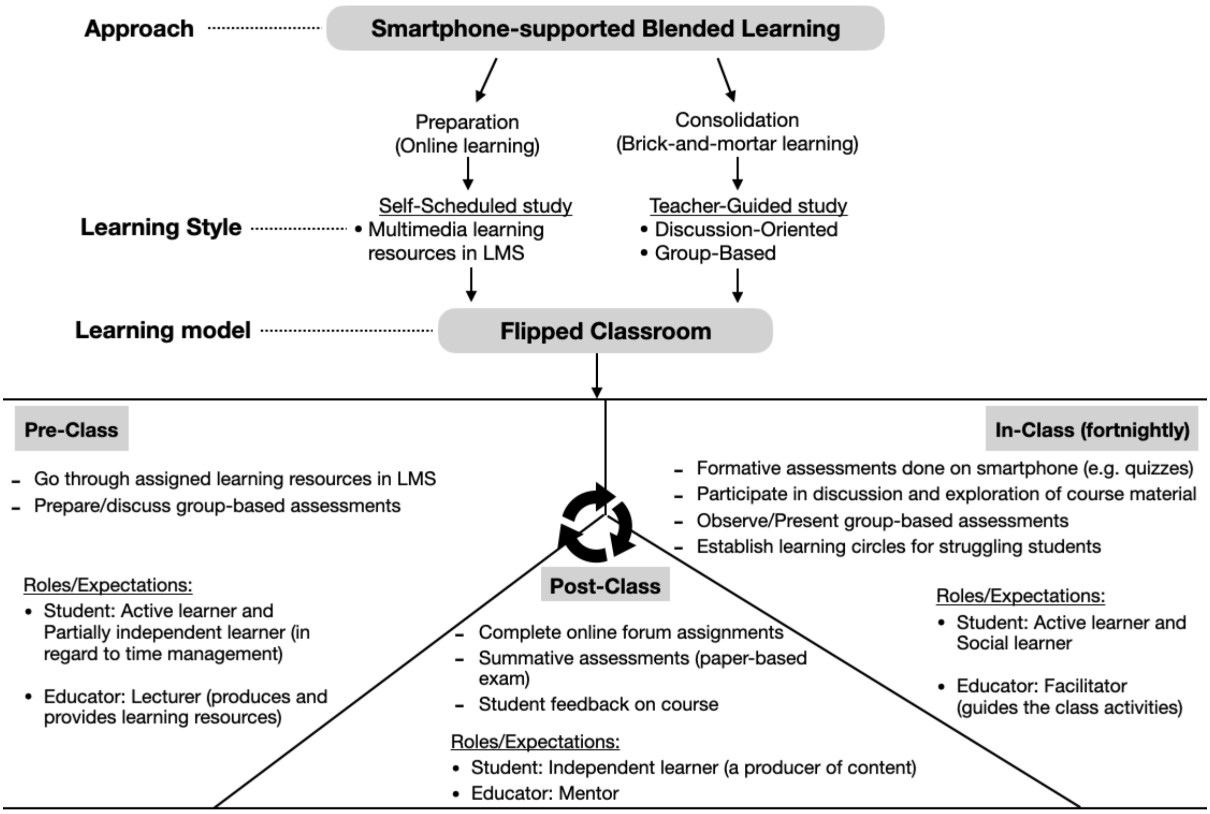
As mentioned in Chapter 1, classroom-based university education is dominant in sub-Saharan Africa. Accordingly, it is inferred that the students are mostly dependent learners who rely on the lecturer to regulate and schedule their learning. However, with this new blended approach, the students will be expected to move from a dominant on-campus synchronous face-to-face learning to a partially off-campus asynchronous learning. This shift will inevitably require the students to adopt new learning and teaching styles (Napier et al., 2011; Ouda & Ahmed, 2016). It is important to take note of these changes so as to design the learning content with these new roles in mind.

For the online component, the students will be expected to partially learn on their own. The self-scheduled online lectures will force the students to plan their time, making them independent learners in this respect. Needless to say, not all students are comfortable being independent learners (Napier et al., 2011). Hence, the educators will have to create a well-structured time plan for the students to follow through as they consume the online coursework (Kenney & Newcombe, 2011); with time, the students will pick up the necessary skills required for self-paced learning.

In regard to the in-classroom component, generally, most of the students are forced to be passive learners. This is because the overcrowded lecture halls coupled with limited resources force the teachers to adopt a lecture-based style of teaching, which greatly limits frequent student participation (Gudo et al., 2011). However, because the flipped classroom pedagogy redirects the lectures to the online platform, this opens up an opportunity for the educators to exercise group-based discussion activities during the in-classroom sessions. Accordingly, the students will shift from being passive learners to active learners (Long et al., 2016; Ouda & Ahmed, 2016).

For the teachers, their role will shift from being the 'sage on stage' to a 'guide on the side' (Ouda & Ahmed, 2016). It should be noted that flipped classroom pedagogy does not weaken the role of the teacher. Once the learning content is created, the role of the teacher is to: guide the students through the coursework; facilitate higher learning activities such as peer-to-peer instruction and inquiry-based learning; and provide mentoring and tutoring sessions as needed (Sun et al., 2017). According to Ouda and Ahmed (2016), this shift to a facilitator is an involving process that requires great consideration of student-centric learning, and should involve collective inquiry and action research in which the teacher must continuously review their practices and strive to improve their performance. Figure 2.10 provides an overview of the proposed smartphone-supported blended course design.

**Figure 2.10: Conceptual model of the proposed smartphone-supported blended course**




*Decision #4: How can teachers develop the online learning content?*

*First phase: Teachers exploit open educational resources (OERs)*

As previously outlined, the introduction of blended learning will cause a paradigm shift in the learning and teaching styles. Teachers will be required to restructure a portion of their courses to make them online accessible. However, many teachers may worry that the creation of digital learning content will be time consuming (Farley et al., 2015; Iqbal & Bhatti, 2020; Raghunath et al., 2018). In consequence, this sentiment may lead to their unwillingness to incorporate smartphone-based learning into their courses. Taking this into consideration, the use of OERs could be a practical first step towards integrating this shift.

OERs are free digital learning resources developed by learning institutions/individuals and are accessed via the Internet. Teachers, students and self-learners can then openly use, reuse, modify and redistribute these OERs for teaching, learning and research (Allen & Seaman, 2014). Generally, OERs "... include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge" (Atkins et al., 2007, p. 4). In their survey of 2,114 respondents, Allen and Seaman (2014) reported that faculty members stated the quality of OERs is roughly equivalent to or sometimes even better than the traditional educational resources. In fact, today, institutions such as: The Open University, Massachusetts Institute of Technology, Stanford University and Delft University of Technology have made great strides to provide worldwide access to a range of their online learning resources as OERs. Other notable institutions partnering with universities to provide access to a variety of high quality OERs include: edX.org, OERu.org and P2PU.org. With OERs widely available, teachers can more quickly develop online lessons for their students. Due to the proliferation of smartphones, many of these OERs are adapted for viewing on smartphones. Hence, teachers will spend less time designing the online courses and more time doing what they do best – researching appropriate online learning content to share with their students.

*Second phase: Teachers develop their own smartphone-supported learning content*

Through the use of OERs, the teachers will be exposed to the various ways the developed world designs their online courses. As such, the second step for sub-Saharan Africa university teachers would be to use the knowledge gained to start designing their own digital learning content. This second phase is crucial because the current online learning approaches merely take content designed for PC consumption and adapt it for viewing on the smartphone's physical form factor, without considering the inherent functional differences that set the smartphone apart from other computing devices (Parsons, 2014). Consequently, some learning activities (especially student assignments) can still only be successfully completed on a PC. For example, upon examining OERu (n.d.) course *Digital Literacies for Online Learning* that claims to be smartphone-compatible, completing the learning activity that instructs students to annotate web resources using the application, *Hypothes.is*, requires access to a desktop PC or a laptop. This is because in order to use *Hypothes.is* on a smartphone, one has to first install a mobile app called *AnnoteWeb* and use *Google Chrome mobile app* ('Hypothes.is' is not supported by other browsers). However, to integrate *AnnoteWeb* into *Google Chrome mobile app*, a laptop or desktop PC is required to configure the extension settings because *Google Chrome mobile app* does not support the 'extensions' feature[13]. Therefore, there is a need for the teachers to design learning content that not only takes into account the smartphone's physical form factor (such as screen size, memory/storage, and networking hardware) but also considers the functional capability of the software.

As a start, given the varying contexts in which smartphones can be used, it is advisable to present online material in multiple formats. For example, in addition to videos and PDFs, the lectures should be in form of podcasts (audio), which easily facilitate learning while *on the go* (Elias, 2011; Evans, 2008; Kim & Jin, 2015; Ng'ambi & Lombe, 2012). Moreover, seeing as more people use smartphones to access social media networks (Lipsman & Lella, 2016; Mander & McGrath, 2017), teachers could incorporate social media in their lesson plans (Farley et al., 2015). For instance, teachers could create learning communities (forums) on Facebook or microblogs on Twitter, which allow students to collaborate and share their opinions on course materials. Xue and Churchill (2019) propose a framework for the educational adoption on mobile social media.

[13] Further information about this investigation is discussed in Chapter Four.

Against the backdrop of the first and second phase, in the webinar series '*Smartphones as sole devices for study'*, Hawi (2020) discusses feasible ways university educators can start to create their own smartphone-supported blended courses.

*Decision #5: How could a community of learners be created?*

As stated earlier, the collectivist culture observed in sub-Saharan Africa plays a vital role in the learning process. Accordingly, Garrison and Kanuka (2004, p. 97) assert that, *"what makes blended learning particularly effective is its ability to facilitate a community of inquiry… that balances the open communication and limitless access to information on the Internet".* Furthermore, Poushter (2016, p. 21) reports that "once online, people in emerging economies and developing nations [such as those in Sub-Saharan Africa] are hungry for social interaction" – a sentiment later reiterated by Silver et al. (2019). Therefore, it is important to develop a community of learners not only face-to-face (in a physical classroom) but also online.

For example, to create an online community, the strategy used by Kenney and Newcombe (2011) serves as a good starting point. The authors created a discussion forum in which students were required to post their thoughts about the course case study and comment on at least one class member's post. Also, since the class was large, the students were required to use the discussion board on the course management system to post a personal profile as a way of introducing themselves to the teacher and getting to know the other students. Then, regarding the in-classroom activities, the authors divided the class into groups of four to five students to facilitate collaborative learning. Due to the large class size, Kenney split the class into half such that for one class session a week, half of the students were excused from attending on-campus (in-classroom) sessions to work on the online assignments, while the other half were on-campus (physical classroom) doing interactive activities. These two groups would then switch in the next class session. Kenney opted to use this technique upon noticing that during the traditional lecture (on-campus), some of the students were fearful of speaking or answering questions when the class was large. Reducing the class size encouraged participation during the on-campus classroom sessions and made it easier logistically to engage in activities that required more interaction and higher-order thinking skills.

*Decision #6: What LMS is suitable for facilitating online learning?*

Having developed the online content, the next step is to determine where to host the online course material. Two popular LMSs used across the globe are: Moodle and Blackboard. However, given the high maintenance costs that come along with LMSs, the question lies in: how can teachers still integrate an online learning environment into their courses even when their university does not yet offer online courses?

As a start, teachers could take advantage of the free, open-source LMSs like Moodle and free web hosting platforms like Gnomio.com. For example, using the *Gnomio* platform, teachers can create their own Moodle-based learning environment. Hawi (2020) presents a short but informative tutorial on how teachers can create and manage their own Moodle site on the Gnomio platform. Here, it is essential to point out that the LMS selected should have a mobile app version. Unlike the web-based version that requires constant internet connectivity, a mobile LMS (shorthand, m-LMS) allows students to access learning content even in offline mode. Not only is this cost-effective, but offline access is vital since not all areas in sub-Saharan Africa have continuous internet connectivity. Of course looking ahead, once blended learning is at the *Institutional level*[14] teachers will use the LMS provided by the university.

*Decision #7: How can teachers evaluate the effectiveness of the course prior to introducing it to the students?*

Whilst refinements will be made during implementations as a result of informal observations by the teacher, feedback from students and/or information obtained in training workshops (Kenney & Newcombe, 2011), it is possible to evaluate (to some extent) the effectiveness of the new flipped classroom before testing it with the students. For example, teachers can take advantage of the several years of blended learning knowledge gained by educators in the developed world, by using the *Global Elements of Effective Flipped Learning* (GEEFL) chart, to check that their flipped classroom employs the most current international best practices (FLGI, n.d.). Given the experimental nature of the smartphone-supported blended approach, it is not possible to satisfy all 93 standards in the GEEFL chart. Effectuating one-third of the standards would be a comfortable start for early adopters. Table 2.6 highlights some noteworthy standards.

[14] 'Institution-level' blended model has been previously described in more detail in Section 2.2.2 – Blended Learning Models

**Table 2.6: Some GEEFL standards to consider when designing a smartphone-supported blended course (FLGI, n.d.)**

| Area of Focus | GEEFL Element |
|---|---|
| **Technology** | ▪ **$Ct_{IT-2}$ -** Choose technology tools which work both in your school and on students' devices.<br>▪ **$Tf_{IT-3}$ -** Choose tools which have the capability for formative and diagnostic assessment.<br>▪ **$Am_{IS-5}$ -** Strategically choose an appropriate medium for the pre-class media (text, annotated whiteboard video, screencast, plain video).<br>▪ **$Dg_{GS-11}$ -** Use both digital and analog tools to foster students' in-class work. |
| **Balancing the Blend** | ▪ **$Ni_{GS-4}$ -** Never lecture or explain the videos in classroom for those who did not do the pre-class media.<br>▪ **$Lk_{IS-4}$ -** Ensure there is a strong link between pre-class media and what happens in the classroom.<br>▪ **$Gs_{IS-3}$ -** Focus on what you want to achieve in the group space when creating the individual space pre-work. |
| **Content or Learning Activities** | ▪ **$Pr_{IS-12}$ -** Include practical concrete activities that students can engage in during or after the pre-class media and tasks.<br>▪ **$Mc_{A-7}$ -** Use a large portion of teacher class time to engage in structured micro-conversations with students.<br>▪ **$Pi_{GS-15}$ -** Have a plan for students who come to class having completed the pre-work but still don't fully grasp the concepts.<br>▪ **$Ss_{GS-5}$ -** Set up student-centred activities that encourage students to summarise the content of the pre-class media.<br>▪ **$St_{IS-7}$ -** Make sure pre-class media are short.<br>▪ **$Mx_{IS-10}$ -** Ensure that videos include an appropriate mix of text, pictures, discussions between people, short integrated films, the instructor writing, narration.<br>▪ **$Fw_{P-9}$ -** Present course content in a logical and consistent fashion.<br>▪ **$Bi_{IS-6}$ -** Make sure pre-class media contain the big idea. |

| Area of Focus | GEEFL Element |
|---|---|
| **Learning Style** | ▪ **Cb$_{GS-6}$** - Promote collaborative and group work.<br>▪ **Bc$_{P-11}$** - Adapt flipped instructional techniques to make them effective with large groups.<br>▪ **Lb$_{IS-1}$** - Use lower levels of Bloom's Taxonomy (remembering, understanding) for individualised learning content/activities.<br>▪ **Hb$_{GS-1}$** - Use higher levels of Bloom's Taxonomy (applying, analysing, evaluating, creating) for group-based activities.<br>▪ **Cr$_{GS-12}$** - Include activities that encourage students to create their own content.<br>▪ **As$_{GS-10}$** - Use a variety of active learning strategies in the group space such as Project Based Learning, Inquiry, Mastery, Genius Hour, and Peer Instruction. |
| **Assessments** | ▪ **Fa$_{A-2}$** - Use frequent, formative assessments.<br>▪ **Rl$_{A-4}$** - Provide assessments that involve the creation of a real-life product or the use of real-life skills.<br>▪ **An$_{ST-5}$** - Constantly monitor students' attitudes and achievement and adapt as necessary.<br>▪ **Qs$_{IS-14}$** - Ensure there are questions to test understanding of concepts in the pre-class media.<br>▪ **Rg$_{ST-6}$** - Plan regular times during a semester/year to get feedback from students. |
| **Expectations** | ▪ **Ce$_{GS-2}$** - Establish clear expectations for student responsibilities during class time.<br>▪ **Cl$_{P-2}$** - When possible, define clear roles for everyone involved in creating Flipped Learning courses (subject specialist, instructional designer, technologist).<br>▪ **Lf$_{U-5}$** - Understand how the role of an educator moves from lecturer to facilitator.<br>▪ **Ac$_{IS-15}$** - Hold students accountable for pre-class work. |

b) Role of Institutions

Certainly, shifting an entire university system to blended learning, especially in a resource constrained environment, is not an easy feat (Kenney & Newcombe, 2011). More disconcerting is the lack of research to guide institutions of higher education on how to strategically adopt and implement *Institution-level* blending (Graham et al., 2013). As such, *Course-level* blending is an ideal starting point for institutions in sub-Saharan Africa. Graham et al. (2013, p. 4) advocate for this strategy stating:

*"… many institutions (perhaps most) have BL courses because BL has been experimented with or adopted by faculty although the institution itself has not officially adopted it. BL has started in many places as a grass-roots effort, adopted by individual faculty interested in using both online and traditional strategies to improve student learning outcomes rather than promoted as a strategic institutional initiative".*

Even so, institutions (university management) still can participate and support faculty members in their transition to *Course-level* blending. Accordingly, many aspects need to be explored as institutions facilitate this transition, notably: institutional policies, resources, course scheduling and training (Garrison & Kanuka, 2004).

### *Establish clear policies on change management*

"Getting a new idea adopted even when it has obvious advantages is difficult" (Rogers, 2003, p. 1). Graham et al. (2013) assert that university management are generally slow to adopt changes, especially when the change is initiated by an individual faculty. However, the authors went on to stress that formal institution-level blended learning policies that enable and encourage individual faculty innovations will inevitably strengthen a university's commitment to improving student learning. Furthermore, establishing clear formal institutional directions and policies that guide teachers on how to adopt and implement blended learning will ensure that the faculty's strategic reasons for adopting blended learning and the institution's vision and purpose for supporting blended learning are in harmony. A disconnect between the blended learning goals of the faculty member and those of the institution can inhibit growth of the innovation even though both parties support blended learning (Graham et al., 2013).

To begin with, a policy regarding the evaluation of the new blended learning courses is crucial (Graham et al., 2013); it will allow the institution to maintain quality assurance. As mentioned earlier, if good pedagogical practices are not followed, early adopters of blended learning risk falling into the 'course-and-half-syndrome' which is not only overwhelming on the students, it also increases the teacher's already full workload. Garrison and Kanuka (2004) propound that in order to ensure that the transition to blended learning enhances the teaching and learning process, a systematic evaluation of the new blended course is important. For example, borrowing from Graham et al. (2013), the issues addressed within this policy could include: How will the course evaluation be conducted? Who should evaluate the process? How will the evaluation data be used?

Another policy that needs to be established upfront is that of ownership of intellectual property rights for digital work (Graham et al., 2013). The partial shift to online learning means the teachers will often utilise OERs as well as create their own digital learning content. As such, institutions should provide clear and specific guidelines indicating how ownership of the course content in the online learning environment is distributed. For example, this policy could address the following: where does ownership for blended learning courses reside, within the academic departments (Graham et al., 2013)? Does the institution own all property hosted on the university LMS? Or does the teacher retain some rights to the online course materials developed? This policy should also cover the students' contribution to the course (e-portfolios).

*Provide human and technical resources*

Ideally, to more effectively support blended learning initiatives, institutions should be able to provide the three basic resources: financial, human and technical. However, this section will not discuss financial resources. This is because, public universities in sub-Saharan Africa already face such significant budget cuts that they often rely on inter-governmental assistance and donor aid from non-governmental organisations (NGOs) for the day-to-day running of the institution (Agbatogun, 2013; Spector et al., 2014; Tarus et al., 2015); therefore, the idea by Garrison and Kanuka (2004) that institutions should provide faculty with 'seed money' to implement blended learning is currently not a sustainable one. But, the idea proposed by Agbatogun (2013) that university management could organise annual awards to be given to faculty members who proactively attempt to integrate technology-enhanced (blended) learning into their courses can be a workable trade-off and material incentive.

Regarding human resources, although teachers may generally be familiar with blended learning systems, they still may not know how to properly integrate newer technologies (like smartphones) into their course delivery (Agbatogun, 2013; Mbengo, 2014). Garrison and Kanuka (2004) suggest that institutions should create a task force that strategically examines and communicates the issues, challenges and opportunities that emerge during implementation. The recommendations from the task force (which could comprise faculty members who have skills in instructional design, curriculum development and technology) could provide teachers and institutions with further insight on how to refine their transition into blended learning (Mestan, 2019).

Concerning technical resources, since the students are using their own smartphones, the university should make more concerted efforts towards ensuring students have access to subsidised mobile data plans. While most universities provide free Wi-Fi access for their students, it is only available within the campus area. However, smartphones are typically used across various physical environments. Therefore, universities can negotiate with the internet service providers (ISPs) to subsidise mobile data plans for their students. Facebook is already doing it in a number of countries. For instance, in Kenya, Facebook has partnered with local ISPs such that everyone has free and unlimited access to the Facebook via the mobile app. Elsewhere in South Africa and Finland, MoMath a large scale mobile learning research project managed to provide free access to over 10,000 mathematics exercises stored in a database that learners could access  through a unique IP address (Isaacs, 2012). Still in South Africa, Siyavula Practice project (Siyavula, 2015) partnered with Vodacom a mobile service provider to provide free access to their learning content provided the device used a Vodacom sim card.

*Allow flexible course scheduling*

Since the flipped classroom technique aims to enable students to access lectures at their own time and pace, Garrison and Kanuka (2004) emphasise that flexible scheduling that allows students and teachers to 'time-shift' is vital for the success of any blended learning initiative. Here, it is important to note that, scheduling for a blended course is a complex process that requires careful consideration and ample time – *"while quantifying the time that instructors spend in class is relatively easy, negotiating an acceptable figure for online or blended courses, along with other often contentious issues relating to faculty workload in online courses, will be more of a challenge"* (Wallace & Young, 2010, p. 9). Regardless, in order to cater to the needs of the many students in sub-Saharan Africa who cannot regularly attend classroom based lectures due to socio-economic barriers (World Bank Group, 2018), the need to reduce class time and offer flexible learning times cannot be overemphasised. A sentiment shared by Wallace and Young (2010, p. 9) who stated: “if blended learning is to be [effectively] supported, policies will need to be updated to provide the criteria and process whereby classroom contact hours may be reduced when some teaching components are moved online”.

*Training*

As discussed earlier, professional development in blended learning pedagogy is absolutely necessary for a teacher to more easily transition from teaching traditional courses to blended courses (Alammary et al., 2014; Graham et al., 2013; Napier et al., 2011). However, in institutions where blended learning is not fully or formally supported, early adopters often must seek out training on their own and at their own cost (Kenney & Newcombe, 2011). While Kenney and Newcombe (2011) go on to suggest that institutions could provide university grants to their faculty to further their training in blended learning, in exceptionally resource constrained environments such as public universities in sub-Saharan Africa, university grants/funding for faculty are not easily accessible (Tarus et al., 2015).

Instead, a more practical approach would be for institutions in sub-Saharan Africa to support their faculty by establishing frequent formal venues (workshops) where adopters of blended learning can share their experiences and even collaborate with other faculty using the approach. According to Kenney and Newcombe (2011, p. 54), “Blended learning is a ‘collegial’ process. Working with other faculty builds up confidence, maintains energy and minimises mistakes” – a viewpoint later reiterated by Mestan (2019). The goal of these blended learning support groups is to promote best practices in blended learning course development. Through these workshops, it is possible for institutions to not only develop formal checklists that guide teachers in best practices for teaching blended courses, but also use these checklists to assess the effectiveness of the blended courses (Napier et al., 2011).

## 2.4 Summary

As described in this chapter, there exists a significant gap in literature within the field of learning technologies – the lack of research pertaining to smartphones as sole devices for study. The literature evaluated shows that, although smartphones have the technical capacity to facilitate formal learning, the device is still viewed as secondary to the PC. However, in sub-Saharan Africa where only 11% of the population have access to PCs (ITU, 2019) compared to over 55% who have access to smartphones (see Figure 1.2), the dismissal of smartphones as primary learning tools has contributed to undesirable implications. Specifically, technology-enhanced university education strategies like blended learning (and their affordances) are significantly impoverished, leaving majority of the learners with no other choice but to attend classroom-based lectures. Yet, for many of these students, particularly the rural-based learners, socio-economic barriers seriously limit them from regularly attending classroom-based lectures (Kaliisa & Picard, 2019; World Bank Group, 2018).

Therefore, as a contribution to the dialogue needed to bridge this gap, this chapter critically: examined the salient barriers to the fast adoption of smartphones as formal devices for study in university education; explored the key roles of the institution (university management) in leading the adoption of smartphone-supported blended learning; and presented a conceptual analysis demonstrating how teachers can start to incorporate formal smartphone-use into their existing courses. The practical impact of the conceptual analysis is empirically tested and discussed in the succeeding chapters.

# 3. METHODOLOGY

This study investigated how a student who owns only a smartphone and does not have access to a laptop or desktop PC can successfully participate in a technology-enhanced university course. The conceptual analysis developed from the literature in Chapter 2 revealed that it is possible to deliver a blended course with the smartphone as the technology basis. Accordingly, shaped by the Pragmatist philosophical perspective, this present chapter describes how I used a Mixed-Methods Case Study design to investigate the research question and gain insights into the research objectives described in Chapter 1.

The chapter begins by presenting my philosophical perspective and its inherent assumptions. The overall research design is then discussed, as well as how threats to validity and ethical concerns were managed. However, details of the methods used are not presented in this chapter. Instead, details of the methods for each phase of the research are presented separately within each of the next four chapters along with the findings of the research. This facilitates discussion of methods that depend on the findings of previous phases, as occurs in Phase 4. It also facilitates interpretation of the findings of each phase in the light of limitations in the methods. The final part of this chapter introduces the research setting in which the phases of research took place.

## 3.1 Research Perspective: Pragmatism

My philosophical stance involves a combination of relational epistemology, non-singular reality ontology and mixed-methods methodology. It is thus consistent with the theoretical perspective of pragmatism (Kivunja & Kuyini, 2017). The assumption of a *relational* *epistemology* means that knowledge is largely based on social experiences. Kaushik and Walsh (2019, p. 4) echoed similar sentiments: "[although] each person's experience is unique as it is created by her/his unique experiences … much of this knowledge is socially shared as it is created from socially shared experiences". Next, the assumption of a *non-singular reality ontology* means that based on experiences, different people can hold different perspectives and concepts of reality, hence more than one account (truth) of any phenomenon can be valid (Kivunja & Kuyini, 2017). Lastly, the assumption of a *mixed-methods methodology* implies that it is not possible to draw well-founded conclusions about the real world solely by virtue of a single data collection method (Johnson & Onwuegbuzie, 2004; Kivunja & Kuyini, 2017). Therefore, the pragmatic research paradigm takes on the view that 'truth' is tentative, and is constructed and based on the reality we each experience and live in; hence, the validity of the theories we generate should be based on how well they currently work (Johnson & Onwuegbuzie, 2004). However, it is pertinent to note that pragmatism does not simply mean that if it works then it is true – the truth derived has to be able to withstand individual scrutiny over time (Kivunja & Kuyini, 2017; Nowell, 2015).

A relational epistemology allows for the meaning that I create with this research to be based on 1) the local practices, cultural beliefs and values of the community within which the research participants come from; 2) my social interactions with the research participants (i.e., the students and lecturers) and 3) my personal experiences as a lecturer in a rurally based public university in sub-Saharan Africa. Concerning the third basis, while every effort was made to ensure my beliefs are sufficiently supported by literature and constrained by the need to present my individual perspective in a credible manner, unlike in the postpositivist paradigm where being objective is an essential aspect of inquiry (Creswell, 2014), the pragmatist philosophy holds the belief that it is difficult to separate a researcher's actions from their past experiences and from the beliefs that have originated from those experiences (Kaushik & Walsh, 2019). Indeed, "there is an objective reality that exists apart from human experience. However, this reality is grounded in the environment and can only be encountered through human experience" (Kaushik & Walsh, 2019, p. 3).

A non-singular reality ontology is a useful stance from which to pursue the goals of my research since, it accommodates the belief that context needs to be taken into account in the pursuit of knowledge and understanding of a phenomenon (Kivunja & Kuyini, 2017). My research aims to investigate formal smartphone use in public universities in rural sub-Saharan Africa – and needless to say, technology adoption in general is largely influenced by the context in which it is used in (i.e., its performance may vary across contexts (Spector et al., 2014)). This context-specific stance is somewhat similar to the views held by the relativist ontology of the interpretivist paradigm. However, while the interpretivist researcher bases their assumptions predominantly on their interactions with the research participants and only within the natural settings investigated (i.e. complete subjectivity), the pragmatist researcher bases their assumptions on the premise that there needs to be a sufficient degree of mutual understanding with not only the research participants, but also with the readers and reviewers of the research, who may be outside the research context (i.e. intersubjectivity) (Kivunja & Kuyini, 2017).

In the matter of mixed-methods methodology, because the pragmatic philosophy holds the view that it is the practical use of the theories generated rather than their 'truth' that is an indicator of their value (Johnson & Onwuegbuzie, 2004), more focus is on the implications of the research and the research questions rather than on the research methods employed (Creswell, 2014; Kaushik & Walsh, 2019). This stance allowed me to be less concerned about whether the research question being investigated is wholly quantitative or qualitative in nature.

Also, seeing as 'context' is a major part of this research, it was impossible to solely rely on a single data collection method due to the richness of the context (Yin, 2014). The methodological approach taken by a pragmatist researcher is based on 'what works at the time', and thus researcher is 'free' to use a combination of methods best suited for studying the phenomenon at hand (Creswell, 2014; Johnson & Onwuegbuzie, 2004; Kivunja & Kuyini, 2017). The 'workability' of the methods is judged especially on the criteria of predictability and applicability (Johnson & Onwuegbuzie, 2004).

Whilst the practice-oriented (or problem-centred) approach of pragmatism (Creswell 2014) closely mirrors my own beliefs and values, I acknowledge that pragmatism has been criticised for focusing on the practical results and research question but ignoring the philosophy/theory that underpins the research methods used (Doyle et al., 2009; McCready, 2010; Nowell, 2015). Early educational researchers (Barab & Squire, 2004; Cobb et al., 2003) expressed the importance of having theory in educational research projects. These researchers averred that the understanding of the theory behind educational research designs makes it possible to extrapolate the designs to other contexts other than the one in which it was evaluated, thereby leading to its potential widespread adoption. So to address this issue and further enhance the transferability of my research, when choosing the research methods, careful consideration went into underpinning '*what works'* with *'why it works'*.

In summation, all the aforementioned assumptions regarding the nature of reality and knowing, were compatible with combining quantitative and qualitative methods in form of a case study, which is discussed further in the next section.

## 3.2 Research Design: Mixed-Methods Case Study

### *3.2.1 Rationale for Using Case Study Research*

As previously mentioned, a mixed methods methodology was used in this project. However, the research strategy i.e., how the methodology is implemented (Harrison et al., 2017) took on the form of a case study. Therefore, a mixed-methods case study design guided the research process. According to Creswell and Plano Clark (2018, p. 116):

> *"a mixed methods case study design is a type of mixed methods study in which the quantitative and qualitative data collection, results and integration are used to provide in depth analysis for a case(s)."*

For this research, the case is Tom Mboya University College (TMUC), a public university in rural Kenya that exclusively offers on-campus courses and largely encompasses domestic students. Further information about the case setting is described in section 3.5.

Yin (2014) describes a case study as an empirical inquiry that investigates a phenomenon within its real-life context, owing to the assumption that the phenomenon under study is not readily distinguishable from its context. Unlike in the experimental design where there is often a control group, for a case study, it is important that the research focus is within a 'natural setting' to prompt understanding of the phenomenon within its own habitat, where the research designer has not contrived all of the activities to be investigated (Cousin, 2005). Furthermore, the case study design differentiates itself from action research in that: at the onset, action research strives to treat participants as co-researchers and offers them a greater role in deciding the issues to be addressed; conversely, in case study research, the researcher specifies the issues (phenomenon) to be addressed prior to recruiting the participants and thus primarily views (and observes) the participants as sources of evidence (Blichfeldt & Andersen, 2006; Cousin, 2005).

To engender coherence among the different components of a research project, Harrison et al. (2017) stress that the chosen research strategy must be consistent with the underlying research perspective. On that note, the case study design is compatible with the philosophical stance of pragmatism (Harrison et al., 2017) adopted in this present study. For example:

- Regarding the relational epistemology, case study research is bound by the cultural beliefs, values, and community practices of the research participants, which means the researcher seeks to explore how these factors influence the phenomenon being studied. This not only indicates the researcher's level of connection to and being immersed in the field (Harrison et al., 2017), it also demonstrates the importance of observing the social experiences of the participants when evaluating the phenomenon (case).
- Concerning the non-singular reality ontology, case study research also views reality as subjective since the context of the phenomenon under study must be considered when generating knowledge. For this reason, using the term *generalisation*[15] in case study research has been a contentious issue among scholars over the years (Ebneyamini & Sadeghi Moghadam, 2018; Yin, 2013). To this end, some case researchers prefer the term *transferability*[16] when describing the applicability of the case study research findings beyond the context in which it was examined (Kivunja & Kuyini, 2017; Polit & Beck, 2010).
- Finally, the case study design fits in well with the mixed-methods methodology stance of pragmatism since, by making the context a major part of the study, the research cannot solely rely on a single data collection method due to the richness of most contexts. Thus, to reach the depth of insight that allows a case researcher to draw well-founded (rich)

[15] Generalisation: involves drawing broad conclusions about a population at large based on the findings from a sample population.

[16] Transferability: it does not involve broad claims (conclusions), instead it invites readers of research to make connections between elements of the study and their own experiences Writing@CSU. (2021). *Generalizability and Transferability*. Colorado State University. https://writing.colostate.edu/guides/guide.cfm?guideid=65.

conclusions for the chosen context, there is a need to employ a mix of qualitative and quantitative methods.

The methodological steps in case study research are similar to other research strategies: conducting literature review; constructing a theoretical framework; conducting the field research; data analysis; and development of conclusions, recommendations and implications based on evidence. However, the defining feature of case study research is that the sampling technique is always purposeful, not random (Ebneyamini & Sadeghi Moghadam, 2018). This is because representativeness is not the criteria for case sampling; instead, information richness is the primary focus (Ebneyamini & Sadeghi Moghadam, 2018). In other words, the aim is to find individuals who are willing to participate and have the ability to communicate their experiences and opinions in an articulate, expressive and reflective manner, so as to maximise understanding of the phenomenon (Creswell & Plano, 2011; Etikan, 2016; Onwuegbuzie & Collins, 2007). Therefore, purposeful sampling is *not* driven forward by underlying theories (such as a set sampling size) but by practical and pragmatic considerations (Emmel, 2014; Etikan, 2016). As Patton (2002, p. 72) emphasises: “The point is to do what makes sense, report fully on what was done, why it was done, and what the implications are for the findings.” Judgements about who or what to sample are made by virtue of the purpose of the study, its context, resources available and the specific audience of the research (Emmel, 2014). Patton (2002) describes several strategies for purposeful sampling.

For this research, the typical case sampling strategy was adopted. This strategy is preferred when the researcher is dealing with a large context, and the participants are chosen based on the likelihood that their behaviour or opinions will illustrate what is ‘typical’ (normal) within the context under evaluation (Creswell, 2012). For example, while the wider context of this research is developing countries in sub-Saharan Africa, a single Kenyan case sample was chosen. Here it is important to reiterate that the typical case sample is illustrative, not definitive or representative of the affected population (Patton, 2002). The term 'typical' implies that the researcher is able to compare the findings of the study with other similar samples. Lastly, using a typical case sample strategy is especially helpful when describing a phenomenon to readers who are unfamiliar with the setting studied (Creswell, 2012; Emmel, 2014; Patton, 2002).

### *3.2.2 Overview of the Mixed-Methods Approach Used: Convergent Parallel Design*

To gather data that would inform this study's research question: "*What learning and teaching strategies are effective in facilitating the use of a smartphone as the sole device for formal study in university courses?",* a convergent parallel mixed-methods approach was adopted. Creswell and Plano (2011) highly recommend this approach for researchers who work under the philosophical assumptions of pragmatism. Moreover, this approach was suitable as it facilitated parallel collection of qualitative data (QUAL) and quantitative data (QUAN). The term 'parallel' implies that while data collected from one method (i.e., QUAN or QUAL) may inform the procedures and products of the other method, usually, these two forms of data are collected and analysed separately and independent of each other, then later the results are compared (merged/integrated) to provide a more holistic and in-depth understanding of the conclusions drawn (Creswell, 2014). Furthermore, both datasets are weighed equally thus the convergent parallel mixed-method research process is symbolised as QUAL+QUAN, as opposed to the sequential exploratory or sequential explanatory designs which are respectively symbolised as QUAL+quan and QUAN+qual (Creswell, 2014).

The convergent parallel mixed method design employed in this research had four phases (see Figure 3.1). The first and second phases were quantitative, the third was a qualitative study, and the fourth phase incorporated both quantitative and qualitative methods. Each phase of the research addressed one of the three research objectives described in Chapter 1. The use of qualitative and quantitative methods was governed by the nature of each research objective as I now explain. A detailed discussion of the individual data-gathering methods used, and their justification is provided later, when the research methods are discussed, in each of the next four chapters.

Phase 1 addressed the following research objective: *To determine technical requirements for participating in an existing course solely on a smartphone.* Using quantitative observations, two feasibility studies were undertaken to evaluate two existing online courses. The aim was to investigate whether the technical capabilities of the smartphone (e.g., screen size, storage capacity, processor capacity and bandwidth) can support existing pedagogy, or be extended to further enhance the learning experience. The first feasibility study examined an online course offered by Massey University that was predominantly desktop PC or laptop supported; the quantitative data measured included bandwidth requirements (upload and download speeds), data volume of course materials, smartphone storage and screen capacity requirements. The second feasibility study examined an online course offered by OERu.org that claims to be smartphone-supported; the quantitative data measured included smartphone processor capacity consumption while interacting with the coursework and screen capacity (user-interface requirements). The first study provided insight on what needs to be ‘modified’ in order for a desktop PC or laptop supported course to become fully smartphone compatible. The second study provided insight on what needs to be ‘improved’ to make the smartphone-based learning experience more efficient. Overall, quantitative observations were sufficient since the variables measured can easily be expressed in numbers. Chapter 4 further elaborates on the procedures and results of these preliminary studies.

Phase 2 addressed the following research objective: *To evaluate the roles of lecturers, students, and institutions in the delivery of a smartphone-based course.* In this quantitative phase, an online survey in the form of a structured questionnaire (closed-ended) was extended to TMUC undergraduate students (n = 114) to examine their attitudes to using their smartphones for formal university learning. This survey was underpinned by the assumption that, given the lack of laptops and desktop PCs in the region, many students in Kenya have proactively found ways to use their smartphones to access free online, informal education. Hence, to build an evidence-base that this assumption is valid, the online survey specifically aimed at: investigating the smartphone ownership trend among the students (compared to desktop PCs and laptops); their level of expertise in using the smartphone; and their awareness of free online learning resources. The survey also evaluated the participants' perceptions on using smartphones for various academic activities and assessed the factors influencing students' real-life usage of smartphones for education. Because the aim was to understand students' most common smartphone habits, activities, and preferences regarding facilitating learning, a large sample size was ideal. An online survey was appropriate since it is especially useful in analysing research trends and can be easily administered to a large population (Creswell, 2012). Chapter 5 describes in detail the methods and findings of this phase of the research.

Phase 3 addressed the following research objective: *To evaluate the roles of lecturers, students, and institutions in the delivery of a smartphone-based course.* In this qualitative phase, semi-structured interviews with TMUC lecturers (n = 17) were used to generate a rich descriptive picture of the participants' views on introducing blended learning in their courses, with smartphones as the technology basis. Considering that teachers are pivotal when integrating technology in the classroom (O'Bannon & Thomas, 2015), examining their attitude towards smartphone-supported blended learning was essential. The major themes explored during the open-ended interviews included: 1) the lecturers' current teaching practices that incorporated smartphone-use, which provided insight on how to build the proposed approach onto the existing pedagogy, so as to accelerate its uptake; 2) the lecturers' perceptions on the merit of using smartphones in education i.e., do they see the value of smartphone supported blended learning?; 3) barriers to the fast adoption of smartphone-supported blended learning and possible ways to mitigate these obstacles; and 4) their feelings towards having to alter their teaching styles. Qualitative research is especially useful for investigation of a participant's perspective; the open-ended interview questions allow the full expression of the participants' experience unrestrained by the researcher's opinion or past research findings (Creswell, 2012) and thus was appropriate for this phase of the research. Chapter 6 provides a more detailed account of the procedures undertaken and results obtained in this phase.

Phase 4 addressed the following research objective: *To develop a framework that provides a set of guidelines on how to successfully deliver a university course solely to a smartphone.* This phase involved evaluation of both qualitative and quantitate data through a series of steps. It began with a qualitative step that involved frequent one-on-one discussions (interviews) with one of the lecturers at TMUC to restructure a portion of their course and make it smartphone ready. Once this restructured course was hosted on Moodle LMS and rolled out to the students, the second step in this phase was quantitative in nature. This step involved examining the course analytics generated in Moodle, for example: 1) trends in course participation (e.g., number of days spent online, preferred media – audio/video/PDFs, as well as contribution to the course – number of student posts in the forums); and 2) student user experience in form of an online survey activity administered at the end of each smartphone-based lesson. The third step was qualitative in nature and involved naturalistic observations, focus groups and interviews with the students. The main aim of this last step was to gather more data that would elaborate on the quantitative results obtained in the second step. The outcome of this phase was the development of a framework entitled, *Smartphone Only Learning Environment (SOLE),* that provides practical guidelines for delivering a blended university course solely to a smartphone. Chapter 7 provides a more detailed account of the procedures undertaken and results obtained in this phase, while the framework (SOLE) is discussed in Chapter 8.

This was thus a complex mixed-methods case study design in which qualitative and quantitative phases were of equal importance, and converged at the end of Phase 4, where the data from all phases was integrated. Whilst the convergent parallel mixed methods design is at times referred to as 'concurrent design', it should be noted that the term concurrent is used to imply that the two datasets (QUAN+QUAL) are collected and analysed at roughly the same time and not necessarily simultaneously (Creswell, 2014). In my research, the timing of Phases 2 and 3 was theoretically concurrent but determined pragmatically by the fact that I could only do one at a time. Phase 4 was mostly dependent on data from Phase 1, 2 and 3 and so was necessarily performed last. Figure 3.1 describes the sequence and relationship of the qualitative and quantitative research phases and Table 3.1 provides a summary of the steps taken to achieve the research objectives.

**Figure 3.1: Sequence and relationship of qualitative and quantitative research phases designed to investigate smartphone-supported blended learning.**

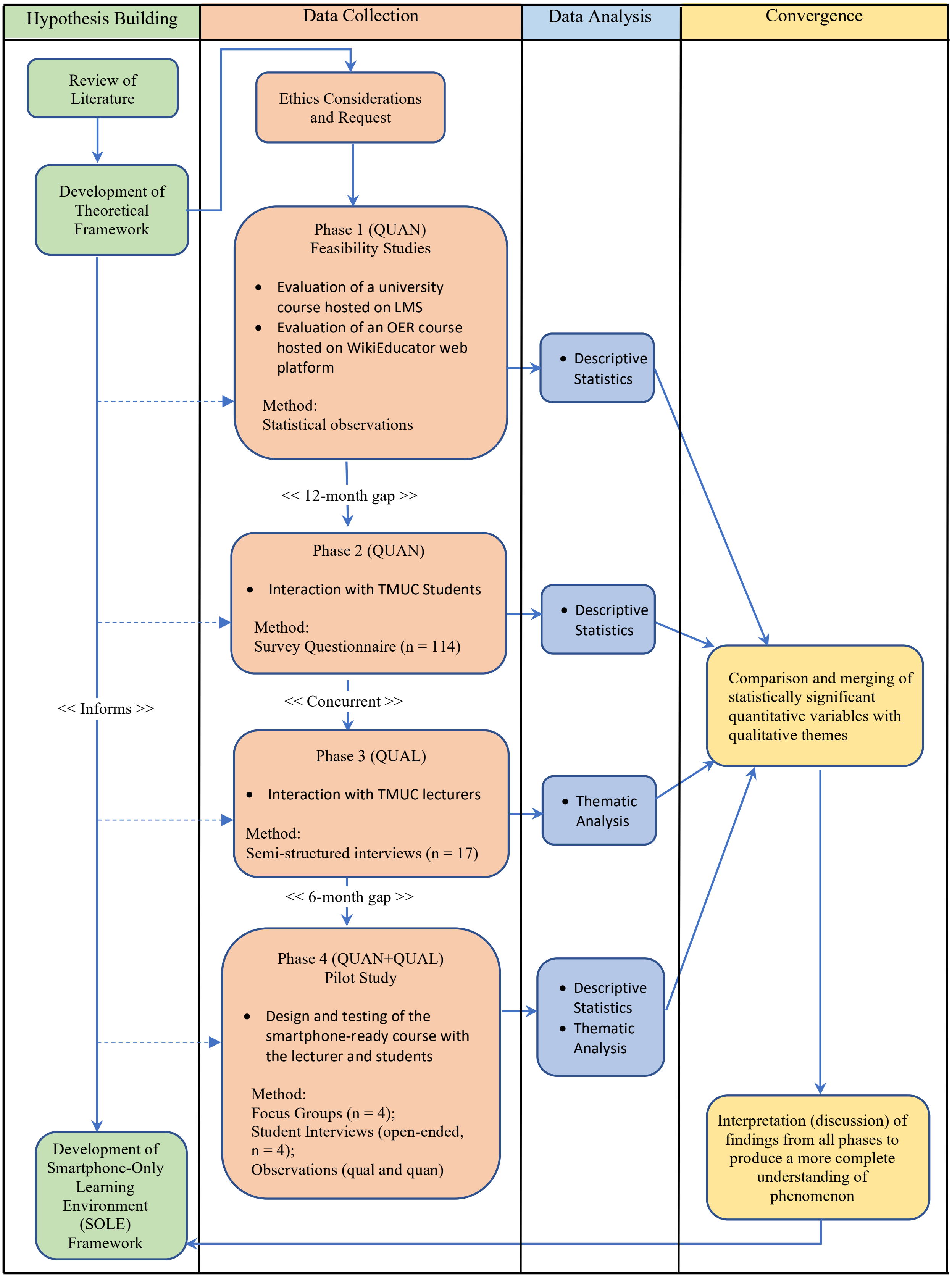


**Table 3.1: Summary of steps taken to achieve the research objectives**

| **Research Question:** *What learning and teaching strategies are effective in facilitating the use of a smartphone as the sole device for formal study in university courses?* | | |
|---|---|---|
| **Research Objectives** | **Questions** | **Steps** |
| 1. To determine technical requirements for participating in an existing course solely on a smartphone. | ▪ Can the technical aspects of the smartphone support existing pedagogy (e.g., the screen size, storage capacity, bandwidth)?<br><br>▪ How can the smartphone's potential be extended (e.g., technical add-ons/innovations) to further enhance the learning experience? | i) Examine an existing course:<br>▪ Take one that is mainly desktop PC or laptop supported to investigate how the smartphone handles such a course. This provides insight on what needs modification for the course to be fully smartphone supported.<br><br>▪ Take one that is fully smartphone supported to investigate areas that need improvements. |
| 2. To evaluate the appropriate roles of lecturers, students, and institutions in the delivery of a smartphone-based course. | ▪ What can each of these stakeholders individually do to support the smartphone-based course? | ii) Work with a lecturer at Tom Mboya University College (TMUC) to restructure a course, to make it smartphone ready.<br>▪ Provides insights on what the Lecturer should do.<br><br>iii) Offer the restructured course to the students, to evaluate effectiveness.<br>▪ Provides insights on what the Student should do.<br><br>iv) Examine ways the institution (university management) can support the Lecturer and Student. |
| 3. To develop a framework that provides a set of guidelines on how to successfully deliver a university course solely to a smartphone. | ▪ What works, and what does not work? | v) Collate (and suggest) a list of dos and don'ts. |

## 3.3 Validity of the Research

Validity relates to quality of research (O'Cathain, 2010). Whilst this term is still a contentious issue in mixed-methods research and its definitions have evolved over the years (O'Cathain, 2010; Onwuegbuzie & Johnson, 2006), I have adopted the definition by Dellinger and Leech (2007, p. 316):

*"… an overall evaluative judgment of the extent to which empirical evidence and/or theoretical rationale support the adequacy and appropriateness of interpretations and actions on the basis of data generated through any means".*

In other words, validity is a value judgement and interpretation of how well the claims being made are defensible to research and practice communities for whom research is produced and used (Maxwell, 2013; Onwuegbuzie & Johnson, 2006). Moreover, since validity from the pragmatic philosophical perspective is seen as a property of inferences (i.e. what currently works) and cannot be proved on the basis of methods used, it is considered a key issue in research design and should be explicitly addressed (Maxwell, 2013). Methods are seen only as a way of getting evidence that can help the researcher to rule out validity threats (Irwin, 2008, as cited in Maxwell, 2013). Therefore, in evaluating the strength of claims (validity), the areas that deserve most attention are those that are most likely to threaten the plausibility of the specific research project (Maxwell, 2013). For this research, the salient threats were researcher bias, reactivity and sampling adequacy. In the next four chapters, I have detailed how each of these threats was managed in the methods sections for each phase of the research and discussed their implications when presenting the findings. Here, I provide some detail of my own background and influences, which is relevant to the researcher bias and reactivity threats.

I began this project because of the frustrations I experienced while teaching a computer programming course at two technologically underserved public universities in Kenya, which face extreme government budget cuts. As a computer programming lecturer at a public university, ensuring that all the students had access to computing resources was troubling and difficult. The computer laboratories are few and under-equipped. Moreover, while some students could afford to buy their own laptops, a significant number of students came from low-income households and were government funded; thus, could not afford to buy their own laptops. I often found myself in a position where I had to allow some students to share my personal laptop, upon which I had to adopt a rotational time-based system where each group of students would have their turn using my laptop to complete the coursework. Although this method worked adequately for the small classes (of about 15 - 20 students), for the larger classes (upwards of 50 students), it was not feasible. Interestingly, in the large classes, I soon discovered that the students (especially the ones from lower income households) were using computer programming mobile apps (from Android App Store) as a way to support their learning.

Naturally, this began my fascination with mobile learning (previously defined as learning involving the use of a mobile device such as a smartphone). However, through my reading to learn more about this concept, I discovered that a framework that describes how a student who owns only a smartphone and does not have access to a desktop PC or laptop can still formally participate in a university course, was not "out there". In Kenya, many of the mobile-based learning applications that exist (e.g. mElimu) are either using tablets as the technology basis or are revision sites supporting primary and secondary school level learning (e.g. eLimu). During my reading, statements like this struck a chord:

*"… after more than 20 years of mobile learning research, there is still relatively little systematic knowledge available, especially regarding the use of mobile technology in higher education settings" (Pimmer et al., 2016, p. 492).*

*"… mobile learning in developed and developing country contexts is still at an experimental stage with students using mobile technology in pedagogically limited ways" (Kaliisa et al., 2019, p. 546).*

I knew that I wanted to explore this gap in mobile learning literature, to try and find solutions for my students. Clearly then, I am invested in this research and have brought to it preconceived ideas about the smartphone's potential to facilitate learning, informed by my own experiences and my reading. There was great potential for me to find what I expected in all phases of the research, but especially during the thematic analysis of lecturer interviews (Phase 3) and the smartphone-supported blended course intervention (Phase 4).

A strength I brought to the aforementioned two phases of the research was my seven years of experience as a lecturer in a resource-constrained public university setting. Whilst I do not work in the same university where the research participants were obtained, my teaching experience gave me 'insider knowledge' on the teaching and learning strategies prevalent in most Kenyan public universities, which not only facilitated a more relatable, open and relaxed interview atmosphere, but also made it easier to collaborate with the students during the testing of the smartphone-supported blended course.

Although researcher bias and reactivity can never be completely eliminated, I was aware of their possible influence and took a careful and systematic approach to limit their effect as much as possible. In summarising (interpreting) the findings, I have: 1) provided rich detail as well as direct quotes (to the degree allowed by the promises of anonymity and confidentiality of participants) so that the conclusions are, I hope, transparent to readers; 2) documented the findings in a way that enables the reader to draw their own conclusions; 3) submitted my developing ideas to peer scrutiny through six international and national conference presentations; finally, 4) peer debriefing in the form of supervision was ongoing in this doctoral study. Thus, in these ways, I sought to support the strength of evidence for the claims made in this research.

## 3.4 Ethical Considerations

The goal of ethical consideration is to ensure that no harm results from research (Kivunja & Kuyini, 2017). Ethical considerations, as detailed in the application to the Massey University Human Ethics Committee, included: respect for persons; minimisation of risk of harm to participants, researcher, groups, and institutions; informed and voluntary consent; respect for privacy and confidentiality; ownership of data and publication; avoidance of conflict of role; as well as social and cultural sensitivity. Ethical approval, specifically, a '*low risk MUHEC notification'* (see Appendix A), was obtained from Massey University through submission of an application and supporting documents.

Regarding avoidance of conflict of role, while TMUC is a constituent college of the university I work for (i.e., Maseno University), the risks were negligible because none of the interview participants were people I ever worked closely with, or met. Furthermore, I have been on study leave for the past four years, and I was not involved in teaching or assessment of any undergraduate students at the time this research was conducted.

Concerning respect for persons, all procedures were designed to maximise feelings of validation of the participants. For example, consent was obtained in advance to collect the qualitative and quantitative data, as well as disseminate the findings to the international community, for example, during conferences or as journal publications. Research participants were informed verbally and in writing of the research purpose, and participation was voluntary. Participants had the right to decline to answer any question; to withdraw their data; to turn off the recorder; to ask questions of clarification; to check transcription summaries for accuracy and to receive a summary of the findings of the completed research; and/or withdraw from the study at any point until analysis of the data was undertaken.

Pertaining to privacy, confidentiality of all participants was maintained. The student survey participants were completely anonymous and pseudonyms were used to identify all the lecturers interviewed. All images and videos revealed during the intervention course, student focus groups, and of the University setting, were confirmed not to be in breach of privacy. Moreover, in accordance with Massey University's ownership and storage of data protocols, data and consent forms were kept in password protected storage and only the researcher and supervisors had access.

In relation to social and cultural sensitivity, given the collectivist culture of Kenya, especially observed in the rural regions, it was important to meet the participants face to face, when introducing the research idea. Hence, for three months, I got acquainted with the University setting (TMUC) and all the research participants. Furthermore, during my interaction with the participants, I adopted a collaborative approach, which allowed knowledge to more easily flow both ways and helped to acknowledge the researcher as a learner (i.e., part of the exploration) and not just a data gatherer or observer. Smith (2005, p. 98) echoed similar sentiments about the need for the researcher to adopt a collaborative approach and refrain from 'flaunting their knowledge' during data collection: "… sharing knowledge is about empowering a process, but the community has to empower itself".

Regarding the minimisation of risks of harm, the intervention course did not impact the students' academic grades; therefore, there was no perceived harm in terms of academic progression. Albeit, participants were encouraged to put in the effort required so as to excel to the best of their ability in the intervention course activities. The main potential for harm seemed to lie in the possibility of tainting the reputation of the University and its academic staff. There was the potential for the research to suggest that previous and current teaching practices or university resources were not sufficient to cater to the students' learning needs. Therefore, there was strict adherence to procedures to safeguard this. For instance: the risk of harm to individual staff members was minimised by the maintenance of anonymity and confidentiality; and the risks of harm to the reputation of the institution was minimised by the fact that any problems found were likely to be typical of those reported for many other institutions across sub-Saharan Africa. Since the research findings had potential benefits to the institution, staff, and students in suggesting ways to improve practice, these risks were discussed with the concerned Deans and the University Principal, who were all supportive. Thus, written permission to conduct the research, and name the institution, was sought and obtained from the Principal at Tom Mboya University College, as well as NACOSTI – the government body responsible for authorising all research carried out in Kenyan Universities (see Appendix  B).

## 3.5 Research Setting

The present study was conducted at Tom Mboya University College (TMUC) – a rural-based public university in Homa Bay county in Kenya. But before describing TMUC's setting in detail, because this present study views Kenya as a typical example of a sub-Saharan African country, to better facilitate transferability of the research, it seems necessary to first give the reader (especially non-Africans) a brief account of Kenya's economy and higher education landscape.

### *3.5.1 Community Setting: Kenya's Economy and the Higher Education Landscape*

Kenya (population: 54.5 million) is situated on the East African coast and on the equator. It is bordered by South Sudan and Ethiopia to the north, Somalia and the Indian Ocean to the east, Tanzania to the south, and Uganda and Lake Victoria to the west. According to World Bank Group (2018), Kenya is classified as a 'lower-middle income' economy and is the only nation with this ranking in East Africa; the other bordering countries are classified as 'low income'. Agriculture and tourism are the key industries in Kenya's economy. For instance, the earliest hominid fossil (mankind's earliest ancestor) was found in the Tugen Hills of Kenya's Baringo county; additionally, Nairobi, is said to be the only capital city in the world with a national park, thus the country attracts many tourists. Moreover, Kenya's highland region is one of the most productive regions in Africa and is a global leader in tea export (OECD/FAO, 2016). However, although Kenya's economy shows great promise and poverty incidence in Kenya is amongst the lowest in East Africa, when compared to other lower-middle income countries in sub-Saharan Africa, poverty rates in Kenya remain relatively high, and unlikely to be eradicated by 2030 (The World Bank, 2018). Presently, about 80% of the population in the north and north-eastern parts of the Kenya live below the international poverty line (World Bank Group, 2018).

As far as population distribution is concerned, despite increasing levels of urbanisation, like most countries in sub-Saharan Africa, Kenya is still largely rural (see Figure 3.2). According to WBG (2018) report, 72% of the population in Kenya live in rural areas, and Figure 3.3 demonstrates that this pattern is expected to stay the same even in the next 30 years. In the same vein, Figure 3.4 and Figure 3.5 show the expected growth trend of urban population in Kenya, in relation to other countries in Sub-Saharan Africa. While there is no universal standard for distinguishing rural from urban areas, and the two distinct images – isolated farm, thriving metropolis are an oversimplification (WBG, 2018), for the sake of consistency and clarity, this present study proposes an operational definition of rurality based on three criteria: remoteness (distance from large cities); limited basic amenities; and lower purchasing power among the population. This definition takes into account the fact that: *"[where large urban areas are distant] ... markets of all kinds are thin, and the unit cost of delivering most social services and many types of infrastructure is high... and it will be difficult to recruit skilled people to public service or private enterprises"* (WBG, 2018). Despite national differences and a wide variety of situations across countries in sub-Saharan Africa, many of the rural areas in sub-Saharan Africa share the aforementioned criteria (World Bank Group, 2018). Certainly, a major reason for Kenya being predominantly rural is because more than 80% of the population rely on agriculture for their livelihood and demand for food in cities is supplied by the arable rural areas (FAO, 2018). However, national poverty also plays a key role in this imbalance in population distribution, seeing as a significant portion of the population cannot afford the higher living standards observed in urban centres (World Bank Group, 2018).

**Figure 3.2: Year 2021: Share of the world population that lives in urban versus rural areas (Ritchie & Roser, 2019)**

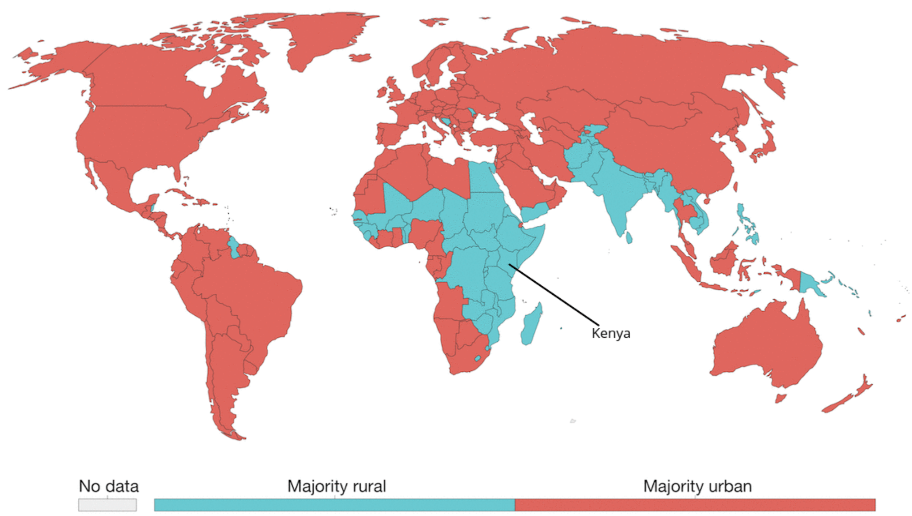


**Figure 3.3: Year 2050: Share of the world population that will live in urban versus rural areas (Ritchie & Roser, 2019)**

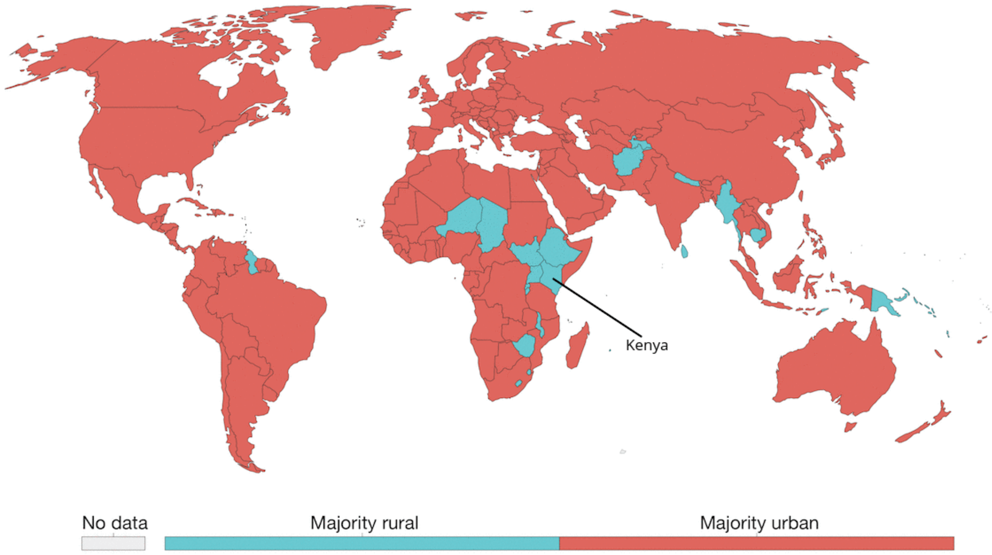



**Figure 3.4*:* Year 2021: Urban population distribution in sub-Saharan Africa (Ritchie & Roser, 2019)**

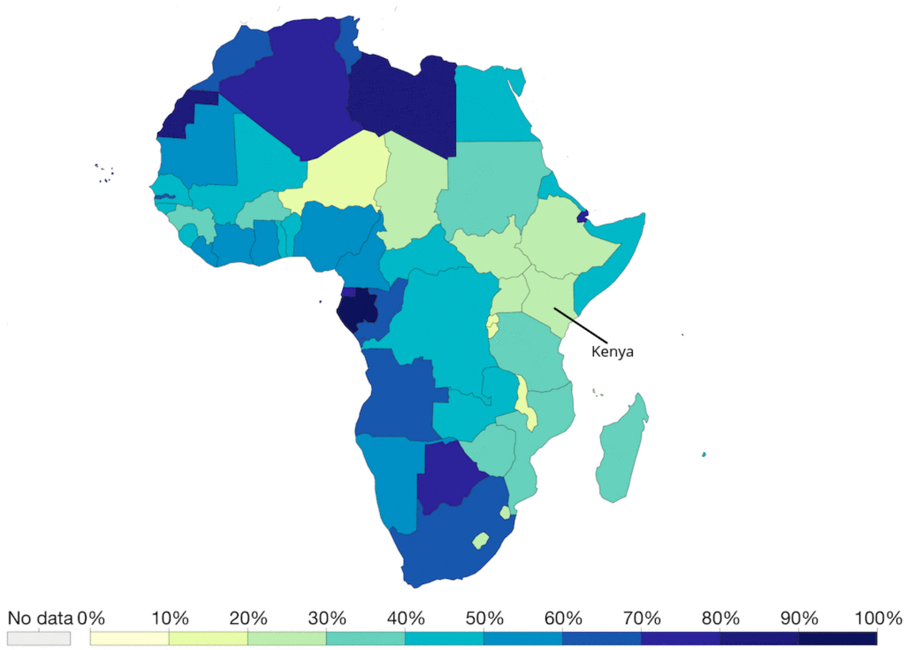
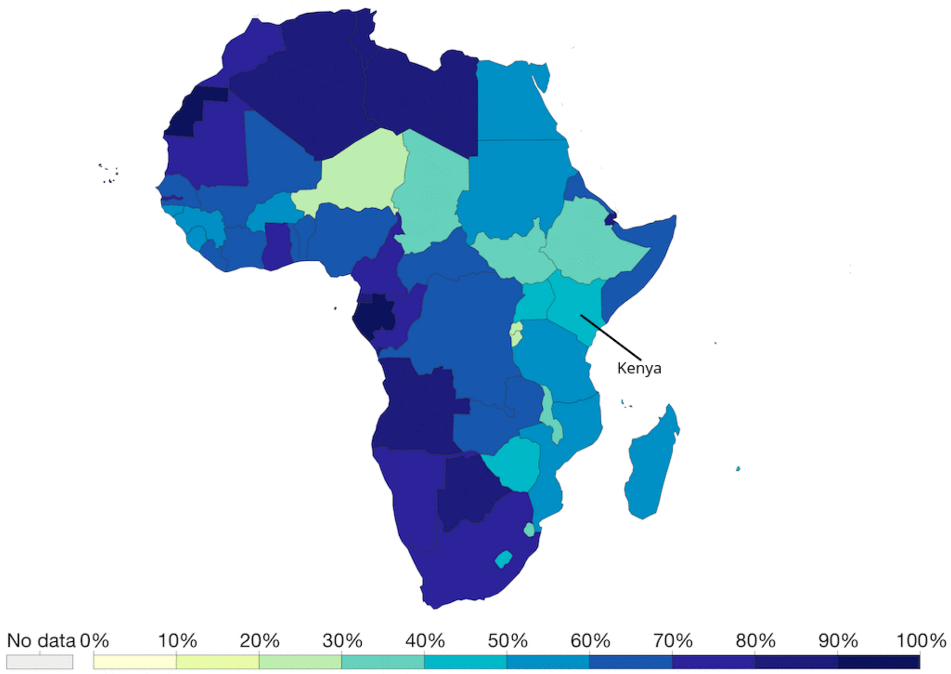


**Figure 3.5: Year 2050: Urban population distribution in sub-Saharan Africa (Ritchie & Roser, 2019)**




In the matter of higher education landscape, The World Bank (2020) enrolment report indicates that tertiary education in Kenya constitutes only 11%; this correlates with the 9% tertiary enrolment average recorded for sub-Saharan Africa as a whole, in the same report. As outlined in Appendix C, Kenya has 36 public universities[17]; from this number, only 11 institutions are located in urban-defined counties, the rest are in the rural regions (as illustrated in Figure 3.6). However, given the fact that Nairobi (a predominantly urban county and the most populous with 4.4 million people) is host to 6 of the 36 public universities, it would not be unwise to assume that the urban population makes up a large portion of the aforementioned tertiary enrolment percentage. Trines (2018) postulated a similar conclusion.

[17] In this research, the focus is on public universities because they serve as the most affordable gateway to formal higher education.

Against the backdrop of my earlier proposed definition of rurality, it can be argued that the higher education sector in rural Kenya faces significant developmental challenges mainly as a result of remoteness, inadequate basic amenities and the lower purchasing power of the population. For example, despite having a population average of about 500,000, most rural-defined counties have only one public university (see data in Appendix C). This means majority of these institutions are overcrowded, and many prospective students are forced to look for alternative public universities in other counties. Furthermore, because the government-subsidised student hostels are few, many students have no other choice but to commute daily from home to campus. Unfortunately, the distance between these rural-based counties is not practical for daily commute. For instance, in Homa Bay county (population: 1.1 million), TMUC is the only university in the region, and the nearest two universities in Migori and Kisii counties (still predominantly rural) are 50 kilometres (km) and 72km away, respectively. The other nearest public university, Maseno University, is in Kisumu county which is 145km away. More disconcerting is the fact that public transport across these rural-based counties is not scheduled or reliable (Transport & ICT, 2016). Thus, insurmountable travelling costs (due to remoteness) serve as one of the factors that exclude majority of the rural population from pursuing higher education.

Further exacerbating the slow growth of higher education in rural Kenya is the fact that, due to the low purchasing powers observed in rural settings, after attaining post-secondary education, families tend to balance the utility of children against the costs of bearing them and raising them. In other words, many rurally based university students have a filial duty to contribute to the family income (World Bank Group, 2018). This means, unless the institution they attend offers part-time learning (which is rare for undergraduate courses in rural-based Kenyan public universities), most of these students irregularly attend lectures, which consequently diminishes their learning experiences. Observably, a significant number of these students end up dropping out because the diminished educational experience is often seen as not worth the economic strain it puts on the family's small income. In an attempt to alleviate some of the financial burden, the government usually sponsors some students through bursaries and tuition fee waivers. However, Kenya being a lower-middle income economy, the government's educational budget is significantly strained and cannot sufficiently support the underserved population (Tarus et al., 2015; Trines, 2018). Overall, this lack of financial resources in the rural settings extends to the public universities' infrastructure (amenities) in the form: not enough lecturers; under-equipped computer laboratories (i.e., limited ICT resources); few classrooms leading to overcrowded lecture halls; and limited government-subsidised student hostels. Table 3.2 provides a summary of characteristics of rural areas, rural learners and rural universities in Kenya, which are also typical in other countries in sub-Saharan Africa.

**Figure 3.6: Distribution of public universities in Kenya (n = 36)**

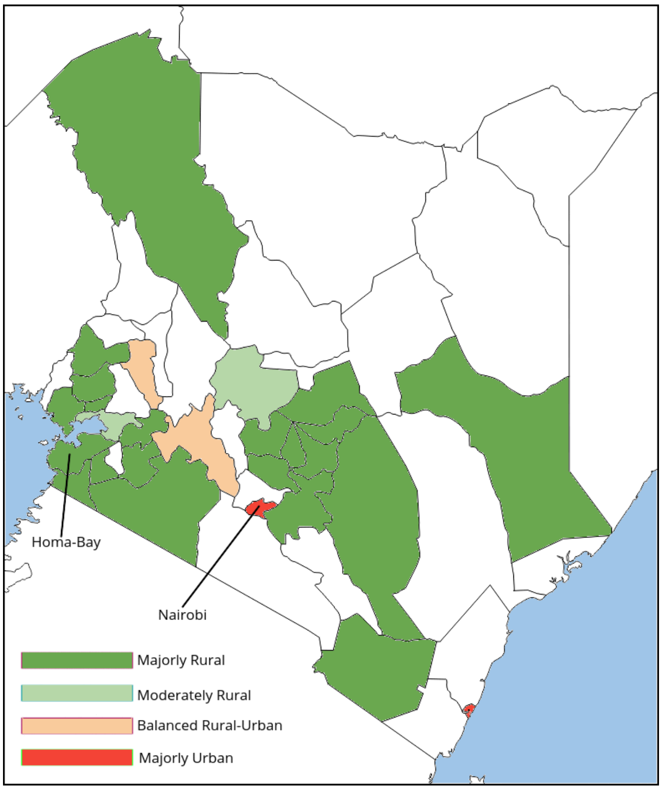


**Table 3.2: Characteristics of rural areas, rural learners and rural universities in Kenya and most countries in sub-Saharan Africa**

| Characteristics | Description |
|---|---|
| | **Rural areas in sub-Saharan Africa** |
| Remote | ▪ Usually far from basic amenities/infrastructures e.g. roads, technology, and tertiary institutions (GSMA, 2016; World Bank Group, 2018). |
| Subsistence Lifestyle | ▪ Inhabitants typically live on minimum wages, just enough for survival (World Bank Group, 2018). |
| | **Rural learners in sub-Saharan Africa** |
| Digital Exclusion | ▪ Limited access to technological resources e.g. laptops, desktop PCs, fixed broadband networks and/or Wi-Fi, but most have access to a smartphone (Deloitte, 2016; GSMA, 2019, 2020). |
| Educational Constraints | ▪ Limited access to tertiary institutions due to location remoteness (Transport & ICT, 2016).<br>▪ Typically, cannot afford current university tuition fees (due to subsistence lifestyle) unless funded by the government (Kaliisa & Picard, 2019; Spector et al., 2014; UNESCO, 2010). |
| Part-time Students | ▪ Have to work to support and contribute to the family income (World Bank Group, 2018). |
| Social Learners | ▪ Prefer to work in communities or as a group (Poushter, 2016). |
| | **Rural universities in sub-Saharan Africa** |
| Overcrowded | ▪ Very few, hence puts a strain on the institution's resources e.g. lecture hall space, learning technologies, and hostel accommodation (Gudo et al., 2011; Kearney et al., 2012). |
| Non-comprehensive teaching approaches | ▪ Predominantly supports teacher-led approaches in which students have to attend classes on-campus (Tarus et al., 2015).<br>▪ The technology-enhanced courses available are outdated and underdeveloped due to lack of resources (human, technical, and financial) (Kaliisa & Picard, 2019; Spector et al., 2014). |

### *3.5.2 University Setting: Tom Mboya University College (TMUC)*

a) Background: Origins of TMUC and Organisational Structure

Named after the legendary politician Tom Joseph Mboya, TMUC is located approximately 100 metres from the shore of Lake Victoria, in Homa-Bay county. The university is a product of the merger between 'Agricultural Training Centre' and 'Agricultural Technology Development Centre'. The institution attained public university status in 2016, when it was gazetted as a constituent college of Maseno University. Presently, the student body consists of 2,919 students and classroom-based learning is the only mode of formal study. The university has six faculties within which there are 20 full-time lecturers and around 40 part-time lecturers. As earlier stated, a defining feature of rural areas is the difficulty in recruiting skilled people to public service due to constrained government budgets and the generally low education levels; as such, this low count of lecturers at TMUC is expected and similar lecturer-student ratios are observable in many other rurally based public universities in Kenya. Regarding courses offered, the university has several programs ranging from diplomas up till doctorate degrees, as well as a few professional courses. Table 3.3 gives an overview of the faculties in the institution. In the next four chapters, I have provided more details about the setting for each phase of the research.

**Table 3.3: Faculties at TMUC**

| **Student Body:** n = 2,919<br>**Permanent Lecturers:** n = 20; **Part-Time Lecturers:** n = 40 | |
|---|---|
| **Faculties** | |
| ▪ Faculty of Agriculture and Food Security | ▪ Faculty of Business and Economics |
| ▪ Faculty of Arts and Social Sciences | ▪ Faculty of Education |
| ▪ Faculty of Biological and Physical sciences | ▪ Faculty of Mathematics and Statistics |

b) Pictorial Overview of TMUC's Physical Infrastructure

- TMUC Main Tuition block

As can be seen in Figure 3.7, TMUC is a fairly small university and thus has a modest tuition block. However, Figure 3.8 shows concerted efforts put towards constructing a more modern tuition block that can support a larger student population.

**Figure 3.7*: *TMUC main tuition block**


**Figure 3.8: Construction of a state-of-the-art tuition block at TMUC is underway**

- TMUC Largest lecture hall

Figure 3.9 shows TMUC's largest lecture hall, which can comfortably accommodate about 70 students. Most of the other classes resemble this one albeit much smaller. Like many other Kenyan public universities, TMUC's lecture halls tend to be overcrowded. For example, a common course (i.e., it is shared across faculties) can have upwards of 400 students per class.

**Figure 3.9: The largest lecture hall at TMUC (approximate maximum capacity is 70 students)**

- TMUC Computer Laboratory

Currently, as displayed in Figures 3.10 and 3.11, TMUC has two computer laboratories with a total capacity of about 65 computers. Certainly, this amount is concerning; however, as earlier stated, most public universities in Kenya face extreme budget cuts, which negatively impact the provision of ICT resources. Additionally, because TMUC is still a fairly new university, it does not get the same share of financial backing from the government as the other more established public universities like, University of Nairobi or Kenyatta University. Therefore, for now, much of the funding is focused on building new classes for the students and supporting the day-to-day running of the institution.

**Figure 3.10*: Largest computer laboratory at TMUC (approximately 45 computers)***

**Figure 3.11*: The other computer laboratory at TMUC (approximately 20 computers)***

- TMUC Student Library

As seen in Figure 3.12, the library is small given the student population. However, from my teaching experience, I noticed students in collectivist cultures (such as those in Kenya) tend to prefer studying in groups. These collaborative study groups are often convened outside the library so as to better facilitate open discussions. Because of the silent reading requirements observed in most libraries, holding discussions in the library would not be ideal. Nonetheless, the library is open until 8 p.m. Monday to Saturday; the extended hours (from 5 p.m.) allow more students to access the amenity even after school hours.

**Figure 3.12: TMUC student library**

- TMUC Student Hostels

TMUC only has three hostels, each with a maximum capacity of 36 students (see Figure 3.13). The university has leased out a local hotel to accommodate an additional 450 students. For the government hostels and the leased hotel, each student pays the university Kenya Shillings (KES) 5000 ($NZD 65) per semester. The accommodation charges are for bed only – students pay for food separately. Evidently, these government subsidised hostels cannot accommodate the current student population (n = 2,919); hence, majority of the students (if not commuting from their family homes) have to find their own accommodation facilities in the neighbourhood, which normally charge KES 8,000 to KES 10,000 ($NZD 100 - $NZD 130) per semester. It should be noted here that, given Kenya is a lower-middle income economy with a gross national income per capita of $NZD 1,390 - 5,500 (World Bank Group, 2018), these accommodation charges on top of the tuition fees can be quite overwhelming for the rurally based families.

**Figure 3.13*: Government-subsidised student hostels within TMUC campus (total capacity: 108 students)***

- TMUC Malaria Laboratory

Being so close to Lake Victoria, malaria is a significant threat to the population in Homa-Bay County. In this vein, International centre of Excellence for Malaria Research (ICEMR) established one of its research laboratories at TMUC (see Figure 3.14). The laboratory is a joint venture with University of California-Irvine. This puts TMUC on the map as a research-driven university.

**Figure 3.14: Malaria research initiative at TMUC**


## 3.6 Summary

In this chapter, I have presented the philosophical perspective of pragmatism that underpins this research and justified the use of a mixed-methods case study methodology to address the research question. I have given an overview of the research methods used, but the detailed discussion of these and their justification is left for the subsequent chapters where it is presented along with the research findings. I have discussed what I perceive to be the most salient threats to the validity of this research, these being researcher bias and reactivity – other threats such as sampling adequacy are discussed further during discussion of the methods in each of the next four chapters. I have outlined ethical considerations and approvals, as well as discussed how reputational risks were managed to minimise their impact. Finally, the setting for the research has been detailed as a prelude to the four chapters which now follow, in which the details of the methods used and the findings for each phase of the research are provided.

# 4. FEASIBILITY STUDY

Technical requirements for a smartphone-support blended course – Phase 1

## 4.1 Background

As described in Chapter 2, blended university courses in developed countries are already making heavy use of learning technologies. The more advanced courses make extensive use of purpose-made video recordings for lecture and demonstration material. When creating this laptop or desktop PC-based course material, some thought is given to the technical aspects such as file sizes, but primary considerations are around pedagogy. Indeed, to avoid what Kinchin (2012) referred to as "technology-enhanced non-learning", educational technology should be led by pedagogy (Anderson & Dron, 2011; Kinchin, 2012; Njenga & Fourie, 2010). However, given the physical form factor differences between smartphones and PCs and the fact that current university pedagogies do not comfortably support smartphone use, this research argues that when considering the implementation of a smartphone-based course, it is imperative to more thoroughly contemplate the technical aspects of delivering the course. According to Anderson and Dron (2011, p. 81), "technology sets the beat and creates the music, while pedagogy defines the moves". Failure to reconcile these two viewpoints (technology and pedagogy) leads to indigent explanations of the value or impact of learning technology, resulting in slow adoption by learning institutions (Oliver, 2013).

Therefore, against this background, this Phase 1 of the research aims to provide a comprehensive analysis of whether the smartphone's technical capabilities (e.g., screen size, storage capacity, processor capacity, and bandwidth) can support existing pedagogy or be extended to further enhance the learning experience. A feasibility study was undertaken to evaluate two existing online courses, and quantitative analysis was the research method used to inform this investigation. An inquiry into the technical requirements for participating in an existing course solely on a smartphone was an essential first step (objective) in determining whether I could proceed to carry out more comprehensive evaluations. In other words, the feasibility study provided an opportunity to assess whether the idea of 'smartphone-supported blended learning' can be shaped to be relevant and sustainable. From the Pragmatist perspective, the overarching question for this phase was: *can the technology work?*

## 4.2 Research Method

*Quantitative Analysis: Collection of Technical Data*

Two existing online courses were examined in this phase of the research. The variables investigated included 1) how much bandwidth (upload/download speeds) is required to access course materials, 2) the total data volume of course materials and 3) smartphone-storage capacity, screen capacity, and processor capacity consumption while interacting with the course materials.

## 4.3 Feasibility Study One: Description, Procedure, Findings and Discussion

### *4.3.1 Course Description: Fundamentals of Information Technology*

The first online course examined, *'Fundamentals of Information Technology'*, was provided by Massey University in 2018. This ongoing course is delivered on Moodle LMS, makes heavy use of video and audio presentations for all lectures, and is predominantly designed for the laptop or desktop PC. Additionally, it comprises multimedia intensive assignments, whereby students are required to take screenshots of their work. The rationale for choosing this course was to gain insight into what needs to be 'modified' for a desktop PC or laptop-supported course to become fully smartphone compatible.

### *4.3.2 Procedure for Evaluating the Course*

To gain an understanding on the data volumes involved, two weeks' worth of content was examined. The video and audio lecture recordings were considered downloads, while the uploads comprised student submissions for one of the course assignments.

To evaluate the data transfer speeds (bandwidth), the downloads and uploads were analysed against Kenyan mobile internet speeds (with Kenya being an example of a developing country in sub-Saharan Africa). This was achieved by theoretically estimating the maximum 2G, 3G, and 4G speeds (i.e., peak speed and expected speed) of smartphones within the price range[18] most affordable to students in Kenya. The peak speed data was derived from Naija Android Arena (2018), a popular online smartphone retailer used in Kenya. The expected speed data was retrieved from Ookla (2018) and the literature by Akamai (2017) on the state of mobile internet in Kenya. Certainly, bandwidth does not tell the whole story for mobile network performance; however, since it is the feature most internet providers advertise, I decided to use it to represent network performance.

For considerations around readability of content, the lecture presentations were examined under 4:3 and 16:9 aspect ratios using a smartphone with a 5-inch display and a 1080p screen resolution. This approach was preferred since typical low to mid-range smartphones (NZD$80 – $150) can comfortably support the aforementioned aspect ratios, have a display of between 5 and 5.7 inches, and screen resolutions of between 720p and 1080p (Jumia, 2018; Naija Android Arena, 2018). Additionally, various font sizes were analysed against the same 5-inch display to evaluate the optimum size for legibility.

[18] The most affordable smartphones in Kenya cost between NZD$80 – $150.

### *4.3.3 Findings from Feasibility Study One*

The course material the students were expected to download comprised 121 minutes of video recordings plus PDF versions of the lecture slides. This amounted to 902MB of data. For the assignment related to this course section, the students had to prepare a document containing text and screenshots that were to be uploaded to the LMS in .pdf or .doc file formats. To determine the file size per student, twelve student submissions with the highest scores were analysed – the assumption being that these submissions had addressed all tasks. This resulted in an average of 760KB per file upload.

Using mobile internet speeds from Kenya, Table 4.1 indicates that it takes less than 10 minutes to download about 1GB of course material, and on a very good network, it can take less than 3 minutes. Additionally, it can be observed in Table 4.2 that the upload time of a 760 KB student assignment takes less than one minute, even on a slow 2G connection.

**Table 4.1: Download speed for 902MB using mobile internet**

<table>
<tr><th colspan="6">Estimated download time for 902MB of lecture material compared against typical smartphone data transfer speeds across various networks in Kenya</th></tr>
<tr><td colspan="6">Key Terms: MB – Megabyte; Mbps – Megabits per second; Kbps – Kilobits per second</td></tr>
<tr><td colspan="6">Formula: Transfer Time = File Size (in bits) / Transfer Speed; 1MB = 8 bits; 1Kbps = 0.001Mbps</td></tr>
<tr><th colspan="6">Download</th></tr>
<tr><th rowspan="3">Category:</th><th colspan="3">Theoretical Peak Speeds</th><th colspan="2">Theoretical Expected Speeds</th></tr>
<tr><td colspan="3">(Naija Android Arena, 2018)</td><td>(Ookla, 2018)</td><td>(Akamai, 2017)</td></tr>
<tr><th>2G (up to 236.8 Kbps)</th><th>3G (up to 42.2 Mbps)</th><th>4G (up to 150 Mbps)</th><th>15.70 Mbps</th><th>13.7 Mbps</th></tr>
<tr><th>Approximate Transfer Time:</th><td>9 hours</td><td>3 minutes</td><td>1 minute</td><td>8 minutes</td><td>9 minutes</td></tr>
</table>

### Table 4.2: Upload speed for 760KB using mobile internet

| **Estimated upload time for 760KB of course assignment compared against typical smartphone data transfer speeds across various networks in Kenya** | | | | |
|---|---|---|---|---|
| **Key Terms:** MB – Megabyte; Mbps – Megabits per second; Kbps – Kilobits per second | | | | |
| **Formula:** Transfer Time = File Size (in bits) / Transfer Speed; 1MB = 8 bits; 1Kbps = 0.001Mbps | | | | |
| **Upload** | | | | |
| **Category**: | **Theoretical Peak Speeds** | | | **Theoretical Expected Speeds** |
| | (Naija Android Arena, 2018) | | | (Ookla, 2018) |
| | **2G (up to 236.8 Kbps)** | **3G (up to 11.5 Mbps)** | **4G (up to 50 Mbps)** | **8.55 Mbps** |
| **Approximate Transfer Time:** | 25 seconds | Less than 1 second | | Less than 1 second |

Regarding content, readability was an issue in some videos since the images were blurred. Figure 4.1 and Figure 4.2 show examples of the videos that were not easily readable. Figure 4.3 and Figure 4.4 depict a video recording that was only slightly legible upon expanding the image. There were no concerns with regards to accessing text-based course materials and listening to audio content. However, content creation for the assignments required a desktop PC or laptop.

### Figure 4.1: Screenshot of an illegible video lecture recording in landscape view

**Figure 4.2: Screenshot showing that Figure 4.1 is still illegible even in expanded view**

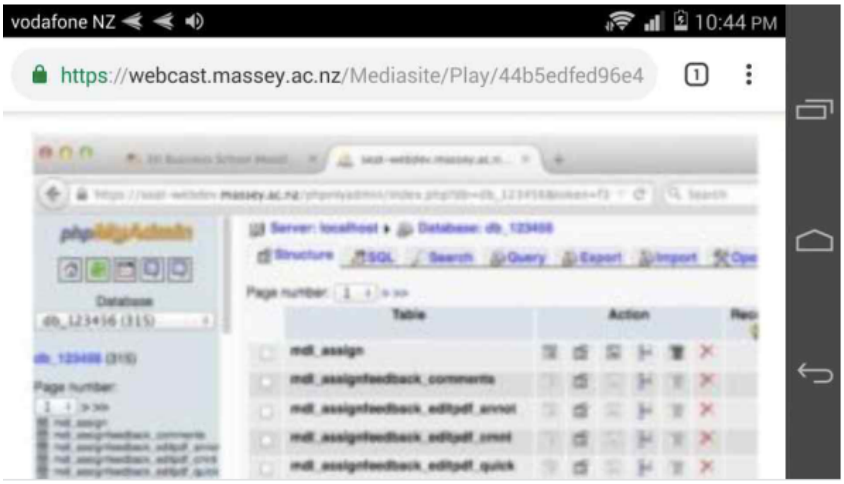



**Figure 4.3: Video layout needs to be expanded to improve readability**

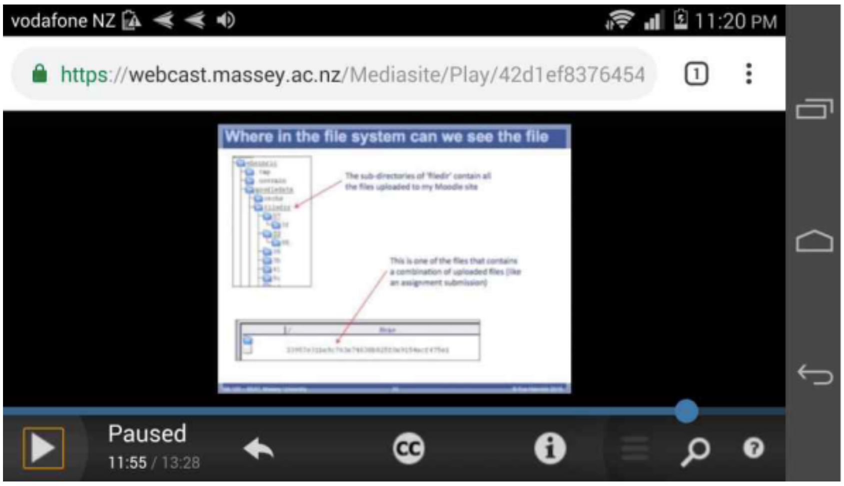
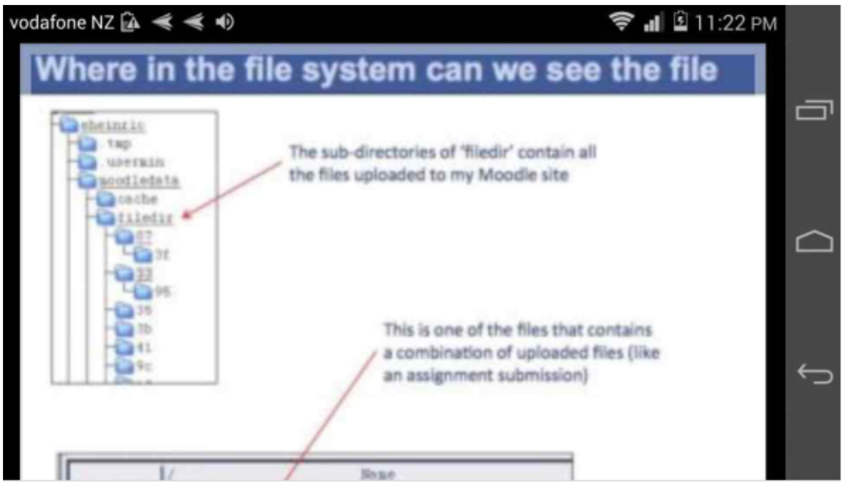



**Figure 4.4: Expanding the view of the video in Figure 4.3 only slightly improved readability**



### *4.3.4 Discussion of findings from Feasibility Study One*

The data in Table 4.1 and Table 4.2 indicate that mobile bandwidth is sufficient to facilitate a smartphone-only course. According to Ookla (2018), the recommended *consistency score*[19] for streaming mobile-based content in high definition (HD) is 5Mbps for download speeds and 1Mbps for upload speeds. On the same note, Ookla's report indicates that currently, the most popular networks in Kenya (*Safaricom* and *Airtel*) meet these bandwidth requirements 86% and 79% of the time, respectively. However, it should be noted that having high bandwidth, while necessary, is not enough to ensure fast internet speeds. Another crucial aspect that needs to be examined is network latency. Whilst bandwidth determines how much data one can download or upload at a time, latency determines how long (in milliseconds) it takes for the data to travel from one location to another. This means that a high latency will inevitably lead to diminished internet speeds despite a user having high bandwidth.

As per Ookla (2018) data, wireless networks such as mobile internet have the highest latency. Table 4.3 suggests the typical latency mobile users can expect for the various mobile network technologies (2G, 3G, and 4G). An acceptable latency is typically anything under 129 milliseconds (Ookla, 2018). Figure 4.5 shows that the 3G mobile network, which can have high latency values (i.e., above 129 milliseconds), is widely available in Kenya[20]. Nevertheless, Ookla (2018) data indicate that the mean latency for mobile internet providers in Kenya is 44 milliseconds, which is below the acceptable range of 129 milliseconds. Furthermore, Figure 4.5 shows that the 4G mobile network, which has low latency, is gaining momentum even in

[19] Consistency score: metric used to identify mobile networks that provide a consistent quality of service – the higher the score, the more likely the user will enjoy acceptable internet performance and quality. Ookla. (2018). *Speedtest Global Index*. http://www.speedtest.net/global-index/kenya#mobile.

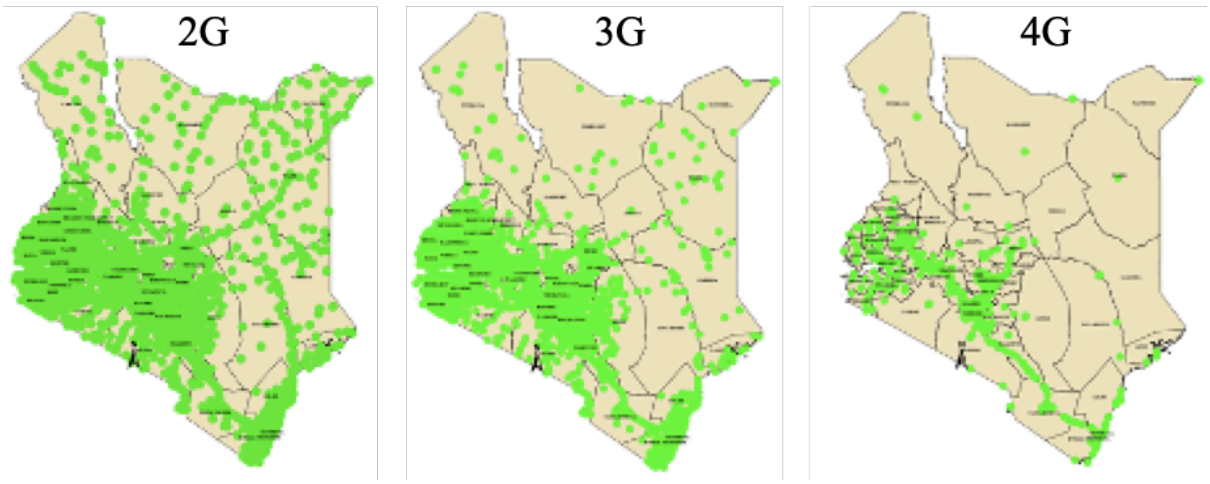
[20] The northern and north-eastern parts of Kenya are predominantly deserts, and the population there live below the international poverty line; so, the provision of resources is focused on the bare necessities: food, shelter, and clothing, rather than on technological advancements. Therefore, I have excluded 2G in this argument.

the rural parts of Kenya where the outcomes of my research are targeted (e.g., Homa Bay county, where my research was carried out). Therefore, I conclude that mobile network coverage[21] and internet speeds in rural Kenya are sufficient for students to access online course materials via their smartphones.

**Table 4.3: Typical latency for the various mobile network technologies (2G, 3G, and 4G) (Ilumba, 2019; Ken's Tech Tips, 2018)**

| Network | Typical Latency (milliseconds) |
|---|---|
| 2G | 300 – 1000 |
| 3G | 100 – 500 |
| 4G | 50 – 100 |

**Figure 4.5: 2G, 3G and 4G network coverage (of the most popular mobile internet provider) in Kenya in 2016**




[21] As of 2016, the area coverage for 3G in Homa-Bay county, where this research was carried out, was 87%, with only 7.6% of the population unserved. Communications Authority of Kenya. (2016). *Mobile Network Coverage - Working Model V9A* [Unpublished Dataset].

Concerning content readability, Figure 4.1 to Figure 4.4 indicate that the lecture recordings in this course were assumed to be watched on a full monitor size. However, the underlying reason for these illegible video presentations was not the small screen size of the smartphone but the aspect ratio of the recordings. The two commonly used aspect ratios are 4:3 (33% wider than tall) and 16:9 (78% wider than tall). The aspect ratio does not affect the quality of the video, but it changes what is viewed on-screen. For instance, when put in landscape view, a 4:3 slide will appear smaller on a smartphone that supports a 16:9 aspect ratio. This is because 4:3 cannot fit into the widescreen of a 16:9 aspect ratio, and if the screen was manually stretched, the image could become distorted or blurred. Figure 4.6 illustrates how a 4:3 slide would be viewed in a 16:9 mode. On the other hand, Figure 4.7 demonstrates that a slide in landscape view with a 16:9 aspect ratio will comfortably (without being cropped) occupy the entire screen of a smartphone with at least a 5-inch display. Therefore, assuming most lecturers use laptop and desktop PCs to prepare their video lectures, consideration of aspect ratio is essential when trying to optimise videos for smartphone viewing. Additionally, from Figure 4.7, it can be concluded that text size larger than 32pt is preferable, but text in font size 28pt can still be used on 16:9 landscape mode of a 5-inch smartphone screen display.

**Figure 4.6: A 4:3 lecture slide viewed on a 16:9 landscape mode; slide does not occupy the whole screen – space is replaced by a black border**

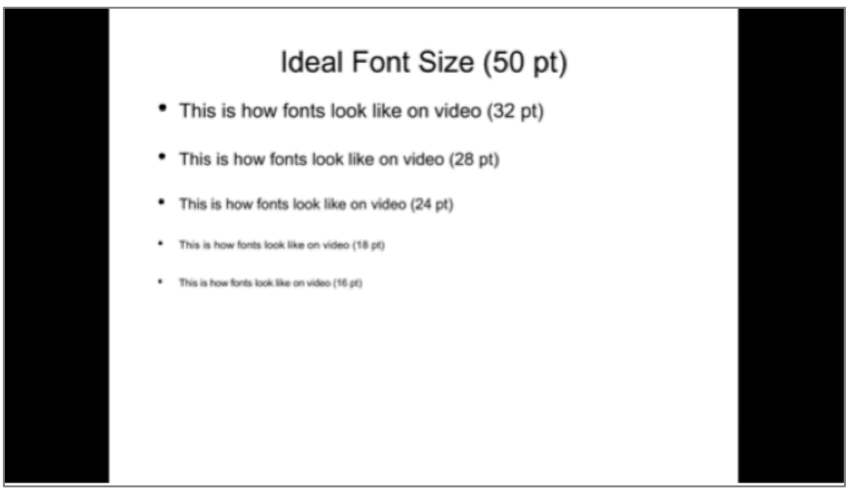
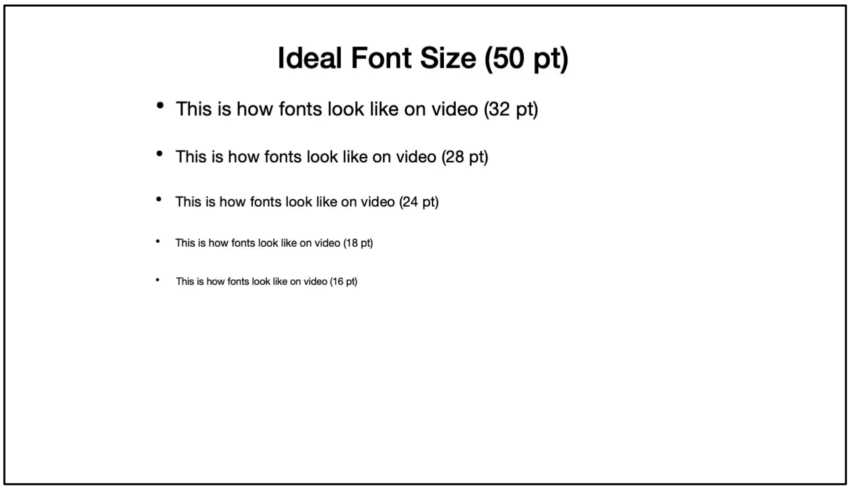


**Figure 4.7: A 16:9 lecture slide as viewed on a 5-inch smartphone screen display – slide occupies the entire screen**




Noticeably, despite the use of a 4:3 aspect ratio instead of the preferred 16:9, a significant portion of the analysed course content was not distorted; this led to the assumption that the screen resolution of the recording software could also have been an issue (as it pertains to the creation of the illegible videos in Figure 4.1 to Figure 4.4). Unlike the wrong aspect ratio, which distorts the image on the screen, a low screen resolution affects the quality ('sharpness') of a video resulting in an unclear (blurry) image. As previously stated, the typical low to mid-range smartphones (NZD$80 – $150) can at the very least support 720p resolution, so this should be taken into consideration when setting preferences on the recording software. Figure 4.8 illustrates how images appear when viewed in different screen resolution settings. Table 4.4 provides the optimum (standard) aspect ratio and screen resolution combinations that instructors can use to ensure their video images are clear on smartphones.

**Figure 4.8: Image quality as viewed on 360p, 480p and 720p screen resolution settings (left to right)**

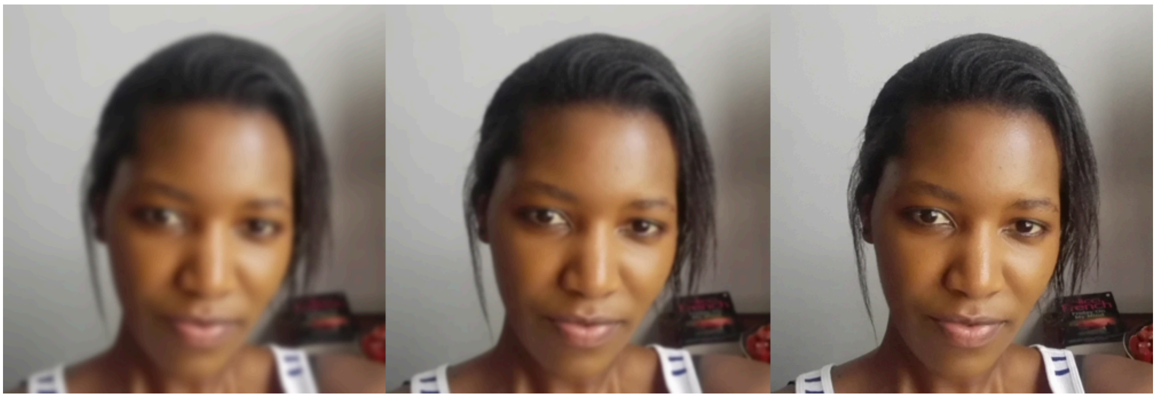


**Table 4.4: Standard combinations of aspect ratios and screen resolutions, to ensure optimum video qualities (Sohphoh, 2020)**

| Video Quality | 4:3 Aspect Ratio Resolution | 16:9 Aspect Ratio Resolution |
|---|---|---|
| 360p | 480 x 360 pixels | 640 x 360 pixels |
| 480p | 640 x 480 pixels | 854 x 480 pixels |
| 720p | Not generally used | 1280 x 720 pixels |
| 1080p | Not generally used | 1920 x 1080 pixels |

When examining data volumes, the idea was to evaluate whether current online courses that make heavy use of videos, audios and other multimedia content can be efficiently delivered on a smartphone. The sample for two weeks of course material translates to about 5.5GB for a twelve-week course (equivalent to a semester); this calculation assumes that the same high use of video material is observable in the other ten weeks. Additionally, to arrive at this 5.5GB semester-worth data volume, I considered data related to student assignments and communication via discussion forums. From this calculation, it is possible to conclude that a semester's worth of course material can fit within 16GB of storage that most Kenyan smartphones have. Table 4.5 shows the common storage capacities for typical smartphones in Kenya today. Furthermore, most mobile internet contracts in Kenya come with affordable data costs that are reducing with time (GSMA, 2020; Karlsson et al., 2017). For example, in Kenya, the cost of a 5GB data plan on the most popular mobile networks ranges between NZD$6 - $12

(Airtel, 2020; Safaricom, 2020). Considering that this mobile internet data will go towards consuming an entire semester's worth of course content, then the associated costs are within reach of students in Kenya. However, to further reduce data volumes and speed up downloads or streaming, instructors can reduce the screen size while recording instead of having it maximised. Doing so will make a massive difference in the resulting file size. Also, compression software such as *HandBrake*, *Windows Movie Maker* or *QuickTime Player* can assist in reducing the file sizes.

**Table 4.5: Typical smartphone specifications in Kenya**

| | |
|---|---|
| **Screen Resolution** | ▪ High Definition: 1280 x 720 pixels (720p)<br>▪ Full High Definition: 1920 x 1080 pixels (1080p) |
| **Display/Screen Size (diagonal measurement)** | ▪ 5-inch to 5.7-inch |
| **Aspect Ratios** | ▪ 16:9 and 4:3 |
| **Storage and Memory** | ▪ RAM: 1GB – 3GB<br>▪ Minimum internal storage: 8GB |

## 4.4 Feasibility Study Two: Description, Procedure, Findings and Discussion

### *4.4.1 Course Description: Digital Literacies for Online Learning*

The second course examined was '*Digital Literacies for Online Learning',* which is an online offered by OERu (n.d.) in partnership with Otago Polytechnic. OERu is an independent non-profit organisation that partners with tertiary institutions to offer formal courses under the open education framework. This micro-course is a web-based course hosted on the *WikiEducator* platform and claims to be designed for smartphones, laptops, desktop PCs and tablets. The website uses a responsive design approach to render content across these mentioned platforms. The learning content mainly comprises textual data, but the course also makes moderate use of embedded YouTube videos. The assignments are multimedia intensive in that the students are required to take photos as part of the learning activities and create personal blogs to showcase their portfolio. The intention for evaluating this second course was to gain insight into what aspects needs to be ‘improved’ (i.e., made more efficient) in the courses that claim to be smartphone compatible. This examination was essential since given the lack of literature regarding the use of smartphones as sole devices for study, many courses that claim to be smartphone-compatible mainly support viewing of content on a smartphone, meaning in most cases, for a student to successfully complete an online course, they will eventually need access to a desktop PC or laptop. Please visit this link for further information about this micro-course: https://oeru.org/oeru-partners/otago-polytechnic/digital-literacies-for-online-learning/. (OERu, n.d.)

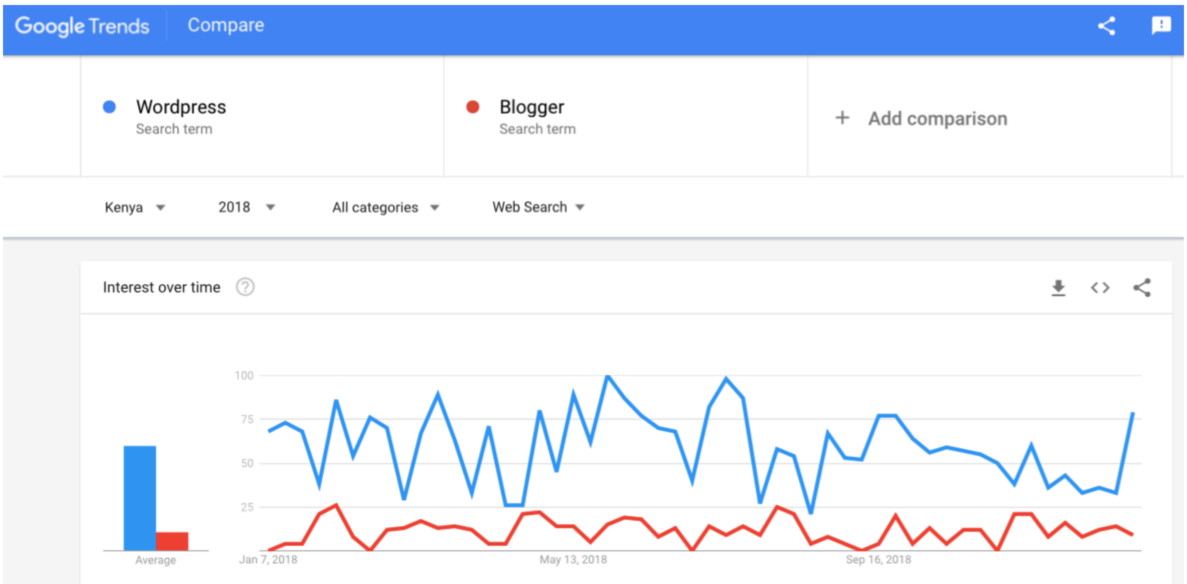
### *4.4.2 Procedure for Evaluating the Course*

To analyse whether this course is fully optimised for smartphone access, various web pages were viewed in landscape and portrait mode. This analysis provided insights into the effectiveness of the responsive design.

Next, to evaluate whether a student could contribute to the course via a smartphone, that is, can create and submit assignments, I assessed the learning tasks/activities that involved the use of additional software, specifically, *mobile apps*. This rationale was informed by the literature in Chapter 2, where I echoed Parsons (2014) and Pechenkina (2017) sentiments that it is mainly through mobile apps that smartphones can now accomplish most tasks typically done on laptops and desktop PCs. Notably, emphasis was on Task 1 of the course, which required students to 1) use *Hypothes.is* application to annotate web resources, 2) maintain a personal blog using content management systems and, 3) use citation management software to generate a bibliography for all resources used. For further information about Task 1 requirements, please visit this link: https://course.oeru.org/lida101/assessment/lida101-edubit/.

For the activity that required creating a personal blog, there are certainly several effective blogging platforms; arguably, *WordPress* and *Blogger* are the most common. For this feasibility study, I chose *WordPress* because it is the most popular blogging site in Kenya. To arrive at this choice, I compared the search terms "WordPress" and "Blogger" on *Google Trends* website to see the interest over time for each platform in the year 2018 (when this feasibility study was carried out). As shown in Figure 4.9, interest in *WordPress* among the Kenyan online community maintained steady popularity over time. It is still more popular than *Blogger* today.

**Figure 4.9: Interest over time for the most popular blogging sites – WordPress versus Blogger, in Kenya**




For the activity that required citation management software, the OERu recommended software for this micro-course was *Zotero*; however, *Zotero* does not have a mobile app version; hence I could not use it. Furthermore, the other referencing software recommended by most universities, *EndNote*, is also only laptop or desktop PC compatible. At the time of this study

(2018), the only university-recommended reference management software with a mobile app version was *Mendeley*[22]. Whilst the intention was to evaluate software recommended by university management (to maintain the 'formal context' storyline), I did find another non-university-recommended app, *Citationsy*, which showed great promise. Hence, I evaluated both *Mendeley* and *Citationsy* mobile apps.

### *4.4.3 Findings from Feasibility Study Two*

Regarding web page responsiveness, a few problems were observed when it came to content rendering. In these instances, the content did not fit within the smartphone's display unless the user manipulated the web page by either expanding or shrinking the view. Figures 4.10 and Figure 4.11 indicate that some content was cropped both in portrait and landscape mode. Figure 4.12 illustrates that even after manipulation (expanding/shrinking), the content still did not render well on display. Similarly, Figure 4.13 and Figure 4.15 further demonstrate the rendering issues observed when switching between landscape and portrait modes.

[22] As of March 2021, Mendeley discontinued its mobile app version. Hence, to ensure the content in this thesis remains relevant, the findings section of this phase of the research will elaborate more on *Citationsy* mobile app. Nevertheless, seeing as Mendeley is a university-recommended reference management software (i.e., considered a formal learning tool), it is still worth discussing some of the features the mobile app had. Examples of universities in sub-Saharan Africa that recommend Mendeley include Kenyatta University, Botswana University of Agriculture and Natural Resources, and Rhodes University.

**Figure 4.10: Example of a web page in which the content did not render well in portrait mode**

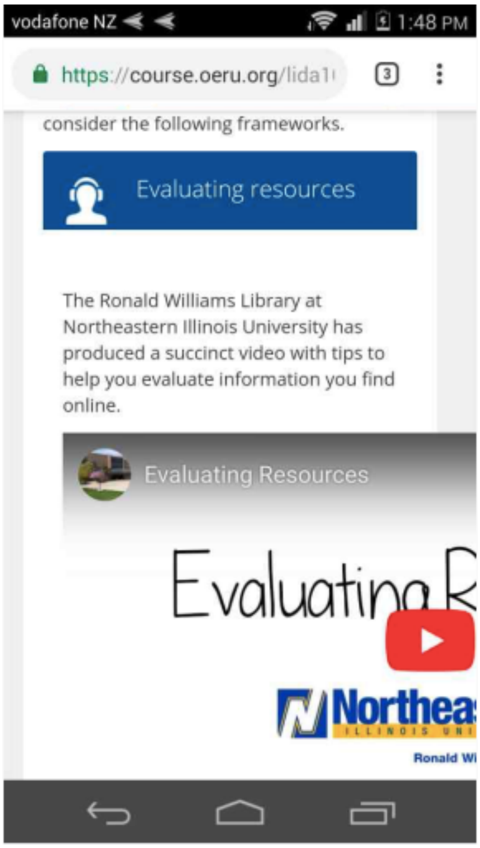



**Figure 4.11: Web page content previously rendered in Figure 4.10 still does not fit screen even in landscape mode**

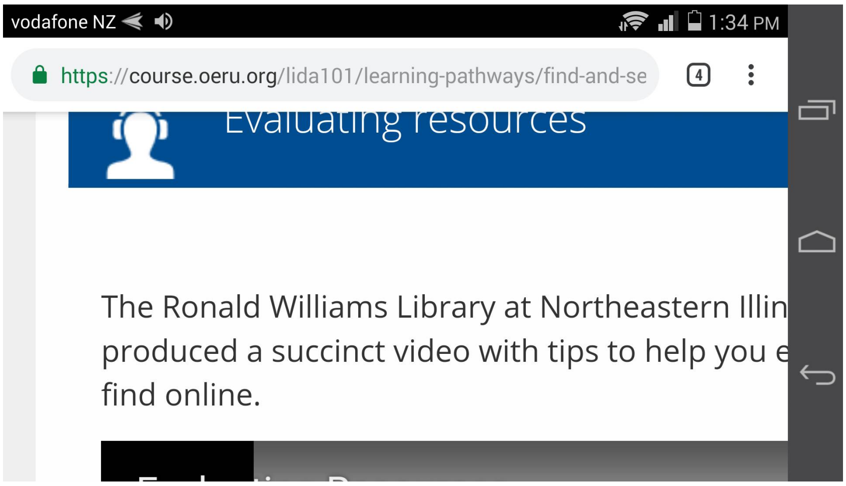


**Figure 4.12: Web page content previously shown in Figure 4.11 still does not fit screen even after shrinking the layout**

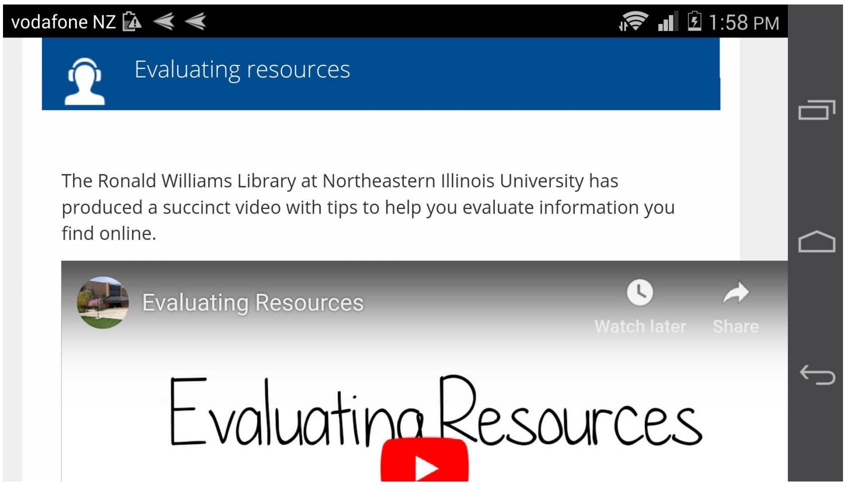



**Figure 4.13: Effect of returning the web page displayed in Figure 4.12 to portrait mode; the content does not render back to its original state as shown in Figure 4.10**

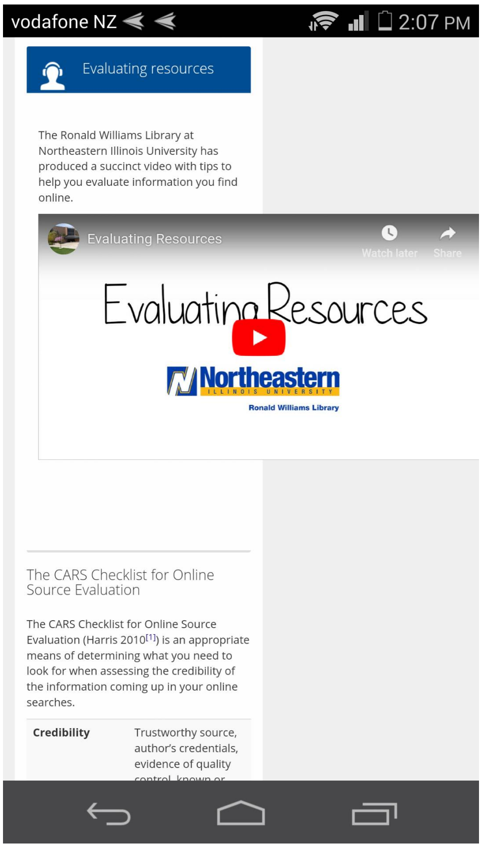


**Figure 4.14: Example of a web page that fits well in landscape mode but not in portrait view as shown in Figure 4.15**

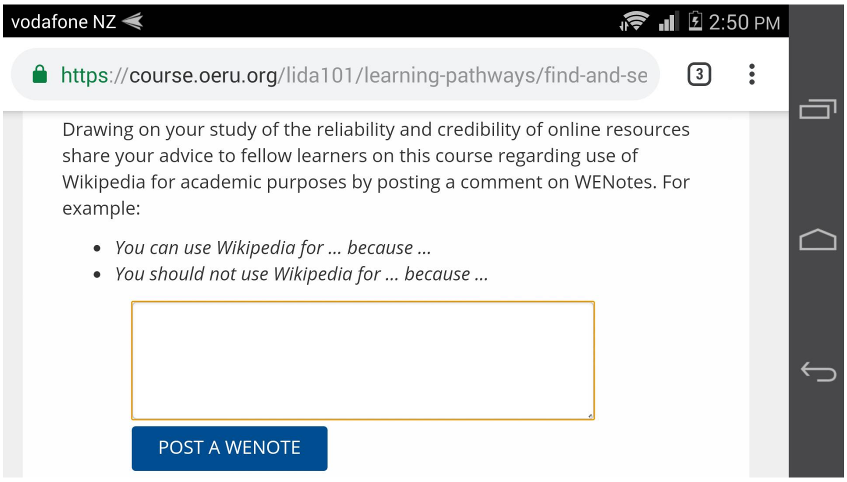
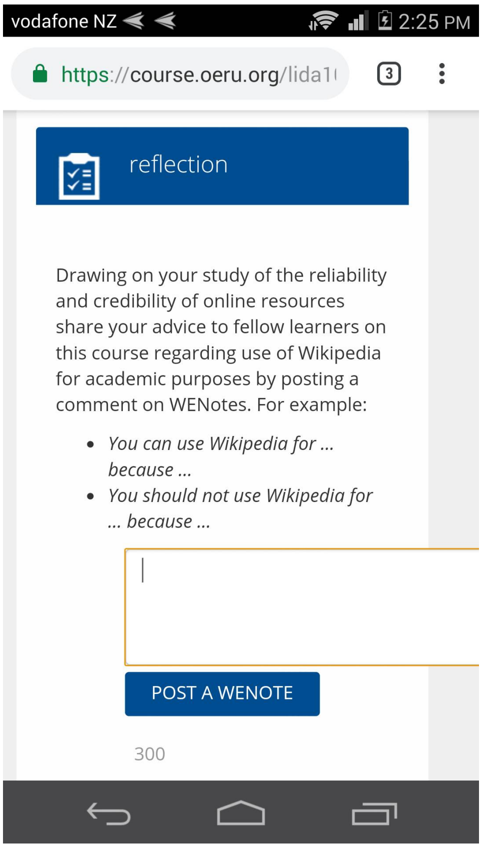



**Figure 4.15: The content does not fit when the web page in Figure 4.14 is in portrait view**




On the matter of course contribution in the form of student assignments via smartphones, it was observed that *Hypothes.is*, the tool required to complete Task 1 (annotation of web resources), had to be installed as a mobile app with the alias *AnnoteWeb*. Furthermore, to integrate *AnnoteWeb* into *Google Chrome's* mobile app, a laptop or desktop PC was required to configure the extension settings. This is because the extension settings are not supported on the *Google Chrome* mobile app. Here, it should be noted that *Hypothes.is* only works on the *Google Chrome* browser, so I could not test this activity in another browser. Figure 4.16 and Figure 4.17 show the settings options available on *Google Chrome* mobile and desktop applications. Observably, when it came to tasks that required students to annotate locally stored files (offline), *AnnoteWeb* mobile app was unsuccessful. This is because the application requires the files to be opened in *Google Chrome* browser even though locally stored. Hence, it was only possible to annotate online web resources using *AnnoteWeb*. Figure 4.18 shows how annotation was achieved using *AnnoteWeb* features indicated by a red rectangle boundary. Figure 4.19 shows how any completed user activity is harvested into the course feed.

**Figure 4.16: Google Chrome mobile app settings options – does not have the 'extensions' feature**

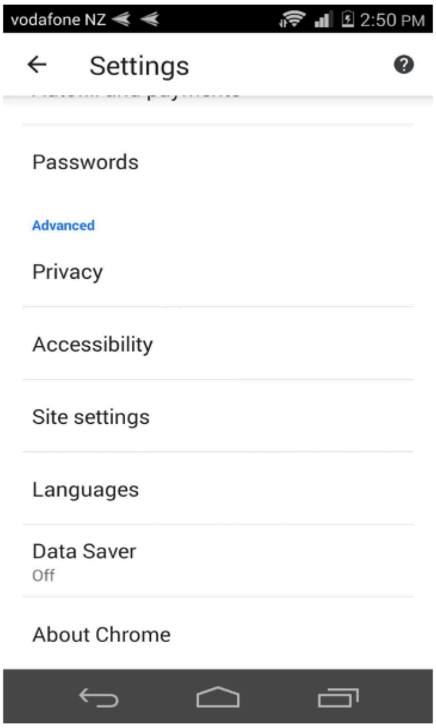



**Figure 4.17: Google Chrome desktop application settings options – supports the 'extensions' feature**

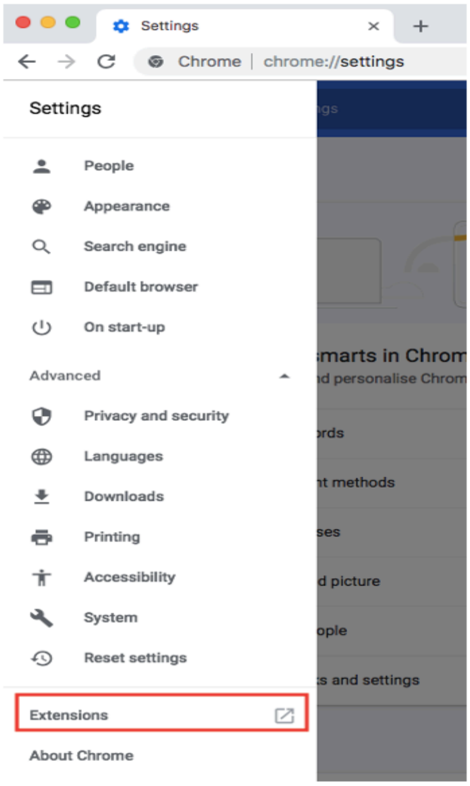


**Figure 4.18: Annotating online web resources using Hypothes.is (alias AnnoteWeb mobile app)**

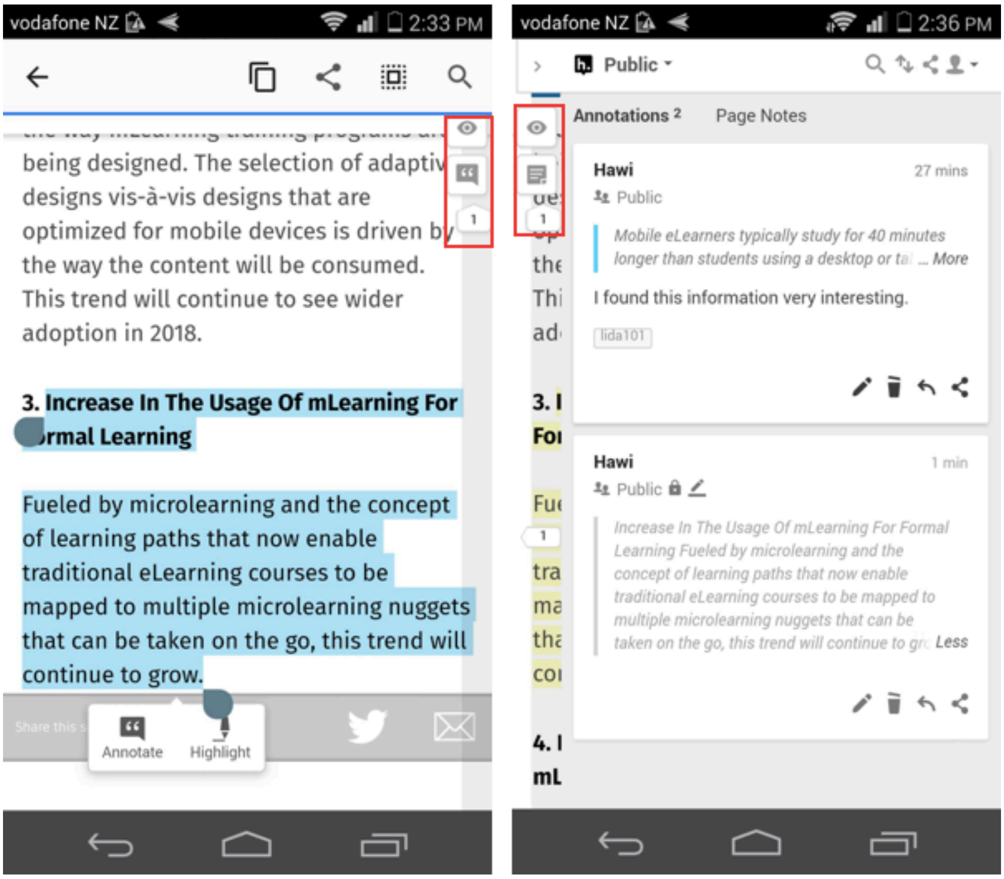
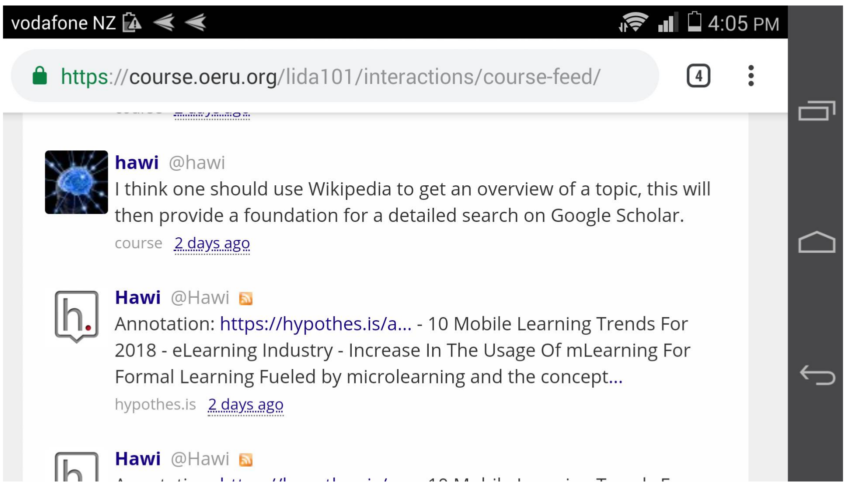



**Figure 4.19: OERu.org course feed indicates learner activity on Hypothes.is was successfully completed**



Concerning the use of citation management software to create an online reference library, this activity was completed successfully. The task required the student to either provide a public link to their reference library or a screenshot of the same. While testing *Mendeley,* I opted to submit a screenshot instead of a link, as shown in Figure 4.20. At the time of this feasibility study, *Mendeley* mobile app only worked as local and remote storage for literature resources – it did not support automatic citation and reference list generation. Conversely, *Citationsy,* the other mobile app I examined, supported automatic citation and reference list generation, as shown in the sequence in Figure 4.21. However, on the Android platform, *Citationsy* consistently hang or crashed, which made it impossible to use. On the iOS (Apple) platform, *Citationsy* worked fine, with only minor user interface issues that resolved after a few attempts. Figure 4.22 shows the sequence of creating and sharing a public link to an online reference library using *Citationsy* mobile app.

**Figure 4.20: Mendeley reference management software – screenshot on the right shows the online reference library for the course assignment**

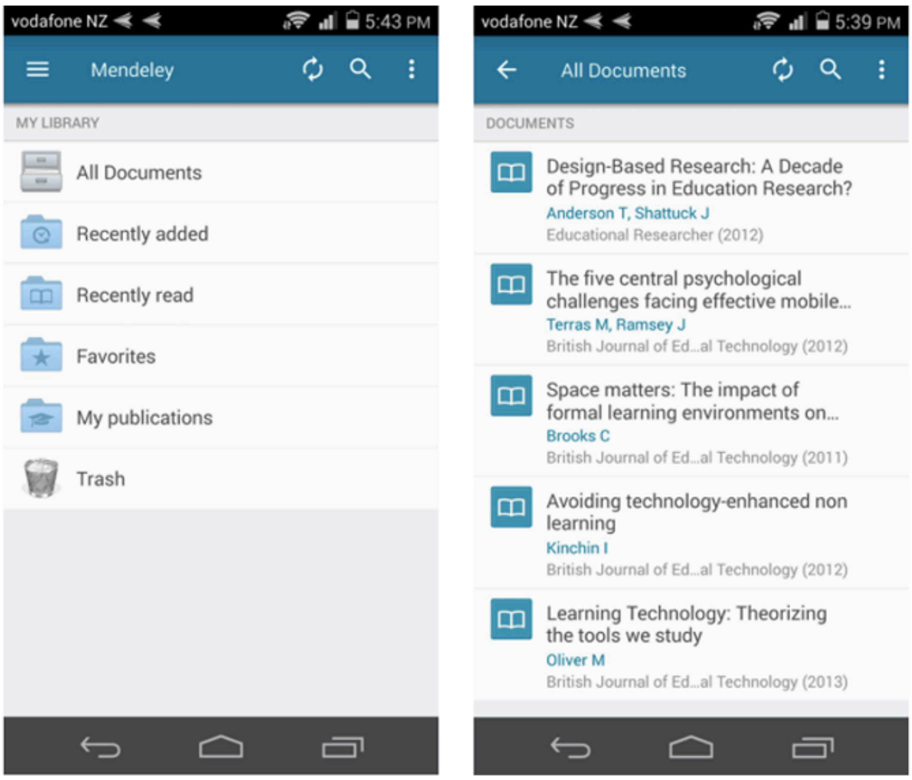
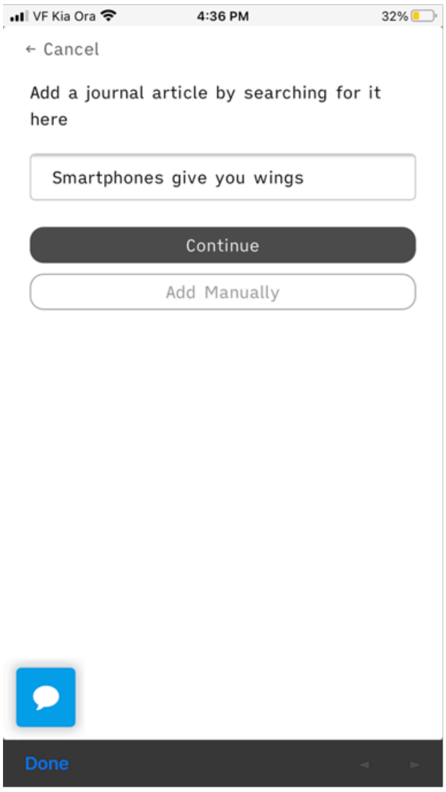
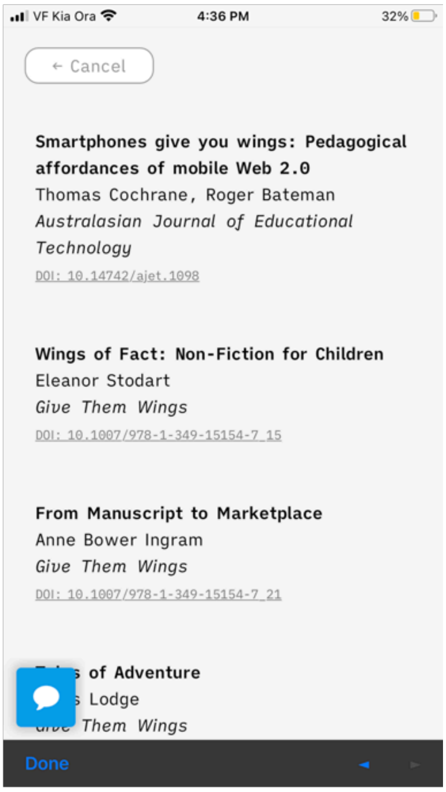


**Figure 4.21: Automatic reference list and citation generation in Citationsy app (Apple iOS platform)**

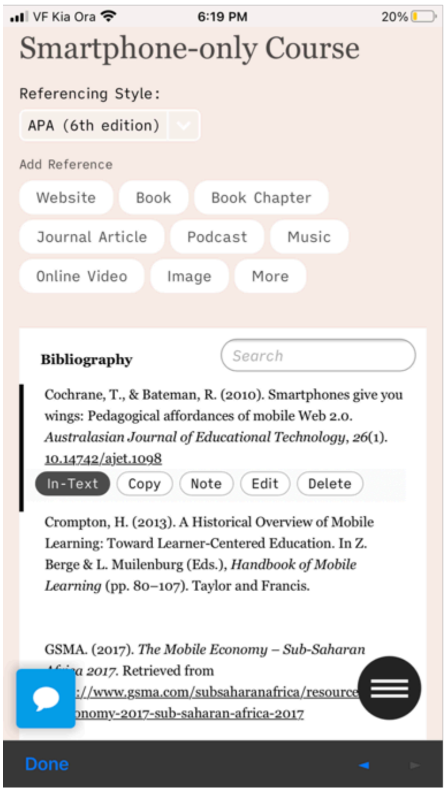
Step 1




Step 2




Step 3




Step 4

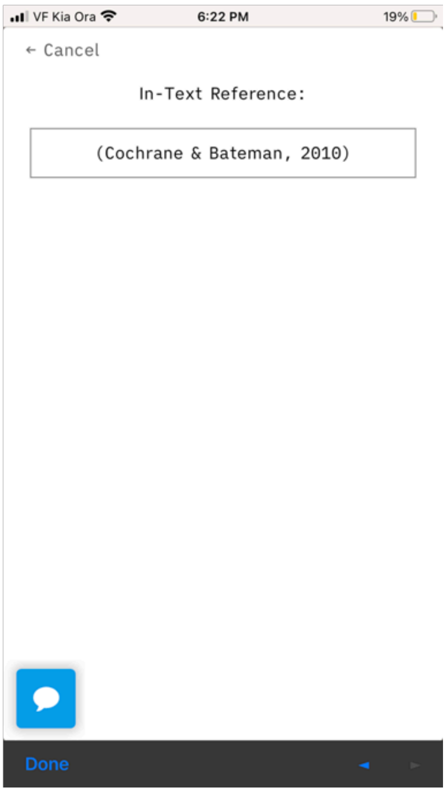
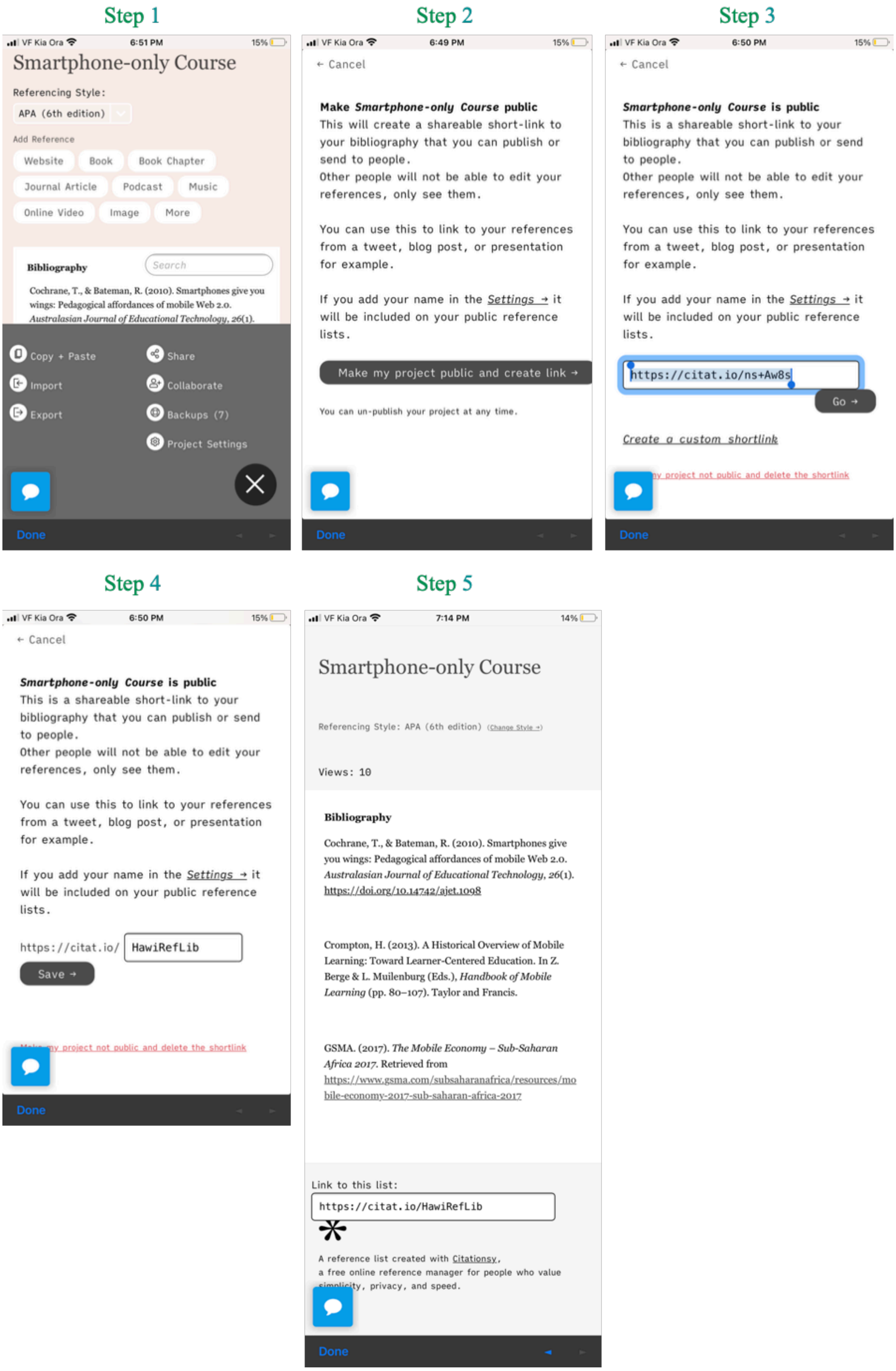


**Figure 4.22: Creating a public link to the online reference library using Citationsy app (Apple iOS platform)**



Considering the personal blog that students were required to design and maintain, setting up the blog via *WordPress* was not a concern. Both versions of *WordPress*, the mobile app and the mobile website, provided all the tools required to create a simple blogging site with multimedia content. Figure 4.23 provides a screenshot of *WordPress* mobile app setup and an example of a blog post created using the mobile app. Alternatively, Figure 4.24 shows *WordPress'* mobile web version.

**Figure 4.23: Screenshots of WordPress mobile app (left) and a blog post created using the app (right)**

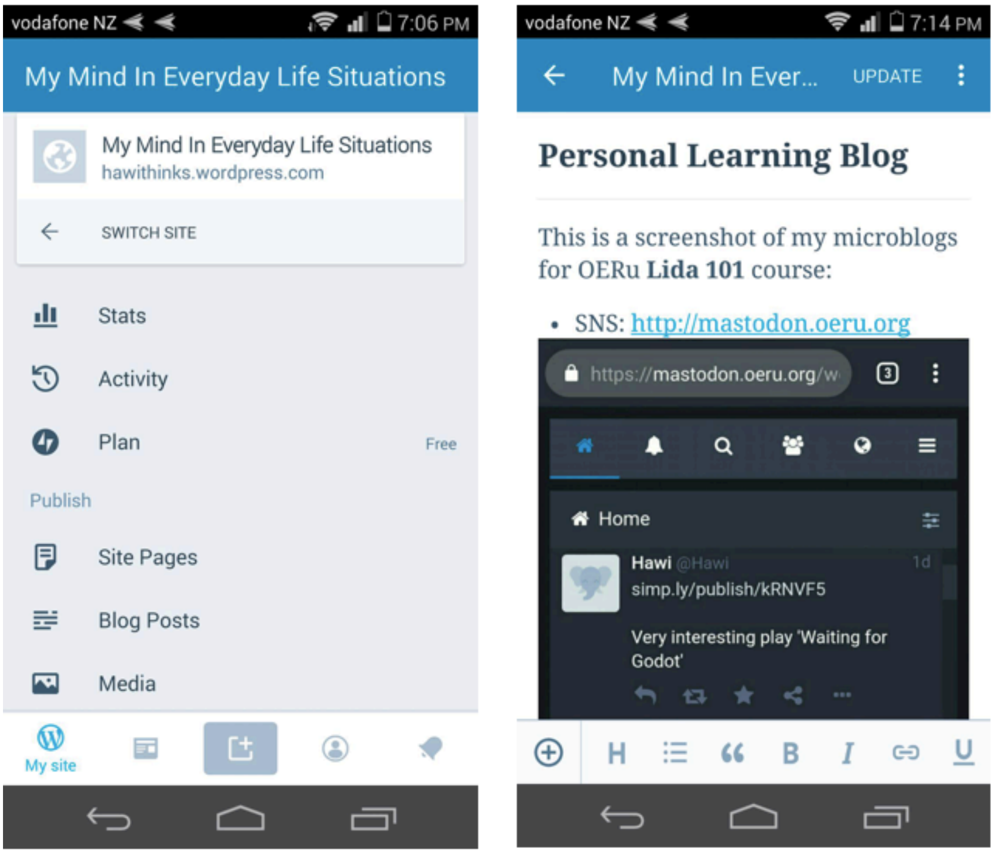
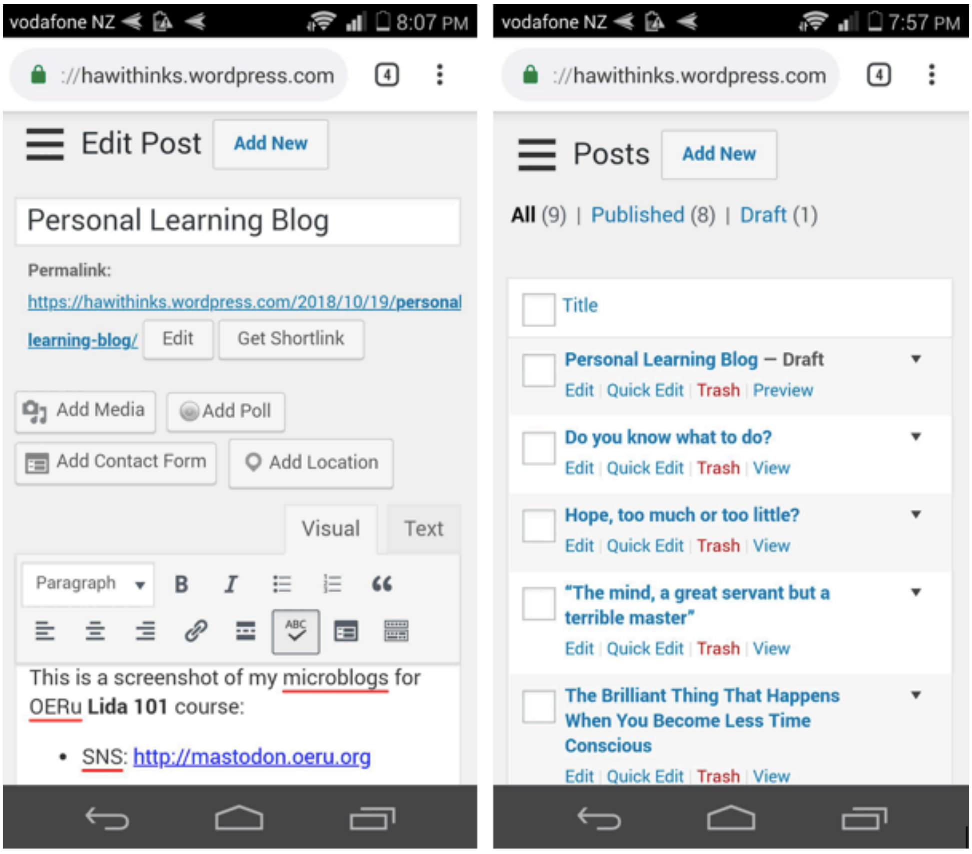


**Figure 4.24: Screenshots of WordPress mobile web version**




### *4.4.4 Discussion of findings from Feasibility Study Two*

The motivation for analysing this micro-course was to identify technical issues in existing smartphone-compatible courses that need improvement. I identified three critical technical aspects that need to be addressed when designing smartphone-supported courses. The first is display responsiveness – for efficient and effective content rendering in landscape and portrait views. The second is concerned with the provision of offline access to web pages. The third is application integration – to facilitate seamless workflow and sharing of data across multiple applications within a single environment.

Regarding display responsiveness, consideration around whether to use a web application or native application is essential. Native applications are purposely designed for the smartphone's operating system. This makes native applications highly responsive since the content adapts to the display based on the operating system specifications. On the other hand, web applications are platform-independent. In web applications, the content is adapted for various computing platforms using a responsive web design approach. Arguably, setting up a web application is generally considered faster than developing a native application. A significant reason for this is that web applications only require one build for all platforms, unlike a native application that requires one to design a distinct version for each operating system (Dua, 2018). However, the downside of web applications is that content does not always adapt to all displays. This happens because, during responsive design, the developers typically include a finite number of screen layouts. As such, rendering content outside these prescribed screen layouts will produce a distorted image. Figure 4.10 to Figure 4.13 and Figure 4.15 demonstrate the issues web-based applications have when content is rendered in different views that were perhaps not considered during the design. In this analysis, the web pages that had content rendering issues interrupted and lengthened task completion due to constantly switching between portrait and landscape mode and expanding and shrinking web pages. Diversely, native applications are fully responsive; hence one could argue that task completion times for native applications are generally shorter due to the seamless switching between different display layouts.

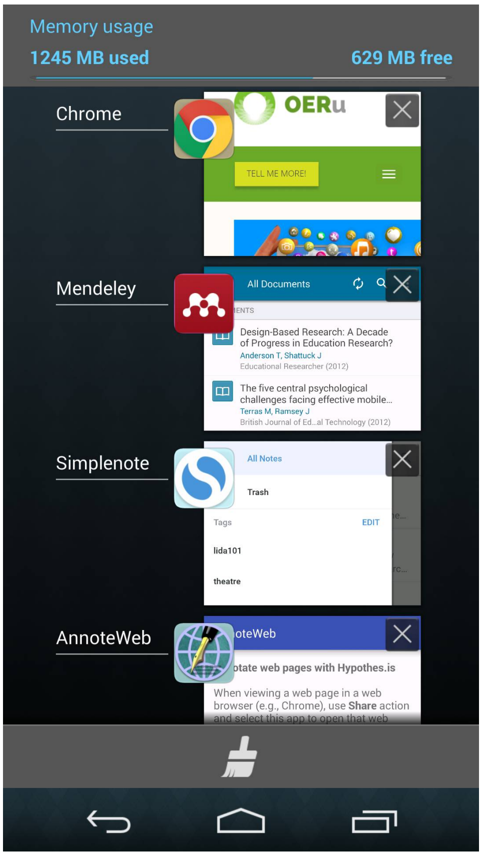
Against this backdrop of native applications versus web applications, the second crucial technical aspect to consider is whether or not to enable offline access to the course web pages. Native applications support offline mode, but web applications (such as the course examined) require an active internet connection to load web pages. This means that access to the conventional responsive web pages is often restricted in areas with unstable internet. However, enabling the offline mode is critical when designing smartphone-supported courses. As discussed in Chapter 2, due to the portable nature of smartphones, learners typically use the device across various contexts. A disruption in access to learning content as the learner moves across these contexts could lead to a fragmented learning experience, which, as previously mentioned, is one of the perceived barriers to smartphone-based learning. For example, Tossell et al. (2015) study pointed out that students were initially excited to use their smartphones for accessing their coursework because they could use their device over a wider variety of settings and at almost any time. However, over time, the participants' desire diminished, with some reporting limited internet connectivity (e.g., long page loading times). While this offline feature of native applications is admirable, they only work on the operating systems they have been designed for. In this instance, web applications come in handy as they are platform independent. Therefore, to maintain the usage of web applications but leverage the best of native applications, there have been concerted efforts towards integrating offline access in web applications. For example, although still in its infancy stages, Progressive Web App (PWA) technology has gained much attention in the last few years. PWAs are websites intentionally designed to provide a *native-app-like* experience. These websites can cache page content in the smartphone's local storage, allow push notifications, and even install a home screen icon that links to the intended website, similar to the smartphone's native application functionality (Dua, 2018). The caching techniques used by PWAs allow users to bypass the network and access web pages even without an active internet connection. PWA is an innovative technology with great potential in the future. Table 4.6 highlights the critical comparisons between native applications and web applications.

**Table 4.6: Comparisons between native applications and web applications**

| Native Application | Web Application |
|---|---|
| ▪ Purposely designed for a specific smartphone operating system (e.g., iOS or Android). | ▪ It is platform-independent (works on all device types). |
| ▪ Has higher development costs since it must be designed for each version of operating system. | ▪ Generally faster to setup because it requires only one build for all platforms/devices. |
| ▪ Fully responsive content display – content adapts to the display based on operating system specifications; hence there is seamless switching between screen layouts. | ▪ Semi-responsive content display – uses responsive web design approach, which typically has a finite number of screen layouts; rendering outside these prescribed layouts could lead to a distorted image. |
| ▪ Web pages load in offline mode. | ▪ Web pages require internet access to load. |
| ▪ It may be incompatible with some smartphone operating systems, especially the older models or low-end smartphones. | ▪ Suitable for low-end smartphones. |

In the matter of application integration (i.e., sharing of data across multiple applications within a single environment), this study's findings demonstrated that this is also an essential component to consider when it comes to designing smartphone-based courses. During the course evaluation, a single task required several mobile apps to work in tandem. Although this micro-course employed *tags* to harvest data from the various applications, none of the mobile apps provided a link to connect and share data with each other. This meant that each mobile app ran independently of the others. This manual switching between applications proved to be cumbersome and taxing on the smartphone's processor. I noticed that when several applications were running in the background, processing speed decreased, thereby slowing down task execution. Figure 4.25 shows that a significant amount of memory was used as several apps were running simultaneously and independently during course evaluation. Here, it is worth mentioning that this course analysis was conducted using a smartphone with 2GB RAM, which one could argue does not allow the user to keep lots of apps easily accessible when multitasking. In fact, at the time of this study (2018), high-end smartphones such as *Samsung Galaxy Note 9* and *Oneplus* boasted 8GB RAM capacity. High RAM capacities increase processing efficiency, consequently enhancing overall device performance. However, most laptops and desktop PC operating systems (e.g., *Windows 10*) require only 2GB RAM to provide a comfortable user experience. Therefore, it is fair to say that the 2GB RAM on the smartphone used was enough to study this course; instead, to improve the smartphone-based learning experience, the course needed better application integration. With application integration, data sharing would have been automated, and the course-required apps would only be initiated when the need to connect to another mobile app arose (Safe Software, 2018). Consequently, this would have reduced the processor's workload.

**Figure 4.25: Screenshot of course-required apps running simultaneously and independently; this significantly reduced smartphone memory and consequently slowed down processing speed**



## 4.5 Strengths and Limitations of Phase One

Phase 1 of the research, in the form of a feasibility study, aimed to provide a comprehensive analysis of whether the smartphone's technical capabilities (e.g., screen size, storage capacity, processor capacity, and bandwidth) can support existing pedagogy or be extended to further enhance the learning experience. A strength of this phase is that it provided a first insight into where we lie in principle with participating in an existing formal course on a smartphone only. As mentioned in Chapter 3, I began this research project with preconceived ideas about the potential of the smartphone to facilitate learning, informed by my experiences with students who demonstrated that it worked for them. However, the context in which 'it worked' was informal (i.e., use of independent mobile apps) so, it would have been unwise to dive in headfirst into designing a smartphone-supported blended course without examining the practicality of my ideas within a formal context (i.e., use of university-grade LMS). The associated research costs, if my ideas were proven impractical, would be frightful. Therefore, a feasibility study was an appropriate approach to explore this phenomenon, especially given the dearth of fieldwork on formal smartphone-only university courses that I could have used as a baseline. As defined by Bowen et al. (2009, p. 453), a *feasibility study* is "any sort of study that can help investigators prepare for full-scale research leading to intervention". Accordingly, in interpreting the findings of this phase, it was possible to determine the data collection procedures (e.g., ethical considerations and research skills required) as well as the resources (e.g., time to conduct the study and budgetary considerations) needed to manage and implement the next phases of the research. The implications of the findings of this feasibility study will be discussed further in relation to the results of the other phases of research in Chapters 7 and 8. Here, some limitations that need to be considered in interpreting the results are discussed next.

A noteworthy limitation was observed in *Feasibility Study One*. The expected data transfer speeds highlighted in Table 4.1 and Table 4.2 were theoretical since 1) the averages were derived from literature (i.e., secondary data rather than primary data); and 2) the speeds represent the country average and not town averages. This means there is a possibility that the real-world speeds at my research location, Homa-Bay town, could be slower. Naturally, internet speeds in urban towns are often faster than the speeds observed in rural towns such as Homa-Bay, due to better infrastructure. Several other factors slow down real-world internet speeds. For instance, besides bandwidth rates, latency, and the smartphone model (e.g., *Samsung Galaxy S9* is faster than *Samsung Galaxy S8*), the number of online users and distance from the base station (mobile internet provider) could also affect connection speeds. For example, since the mobile network capacity is often shared by many users using the same network, connection speeds are usually slower during peak times when most users are online. Likewise, the further away from the base station, the slower the internet speed. It is also worth mentioning that some mobile internet providers may intentionally slow down data access when the user reaches a predetermined limit. In this vein, the data transfer speeds derived in Phase 1 should be viewed as illustrative rather than definitive. Nonetheless, Orsmond and Cohn (2015) emphasise that researchers and reviewers alike should not expect rigorous examination outcomes when assessing the feasibility of a newly developed intervention. Furthermore, the fieldwork undertaken in Phase 4 of this research implies that the derived theoretical speeds are not far off from the real-world speeds, as the participants reported they were able to comfortably download, stream and upload their coursework via their smartphones.

## 4.6 Summary

This chapter has discussed Phase 1 of the research, which addressed the research objective: *To determine technical requirements for participating in an existing course solely on a smartphone*. To inquire into this objective, I inspected two online courses offered at two tertiary institutions. The first course was hosted within a university LMS, was predominantly designed for laptops and desktop PCs, and made heavy use of video and audio content. The aim for analysing this course was to answer the following questions: Is the screen size sufficient to view course material? Is the storage capacity enough to store course material? Is the bandwidth high enough to download and upload course material? The considerations around readability of content show that lots can be achieved, with the instructor creating the material considering some basic guidelines around aspect ratios and screen resolutions. The preliminary calculations indicate that it is feasible to 'consume' a video intensive course on a smartphone.

The second course was a web-based application with a responsive design that adapts to all computing platforms, including smartphones. The aim for analysing this course was to answer the question: Do smartphones have the software required to work on the course materials (i.e., write or create assignments)? The preliminary results demonstrate that current smartphones can perform most tasks typically done on laptops or desktop PCs. Many smartphone-based apps have been developed that simplify activities such as note-taking and essay-like typing, and even automated referencing; although not perfect, the accuracy is already promising. Therefore, the preliminary conclusion for this study was that participating in an online course via a smartphone is possible.

Ergo, having evaluated key technical capabilities of the smartphone and demonstrated that a smartphone-only course is indeed a conceivable idea, the next step is to examine whether the smartphone-supported blended course intervention shows promise of being accepted by the intended population. In other words, conduct a preliminary evaluation of the targeted participants' reactions to the proposed idea, which is the subject of the subsequent two phases.

# 5. WHAT STUDENTS THINK

TMUC student attitudes to using smartphones for university education – Phase 2

## 5.1 Background

As discussed in Chapter 1, Kenyans, especially those interested in agricultural education, have proactively found ways to use their smartphones (mobile apps) to access free online, informal education. Nonetheless, the systematic review in Chapter 2 demonstrated that very little is known about exactly how students use smartphones to support their educational activities. Farley et al. (2015) and Kaliisa et al. (2019) assert that the inability to understand the myriad of ways students use smartphones to support their learning is a formidable barrier to the adoption of smartphones as formal learning tools. Therefore, this chapter discusses TMUC student attitudes to using smartphones for formal university learning. The intention here is to identify the students' most common educational smartphone habits, activities, and preferences. The underlying assumption is that if the university management understands the factors influencing students' use of smartphones for education, they will gain insight into integrating smartphone-based learning activities into the curriculum. In this vein, a survey was extended to TMUC undergraduate students. Linking back to the methodology of this thesis, the student survey (Phase 2) addressed the following research objective: *To evaluate the roles of lecturers, students and institutions in the delivery of a smartphone-based course.* Furthermore, from the Pragmatist philosophical perspective, the overarching research question that guided this Phase 2 was: *Do the students perceive formal smartphone-supported learning favourable to their studies?* This research question was underpinned by the Pragmatist belief that research should be value-laden, meaning it should generate knowledge that benefits people or leads to the betterment of human conditions (Kivunja & Kuyini, 2017).

## 5.2 Research Method

*Quantitative Research Methods: Cross-Sectional Survey Design*

This phase of the thesis employed quantitative research methods because the variables investigated could be measured using statistical parameters. Specifically, the study utilised a cross-sectional survey design in the form of an online-based questionnaire. Unlike longitudinal survey designs that involve gathering data over time (multiple studies), cross-sectional surveys involve gathering all responses at a single point in time. Considering the research constraints of this study (as described in section 5.3.2), the cross-sectional survey design was a time-saving approach (Connelly, 2016). Moreover, since the study aimed to analyse educational smartphone trends among TMUC students, a large sample size was ideal as it would maximise the generalisability of the results. The larger the sample size, the more likely the sample exhibits similar characteristics to the target population (Creswell, 2012). Therefore, an online-based questionnaire was appropriate since it can easily be administered to a large population (Creswell, 2012).

## 5.3 Survey Design

### *5.3.1 Instrument Design*

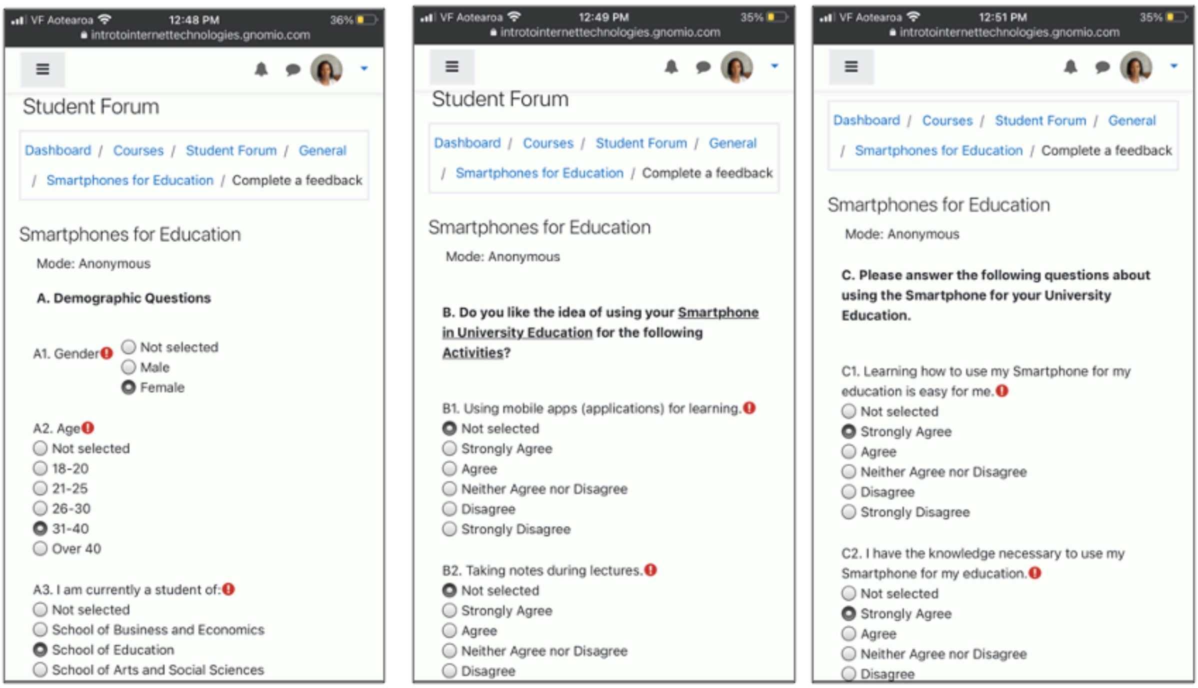
The questionnaire used in this study was adapted from an existing survey instrument by Ahmed (2016). Creswell (2012) advocates for this strategy (i.e., using an existing instrument) and asserts it is a good approach if the survey instrument meets the following criteria. The authors have provided information about the reliability and validity of scores from past uses of the instrument; the instrument should not be more than five years old and; the instrument uses accepted scales of measurement. The chosen existing survey instrument by Ahmed (2016) satisfies the aforementioned criteria and was proven to be valid and reliable. Nonetheless, some of the content was modified to suit the research requirements and the context of my research. In particular, Part C of the original survey instrument was deleted as it focused on non-academic smartphone usage. Similarly, Part D of the original survey instrument was made more concise as some items were deemed to be redundant[23].

After modifying the original survey (which had 97 items), this present study's questionnaire consisted of 42 items and was divided into three parts. Part A gathered nominal data about the respondents' characteristics (age, gender, enrolment level; smartphone ownership, and expertise; and students' awareness of free online learning resources). Part B and Part C gathered ordinal data with five-point Likert scales, ranging from "strongly agree" to "strongly disagree". Part B explored the respondents' perceptions about using smartphones for various academic activities. Part C assessed the factors influencing the respondents' real-life usage of smartphones for education. The questionnaire items were distributed as follows: Part A = 9; Part B = 13; Part C = 20 (as illustrated in Appendix D).

The survey was hosted online as a Feedback Activity on Moodle[24] LMS, and could be accessed via a smartphone (as seen in Figure 5.1). The questionnaire script started with a standardised survey introduction (see Appendix D), which described the level of ethical approval, how to ask the researcher questions and where participants could, with confidentiality, express concerns about the survey. Confidentiality was preserved by making the survey anonymous.

[23] Some examples of redundancy in Part D of the original survey instrument by Ahmed (2016, pp. 269-272) can be found between, items 8, 10 and 41, which appear to be investigating the same issue, as well as items 17, 34 and 44.
[24] Most popular online survey tools with a free version have limited features. Since I had already purchased a premium plan for Moodle LMS to use in Phase 4 for the Intervention Course, it was cost-effective to also host this student survey on Moodle, which offers reliable survey analytics tools.

**Figure 5.1: Screenshots of the online-based questionnaire as viewed from a smartphone**




### *5.3.2 Participants and Sampling*

A non-probabilistic convenience sampling technique was used to access TMUC students. The convenience sampling technique involves recruiting the nearest individuals to serve as research participants and continuing this process until the ideal sample size is achieved in the available and accessible time (Ahmed, 2016). I used the convenience sampling technique because TMUC had closed for the holidays, and due to unforeseen time constraints, it was not possible to conduct the survey when classes resumed. Meaning, I could only approach individuals living near or on-campus to participate in the survey. Arguably, it could have been possible to reach more students online (e.g., via social media). However, as mentioned in Chapter 3, when discussing ethical considerations regarding social and cultural sensitivity in collectivist cultures (especially those in the rural regions), it is important for the researcher to meet potential participants face to face when introducing a research idea. Thus, with support from

TMUC faculty[25], the survey was extended to all potential participants in the six schools at TMUC. Furthermore, to ensure that the survey was free of sampling bias and under-representation, an invitation was extended to the elected leaders of the Student Union at TMUC to help distribute the survey. The assumption was that these leaders had more access to the students thus could help reach the maximum number of participants possible. Due to the sampling technique used, there was no specified sample size for the survey. The survey was a month-long activity that took place in August 2019. By survey close-off time, a total of 114 responses had been collected[26].

Although sampling literature shows that probabilistic sampling techniques in quantitative research are more rigorous and ideal for researchers who want to make generalisations, a convenience sample can still provide useful data for answering research questions (Creswell, 2012). Furthermore, Jager et al. (2017, p. 27) assert that “in terms of generalisability, some convenience samples are less disadvantaged than others”; specifically, the authors advocate the use of homogenous convenience samples. In homogenous convenience sampling, the sample and target population consist of members from the same sociodemographic subgroup. Because the homogenous convenience sample (relative to the heterogenous convenience sample) more closely reflects the sociodemographic distribution of its target population, this sampling technique offers clearer generalisability (i.e., its estimates of the target population are on average more accurate, precise and valid) (Jager et al., 2017). In this research, the sampling frame was homogenous in that it was constrained to a specific university setting and only targeted undergraduate students. Therefore, based on Jager et al. (2017) reasoning on homogenous convenience sampling, and Fowler (2009) guidelines on what defines an

[25] Notably, TMUC Academic Registrar helped by checking that individuals who wanted to participate in the survey were enrolled TMUC students.
[26] At the time of this survey, TMUC had a student body consisting of about 1680 students.

acceptable sample, it was concluded that the sample used in this present study was a close representative of the overall student population at TMUC.

### *5.3.3 Data Analysis*

This research used descriptive statistics to analyse the survey responses. Since hypothesis testing was not the main intention of this study, inferential analysis was not necessary. The summaries from descriptive analyses were sufficient to explain emerging relationships between variables and establish patterns (trends) of educational smartphone usage among TMUC students. IBM SPSS Statistics 27 and Microsoft Excel software were used to render the following descriptive statistics: arithmetic mean, percentages, frequencies, and correlation coefficient. Furthermore, skewness was analysed to assess normality of data and identify outliers. It was essential to check for outliers because whilst they can indicate presence of an unknown phenomenon, they could also distort data distribution and affect the overall accuracy of estimates.

As earlier mentioned, the survey instrument used in this study was adapted from an existing instrument. Hence, to ensure the modified survey instrument provided scores that were still reliable, Cronbach's alpha coefficient was used to evaluate internal consistency. Cronbach's alpha coefficient measures the extent to which a set of survey items are interrelated and is expressed as a value between '0' and '1'. If the inter-relatedness is high (at least '0.70'), there is evidence that the survey items are measuring the same underlying construct, therefore indicating a reliable scale (Creswell, 2012; Tavakol & Dennick, 2011). Part A of the questionnaire was excluded from the internal consistency test because it comprised demographic data.

## 5.4 Findings from Student Survey

### *5.4.1 Reliability and Internal Consistency*

For internal consistency, a Cronbach's alpha ($\alpha$) of 0.8643 was recorded for Part B and 0.9572 for Part C. Although the high alpha (> 0.9) in Part C could suggest duplicated items (Tavakol & Dennick, 2011), after a thorough review of the *mean inter-item correlation* values, it was concluded this was not the case. The mean inter-item correlation for Part C was 0.539 (see Table 5.1), which is approximately within the generally acceptable cut-off range of 0.15 to 0.50. According Bolat et al. (2017) items with a mean above 0.50 are considered redundant, while a mean below 0.15 suggests that the items are not measuring the same construct (poor interrelatedness). In this vein, it was inferred that the derived Cronbach's alpha values (for both Part B and Part C) imply a high degree of interrelatedness among the items and indicates satisfactory reliability of the questionnaire (Tavakol & Dennick, 2011).

**Table 5.1: Summary of reliability and internal consistency statistics**

| Questionnaire Section | Cronbach's Alpha | Inter-Item Correlations | | |
|---|---|---|---|---|
| | | Mean | Minimum | Maximum |
| Part B | 0.8643 | 0.342 | - 0.058 | 0.665 |
| Part C | 0.9572 | 0.539 | 0.152 | 0.773 |

However, still on the matter of item correlations, it was interesting to note that "item B2" (in Part B) had a very low *corrected item-total correlation* value of 0.310, and if it was deleted, the Cronbach's alpha value would increase to 0.872 (see Table 5.2). According to Gliem and Gliem (2003), the rule of thumb is that corrected item-total correlation values (i.e., how well an item correlates with the total correlation scores of the other items) should be at least 0.40. But, Machuca et al. (2015) later assert that if the corrected item-total correlation values are positive then there is internal reliability. On this account, it is argued that all the items in Part B were correctly placed (fit together) since the corrected item-total values were positive (as seen in Table 5.2). Nonetheless, relative to Part B, one could argue that Part C displayed better internal consistency. Table 5.3 indicates that the corrected item-total correlation values for Part C were consistently high (> 0.40) and if individual items were to be removed, Cronbach's alpha would remain stable at 0.95.

**Table 5.2: Part B – Item Correlation Statistics**

| Survey Item | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| B1 | 51.22 | 17.695 | 0.600 | 0.851 |
| B2 | 51.44 | 18.355 | 0.310 | 0.872 |
| B3 | 51.36 | 17.825 | 0.549 | 0.853 |
| B4 | 51.46 | 17.967 | 0.425 | 0.862 |
| B5 | 51.34 | 18.634 | 0.472 | 0.858 |
| B6 | 51.38 | 16.821 | 0.664 | 0.846 |
| B7 | 51.46 | 17.684 | 0.522 | 0.855 |
| B8 | 51.39 | 17.089 | 0.667 | 0.846 |
| B9 | 51.42 | 17.874 | 0.642 | 0.849 |
| B10 | 51.34 | 17.979 | 0.645 | 0.849 |
| B11 | 51.40 | 18.190 | 0.526 | 0.855 |
| B12 | 51.38 | 18.290 | 0.509 | 0.856 |
| B13 | 51.42 | 18.299 | 0.510 | 0.856 |

**Table 5.3: Part C – Item Correlation Statistics**

| Survey Item | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| C1 | 80.19 | 89.750 | 0.616 | 0.956 |
| C2 | 80.33 | 91.162 | 0.485 | 0.958 |
| C3 | 80.65 | 86.247 | 0.543 | 0.959 |
| C4 | 80.58 | 86.281 | 0.659 | 0.956 |
| C5 | 80.44 | 86.355 | 0.810 | 0.954 |
| C6 | 80.40 | 86.101 | 0.759 | 0.954 |
| C7 | 80.38 | 86.290 | 0.786 | 0.954 |
| C8 | 80.46 | 86.410 | 0.757 | 0.954 |
| C9 | 80.50 | 87.438 | 0.592 | 0.957 |
| C10 | 80.41 | 86.244 | 0.806 | 0.954 |
| C11 | 80.48 | 86.570 | 0.740 | 0.955 |
| C12 | 80.41 | 86.103 | 0.819 | 0.954 |
| C13 | 80.46 | 85.968 | 0.749 | 0.955 |
| C14 | 80.48 | 85.739 | 0.778 | 0.954 |
| C15 | 80.58 | 86.600 | 0.613 | 0.957 |
| C16 | 80.41 | 85.678 | 0.818 | 0.954 |
| C17 | 80.57 | 87.769 | 0.626 | 0.956 |
| C18 | 80.53 | 86.039 | 0.761 | 0.954 |
| C19 | 80.49 | 86.341 | 0.784 | 0.954 |
| C20 | 80.40 | 85.092 | 0.866 | 0.953 |

### *5.4.2 Normal Distribution Assessment*

Corresponding to the values in the Likert scale used in this research, the survey data displayed a consistent negative skewness (i.e., scores were clustered to the right, with the tail extending to the left). Figure 5.2 to Figure 5.5 show that most of the participants agreed to all the variables of the study.

**Figure 5.2: Histogram showing that the student responses for Part B of the questionnaire were negatively skewed**

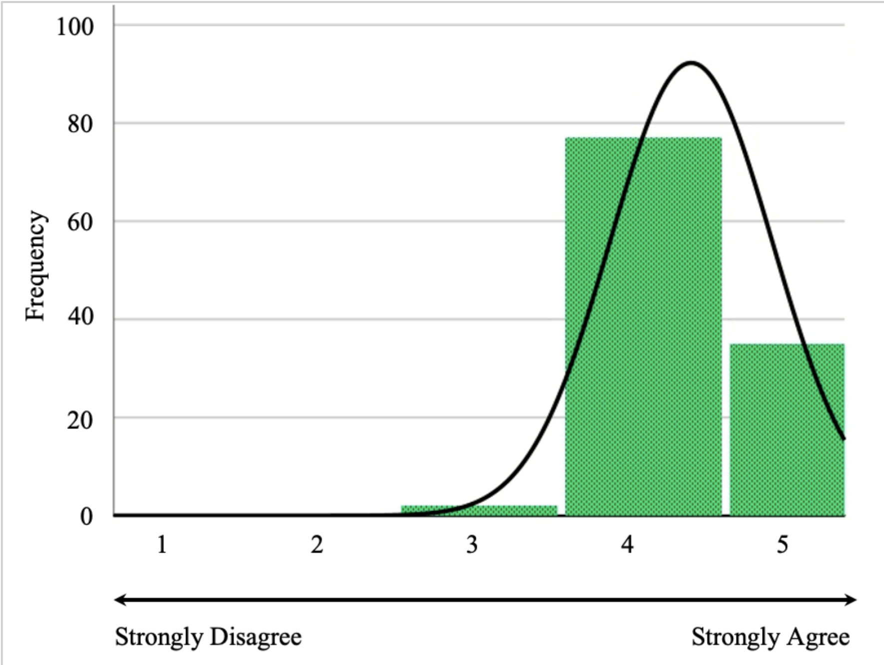



**Figure 5.3: Histogram showing that the student responses for Part C of the questionnaire were negatively skewed**

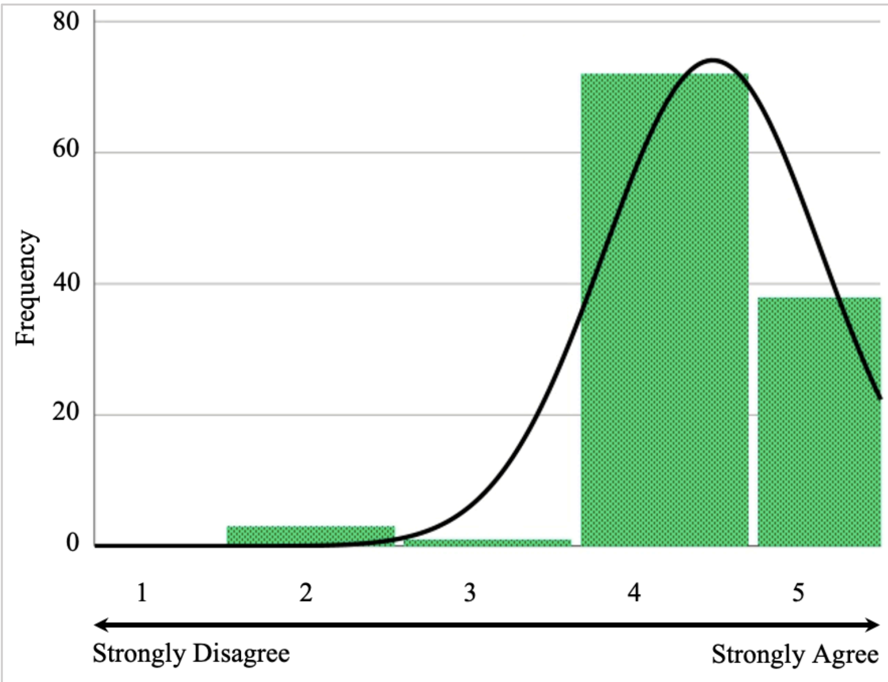


**Figure 5.4: Percentage of student response for all the survey items in Part B**

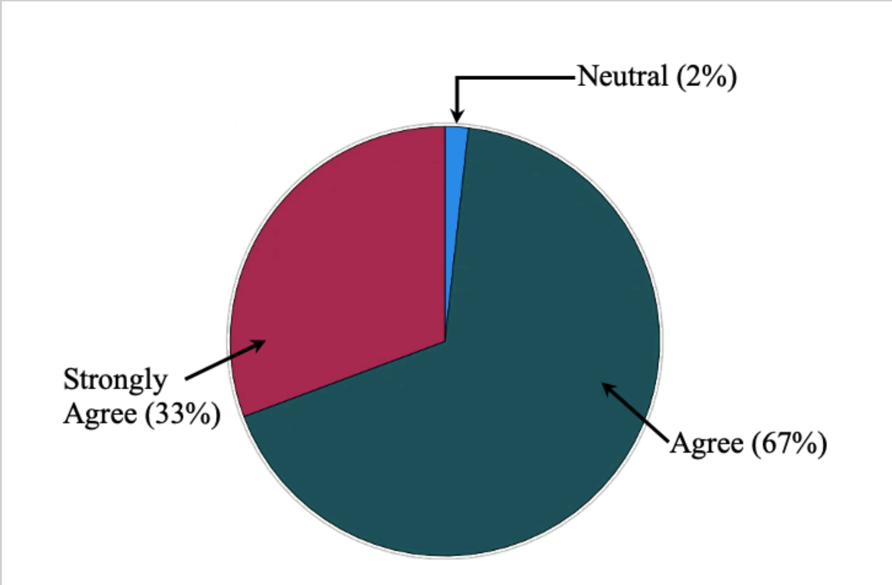
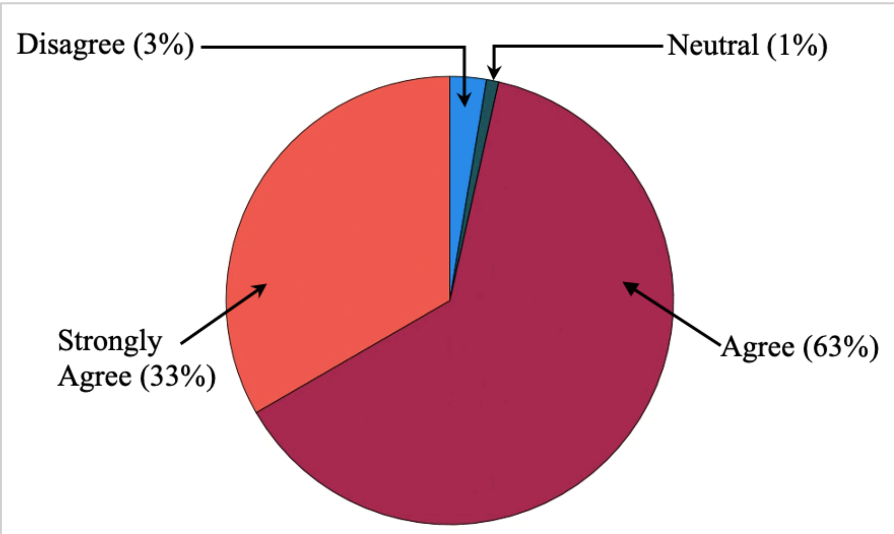
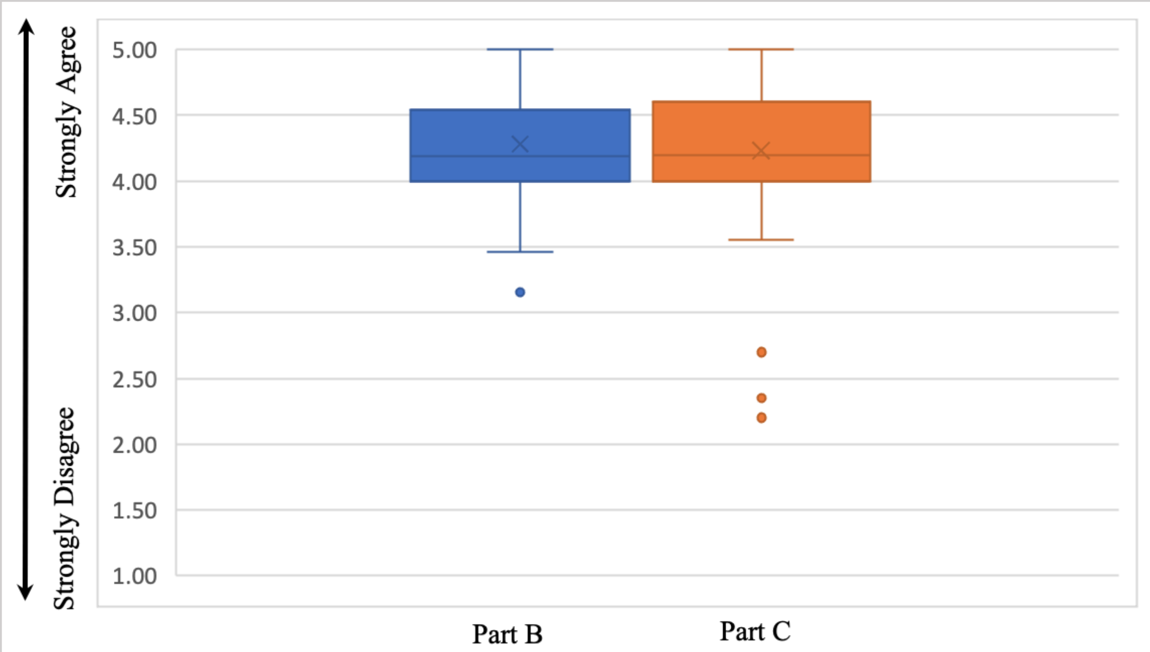



**Figure 5.5: Percentage of student response for all the survey items in Part C**




Looking back at Figure 5.2 and Figure 5.3, the maximum and minimum absolute values of skewness were -0.079 and -2.006 respectively for Part B, and 0.593 and -1.542 for Part C. These values are within the acceptable values of skewness, which fall between -3 and +3 (Griffin & Steinbrecher, 2013; Weston & Gore, 2006). Therefore, it can be inferred that the survey responses were approximately normally distributed, meaning the outliers identified (see Figure 5.6) did not significantly distort the results.

**Figure 5.6: Boxplot showing the outliers in the dataset for Part B and Part C of the questionnaire**




### *5.4.3 Questionnaire Part A Results: Respondents' Profile*

Part A of the survey sought to acquire the respondents' demographic data (age, gender, year of study and educational department); it also collected information about their smartphone ownership, smartphone operating system, their level of expertise in using the smartphone and awareness of free online learning resources (as presented in Table 5.4). Concerning demographic data, 79% percent of the respondents were male and 21% were female, which was consistent with TMUC enrolment rates at the time of the survey – 1050 males and 630 females (Source: TMUC Academic Registrar). Evidently, respondents aged 21 – 25 years showed the highest rate of response. Furthermore, Table 5.4 indicates that the sample mainly comprised third year students followed by second year students.

## Table 5.4: Respondent demographic data and profile

| Item | Respondent Profile | % |
|---|---|---|
| **A1** | **Gender:** | |
| | Male | 79 |
| | Female | 21 |
| **A2** | **Age:** | |
| | 18 – 20 | 22 |
| | 21 – 25 | 76 |
| | 26 – 30 | 0 |
| | 31 – 40 | 2 |
| | Over 40 | 0 |
| **A3** | **I am currently a student of:** | |
| | School of Education | 42 |
| | School of Business and Economics | 36 |
| | School of Biological and Physical Science | 15 |
| | School of Art and Social Sciences | 3 |
| | School of Agriculture and Food Security | 1 |
| | School of Mathematics and Statistics | 3 |
| **A4** | **Year of study:** | |
| | First | 12 |
| | Second | 34 |
| | Third | 52 |
| | Fourth | 2 |
| **A5** | **I own a mobile phone:** | |
| | Smartphone | 100 |
| | Feature phone | 0 |
| | Basic phone | 0 |
| | None | 0 |
| **A6** | **My smartphone operating system is:** | |
| | Android | 99 |
| | Apple iOS | 1 |
| | Windows | 0 |
| | Other | 0 |
| **A7** | **My skill in using a smartphone is:** | |
| | Expert user | 77 |
| | Good user | 22 |
| | Limited user | 1 |
| **A8** | **My choice device for education is a:** | |
| | Smartphone | 94 |
| | Laptop | 5 |
| | Desktop PC | 0 |
| | Tablet | 1 |
| **A9** | **I am aware of the following free online learning resources:** | |
| | Open Education Resources | 18 |
| | MIT Open Educational Resources | 25 |
| | Massive Open Online Courses (MOOCs) | 13 |
| | Coursera | 9 |
| | edX | 0 |
| | None | 35 |

Regarding whether students owned a smartphone, this was an important question as it provided insight into whether ownership trends among TMUC students followed the global trend previously discussed in the literature review. Accordingly, Table 5.4 (“item A5”) shows that all the respondents reported owing a smartphone, and Android was the most popular operating system. Furthermore, 99% of the respondents reported that their range of skills at using smartphones was good to expert.

The question concerning which computing device the students prefer to use for education was significant. It provided insight into whether smartphone-supported blended learning is a practical idea. In this vein, 94% of the respondents selected the smartphone as their preferred device for education; none of the respondents selected the desktop PC as an ideal device for education; and only 5% and 1% preferred to use the laptop and tablet, respectively.

Previously discussed literature showed that Kenyans (in general) use free online learning resources; however, it is still unclear exactly which online learning resources are used by university students. Therefore, the last question (“item A9”) in Part A of the survey focused on the respondents’ awareness and knowledge of free online learning resources. This question was essential as it provided specific information about the free online learning resources the students are cognisant of and possibly use to support their learning. The options included in this survey item were selected after a comparative analysis (on *Google Trends* website) of the most searched online learning resources in Kenya. The survey results indicated that 65% of the respondents are aware of at least one free online learning resource. Narrowing down to specific online learning platforms, 25% stated they know *MIT OpenCourseWare*, and 9% were familiar with *Coursera;* none of the respondents knew *edX*.

### *5.4.4 Questionnaire Part B Results: Respondents' perceptions about using the smartphone for various academic activities*

Part B of the survey aimed to investigate students' opinions on using smartphones for educational activities such as, reading e-books, consuming pre-recorded lectures, taking quizzes, and submitting assignments (as illustrated in Table 5.5). The items in this section were selected following an extensive review of literature on educational smartphone use (section 2.3.2 of this thesis includes some notable research studies). Since the listed activities could be integrated into a formal education setting, the rationale for Part B was to measure the respondents' willingness to accept smartphones as formal learning tools.

The data in Table 5.5 indicate a very high inclination to use smartphones for formal university education. Breaking down the more prominent responses revealed that 99% of the respondents liked the idea of using mobile apps for learning ("item B1"), and 99% reported they liked the idea of using the smartphone for collaborative online learning ("item B12"). Concerning coursework i.e., consuming lectures, taking quizzes, and submitting or completing assignments ("items B6 – B8"), at least 97% of the respondents indicated using their smartphones would be a good idea. Additionally, 95% of the respondents liked the idea of using their smartphone to take notes during lectures ("item B2").

**Table 5.5: Part B – Do you like the idea of using your smartphone for the following academic activities?**

**Key**: Strongly Agree – SA; Agree – A; Neutral – N; Disagree – D; Strongly Disagree – SD

| Item | Activity | % | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | N | D | SD |
| B1 | Using mobile apps (applications) for learning | 48 | 51 | 0 | 1 | 0 |
| B2 | Taking notes during lectures | 33 | 62 | 1 | 3 | 1 |
| B3 | Reading e-books | 37 | 61 | 0 | 2 | 0 |
| B4 | Using online resources | 32 | 65 | 0 | 1 | 2 |
| B5 | Searching for educational resources | 36 | 64 | 0 | 0 | 0 |
| B6 | Viewing Video or Audio recorded lectures | 38 | 59 | 0 | 2 | 1 |
| B7 | Taking assessments, quiz, surveys, and polling | 29 | 68 | 0 | 1 | 2 |
| B8 | Submitting assignments | 34 | 64 | 0 | 1 | 1 |
| B9 | Asking the lecturer questions | 27 | 72 | 0 | 1 | 0 |
| B10 | Communicating with friends for educational help | 34 | 66 | 0 | 0 | 0 |
| B11 | Using Social Networking sites for learning | 31 | 66 | 1 | 2 | 0 |
| B12 | Collaborating online for learning | 32 | 67 | 0 | 1 | 0 |
| B13 | Collaborating with faculty for educational help | 30 | 68 | 1 | 1 | 0 |

### *5.4.5 Questionnaire Part C Results: Factors influencing respondents' use of smartphones for education*

Section 1.1.2 of this thesis demonstrated that in sub-Saharan Africa, smartphones are an integral part of students' daily lives. However, besides the fact that smartphones are the most affordable gateway to online learning resources, very little is known about the factors that motivate students to use the device for learning. To this end, Part C of the survey sought to holistically examine factors influencing students' real-life usage of smartphones for education. This was an important construct as the survey responses helped measure the respondents' willingness to adopt a formal smartphone-supported course.

During the data interpretation, the identified motivational factors were grouped into the following six themes: price, perceived usefulness, effort expectancy, habit, social influence, and hedonic motivation. Table 5.6 provides a brief description of each theme, and the associated survey item while Table 5.7 shows all the questions in Part C of the questionnaire.

**Table 5.6: Description of the themes derived from the survey responses in Part C**

| Theme | Description | Survey Items |
|---|---|---|
| Price | Refers to the financial cost of purchasing the smartphone and the associated charges (e.g., mobile data and mobile phone text messages). | C4, C5 |
| Perceived Usefulness | The degree to which a respondent believes using the smartphone will improve task performance. | C6, C7, C10, C11, C16 |
| Effort Expectancy | The extent to which a respondent considers the use of smartphones easy and intuitive. | C1, C2, C3 |
| Habit | The extent to which a respondent repeatedly performs behaviours unconsciously or automatically. | C8, C13, C17, C18, C19, C20 |
| Social Influence | The degree to which a respondent feels that other individuals (e.g., family, friends, and teachers) believe they should use smartphones for learning. | C12, C14, C15 |
| Hedonic Motivation | Refers to the pleasure or happiness derived from using a smartphone. | C9 |

Concerning price, 93% of the respondents were confident they could comfortably afford to purchase a smartphone that they could use for learning. On the same note, 97% agreed that the benefits of smartphone-supported learning outweigh the cost of the device. Regarding the theme of perceived usefulness, upwards of 94% of the respondents stated that when used as a learning tool, the smartphone increases their productivity as it allows them to access learning content and educational support anywhere, anytime. Moving on to the theme of effort expectancy, although "item C3" in Table 5.7 shows that 12% of the respondents disagreed that using their smartphone for education is effortless, "items C1 and C2" show that all the respondents are confident they can easily learn this skill. Shifting the lens to the theme about habit, the respondents considered themselves habitual users of smartphones. For example, 96% of the respondents stated that using their smartphones for education was a habit, and 95% reported that their smartphone was so central in their daily life as a student that they would never consciously leave it at home. Lastly, concerning the theme of hedonic motivation, 94% of the respondents stated that they enjoy using their smartphone for education; only 4% stated they do not get pleasure from smartphone-based learning while 2% of the respondents were undecided.

**Table 5.7: Part C – Factors influencing respondents' real-life usage of smartphones for education**

**Key**: Strongly Agree – SA; Agree – A; Neutral – N; Disagree – D; Strongly Disagree – SD

| Item | Statement | % | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | N | D | SD |
| C1 | Learning how to use my Smartphone for my education is easy for me. | 51 | 49 | 0 | 0 | 0 |
| C2 | I have the knowledge necessary to use my Smartphone for my education. | 37 | 63 | 0 | 0 | 0 |
| C3 | Using my Smartphone for my education is effortless. | 29 | 57 | 2 | 11 | 1 |
| C4 | I have the resources necessary to use my Smartphone for my education. | 26 | 67 | 1 | 5 | 1 |
| C5 | Considering its benefits, my Smartphone cost is acceptable for my university education. | 32 | 65 | 1 | 2 | 0 |
| C6 | Using my Smartphone for my university education increases my productivity. | 39 | 56 | 2 | 3 | 0 |
| C7 | My Smartphone assists me in my university assignments. | 39 | 58 | 1 | 2 | 0 |
| C8 | I regularly use my Smartphone to access helpful learning content from the Internet to aid my university education. | 33 | 63 | 1 | 3 | 0 |
| C9 | I get pleasure using my Smartphone for my education. | 32 | 62 | 2 | 3 | 1 |
| C10 | My Smartphone lets me learn anywhere and anytime. | 35 | 62 | 1 | 2 | 0 |
| C11 | I use my Smartphone to communicate with my university classmates for educational help. | 32 | 63 | 2 | 3 | 0 |
| C12 | I collaborate with my university classmates using my Smartphone for my education needs. | 35 | 62 | 1 | 2 | 0 |
| C13 | My Smartphone is the first device I use to contact my classmates for educational help. | 34 | 62 | 1 | 2 | 1 |
| C14 | My family is supportive of the use of my Smartphone for my education. | 30 | 66 | 1 | 2 | 1 |
| C15 | My university lecturers and supervisors encourage me to use my Smartphone for my education. | 27 | 66 | 0 | 6 | 1 |
| C16 | My Smartphone gives me flexibility in learning when I access online content for my university education. | 39 | 58 | 0 | 3 | 0 |
| C17 | My Smartphone is central to my daily life. | 25 | 70 | 0 | 5 | 0 |
| C18 | As a student, leaving my Smartphone at home would force me to go back home and pick it up. | 32 | 63 | 1 | 4 | 0 |
| C19 | The use of my Smartphone has become a habit in my education. | 30 | 66 | 1 | 3 | 0 |
| C20 | I plan to continue using my Smartphone for my education. | 39 | 58 | 0 | 3 | 0 |

## 5.5 Discussion of findings from TMUC student survey

The survey results demonstrate that TMUC students are overwhelmingly willing to use smartphones for formal education, especially since they already own smartphones. The fact that only 5% selected the laptop as their preferred device for education while none selected the desktop PC, compared to the 94% who chose the smartphone, validates the technology trends previously discussed in the literature (see Figures 1.1 and 1.2). These findings reemphasise that desktop PC and laptop ownership in rural Kenya is still very low. Moreover, the results lend credence to this thesis' assumption that the smartphone is the most practical device to facilitate technology-enhanced learning in rural regions of sub-Saharan Africa.

Reflecting on the conceptual framework described in Chapter 2 (section 2.3.4), I mentioned that teachers might initially have to exploit the use of OERs when developing the online learning content for a smartphone-supported blended course. On that note, the survey results showed that this idea of using OERs is indeed practical. Out of the 96% of the respondents who expressed they regularly use their smartphone to access online learning resources, 65% reported they know of at least one OER. These results imply that many students at TMUC supplement their coursework with informal online learning resources. Notably, the survey findings suggest that the most popular free online learning platform among TMUC students is MIT OpenCourseWare. Massachusetts Institute of Technology (MIT) is well known as the forerunner of the open educational resource movement; the MIT OpenCourseWare initiative began in the year 2001, and today it is regarded as one of the most valuable OER repositories for students and teachers.

Concerning the types of academic activities best suited for the smartphone, the results showed that nearly all the respondents liked the idea of recorded lectures. This is a noteworthy observation as it justifies this thesis' assumption that integrating online learning into the current classroom-based lessons could enrich the educational experience of many TMUC students. Furthermore, it demonstrates that the previously proposed idea of using a flipped classroom pedagogy whereby the lectures are delivered online, thus freeing on-campus sessions for group discussions, is a promising approach. Regarding the delivery of smartphone-supported academic activities, 99% of the respondents reported they like the idea of using mobile apps for learning. A conclusion that can be drawn from this finding is that if TMUC does implement online learning, management should ensure the LMS has a mobile app function. Unlike web-based LMSs, mobile-based LMSs allow offline access. Given the varying contexts in which students use their smartphones, offline access is invaluable (see Chapter 4, section 4.4.4 for an in-depth comparison between native (mobile) applications and web-based applications).

Moving on to the factors that influence students' use of smartphones for education, research shows that having a clear understanding of these motivational factors can help university management implement proper strategies for smartphone-based learning (Cheon et al., 2012; Yeap et al., 2016). In this study, the respondents displayed an active use of smartphones for collaborative learning. The findings show that almost all the respondents use their smartphones to collaborate online with their classmates. Furthermore, seeing as 97% stated they like the idea of using social media network sites for learning, it is very likely that these collaborative learning activities happen on the most popular social media platforms in Kenya – Facebook, Twitter, and WhatsApp. As previously outlined in the literature, sub-Saharan African countries embody a collectivist culture; hence group-based activities form an essential part of the learning process and significantly increase student engagement. In this vein, any technology that enhances collaborative learning activities is highly regarded in these communities. Social media networks have revolutionised how learners interact. Through social media, learning occurs through a many-to-many approach rather than just the one-to-many or teacher-centred approach. The benefits of social media in facilitating collaborative learning are well-documented (Gikas & Grant, 2013; Kim et al., 2014; Kim et al., 2015; Pimmer et al., 2012; Rambe & Bere, 2013). Therefore, when integrating smartphone-supported learning strategies in sub-Saharan Africa, educators need to have a plan for how a community of learners (discussion forums) will be created online using social media platforms. Xue and Churchill (2019) propose a comprehensive framework for the educational adoption of mobile social media.

Another significant factor influencing the respondents' use of smartphones for education is that the device enables them to work on their assignments. This sentiment was shared by 97% of the survey respondents. Perhaps that is why almost all of them felt that using their smartphone for education increases their productivity. These results demonstrate the need for educators to design assessments that consider the smartphone's functional capabilities that set it apart from laptops or desktop PCs. For example, compared to the laptop and desktop PCs, the smaller screen size of the smartphone could make writing long essay-like assignments a tedious process. Therefore, educators can allow students to submit assignments as audio files, video files or as an image of a handwritten assignment. Arguably, considering the impressive computing capabilities and portability of present-day smartphones, creating and sharing audio, video and image files is faster (more convenient) on smartphones (compared to laptops and desktop PCs).

Finally, although 99% of the respondents reported they are generally skilful smartphone users, it is worth mentioning that 12% of the respondents did not feel confident about their skills when using their smartphones for educational purposes. This observation is consistent with the findings of the research by Gikas and Grant (2013, p. 23), which demonstrated that even learners who consider themselves “technologically savvy” can still struggle with learning with the technology and require support. Therefore, to fully leverage the benefits of smartphone-supported learning, students need to be trained on how to use the smartphone for educational use. After all, how technology is used in the informal space differs from its use in a formal educational context (Merchant, 2012; Spector et al., 2014; Tossell et al., 2015). On the bright side, the survey results revealed that all the respondents were confident they could easily learn how to use their smartphones in a formal education setting.

## 5.6 Strengths and Limitations of Phase Two

This phase examined students’ attitudes to using smartphones for education. The intention was to identify the students’ most common educational smartphone habits, activities, and preferences. The research question that guided this phase was, *Do the students perceive formal smartphone-supported learning favourable to their studies?* Concerning the research question, this Phase 2 has proven that students strongly believe the smartphone is an essential learning tool. Another strength of this phase is that the survey results proved that a significant number of the students at TMUC could afford to access online learning content using their smartphones. The survey results reinforced what was observed in the literature review that despite the poverty levels in the rural regions of sub-Saharan Africa being significant, an increasing number of this population is now finding practical ways to afford low-cost high-specification smartphones. This was evident as all the respondents reported owning smartphones; none owned the cheaper feature phones and basic phones, which have lower computing capabilities (i.e., they cannot facilitate online learning). Therefore, with the knowledge that smartphone-supported learning could be a financial burden on the students, but one they are willing to overcome, Phase 2 paved the way for Phase 4 of this research, which required first-year students at TMUC to participate in a smartphone-supported blended course.

Moreover, Phase 2 provoked reflections about factors that might be influencing students' use of smartphones for education. As stated earlier, literature shows that smartphones are widely used to access online learning content; however, research on why and how students in sub-Saharan Africa use smartphones for education is still very scarce. As such, the survey data in this phase provides insight into the salient factors influencing the use of smartphones for education. These motivational factors are grouped into six major categories: 1) Price – students use the smartphone to access learning resources because it is affordable; 2) Perceived Usefulness – students use smartphones in education because it increases their productivity; 3) Effort Expectancy – students use smartphones because it does not require much effort; 4) Habit – the smartphone has become such a central part of the students' daily life that not using it for education seems counterintuitive; 5) Social Influence – students use smartphones because their family, friends and teachers encourage them to do so; and 6) Hedonic Motivation – students use smartphones because it is an enjoyable (pleasurable) experience. With this knowledge of the factors influencing students' current usage of smartphones, educators can better implement smartphone-based learning strategies that are student-centred. The implications of the findings of this Phase 2 will be discussed further in relation to the results of the other phases of research in Chapters 6, 7 and 8.

A limitation of the survey is that the sample size was small, meaning there might be students who hold other views that have not been captured. Indeed, Fowler (2009) asserts that sample size does not define the credibility of survey results, and a sample size of 150 can still accurately represent the views of a target population of 15,000. According to Fowler (2009) what matters is that the sample size appropriately represents the subgroups of the target population. In this study, the subgroups included first, second, third and fourth-year undergraduate students. Whilst the second and third-year students were well represented, and the first-year students moderately represented, the survey results indicate that fourth-year students might have been under-represented. The latter subgroup constituted only 2% of the sample population (i.e., only two survey respondents were fourth-year students). At the time of the survey, there were 111 enrolled fourth-year students out of a total student population of 1680. Therefore, it must be acknowledged that the survey results could be biased to the extent that some fourth-year students might hold views that differ from what has been captured in this survey.

## 5.7 Summary

This chapter has discussed Phase 2 of this research, which addressed the research objective, '*To evaluate the roles of lecturers, students and institutions in the delivery of a smartphone-based course'*. This phase acknowledged the pivotal role of students in integrating technology-enhanced learning strategies in the classroom, thus aimed to investigate TMUC student attitudes to using smartphones for formal education. The guiding research question for this phase was, *Do the students perceive formal smartphone-supported learning favourable to their studies?* To this end, a quantitative online survey was extended to TMUC undergraduate students. The survey examined students' most common educational smartphone habits, activities, and preferences. The results indicate that smartphones are already an integral part of TMUC students' informal education and that students have a strong desire to integrate smartphones into their formal education. Notably, the respondents reported that the smartphone increased their productivity as it facilitated collaborative learning with their classmates and helped them complete assignments. Furthermore, given that the current university pedagogies do not comfortably support smartphone use, the respondents were confident they could easily learn how to use their smartphones in a formal education context.

Equipped with the knowledge that TMUC students support the idea of a smartphone-supported course, the next step in this mixed-methods case study research is to examine lecturers' attitudes to integrating smartphones as pedagogical tools in their courses. Thus, guided by a qualitative approach, the next chapter (Phase 3) presents findings from interviews with lecturers at TMUC.

# 6. WHAT LECTURERS THINK

TMUC lecturer perspectives on smartphones as pedagogical tools – Phase 3

## 6.1 Background

The relationships between technology and pedagogy have been widely discussed in literature (Anderson & Dron, 2011; Kinchin, 2012; Oliver, 2013). Whilst Phase 1 of this research (Chapter 4) focuses on technology, in this Phase 3, the focus is on pedagogy. Teachers are a crucial centrepiece when it comes to the adoption of any new technology-enhanced learning approach. A feeling of being unable to combine technology with the pedagogy (or subject matter) will likely prevent the teacher from using the technology in their teaching (Spector et al., 2014). Therefore, "considering that teachers are the gatekeepers to technology integration in the classroom" (O'Bannon & Thomas, 2015, p. 110), in this qualitative phase, I interviewed TMUC lecturers to gain insight into their attitudes towards smartphone-supported blended learning.

Here, it is essential to remind the reader why the topic of smartphone-supported blended learning should be of interest to lecturers at TMUC (and educators across public universities in Kenya as they share similar resource constraints[27]). At the time of this research, TMUC only offered classroom-based courses (no online courses). However, the largest lecture halls at TMUC could accommodate a maximum of 70 students (see Figure 3.9), yet the common courses (i.e., those shared across multiple faculties) had upwards of 300 students. Consequently, many students could not attend common course lectures due to overcrowded lecture halls, thus leading to diminished learning experiences. Therefore, a smartphone-

[27] Refer to Chapter 3, Section 3.5.1 for more information about Kenya's Higher Education Landscape.

supported blended course would be ideal as it would allow teachers to deliver their lectures online, thus could help resolve the negative impact of overcrowded lecture halls. Furthermore, as previously highlighted in Chapter 3, TMUC only has two computer laboratories with a total of approximately 65 computers (see Figure 3.10 and Figure 3.11); hence suggesting the use of desktop PCs and laptops to facilitate blended learning would not be practical.

Therefore, the major themes explored during the interviews included: 1) the lecturers' current teaching practices that incorporated smartphone-use; 2) the lecturers' perceptions on the merit of using smartphones in education; 3) perceived barriers to the fast adoption of smartphone-supported blended learning and possible ways to mitigate these obstacles; and 4) their feelings towards having to alter their teaching styles. Connecting back to the methodology, this phase of the research addresses the research objective, '*To evaluate the roles of lecturers, students and institutions in the delivery of a smartphone-based course*'. The constructive dialogue that emanated from the interviews helps to demystify smartphone usage in formal higher education, thereby contributes to the limited body of knowledge concerning smartphone-supported blended learning in sub-Saharan Africa.

## 6.2 Research Design

### *6.2.1 Qualitative Research Method: Semi-Structured Interviews*

This phase of the research was guided by a qualitative design. A qualitative approach allowed me to derive rich descriptions of lecturers' experiences and stories regarding smartphone use in formal education. Interviews are an appropriate method for collecting information about people's views and perspectives (Creswell, 2012). During the interview, the participants were asked a series of open-ended questions as described in Table 6.1. The open-ended questions allowed the participants' thought processes to be fully expressed unrestrained by the researchers' opinions or past research findings, which helped give a sense of the relative importance of the aspects the lecturers discussed. A semi-structured format was suitable as it allowed probing for further information, elaboration, or clarification of the responses, if needed, to help my understanding and gain as full a picture of their views as possible. The semi-structured format also enabled me to phrase and rephrase as necessary to help understanding of the questions. Individual interviews were most suitable because the lecturers were likely to feel comfortable expressing their views one-on-one and because the purpose was to understand individual views in-depth.

I conducted the one-on-one interviews with each participant in person at TMUC Boardroom in July 2019. The interviews were audio-recorded, with permission from the participants. The duration of the interviews ranged in length from twenty to thirty minutes. The interviews were conversational but guided by the questions highlighted in Table 6.1. The responses were mainly in English, but a few respondents used a bilingual medium of English and Swahili. Pseudonyms were used to protect the identity of participant lecturers.

**Table 6.1: Interview questions and the rationale of each question**

| Interview Question | Purpose |
|---|---|
| 1. Have you ever encouraged students to use a smartphone in your course? If so, please describe how? | This question is asked to examine the current teaching practices that incorporate smartphone use. It provides insight into how to integrate smartphone-supported blended learning strategy into the existing pedagogy. Implementing a strategy that considers how the technology is already being used may accelerate the uptake of the technology. |
| 2. Please comment on the merit of using smartphones in education. Can they be used to enhance formal education in universities? If so, please describe the ideal context to use them. | This question probes the perceptions of the lecturers regarding the effectiveness of using smartphones to facilitate student learning. It provides insight into whether the initial implementation of the proposed approach is feasible. If the lecturers do not see the value of smartphone-supported blended learning, university management will probably be reluctant to adopt it. |

| Interview Question | Purpose |
|---|---|
| 3. What factors restrict you from fully incorporating smartphones into your formal teaching? | This question targets the elements that slow down the implementation of smartphone-supported blended learning and provides further insight into mitigating these obstacles. |
| 4. How do you feel about potentially having to alter your teaching style? | The purpose of this question was to capture any existing apprehensions towards having to integrate new teaching approaches. The responses provide insight into how far to extend the teaching capabilities to ensure a smooth transition into smartphone-supported blended learning. |

### *6.2.2 Participants and Sampling*

As previously outlined in Chapter 3 (section 3.5.2), TMUC has six faculties, with 20 full-time lecturers and around 40 part-time lecturers. The sampling for this phase was purposeful as I approached the full-time lecturers. Vasileiou et al. (2018, p. 2) advocate for purposive sampling in qualitative studies stating that compared to random sampling, it is more efficient in ensuring the researcher selects a sample that provides "richly textured information, relevant to the phenomenon under investigation". For the full-time lecturers, teaching is their career, and they typically have tasks beyond classroom teaching (such as planning the curriculum, structuring degrees, and developing new teaching approaches). In this vein, they have increased interaction with the students, hence have more knowledge about the current state of learning in the institution.

Although all 20 full-time lecturers were invited to participate, based on the Pragmatic considerations adopted in this research, the sample size was largely determined by the availability of the participants. Even so, I achieved high participation with 17 lecturer interviews. This high number of participants (17 out of 20) is a testament to the lecturers' interest in smartphone-supported blended learning and their perceived need for change. Regarding sample size, several researchers have proposed 12 as a minimum sample size at which one could expect to reach thematic saturation – the point at which no new concepts emerge from subsequent interviews (Vasileiou et al., 2018). Furthermore, "samples in qualitative research tend to be small in order to support the depth of case-oriented analysis that is fundamental to this mode of inquiry" (Vasileiou et al., 2018, p. 2). Therefore, the sample size (n = 17) was deemed to be a manageable number and sufficient for the qualitative analysis and scale of this present study. The 17 participants came from different faculties at TMUC. Table 6.2 presents a summary of the demographic characteristics of the study participants.

**Table 6.2: Profile of the interviewees (demographic characteristics)**

| **Category** | **Number of Participants (n)** |
|---|---|
| Faculty | Education (n = 6)<br>Biological and Physical sciences (n = 6)<br>Business and Economics (n = 5) |
| Gender | Female (n = 2); Male (n = 15) |
| Age range | 30 – 40 years (n = 4); 41 – 55 years (n = 13) |
| Teaching Experience | 2 to 4 years (n = 2); Above 7 years (n = 15) |
| Qualification | Ph.D. (n = 15); Masters (n = 2) |

### *6.2.3 Thematic Analysis*

I manually transcribed each interview. To ensure transcription accuracy, I employed member checking – a validation strategy suggested by Creswell (2012), which allows participants to review transcribed data. All the participants in this study were given the option of reviewing their transcripts. Four participants responded; one added a few additional comments and minor clarifications, while the other three had no suggestions for changes. To further secure participant validation, I presented a summary of the findings to all the interviewees in the form of videos, then used an online survey to gather feedback on whether their perspectives were effectively captured in the reported findings. Ten participants completed the survey, and they all confirmed that the findings accurately and adequately represented their perspectives.

The transcripts were inductively analysed using the guidelines for thematic analysis proposed by Clarke and Braun (2013). To verify that the findings were consistent with the raw data collected (dependability), I used the code-recode method suggested by Anney (2014). This strategy involves coding the same data twice with an allowance of a two-week gestation period between the two events. Afterwards, the two sets of codes are compared to observe any emerging differences. I obtained nearly identical results, which according to Anney (2014), indicates the stability of the study findings over time. Upon exhausting all possible themes, I assigned verbatim accounts to show relationships between the interview data and the various themes; the prominent themes are reported in the next section. Table 6.3 describes a high-level view of the steps taken during the thematic analysis and an overview of how the code-recode method worked in practice.

**Table 6.3: Steps taken during the thematic analysis of the lecturer interviews**

| Step: | Description of thematic analysis: |
|---|---|
| 1. Familiarisation of data | Read each transcript and noted down keywords (or synonyms) that the lecturers used repeatedly as these indicated that those ideas were important to them. |
| 2. Coding (first round) | Reread each transcript and used the keywords derived in Step 1 as labels (codes) to describe content in a given line, sentence and/or paragraph of the transcript. These were segments of descriptions that seemed significant either because they were recurrent, were emphasised by a participant, or had been mentioned by other authors previously in mobile learning literature. |
| 3. Searching for themes (first round) | Generated a code (label) frequency list, showing the number of times a particular code or label occurred across the 17 transcripts. This initial coding generated 30 key ideas, some of which were overlapping or related. |

| Step: | Description of thematic analysis: |
|---|---|
| 4. Recoding (second round) | Two weeks after performing Step 2, I reread the transcripts, but this time I assigned my own labels/keywords to describe the content in a given line, sentence and/or paragraph (I did not use keywords from transcripts as was the case in Step 1). I altered my approach in the second coding process to see whether I would get the same results despite the alteration in coding style. |
| 5. Searching for themes (second round) | Generated a second code (label) frequency list, showing the number of times a particular code or label occurred across the 17 transcripts. This second round of coding generated 22 key ideas, some of which were overlapping or related. |
| 6. Reconciliation of the two code frequency lists generated in Step 3 and Step 5 | I sorted the codes into groups according to similarities in ideas and merged similar codes (i.e. labels describing the same idea) to come up with one overall code frequency list. |
| 7. Defining the prominent themes | For each interview question, I identified the most recurring codes that had been discussed by 9 or more lecturers as this would show more than half of the participants shared the same perspective, and therefore were prominent themes. Although some themes did not reoccur as often (i.e. less than half of the participants discussed the topic), I included them due to the nature (importance) of the interview question and what existing literature had said about the topic. Following data analysis, 8 major themes and 3 sub-themes emerged. |

## 6.3 Results from Interviews with TMUC Lecturers

The crux of this study was to explore lecturer perceptions regarding the formal use of smartphones to facilitate blended learning at TMUC, a rurally based public university in Kenya. The results are herein presented and discussed in line with the interview questions stated in Table 6.1. Following data analysis, eight major themes and three sub-themes emerged.

The first question (Q1) aimed to investigate whether the participants currently allow their students to use smartphones for academic activities. Two themes surfaced (*sharing of course material* and *information search*):

**Q1 – Theme: Sharing of course material**

Most of the participants (n = 13) encourage smartphone use in their course, especially when sharing course notes with their students. Notably, the lecturers preferred to use *WhatsApp* mobile app on their smartphones to share notes instead of the traditional way of sending an e-mail via a personal computer. The participants felt their smartphone was a more convenient medium to reach out to the students:

> *Participant 16 – Yes, I encourage the use of smartphones in my class because we use a lot of e-books since students cannot afford paperbacks. At times I scan book sections [in compliance with Copyright Acts] and share with them on WhatsApp.*

> *Participant 1 – Some students do not like taking notes in class and often request me to send them soft copy notes. So, sometimes I usually take photos of my handwritten notes and send them to the students via WhatsApp.*

**Q1 – Theme: Information search**

Almost all the interviewees (n = 15) stated they often urge students to search online for educational content during class time. For example, some participants described how they already use smartphones in their formal teaching of complex topics that require audio-visual content from the Internet. These statements from two of the participants are indicative of this theme:

> *Participant 4 – Sometimes when I want to explain to students the nature of how something grows overtime, say grass, I go on YouTube and look for a video that shows this pattern. It is better on video because you can see those small changes which might not be visible to the naked eye. But because I don't have a projector, I simply tell them to search for the same video on their phones.*

*Participant 6 – Yes, I ask them to use it almost all the time in my class. I teach Horticulture and so in some topics, we need to look at images of plants that are not geographically accessible. The images on Google come in handy here.*

The second question (Q2) asked the participants if they think there are advantages to making the smartphone a formal learning tool. In other words, it explored whether there are merits to university management integrating smartphone-based learning into the curriculum. Two significant themes (*improves time management* and *facilitates collaborative learning*) and two sub-themes (*facilitates off-campus learning* and *increases student engagement*) emerged:

**Q2 – Theme: Improves time management by enabling off-campus learning**

Nearly all the participants (n = 16) believed that incorporating smartphones into formal learning environments would lead to good time management. The lecturers felt that the smartphone's portability would allow students to take advantage of the spare moments they have outside the physical campus to continue their learning.

*Participant 16 – In my course, English Literature, I assign the students a lot of online-based reading and listening material to go through prior to discussing it in class. In literature, you can't do everything in class because of time. Their smartphones come in very handy here because the school computer lab closes at the end of the day… but I like that the students can use their smartphone even at home and continue their reading and listening assignments anywhere anytime.*

*Participant 9 – I like the idea of students using their smartphones to access the lectures online. It will enable me to not be dictating notes all the time. Dictation takes* *up a lot of my class time. Especially, in my afternoon classes where the students tend to write much slower.*

*Participant 3 – Our common courses have very many students... and we have very few lecture halls that can accommodate large class sizes. Having the lectures online will allow the students to access these lectures outside class and help resolve the time-consuming issue we have here of trying to sort out overcrowded lecture halls.*

**Q2 – Theme: Facilitates collaborative learning thereby increasing student engagement**

Fifteen participants reported that the smartphone is an ideal tool for supporting collaborative learning, as it provides quick access to social media platforms, notably *Facebook* and *WhatsApp*. Three participants provided good examples of this theme:

*Participant 7 – Having group discussions online like on Facebook will give the shy students a chance to participate more. Over the years, I realised that when it comes to group work done in class, the stronger students keep on dominating the class discussions then the other members feel intimidated and fear participating. But on Facebook these same shy students are quite active when I post educational topics.*

*Participant 13 – Because not all students live on-campus or near each other, at times it becomes difficult for group members to convene a physical meeting…, so I noticed the students usually end up creating WhatsApp groups where they discuss their group-based assignments; they tell me this style simplifies group learning.*

*Participant 2 – There are these students who are usually so quiet in class, but the moment I tell them to pair up and take out their phone to search for something online, all of a sudden, they become so interactive.*

The third question (Q3) aimed to examine the factors preventing the lecturers from fully integrating smartphone-use into their formal lesson plans. I derived three themes (*financial burden on students*, *leads to poor class attendance* and *exacerbates digital divide*):

**Q3 – Theme: Financial burden on students**

A significant number of the participants (n = 10) were concerned that the internet costs associated with using smartphones for education would be a burden on the students. One participant expressed this concern as follows:

*Participant 14 – Although I share some coursework online, I am often worried that the students may not have internet bundles to access the online content. So, when I set tests, I only examine what I have covered in class and not the online content I provided them.*

**Q3 – Theme: Leads to poor class attendance**

Since smartphone-supported blended learning will shift a portion of the courses to an online environment, students can access course material at their convenience. In this vein, six participants expressed concern that online learning could lead to poor class attendance.

*Participant 5 – I have been reluctant to incorporate smartphones because when I send students the soft copy notes on WhatsApp, it makes them not come to class. Yet sometimes, because I teach biological sciences, some topics require the students to be physically present for the practical work.*

**Q3 – Theme: Exacerbates digital divide**

A few participants (n = 4) feared that integrating smartphones into the curriculum would further alienate the students who do not own a device.

> *Participant 17 – I fear that if I integrate smartphones into my lessons, the students who don't own a smartphone will feel left out. I have students who come from diverse economic backgrounds, so I always want to maintain equality at all costs.*

As previously discussed, smartphone-supported blended learning will cause a shift in the teaching style – from a dominant on-campus synchronous face-to-face teaching to a partially off-campus asynchronous teaching. Hence, the fourth and final question (Q4) of the interview asked the participants to comment on how they feel about possibly altering their teaching style. One central theme (*flexible*) and one sub-theme (*requirements for embracing change – training and beta-testing*) developed.

**Q4 – Theme: Flexible but subject to two requirements – training and beta-testing**

All the respondents expressed willingness to accommodate the pedagogical changes that accompany the delivery of courses to a smartphone.

> *Participant 7 − I am willing to adopt the change because I really want to integrate technology into my teaching. I have 460 students in my class and dictating notes in a large hall is a great challenge for me.*

> *Participant 11 − I am always looking for student-friendly methods rather than teacher-friendly methods. So, if most students have smartphones and are comfortable using it for learning, then there is no harm in trying out a smartphone-based lesson.*

However, a substantial portion (n = 10) deliberated that their willingness to embrace the proposed technology-enhanced teaching approach was subject to them receiving training. Two participants echoed this sentiment as follows:

> *Participant 15 – I have been a classroom-based lecturer for a very long time. While I support change, I know I will need some time to fully transition into online teaching. If I get initial training, say for a few weeks, I will be in a much better position to adopt the change.*

> *Participant 8 – I know the smartphone has some features that can be a distraction during study time ... for example, the Twitter mobile app. So, it would be nice to get tips on how I can use these same features to keep my students focused on the academic tasks at hand.*

The approach should be beta-tested was the second factor the participants emphasised would enable them to better embrace the proposed technology-enhanced teaching approach. Six participants stated they would only adopt an approach that had been previously verified in light of actual teaching and learning.

> *Participant 10 − I am flexible. But consistency is important. I don't want to start one teaching style and then have to revert to another. So, I will only adopt a teaching style that has been tested at least a couple of times.*

## 6.4 Discussion of Findings from Interviews with TMUC Lecturers

The results reveal that TMUC lecturers are generally open to the idea of formal smartphone-supported blended learning. They considered the smartphone to be an effective tool in facilitating online learning, not only in class but also off-campus. This finding is consistent with several other studies that have shown the effectiveness of using smartphones to augment learning (Chin & Wang, 2021; GSMA, 2014a; McFaul & FitzGerald, 2019; Price et al., 2014; Reid & Pruijsen, 2015; Vázquez-Cano, 2014; Wang et al., 2018). Furthermore, they were optimistic that online learning via smartphones would alleviate the crippling issue of overcrowded lecture halls experienced by most public universities in sub-Saharan Africa.

Additionally, the interviewees were excited that smartphone-supported blended learning would enhance group-based learning activities through social media applications like WhatsApp and Facebook, thus encourage interactive discussions among the students. These results were coherent with findings of the student survey discussed in Chapter 5, which showed that 97% of the students like the idea of using social media networking sites in their formal studies. As previously outlined, sub-Saharan African countries embody a collectivist culture; hence group-based activities form an essential part of the learning process as they significantly increase student engagement. Any technology that enhances collaborative learning activities is often embraced in these communities. Specifically, social media networks, which most people now access through smartphones (Lipsman & Lella, 2016; Mander & McGrath, 2017), have revolutionised how students and teachers interact. Because of social media, learning occurs through a many-to-many approach, whereby the teacher is not viewed as the 'sage on the stage' but a 'guide on the side'. It is no wonder Poushter (2016, p. 21) reported that "once online, people in emerging economies and developing nations [such as those in sub-Saharan Africa] are hungry for social interaction" – a sentiment later reiterated by Silver et al. (2019).

As far as the major hurdles in using smartphones for formal learning, the lecturers expressed the following challenges: financial burden on students, reduced class attendance, and exacerbation of the digital divide gap among students. While these are reasonable concerns, there are ways to temper the adverse effects of these hurdles. I present my arguments in the following three paragraphs.

Firstly, regarding the theme of financial burden on students, findings from the TMUC student survey (Chapter 5), somewhat negate this concern. Reflecting on that survey, 93% of the respondents indicated that they have the resources necessary to use their smartphone for their education; and 97% of the respondents agreed that considering the educational benefits, the associated costs of their smartphone were worth it. Furthermore, when sharing course material online, the lecturers could use social media platforms like Facebook mobile app, which offers subsidised data plans to users in low-income countries such as those in sub-Saharan Africa. For example, in Kenya, Facebook has partnered with local internet service providers (ISPs) such that anyone accessing the platform via their mobile app has free and unlimited access. Building on Facebook's strategy, I suggest that aside from providing free Wi-Fi access for their students (on-campus), university management can negotiate with ISPs to subsidise mobile data costs (to facilitate off-campus learning). In South Africa, *Siyavula Practice Project* partnered with Vodacom to provide free access to the learning content via a special Vodacom sim card (Siyavula, 2015). Elsewhere in South Africa and Finland, *MoMath*, a large-scale mobile learning research project, provided free access to a database with over 10,000 mathematics exercises that learners could access through a unique IP address provided by their ISP (Isaacs, 2012). Therefore, I argue that this concern can be arbitrated.

The second concern the participants expressed about smartphone-supported blended learning was that it could lead to poor class attendance. Indeed, other studies (Kenney & Newcombe, 2011; Napier et al., 2011) have illustrated that many adopters of blended learning (even experienced practitioners) find it challenging to create balance and harmony between the online and the classroom-based components of their courses. Taking this into account, I postulate that lecturers can tackle this issue of poor classroom attendance by ensuring a clear complementary link between the pre-class media (online coursework) and the on-campus (classroom-based) sessions. As a start, this can be achieved by exercising the following standards previously retrieved from the 'Global Elements of Effective Flipped Learning (GEEFL)' chart (see Chapter 2, Table 2.6[28]):

i) *Establish clear expectations for student responsibilities during class time:* First and foremost, lecturers must inform students that the online portion of the course complements the in-class sessions. Then, teachers could create a schedule at the beginning of the semester to inform the students how often they are expected to attend in-class sessions. Establishing a schedule early on enables the students to manage their study time more efficiently and allows lecturers to hold students accountable for not attending in-class sessions.

ii) *Never lecture in the classroom what is in the pre-class media (online component):* Fearing that some students do not interact with the online content before attending the on-campus sessions, a lecturer could feel impelled to repeat what is in the online lectures in the classroom. Consequently, the students who already interacted with the online content (pre-class media) do not see the need to attend the on-campus sessions. Instead, to bring the entire class up to speed, lecturers could set up student-centred activities in class that encourage students to summarise the content of the pre-class media. Likewise, the lecturer should have a tutorial plan for students who come to class having completed the pre-class media but still do not fully grasp the concepts.

[28] Refer to the following categories on Table 2.6 – 'Balancing the Blend' and 'Expectations'.

Concerning the third sentiment that smartphone-supported blended learning could exacerbate the digital divide gap, indeed, I acknowledge that educators should never assume equal device access (Brown & Haupt, 2018). However, given the collectivist culture of the sub-Saharan African community, sharing is habitual and ingrained at an early age. Therefore, it is likely that if a student does not own a smartphone, their friends, classmates and family members will be more than willing to share their devices for educational purposes. In Chapter 5, while investigating TMUC student perceptions of smartphone use in formal education, the findings showed that 96% of the participants stated their family is in favour of them using a smartphone to augment their learning, suggesting that if at least one of the family members owns a smartphone (which is very likely), they would be happy to let the student borrow it for their education; additionally, 97% of the survey respondents reported they use their smartphone to collaborate with their classmates for educational purposes, implying they do not mind sharing the device for learning activities. Moreover, with the entrance of cheaper smartphone brands into the market (notably, *Techno*, *Infinix*, and *Xiaomi*), previously highlighted reports by GSMA (2020) and Karlsson et al. (2017) demonstrate that a significant number of the population is increasingly finding ways to afford low-cost high-specification smartphones. Thus, I postulate that this barrier can be moderated.

Lastly, the lecturers were made aware that smartphone-supported blended learning would cause a shift in the teaching style – from a dominant on-campus to a partially off-campus mode of teaching. In this vein, all the participants indicated that they are willing to alter their teaching style; however, they had two requirements. The first requirement is training (pedagogical and technical skills). Pedagogical training is essential as it will help the lecturers understand (in-depth) how to constructively use the smartphone's features to engage with their students. For instance, as aforementioned, the benefits of social media in learning are well documented. However, Merchant (2012) cautions that social and educational smartphone-use differ, and there is a need to understand in-depth how learning occurs within these two contexts. To date, much of what has been explored regarding this type of social media learning is in the informal space and is yet to be fully integrated into formal technology-enhanced university education (Xue & Churchill, 2019). Concerning technical training, despite expressing they were proficient in using their smartphones in their daily lives, the participants accorded high priority to this theme. According to Oliver (2013), given the globally pervasive presence of technology, institutions tend to assume that teachers already know how to use the technology. In this vein, one could argue that training workshops for teachers on effectively utilising technology in their teaching are often overlooked. However, to avoid what Kinchin (2012) refers to as 'technology-enhanced non-learning', technical training is crucial because how technology is used in non-school environments differs from its application in school settings (Spector et al., 2014). Failure to prepare the teachers to use technology in a school setting often leads to many teachers feeling confused and frustrated. In principle, the training workshops (pedagogical and technical) could provide an avenue where adopters of smartphone-supported blended learning can share their experiences and collaborate with other faculty using the approach. Furthermore, through these training workshops, institutions can develop formal checklists that guide teachers in best practices for delivering smartphone-supported blended courses and also use these checklists to assess the efficacy of these courses.

As a second requirement, the participants asked that the proposed approach should undergo beta-testing before implementation. Although expressed by less than half of the participants, this requirement is well-founded. As outlined in the literature review, "the 'immediacy' of technology and its rapid pace of development may be in tension with the relatively slow pace of educational change" (Kinchin, 2012, p. E43). Consequently, the focus is often on the novelty of the advances in educational technology rather than on the practicality of the technology in education (Njenga & Fourie, 2010; Spector et al., 2014). In a bid to keep up with the newer, forward-looking trends, many educators speedily adopt the new technology only to see it fail in practical use (Spector et al., 2014). Therefore, before integrating any educational technology, it is necessary to test its effects "in the real and somewhat uncontrollable and chaotic circumstances in which every day learning and instruction occur" (Spector et al., 2014, p. ix). Certainly, refinements will need to be made during implementation due to informal observations by the teacher, feedback from students and information obtained in training workshops (Kenney & Newcombe, 2011). However, to ensure that beta-testing begins from a rich experience base, I assert that teachers could take advantage of the many years of blended learning knowledge gained by educators in the developed world (albeit using PCs instead of smartphone technologies). For example, with the help of colleagues who are educational designers and media specialists, teachers could check that their flipped course employs the most current international best practices included in the previously discussed GEEFL chart. Given the experimental nature of the smartphone-supported blended approach, it is impossible to satisfy all 93 standards in the GEEFL chart. I suggest that effectuating a subset (e.g., one-third) is a comfortable start for early adopters (see Table 2.6 for noteworthy GEEFL standards to consider when designing a smartphone-supported blended course).

## 6.5 Strengths of Phase Three and Suggestions for Future Research

This phase of the research reported findings of a qualitative study undertaken to explore TMUC lecturer perceptions regarding the adoption of smartphone-supported blended learning. It addressed the research objective, *'To evaluate the roles of lecturers, students and institutions* *in the delivery of a smartphone-based course'*. Semi-structured interviews and thematic analysis were the methods employed to meet the aim of this phase.

I found this phase to be of great importance because, despite the pervasive presence of smartphones among the youth (students), the undeniable benefits of technology-enhanced learning, and the extreme paucity of conventional computing platforms (laptops and desktop PCs) in sub-Saharan Africa, adoption of smartphones as formal learning tools is not a prominent discussion (or research) topic among university educators in the region. By acknowledging that lecturers are the gatekeepers to technology integration in the classroom, this Phase 3 of the research served as a starting point for critical and informative discussions on smartphone-supported blended learning in sub-Saharan Africa. Furthermore, the interviews confirmed comments made by the student survey respondents (Chapter 5). For example, the lecturers reported that they are in favour of their students using smartphones to facilitate learning (e.g., completing assignments, accessing lecture notes, and researching online learning content). Similarly, the student survey respondents indicated that they like the idea of recorded lectures, and many students reported they usually use their smartphones to complete assignments and access OERs. Also, the interviewees reiterated the student survey respondents' sentiments about the importance of smartphones in facilitating collaborative learning through social media platforms.

I did not identify limitations in this phase of the research; however, findings from the interviews suggest areas that can be built on to enhance our understanding of smartphone-supported blended learning. Notably, this present study focused solely on how lecturers can facilitate this transition into smartphone-supported blended learning; it did not examine the perceptions of university management. As described in Chapter 2, the introduction of new teaching and learning approaches requires teachers to collaborate with the university management. A disconnect between the goals of the faculty members and those of the university management can inhibit the growth of the innovation, even though both parties favour smartphone-supported blended learning. Therefore, future research could explore university management's perspective on making smartphones official learning tools. Key questions to explore (previously highlighted in section 2.3.4-b) include: What institutional policies on change management need to be in place? What are university management expectations for teachers who adopt technology-enhanced learning strategies? What support systems (human, technical and financial) can the university management offer learners and teachers as it pertains to smartphone-supported blended learning? Despite excluding the university management perspective, I argue that the results of this Phase 3 provide a strong enough basis for future research on smartphone-supported blended learning to build upon. I assert that the lecturer interview findings provide important implications for pedagogical policymakers and educators in sub-Saharan Africa to begin contemplating *'how a student who owns only a smartphone and does not have access to a desktop PC or laptop can still participate in a blended university course'* – which is essentially the subject of the next chapter (Phase 4) of this thesis.

## 6.6 Summary

Teachers are pivotal when integrating technology into the classroom; however, there is a gap in the literature concerning teacher perceptions of formal smartphone usage in higher education. To help bridge this gap, this chapter has reported the findings of interviews that captured 17 TMUC lecturers' attitudes towards smartphone-supported blended learning. In doing so, it has identified many areas of convergence with the literature. Notably, it has shown that smartphone-based learning is already taking place in technologically resource-constrained university classrooms, albeit not formally recognised. Furthermore, the findings emphasised that cultural background is a significant determinant of technology adoption. Owing to the collectivist culture of sub-Saharan Africa, the study participants were more willing to adopt smartphone-supported blended learning due to the smartphone's extensive socialising features (social media apps) that could enhance collaborative learning. However, participants expressed concerns that smartphone-supported learning could be a financial burden on the students and potentially exacerbate the digital divide (previously highlighted in the beginning sections of Chapters 1 and 2). Whilst these are reasonable concerns, I have presented arguments (in the discussion section of this chapter) to mitigate these barriers to adoption.

Overall, the research revealed that faculty at TMUC have positive perceptions about the integration of smartphones into formal teaching and learning processes. These findings lend credence to the idea that smartphones can be worthy contenders as formal learning devices in the university setting. Therefore, having established that the lecturers are flexible and willing to integrate smartphones into their formal teaching, the next step of this research was to redesign an existing classroom-based TMUC course into a smartphone-supported blended course, to determine the requirements and decision points that emerge if smartphone-supported blended learning is adopted at TMUC. The practical work of this next phase of the research is discussed in the succeeding chapter.

# 7. THE INTERVENTION COURSE

Design and evaluation of a smartphone-supported blended course at TMUC – Phase 4

## 7.1 Background

The studies described in Chapter 5 and Chapter 6 of this thesis demonstrate that students and lecturers at TMUC are willing to incorporate smartphones into formal learning and teaching processes. Nonetheless, the research participants' favourable perceptions about smartphone-supported blended learning were insufficient to build an evidence base to support my thesis. I deemed it necessary to examine the effects of the proposed approach in light of actual learning and teaching. The rationale for this decision follows. At the time of investigation, formal smartphone-supported learning was not in effect at TMUC, meaning the favourable perceptions gathered about this topic were based on the research participants' beliefs about what a formal smartphone-supported blended course would look like rather than on real-life experiences. Whilst the participants' beliefs are a reasonable proxy for actual adoption, related literature investigating the relationship between intention (i.e., willingness to adopt) and behaviour (actual adoption) assert that this relationship is not always linear (Cheon et al., 2012; Henderikx et al., 2017; Yeap et al., 2016; Yue et al., 2020). In the context of the present research, what this means is that TMUC students' and lecturers' intention to adopt smartphone-supported blended learning does not necessarily mean it will translate to actual adoption. Therefore, to build a stronger evidence base and demonstrate that smartphone-supported blended learning is indeed a conceivable idea, it was essential to test the effects of this proposed approach, "in the real and somewhat uncontrollable and chaotic circumstances in which every day learning and instruction occur" (Spector et al., 2014, p. ix). This decision was in line with the real-world practice-orientated approach of the Pragmatism philosophical perspective (Creswell, 2014) adopted in this thesis.

This chapter, therefore, elucidates the practical steps undertaken to conduct a mixed-methods study in which I worked closely with one of the interviewed lecturers at TMUC to restructure their course and make it smartphone-ready. Next, I tested the redesigned smartphone-supported blended course with the students to evaluate user experiences. The guiding research question for this Phase 4 was: *'How can a student who owns only a smartphone and does not have access to a desktop PC or laptop successfully participate in a blended university course?'* Linking back to the methodology of this thesis, Phase 4 aimed to advance the research objective: *'To develop a framework that provides a set of guidelines on how to successfully deliver a university course solely to a smartphone'*. Although this phase led to the production of a novel instrument – a framework entitled *'Smartphone Only Learning Environment' (SOLE),* the developed framework (SOLE) has been described in detail in Chapter 8 of this thesis. Here, the practical work of delivering a blended course to a smartphone is discussed.

## 7.2 Research Design: Multilevel Mixed-Methods Design

As described in Chapter 3, this thesis employed a mixed-methods methodology, which involves examining different facets of the same phenomenon by combining qualitative and quantitative methods synergistically. Whilst data collection and analysis from Phase 1 through to Phase 4 of this thesis followed a convergent parallel[29] mixed-methods design, within Phase 4, the mixed-method approach used was the multilevel design. Several definitions of this design exist (Headley & Plano Clark, 2020; McCrudden & Marchand, 2020), but in this thesis, I adopted the definition by Creswell and Plano (2011, p. 100):

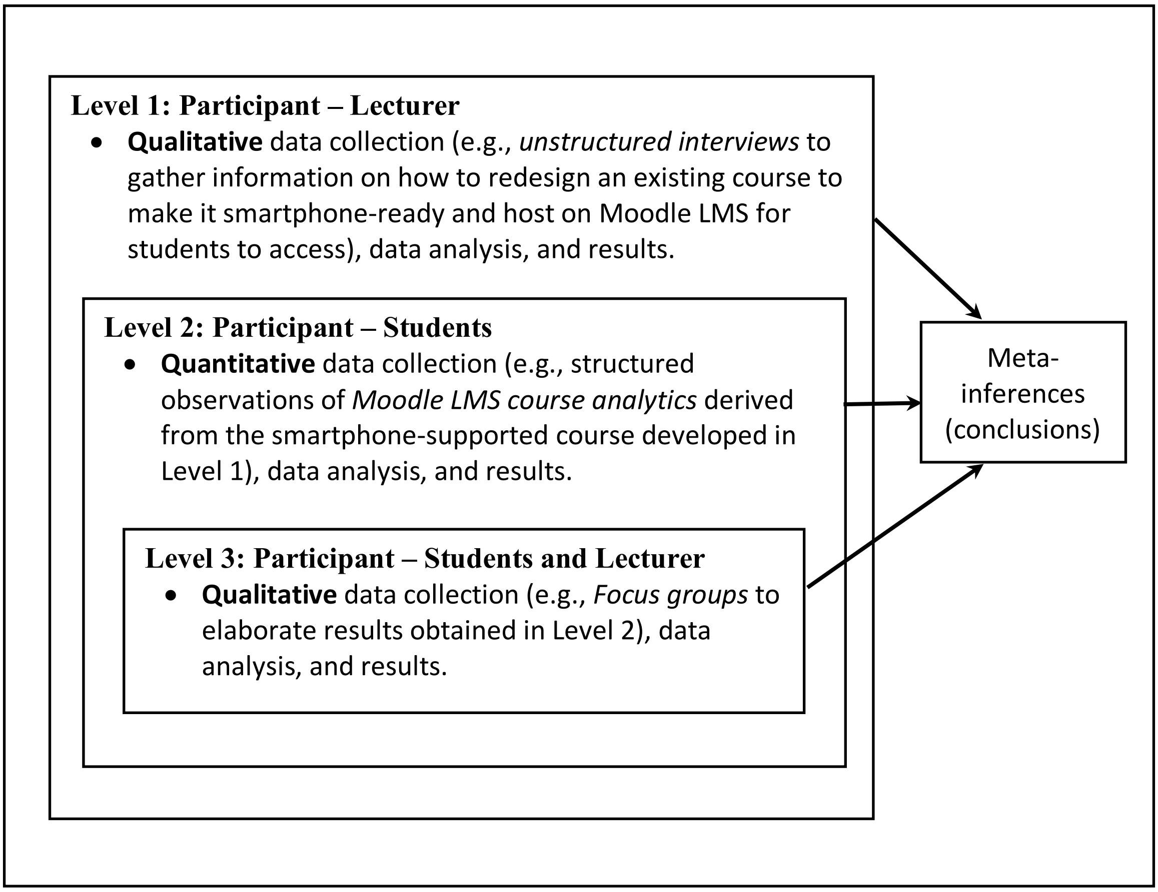
[29] In convergent parallel mixed-methods design, two forms of data are collected and analysed separately and independent of each other, then later the results are compared (merged/integrated) to provide a more holistic and in-depth understanding of the conclusions drawn (refer to section 3.2.2 for a broader description).

*"Multiphase [multilevel] designs occur when an individual researcher… examines a problem or topic through an iteration of connected quantitative and qualitative studies that are sequentially aligned, with each new approach building on what was learned previously to address a central program objective."*

An earlier study highlighted by Onwuegbuzie and Collins (2007) referred to this approach as the 'sandwich design', which occurs when the researcher alternates the quantitative and qualitative methods across three phases i.e., qualitative then quantitative then qualitative (qual → quan → qual) or quantitative then qualitative then quantitative (quan → qual → quan). For this present study, I followed the "qual → quan → qual" multilevel design (as illustrated in Figure 7.1). A strength of this multilevel design is its capacity to give a more complete picture and highlight instances of convergence or contradiction which may indicate areas for further study.

Still on the matter of the research design used in this Phase 4, it is worth noting that in mixed-method designs that are sequentially aligned, such as the multilevel design, either qualitative or quantitative data (or both) may be the primary focus of the study. Thus, the literature recommends that researchers explicitly state how priority is assigned to each method (Creswell & Plano, 2011; Ivankova et al., 2006). In this present study, the emphasis was equal – neither strand had more weight. The rationale for starting with a qualitative strand followed by a quantitative strand was based on the premise that research about smartphone-supported blended courses was scarce; hence, it was necessary to first explore the topic to get a deeper understanding of it before deciding what variables could be measured. According to Creswell and Plano (2011), studies that start with a qualitative strand followed by a quantitative strand are suitable in situations where the mixed-methods project is emerging, and there is no existing framework or theory to guide the research. Next, my rationale for the third qualitative strand was to gather data that would elaborate, clarify, and enrich the understanding gained from the second quantitative strand. Thus, the purpose of the multilevel (sandwich) design I used was complementarity (McCrudden & Marchand, 2020) – the qualitative strands aimed to understand the phenomenon by exploring the participants' views in more depth, while the quantitative strand sought to test and generalise the propositions that emerged from the qualitative strands. The next section describes the specific research steps undertaken to implement this research design.

**Figure 7.1: Sequence and relationship of qualitative and quantitative strands in Phase 4; a multilevel mixed-methods design to investigate how a student who owns only a smartphone can participate in a technology-enhanced (blended) university course**



## 7.3 Research Procedure: Sampling, Data Collection, Analysis and Results

### *7.3.1 Level 1 – Qualitative Strand: Designing the smartphone-supported blended course with a TMUC lecturer*

**a) Purposeful: Criterion Sampling**

The sampling scheme used in this qualitative strand was criterion sampling, which involves selecting participants who meet a predetermined characteristic (Onwuegbuzie & Collins, 2007). Criterion sampling is most suitable when the sampling population is homogenous (e.g., only lecturers) (Palinkas et al., 2015) because it allows a researcher to narrow the population to a more manageable representative sample. Since Phase 4 required actual teaching and learning, a small sample size was ideal, to allow more rigorous interactions with the participants. Therefore, following the interviews I had with the full-time lecturers at TMUC (see Chapter 6), I approached one of the interviewees and requested to work with them to redesign their course and make it smartphone-ready for their students to access. The criterion for selecting this participant was that they had to be teaching a first year second-semester course. The underlying assumption supporting this criterion was based on the premise that first-year students had not experienced university courses and thus had not yet acquired rigid learning styles as it pertains to university education. In other words, the rationale was that redesigning a first year second-semester course would help minimise the initial resistance to change often associated with adopting new learning and teaching approaches. I excluded the first year first-semester cohort because these students directly come from the more rigid school system and still need some time to adjust to the pedagogy of higher education. Table 7.1 provides the participant's profile.

**Table 7.1*: Profile of the participant (first-year lecturer)***

| Category | Description |
|---|---|
| Faculty | Biological and Physical sciences |
| Course | Introduction to Internet Technologies |
| Gender | Male |
| Age | 37 years |
| Teaching Experience | Above 7 years |
| Qualification | Ph.D. |

**b) Data Collection: Unstructured Interviews**

Unstructured interviewing was chosen for this explorative qualitative strand (Level 1) because it is flexible and responsive. An unstructured interview format does not have a standard interview protocol – the interviews adopt a conversational approach, meaning the researcher relies on spontaneity and does not have predetermined questions to ask participants (Zhang & Wildemuth, 2009). This interview format allows the participant's thoughts to be fully expressed unrestrained by the researcher's opinions. Furthermore, unstructured interviews are best suited for when the researcher wants to establish rapport and comfort with a participant (Zhang & Wildemuth, 2009) in anticipation of follow-up interactions or future collaboration, as was the intention in this present study.

A series of six interviews were conducted – four were conducted in-person at the participant's office, and two were conducted online as it was not practical to travel. The interviews were informal and conversational, and direct questions were asked only if the answers did not arise. Provided that the core research topics were covered (described later in the Data Analysis section), the discussions followed the priorities of the participant lecturer. Follow-up questions sought to explore topics more deeply, and the lecturer sometimes referred to course materials to explain their point-of-view. The intention was to gather as much information as possible about the lecturer's pedagogical skills and preferences to determine how these can be tailored into a smartphone-supported blended course. In such conversations where the intention is to understand in-depth the participant's behaviour and motives, Zhang and Wildemuth (2009) recommend that researchers using the unstructured interview format present themselves as learners and strive to listen more than they talk; this approach puts researchers in a better position to build a rapport with the participant. Furthermore, giving the participant a chance to steer the discussions ensured that this study was in line with the ethical considerations on social and cultural sensitivity outlined in Chapter 3 (section 3.4). Given the collectivist culture of Kenya, it was necessary to present myself as 'part of the exploration' and refrain from 'flaunting my knowledge'. Thus, keeping in mind the potential for unstructured interviews to manoeuvre away from aspects of the research topic, I audio-recorded the conversations (with the participant's permission) to ensure I captured crucial points. Audio-recording the discussions instead of note-taking ensured that the flow of our conversations was not disrupted (Zhang & Wildemuth, 2009). The duration of the interviews ranged in length from forty-five minutes to one hour.

**c) Data Analysis**

I manually transcribed each interview. The transcripts were then inductively analysed using the guidelines for thematic analysis proposed by Clarke and Braun (2013). Since the questions asked in each unstructured interview were dependent on the context of the interview, they varied dramatically across multiple interviews. Therefore, as the codes and themes emerged from the transcripts, I organised the interview data into the following eight thematic questions, which summarised the salient research issues discussed during my interactions with the TMUC lecturer:

1. What blended learning model should be adopted?

2. What blended learning pedagogy is most suitable?
3. How much of the course should be blended?
4. How will smartphone-supported blended learning affect the current teaching and learning styles?
5. How can the teacher develop online learning content?
6. How could a community of learners be created?
7. What LMS is suitable for facilitating online learning?
8. How can the teacher evaluate the effectiveness of the course before introducing it to the students?

I listened to the interviews and rechecked the transcripts multiple times to ensure I had assigned the relevant interview data for each of the eight identified themes. Once I was confident that I had exhausted all possible themes, to ensure transcription accuracy, I employed member checking – a validation strategy suggested by Creswell (2012), which allows the participant to review transcribed data. The participant had no suggestions for changes, and we began to develop the smartphone-support blended course based on the decisions outlined in each derived theme. The succeeding Results section presents the final design of the smartphone-supported blended course.

**d) Results**

- *Level 1 Results: Overview of the themes arising from the interviews with the TMUC lecturer regarding the design of a smartphone-supported blended course*

Chapter 2 described the conceptual model of the smartphone-supported blended course adopted in this research and justified the model with related literature. Therefore, to minimise repetition, Table 7.2 provides an abridged description of each of the eight themes derived during data analysis; and the reader is requested to see Section 2.3.4 for a more thorough explanation of the aspects discussed in each theme.

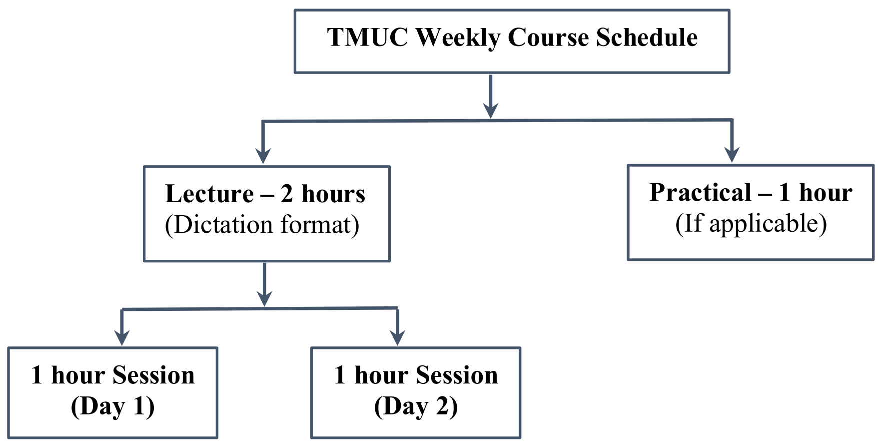
**Table 7.2: Themes arising from the unstructured interviews with the lecturer, as we began designing the smartphone-supported blended course**

| Interview Theme | Description |
|---|---|
| Ideal blended learning model | Adopted the 'medium impact blend' or 'course-level blend' whereby only a few parts of a traditional course are replaced by an online learning activity. |
| Ideal blended learning pedagogy | Adopted the 'flipped classroom technique' – lectures would be delivered online, and assignments (e.g., group discussions and problem-solving activities) were to be completed on-campus. |
| Proportion of coursework to blend | Blended two weeks' worth of course content, meaning students would attend on-campus sessions fortnightly. |
| Impact of blended learning on the current teaching and learning styles | Concerning on-campus learning, the students would shift from being passive learners to active and social learners. For the online learning environment, the students would have to become partially independent learners (in regard to time management). The lecturer, in both environments, was required to assume the role of facilitator (i.e., 'guide on the side'). |
| Developing the online content | Utilised OERs (e.g., embedded YouTube videos and web resources) as well as created (from scratch) audio-visual PowerPoint presentations. |
| Forming a community of learners | Moodle-hosted discussion forums and WhatsApp groups were created. |
| Ideal LMS | Since TMUC did not offer e-learning at the time, I recommended the use of the free, open source LMS, Moodle. We then used Gnomio.com – a free web hosting platform to create the Moodle-based learning environment. |
| Course evaluation | To evaluate the effectiveness of the course prior to rolling it out to students, we used the previously mentioned GEEFL chart to check that the flipped course employs the most current international best practices. |

- *Level 1 Results: Description of the smartphone-supported blended course I designed with the lecturer at TMUC*

In the traditional lecture format used at TMUC, each session is two hours, which are split up into two one-hour sessions delivered on different days (i.e., students have to attend classes twice a week — for all enrolled courses). This format is implemented because at the time of this study, TMUC had few classrooms, meaning lecture halls could only be used for one hour to ensure that all courses are taught at least once a week. Consequently, this means that based on the traditional lecture format, the two weeks' worth of course content that we redesigned consisted of four lectures in total (i.e., two one-hour lectures per week). Figure 7.2 provides a graphical representation of the traditional lecture format used in most courses at TMUC.

**Figure 7.2: Graphical representation of the traditional lecture format (course schedule) used at TMUC**




Keeping in mind that students are enrolled in several courses per semester, the abovementioned traditional lecture format requires most students to be on-campus daily. However, as I stated in the literature, in the long run, this kind of setup results in insurmountable costs (travel and accommodation) for the many students living off-campus[30]. Therefore, learner flexibility and convenience (time and monetary) in regard to attending lectures were the main reasons for encouraging smartphone-supported blended learning at the institution. For this purpose, we redesigned the lecture material so that they could be accessed via Moodle LMS as audio-visual content at any time. The audio-visual content was chunked into mini-recordings. Extant studies (Brame, 2015; Chen et al., 2013; Fyfield et al., 2019; Tseng et al., 2016; Yang et al., 2015) argue that delivering online learning content in small chunks (commonly referred to as content chunking) improves student comprehension and memory retention. The decision to transform the lectures to audio-visual content was based on the student survey results (in Chapter 5) that showed that 97% of the students liked the idea of recorded lectures. Nonetheless, aside from the MP4 files (video) and MP3 files (audio) created, we ensured that in each lecture, the students had an option to view the content as PDF files (text). The multiple file formats cater for the varying contexts in which smartphones are typically used (Farley et al., 2015).

Since the video-based content (i.e. lectures) was created using a laptop, we adopted the approach Hawi et al. (2018) proposed to limit the file sizes and ease streaming and downloading on smartphones. This entailed: reducing the screen size while using recording software and employing compression tools provided by *QuickTime Player*, *Windows Movie Maker* and *Handbrake*. Furthermore, consideration around aspect ratio was essential when trying to optimise videos for smartphone viewing. In Chapter 4, I examined whether the video-based lectures of an existing online course can comfortably be viewed on a smartphone. The results showed that some video presentations were illegible because the 4:3 aspect ratio used while recording the lectures on a laptop was not compatible with the aspect ratio of a

[30] At the time of this study, TMUC only had three student hostels within the campus, which could host only 108 students in total (see Chapter 3, section 3.5.2: Student Hostels). Thus, most of the students at TMUC lived off-campus and incurred higher accommodation and travel costs.

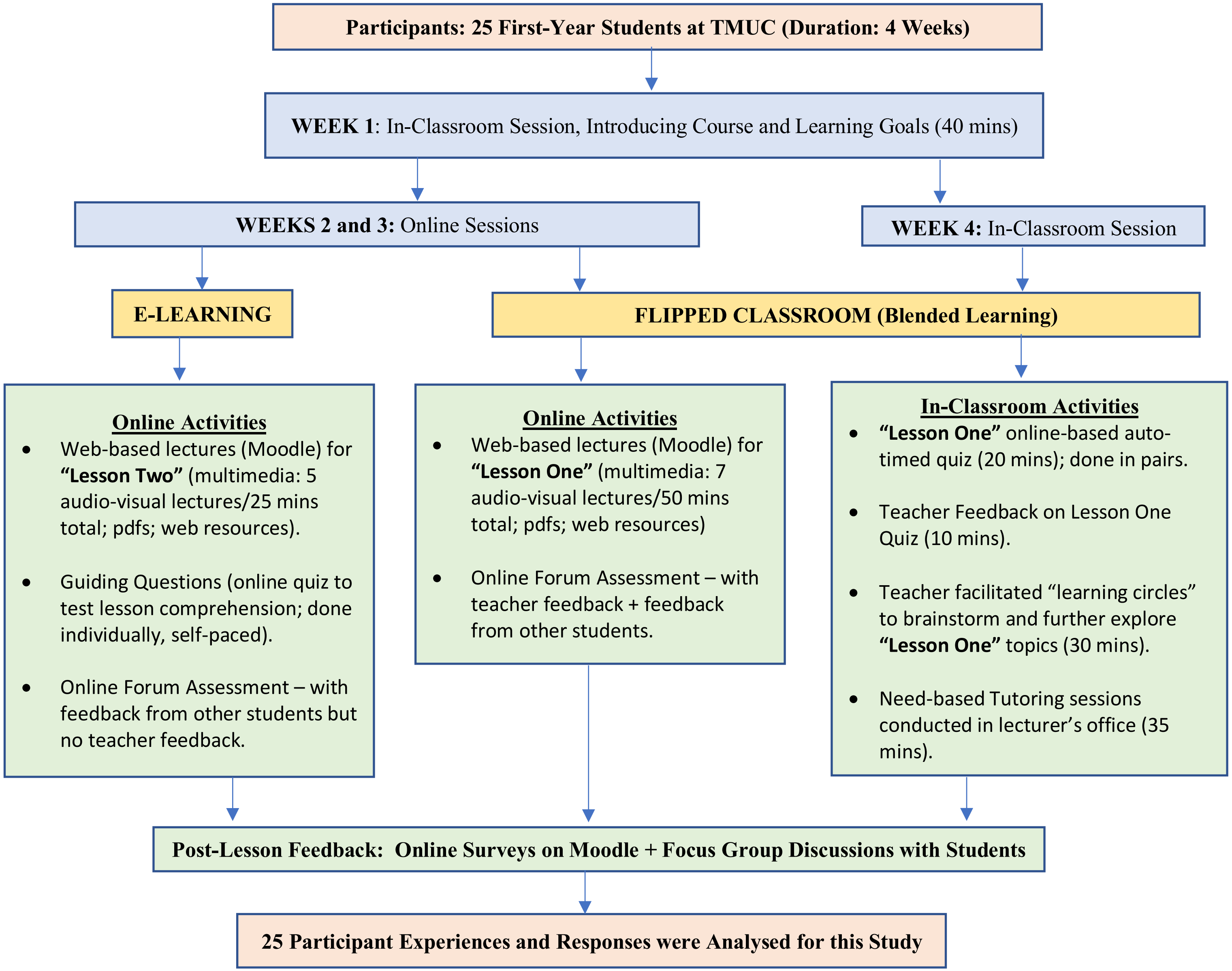
smartphone. Most smartphones now comfortably support a 16:9 aspect ratio. So, making lecture recordings using a 4:3 aspect ratio may result in a distorted image because 4:3 does not fit into a 16:9, and if one attempts to stretch the image, it may become distorted or blurred. Therefore, while recording the lectures on PowerPoint, we set up the presentations to 16:9 aspect ratio. Once we transformed the two weeks' worth of lecture material into mini-recordings, the lecture for week 1 ('Lesson One') was fifty minutes, and the lecture for week 2 ('Lesson Two') was twenty-five minutes[31].

Regarding how each lesson was delivered, we decided to make *Lesson Two* fully online (hence the label 'e-learning' in Figure 7.3), and *Lesson One* utilised the flipped classroom technique. Our rationale was that this setup would allow us to examine whether blended learning was indeed an ideal option for the students or if e-learning was a more appropriate option. The outcome showed that blended learning was ideal but, this shall be discussed later in the last qualitative strand of the present study (Level 3). For *Lesson One*, the session that utilised the flipped classroom technique, the students were expected to attend on-campus sessions fortnightly. These on-campus sessions were group-based and discussion-oriented – the students were required to form learning circles, link a course-related concept to a real-life context and then present their discussion to the rest of the class. Also, the students were required to complete an online-based auto-timed quiz in pairs. These activities were included to maintain the physical face-to-face collaborative learning culture the students were accustomed to and aimed to minimise the effects of learner isolation typically associated with online learning. Figure 7.3 provides an account of the elements contained in each lesson[32].

[31] Note: Lesson Two covered a 'smaller' topic hence the shorter duration.

[32] The reader is also encouraged to see Figure 2.10 in Chapter 2, where I described the conceptual model of this smartphone-supported blended course.

**Figure 7.3: Structure of the smartphone-supported blended course**



Concerning the matter of creating a community of learners, as mentioned earlier, sub-Saharan Africa embodies a collectivist culture; therefore, it was imperative to develop a community of learners not only on-campus but also online. Hence, in addition to the group-based quizzes and group discussions that were delivered on-campus, we designed a 'Forum Assessment' in Moodle. In this online forum, the students were required to post two 250-word essays (one for each lesson). To get a pass for the assessment (i.e., proceed to the next learning activity), each student had to comment on at least two other student posts. This forum assessment successfully created a community of learners; the peer-to-peer interactions exceeded our expectations, as shall be described in the results section of the quantitative strand (Level 2) of this study. Moreover, in the LMS, we included a general 'Student Forum' in each lesson where the students could interact with the teacher and their peers to ask topic-related questions. The students were also required to create WhatsApp groups where they would prepare and discuss the upcoming group-based on-campus presentations.

Refinement during the implementation of any course is inevitable; however, multiple adjustments disrupt learning activities and are time-consuming. Thus, before rolling out the intervention course to the students, it was essential to check that the flipped lessons followed best practices, to minimise the number of refinements during implementation. For this evaluation, we used the previously described GEEFL chart. We focussed on elements that described the following topics: technology; balancing the blend; design of learning content and activities; learning styles; assessments; and student-lecturer expectations regarding the course. The GEEFL chart has 93 standards but, given the experimental nature of the smartphone-supported blended course, we aimed to effectuate only a sub-set (at least one-third) of the standards. Refer to Table 2.6 in Chapter 2 for a detailed account of the standards we considered in this evaluation. Our redesigned course proved to align with the GEEFL standards for a flipped classroom; hence we proceeded to roll it out to the students. The following quantitative strand (Level 2) describes how the students interacted with the intervention course and the outcomes.

### *7.3.2 Level 2 – Quantitative Strand: Evaluating the smartphone-supported blended course with first-year students at TMUC*

**a) Participants**

The students (i.e., first-year second-semester cohort; n = 25) were informed that participation was voluntary and that the intervention course would not impact their academic grades. All the students (n = 25) agreed to participate in the study (i.e., engage with the newly designed smartphone-supported blended course) and expressed they would put in the effort required to excel to the best of their ability in the course activities. Table 7.3 presents a summary of the participants' demographic data.

**Table 7.3: Profile of the participants (students)**

| Category | Description |
|---|---|
| Faculty | Biological and Physical sciences |
| Course | Introduction to Internet Technologies |
| Course level | First Year - Second Semester |
| Gender | Male (n = 20); Female (n = 5) |
| Age Range | 19 to 21 years |

**b) Accessing the Intervention Course**

To access the course, the students were instructed to download Moodle mobile app (but they could also view the course using the mobile web). As mentioned in Chapter 4, a significant benefit of using mobile apps (over the mobile web) is their ability to facilitate offline access, which minimises internet costs. The students were not trained on how to use the mobile app. Instead, a Chat Activity on Moodle LMS was set up, where the students could ask for technical help (e.g., site accessibility issues or lesson navigation queries). The rationale for not providing initial training was so that I could obtain information about the circumstances in which students required training. In Chapter 5, the survey results indicated that all the respondents believed they were skilful smartphone users and were confident they could easily learn how to use their smartphones in a formal education setting. Despite this, relevant literature (Gikas & Grant, 2013) demonstrates that even learners who consider themselves “technologically savvy” can still struggle with learning with technology and require support. However, given the scarcity of research on smartphone-supported learning, little is known about the level (or form) of support students need when using smartphones for formal education. Hence, by examining the conversations in the Chat Activity, it would be possible to infer the kind of training students mostly needed regarding smartphone-supported learning.

**c) Data Collection: Structured Observations**

To examine how the students engaged with the four-week-long intervention course, I utilised structured observation to gather data. Structured observation is a data collection method that allows researchers to examine participant behaviours that cannot be readily captured through surveys or interviews (Stausberg, 2011). It is structured because the behaviours examined are predefined in a check sheet known as an ‘observation protocol’ (Stausberg, 2011). In other words, the researcher only focuses on specific behaviours of interest. Since the researcher is interested in a limited set of behaviours, it is possible to quantify the occurrences of these behaviours; for instance, the researcher can mark down the frequency and/or duration of the behaviours (Stausberg, 2011). As such, structured observations are typically associated with quantitative studies (Price et al., 2017). Additionally, it is observational as there is no direct involvement between the researcher and the participants (i.e., the researcher examines the participants from afar).

The behaviours observed in this phase of the study were organised into three broad categories:

1. Course participation

This included tracking statistics about student engagement with the pre-recorded lectures; the number of days students spent accessing the online coursework; and the number of posts each student created in the online discussion forum. Additionally, since in *Lesson One* the students were required to complete an online-based quiz during the in-classroom session, I examined the quiz scores as these would provide insight into whether the students came prepared for in-class activities after learning the content online. These data (course analytics) were collated from Moodle LMS, where the online component of the course was hosted.

2. Students' study habits

During the on-campus session, the students were required to complete a timed online quiz. One hour before the quiz, a research assistant[33] examined how the students revised, which allowed me to gain insight into their learning habits and preferences. The observation was overt, meaning the participants were aware that they were being monitored. While overt observation could lead to the problem of reactivity (i.e., participants modifying their behaviour in anticipation of being observed), Stausberg (2011) argues that the effects of reactivity are relatively minor when studying classroom behaviours. Furthermore, reactivity is minimised if the participants are accustomed to the presence of the observer. The research assistant who facilitated this activity was well acquainted with the students; hence, their presence during the

[33] Due to COVID-19 travel restrictions, I was unable to physically be present during this phase of the research; hence, TMUC Principal assigned a research assistant to facilitate interactions with the students and lecturer. Nonetheless, I was remotely present during all the activities via video conferencing (i.e., via Skype and Zoom).

study was hardly noticeable and was perceived as a ‘natural’ event. The behaviours observed during this activity included: how the students were revising (e.g., individually or in groups); what resources they used to revise (e.g., PDF notes or audio-visual lectures); the students’ level of concentration; and the levels of interaction amongst themselves as well as with the lecturer. Figure 7.5 in the Results section displays a screenshot of the observation protocol used during this activity.

3. Students’ learning experience

To measure the efficacy of the course, there was a voluntary and anonymous Feedback Activity hosted on Moodle LMS. I examined the students’ responses for each lesson to get a snapshot view of their perceptions about the course. Key aspects observed included how the intervention course affected the students’ level of interest in the topics covered and whether the blended course matched their preconceived expectations. The questionnaire used for this Feedback Activity gathered ordinal data with five-point Likert scales, ranging from “strongly agree” to “strongly disagree” and “excellent” to “poor”.

**d) Data Analysis**

This phase of the study utilised descriptive statistics to analyse the data collected. Microsoft Excel software was used to render the following descriptive statistics: arithmetic means, percentages, and frequencies. Furthermore, to check whether the Feedback activity was a reliable tool to collect the students’ perceptions about the intervention course, Cronbach’s alpha coefficient[34] was used to evaluate whether the Feedback Activity (survey) questions were interrelated (i.e. measured the same construct).

[34] Please refer to Chapter 5, section 5.3.3 for further information about Cronbach’s alpha coefficient.

**e) Results**

*1. Level 2 Results: Description of course participation during the smartphone-supported blended course intervention*

As previously expressed in Figure 7.3, *Lesson One* comprised seven mini-lectures, and *Lesson Two* had five mini-lectures. It should be noted here that the content in the video, audio and PDF lectures were equivalent. Regarding student engagement with the pre-recorded online lectures, video format was the preferred mode of study (for both lessons). For example, on average, 85% of the students watched *Lesson One* videos compared to 56% who interacted with the audio lectures (see Tables 7.4 and 7.5). The minimal interaction with the PDF lecture notes (see Table 7.6) could be because the students downloaded the files hence studied the content offline. Similarly, the decreasing level of interaction with the audio-visual content across topics and the two lessons (as seen in Tables 7.4 and 7.5) was not because the students lost interest but because the students had already downloaded the content and thus engaged with the recordings offline. As noted earlier, we instructed students to use Moodle mobile app so that they could download the lecture material for offline access and save on mobile internet costs. The student survey results (see Figures 7.10 and 7.11) show that the students' interest in the lessons remained high throughout the study.

To capture streaming duration of the lecture recordings in Moodle, we enabled the conditions *'Require Time Spent'* and *'Require End Reached'* for the *'Activity Completion'* setting. Meaning, for a learning activity such as a video recording to be deemed complete, the student must view (click) the activity and watch the recording until the end. For the *"Require Time Spent"* condition, we included a timestamp equivalent to the length of each lecture recording. In this vein, Table 7.4 and Table 7.5 show the number of students who streamed the lecture recordings from start to finish.

**Table 7.4: Student engagement with the pre-recorded online lectures in Lesson One**

| Lesson One | Students who streamed the entire video (%) | Students who streamed the entire audio (%) |
|---|---|---|
| Topic 1 | 100 | 79 |
| Topic 2 | 96 | 46 |
| Topic 3 | 96 | 38 |
| Topic 4 | 79 | 38 |
| Topic 5 | 79 | 33 |
| Topic 6 | 75 | 25 |
| Topic 7 | 71 | 25 |

**Table 7.5: Student engagement with the pre-recorded online lectures in Lesson Two**

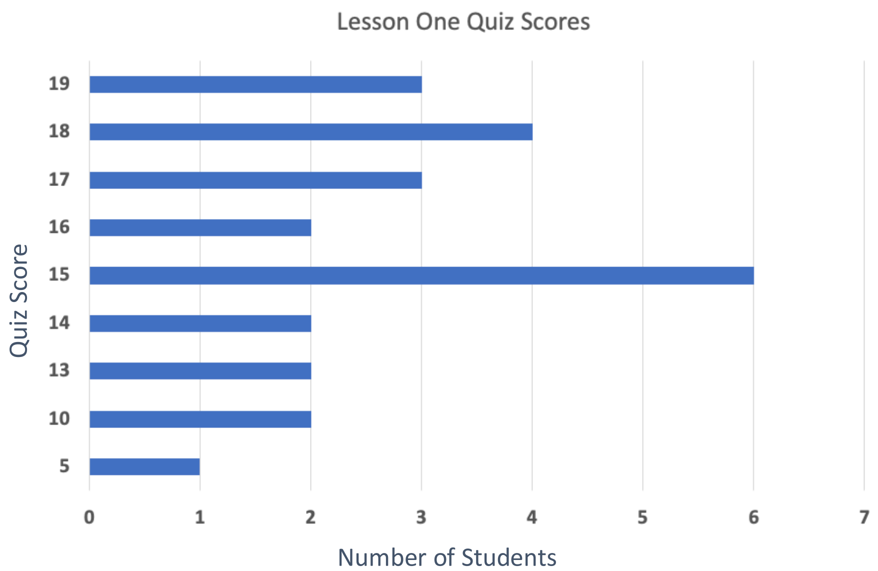
| Lesson Two | Students who streamed the entire video (%) | Students who streamed the entire audio (%) |
|---|---|---|
| Topic 1 | 67 | 33 |
| Topic 2 | 58 | 33 |
| Topic 3 | 46 | 29 |
| Topic 4 | 42 | 17 |

**Table 7.6: Student engagement with the online PDF lecture notes**

| Number of Views | Students who interacted with the PDF notes for Lesson One (%) | Students who interacted with the PDF notes for Lesson Two (%) |
|---|---|---|
| 1 to 3 | 38 | 38 |
| 4 to 7 | 33 | 21 |
| 8 to 11 | 21 | 4 |
| 12 to 15 | 13 | 13 |

Still on the matter of course participation, considering that the smartphone-based course was two weeks' worth of content and the online component required the students to become partially independent[35] learners, it was necessary to examine whether the students can realistically manage their self-paced study time. To this end, I examined the student scores for the classroom-based quiz[36] as these would indicate whether the students came prepared for the in-classroom activities after studying the learning content online. Most of the students had high quiz scores (see Figure 7.4, and Appendix E), indicating that they were capable of studying and understanding the lecture material on their own. Another way I measured the student's ability to effectively manage their self-paced study time was by examining the number of days students accessed the online coursework. Results in Table 7.7 show that most students spent at least eight days on each online lesson. Given that each online lesson contained a week's worth of learning content, the results in Table 7.7 imply that the students had become partially independent learners.

**Figure 7.4: Lesson One quiz scores for the 25 students (grades are out of 20)**




[35] As noted in Chapter 2, due to the dominant classroom-based and teacher-led lecture format employed in public universities, most students in sub-Saharan Africa are dependent learners who rely on the teacher ('sage on stage') to regulate and schedule their learning activities.
[36]As described earlier (see Figure 7.3), in *Lesson One*, the students were required to complete a online-based quiz in-class (on-campus) to test their comprehension of the pre-class media (i.e., online lecture material).

**Table 7.7: Number of days students spent accessing the online coursework**

| Number of Days Online | Number of Students for Lesson One (%) | Number of Students for Lesson Two (%) |
|---|---|---|
| 1 to 3 | 4 | 4 |
| 4 to 7 | 20 | 44 |
| 8 to 11 | 56 | 52 |
| 12 to 15 | 20 | 0 |

Moving on to how the students contributed to the course (i.e., the forum assignment that required them to post a 250-word essay and then comment on at least two other student posts), the required minimum forum posts per student (in each lesson) was three. Results displayed in Table 7.8 show that all the students surpassed this minimum value. In *Lesson One*, the average was four posts per student, and in *Lesson Two*, the average was between four and six posts. For the forum assignments, the average word count per post ranged between 154 to 175 words. In general, peer-to-peer interaction was apparent in the online discussion forums.

**Table 7.8: Student participation and interaction in the online forum assignments; each post had an average word count ranging from 154 to 175 words**

| Number of Posts per Student | Number of Students for Lesson One (%) | Number of Students for Lesson Two (%) |
|---|---|---|
| 4 | 58 | 29 |
| 5 | 13 | 29 |
| 6 | 13 | 25 |
| 7 to 8 | 16 | 4 |
| 9 to 13 | 0 | 13 |

2. *Level 2 Results: Description of observed student study habits during the smartphone-supported blended course intervention*

So far, the aforementioned results have described how the students studied remotely. However, because this was a blended course, it was also necessary to observe their study habits within a physical classroom (i.e. on-campus), to gain a more holistic perspective of the students' study habits and preferences. Therefore, during one of the in-classroom sessions (see Figure 7.3), the students were required to complete a twenty-minute online-based quiz. To this end, one hour before the quiz, a research assistant observed how the students revised and interacted with their lecturer. The observation was continuous, meaning the descriptions in Figure 7.5 represent the average student behaviours over one hour (i.e., they are not one-off observations).

The observation protocol presented in Figure 7.5 shows that the majority of the students preferred to study in pairs, with very few studying individually. In terms of concentration, the students were seen to be fully engaged with the online learning content in the Moodle mobile app; the students were seldom distracted by calls, text messages or other smartphone applications (e.g., social media). It was interesting to note that most of the student-teacher interactions were not course-related; the students mostly wanted advice (mentorship) about achieving personal growth through university education.

**Figure 7.5: Observation protocol describing how the students revised before Lesson One Quiz that took place in-classroom (on-campus)**

**Checklist for observations**

Day: 06/03/2020 Time: ONE HOUR BEFORE QUIZ Activity: LESSON ONE REVISION

| *Occurrences to observe* | ***High*** | ***Mid*** | ***Low*** |
|---|---|---|---|
| **1. How the students were studying:** | | | |
| a) Individually | | | ✓ |
| b) In pairs | ✓ | | |
| c) In groups (3 to 4 members) | | ✓ | |
| d) Watching pre-recorded lectures with high volume | | | ✓ |
| e) Watching pre-recorded lectures with earphones | ✓ | | |
| f) Did not watch pre-recorded lectures | | | ✓ |
| g) Reading the PDF lecture notes | | ✓ | |
| **2. Level of concentration while watching pre-recorded lectures:** | | | |
| a) Watch entire pre-recorded lectures in silence | | | ✓ |
| b) Discussing the pre-recorded lectures while watching | ✓ | | |
| c) Sometimes distracted by other activities on their smartphone | | | ✓ |
| **3. Interaction between the different study groups:** | | | |
| a) Students discuss or share information about the pre-recorded lectures with members in other groups | ✓ | | |
| b) The interaction with the members in other groups was non-educational | | ✓ | |
| **4. Interaction between the student and teacher:** | | | |
| a) Related with the content in the pre-recorded lectures | | | ✓ |
| b) Related with doubts about their performance in the upcoming quiz | | ✓ | |
| *c) Others* | ✓ | | |

3. *Level 2 Results: Description of the students' learning experiences during the smartphone-supported blended course intervention*

Each Feedback Activity (survey questionnaire) had nine items (as described in Appendix F). To ensure the feedback questionnaire was reliable (i.e., all the items were interrelated or measured the same construct), I computed Cronbach's alpha coefficient. The feedback responses for *Lesson One* recorded an alpha of 0.9312, and *Lesson Two* had an alpha of 0.7595. Related literature postulates that Cronbach alpha values ranging between 0.70 and 0.95 imply a high degree of interrelatedness among the items, thus indicating a questionnaire's satisfactory reliability (Tavakol & Dennick, 2011). Notwithstanding, when examining the student responses, I only focused on the feedback items that specifically measured whether the intervention course: 1) matched the students' preconceived expectations about what blended learning entailed and 2) influenced the students' level of interest in the course topics. In this vein, I only examined the student responses for items 4, 5, 7 and 9 of the questionnaire. Table 7.9 presents a description of each of the aforementioned items. The other items in the questionnaire (that I did not focus on) were primarily designed for the lecturer to evaluate whether the course objectives had been met (see Appendix F for a complete account of the questionnaire and additional results).

**Table 7.9: Items examined in the online feedback survey measuring the students' perceptions about the intervention course**

| Feedback Survey Item | Description/Statement |
|---|---|
| Item 4 | The lesson increased my interest in the subject. |
| Item 5 | The lesson corresponded to my expectations. |
| Item 7 | The lesson was organised in a way that helped me learn. |
| Item 9 | What overall rating would you give Lesson One and Lesson Two? |

Concerning expectations for *Lesson One*, all the students (n = 25) completed the survey and, Figure 7.6 shows that 92% agreed that the lesson was as per their expectations. Furthermore, 76% of the students gave *Lesson One* an overall rating of 'Excellent' (as seen in Figure 7.7). A similar observation was noted in *Lesson Two* – 23 students completed the survey, 96% gave the lesson an overall rating of 'Excellent', and all survey respondents agreed that the lesson was congruent with their expectations (see Figures 7.8 and 7.9).

**Figure 7.6: Lesson One corresponded to my expectations (n = 25)**

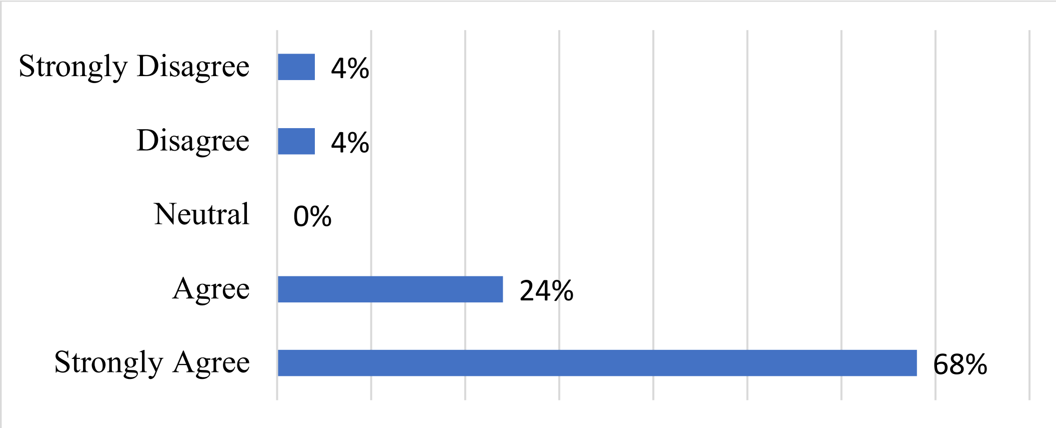



**Figure 7.7: What overall rating would you give Lesson One? (n = 25)**

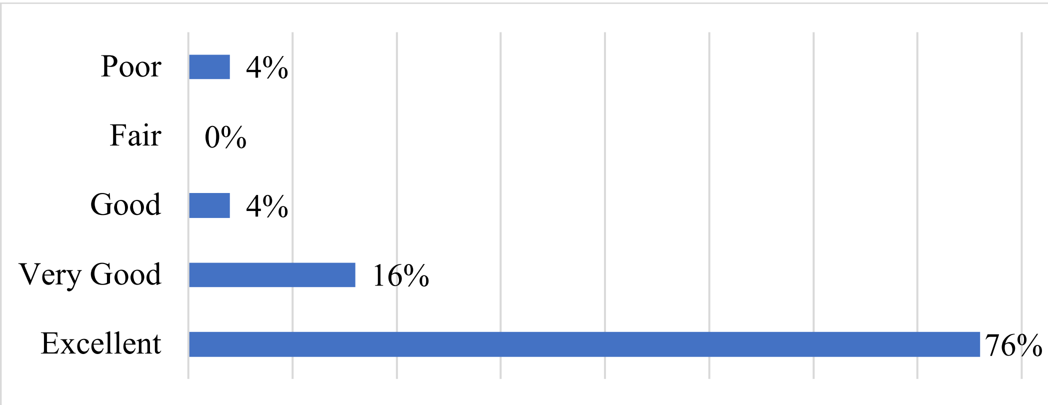



**Figure 7.8: What overall rating would you give Lesson Two? (n = 23)**

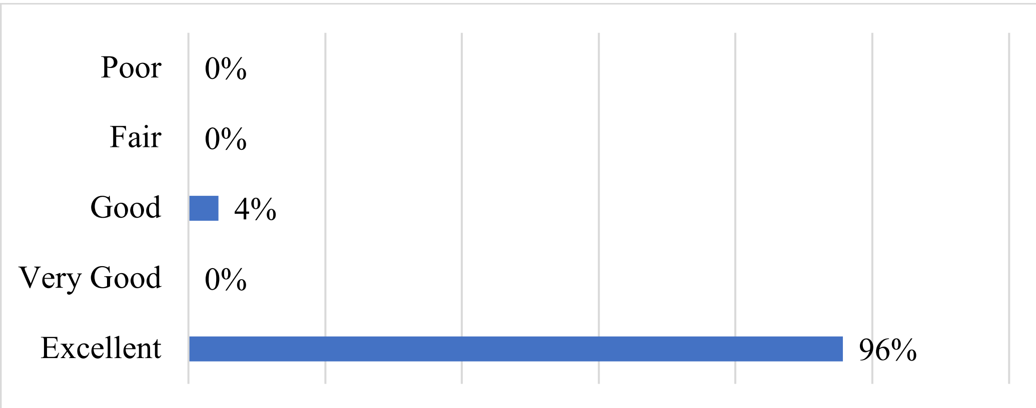
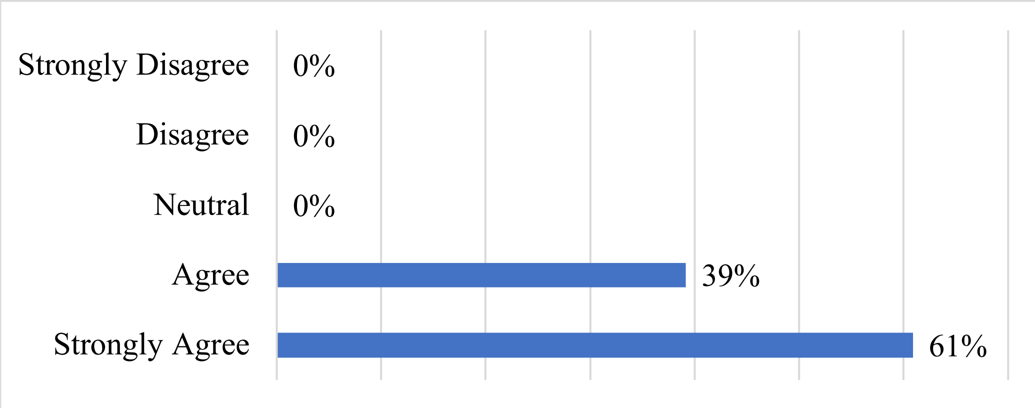
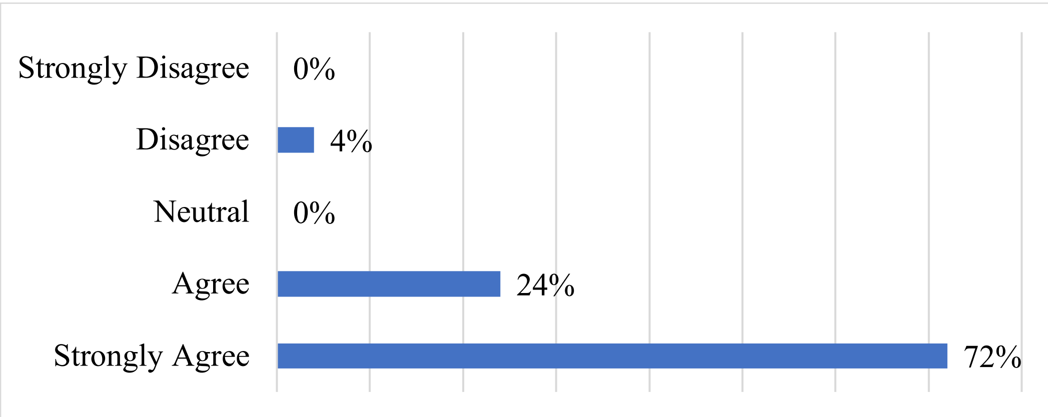


**Figure 7.9: Lesson Two corresponded to my expectations (n = 23)**




Regarding whether the intervention course helped improve learning outcomes[37], Figure 7.10 shows that in *Lesson One*, 96% of the students reported the lesson was organised in a way that helped them to learn; similarly, 96% stated that the course increased their level of interest in the topics covered (as displayed in Figure 7.11). For *Lesson Two*, all the survey respondents (n = 23) indicated that the intervention course increased their level of interest in the topics covered and enhanced their mastery of the subject (see Figures 7.12 and 7.13).

**Figure 7.10: Lesson One was organised in a way that helped me learn (n = 25)**




[37] In this context, learning outcomes refer to the development of intellectual abilities and mastery of domain-specific knowledge that result from the students' engagement with the course content.

**Figure 7.11: Lesson One increased my interest in the subject (n =25)**

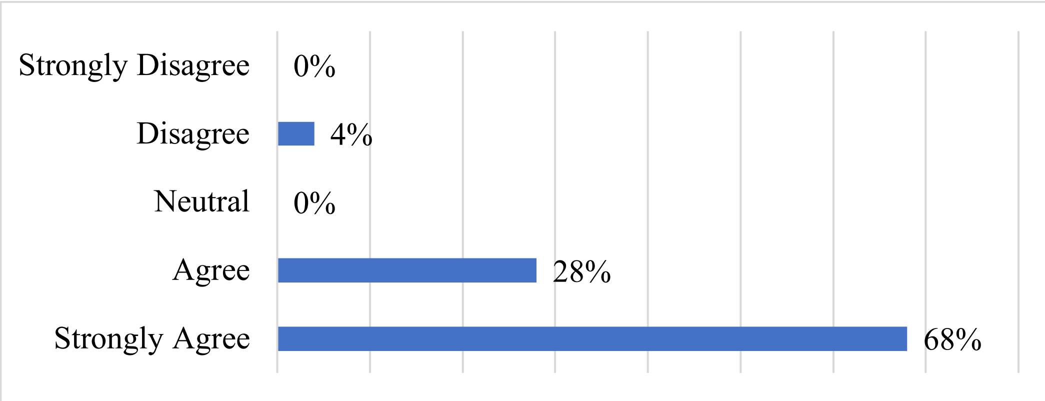



**Figure 7.12: Lesson Two increased my interest in the subject (n = 23)**

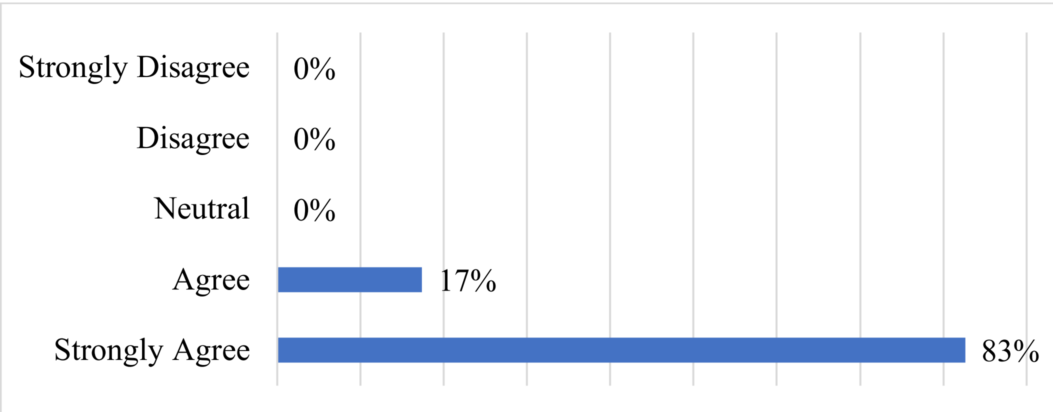
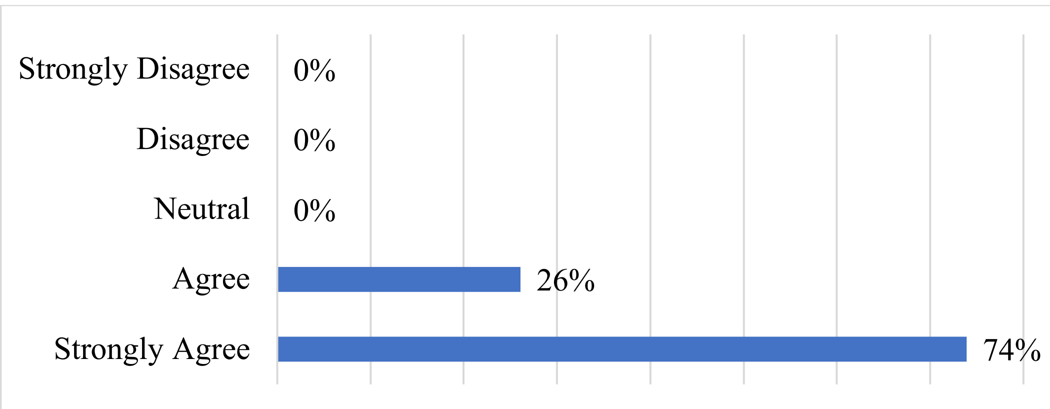



**Figure 7.13: Lesson Two was organised in a way that helped me learn (n = 23)**



### 7.3.3 Level 3 – Qualitative Strand: Exploring student perceptions about smartphone-supported learning post-intervention course

While data constructed from observations are valuable in establishing empirical regularities, structured observation is rarely used as a mono-method (it produces optimal results when used with other data collection methods) (Stausberg, 2011). This is because the observation protocol used "directs attention to a specific set of phenomena [which could make the researcher lose sight] of other potentially interesting things that might occur in the field" (Stausberg, 2011, p. 390). For example, the results discussed in the previous quantitative strand (Level 2) showed that students preferred video-based lectures and preferred to study in groups; however, data explaining why the students displayed these preferences could not be constructed from the observation. In this vein, this qualitative strand (Level 3) aimed to gather data that would elaborate, clarify, and enrich the understanding of the results gained from the previous quantitative strand.

**a) Participants**

Participation in this phase of the research was voluntary. All the participants (n = 25) from the previous quantitative strand (Level 2) were invited to participate. All the students volunteered to partake in the study. They were informed of the purpose of the study and then provided with a leaflet of the research agenda.

**b) Data Collection: Focus Group Discussion**

Focus group discussion was the data collection method used. A focus group is a small group of purposefully selected participants (typically comprised of four to ten people) who convene to discuss their perceptions and beliefs about a particular research topic (Nyumba et al., 2018). Unlike in semi-structured interviews where the researcher assumes the role of "investigator" (meaning dialogue is between the researcher and the participants and the researcher controls the dynamics of the interaction), during a focus group discussion, the researcher assumes the role of "facilitator" or "moderator" (Nyumba et al., 2018). In other words, in focus groups, the researcher takes on a peripheral role as the discussions are typically not between the researcher and the participant; instead, the researcher's role is to ask broad questions that generate discussions among the participants. The rationale for electing focus groups (instead of individual interviews) was based on the assumption that by allowing participants to expand on each other's responses, I would be able to reach a consensus on the value the participants placed on smartphone-supported blended learning.

- Focus Group Protocol

The focus groups were structured to answer five open-ended questions (see Table 7.10). These questions were created based on the findings of the quantitative strand and sought to provide further insight into the students' experiences with the intervention course. Each focus group comprised four to five students; the number of participants per group was based on Nyumba et al. (2018) recommendation of four to ten participants. Given that the total number of participants in this study was 25, six focus groups were created. Before the sessions began, the students were asked to list the dates they would be available to partake in the study. All listed dates were reconciled, and a single date was chosen and communicated to the students. Figure 7.14 is a photo of some of the focus groups.

The focus groups were managed by a skilled facilitator and a research assistant (TMUC Principal appointed[38] both). The facilitator was in charge of moderating the group discussions,

[38] As earlier mentioned, due to COVID-19 travel restrictions, I was unable to physically be present during this phase of the research. Nonetheless, I was remotely present during the focus group sessions via video conferencing (i.e., via Skype and Zoom).

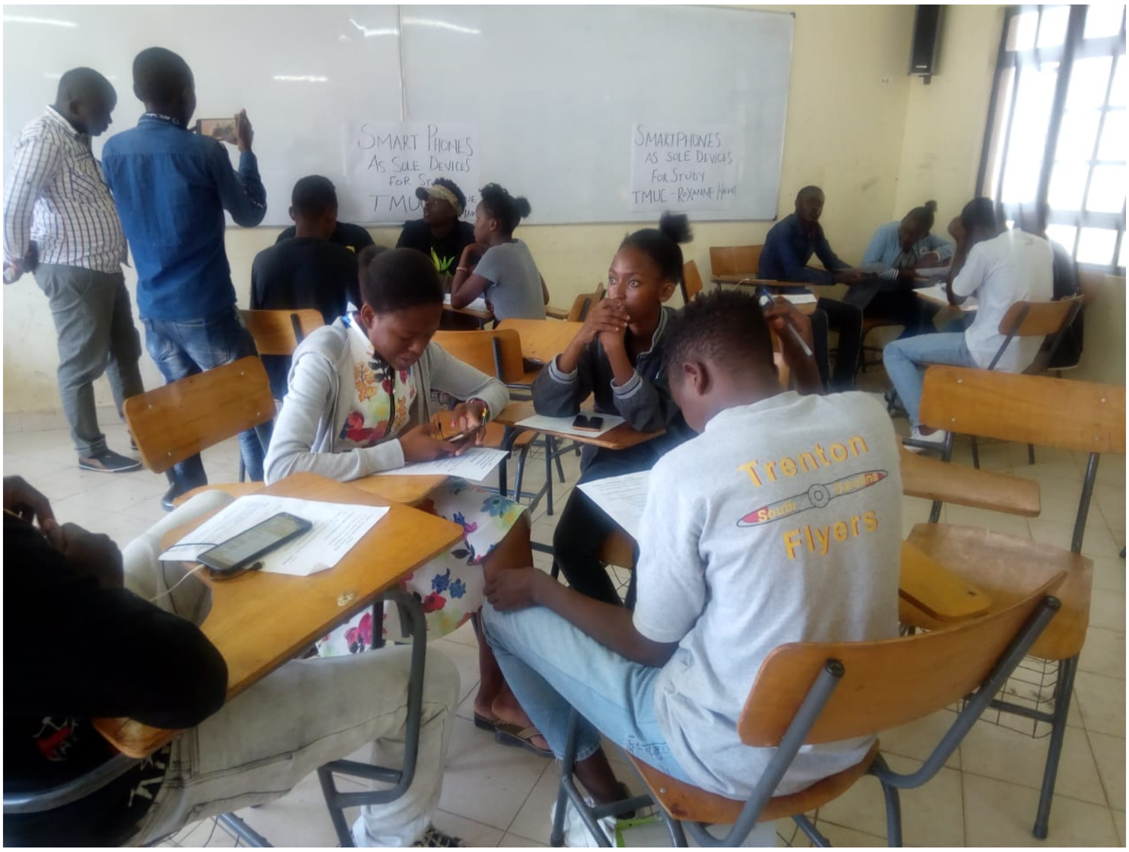
while the research assistant's role was to document the general content of the discussions (e.g., observing non-verbal interactions, which enrich verbal data) (Nyumba et al., 2018). In addition to the research assistant's notes, discussions were video-recorded to ensure the nuances of the dialogue were not lost, thereby aiding data analysis. The facilitator and the research assistant met with the focus groups outside of class (i.e., after the on-campus session on week 4, refer to Figure 7.3). Concerning the number of meetings per group, the researchers met with each group once. Although literature asserts that a single group meeting is not sufficient to exhaustively discuss a research topic and recommend a minimum of three to four meetings (Nyumba et al., 2018), due to time constraints[39], it was not possible to reconvene the focus groups for subsequent discussions. Hence, the principle of theoretical saturation was employed, where each focus group discussion continued until a clear theme emerged and the subsequent groups produced no new information (Nyumba et al., 2018). Consequently, each focus group discussion lasted approximately 45 minutes.

**Table 7.10: Research questions discussed during the Focus Group sessions**

| | Research Questions |
|---|---|
| 1 | What did you like about the smartphone-base course? |
| 2 | What challenges did you encounter while interacting with the smartphone-based course? |
| 3 | Which version of the smartphone-based course did you prefer, *Lesson One*, the one that had an on-campus and online component or, *Lesson Two*, the one that was fully online with no on-campus sessions? Why? |
| 4 | Would you like it if your lecturers incorporated a smartphone-based lesson into their courses? Why? |
| 5 | What suggestions do you have that might help improve this smartphone-based course in the future? |

[39] This strand of the research took place during school hours, and the students were not excused from attending their usual courses. Therefore, the focus groups could only be scheduled when it was convenient for the participants.

**Figure 7.14*: A photo showing some of the focus groups created to discuss students' experiences with intervention course***




**c) Data Analysis**

The transcripts from the focus group discussions were inductively analysed using the guidelines for thematic analysis proposed by Clarke and Braun (2013). The thematic analysis was manual (i.e., no software was used). To verify that the findings were consistent with the raw data collected (dependability), I used the code-recode method suggested by Anney (2014) (previously discussed in Chapter 6, section 6.2.3). Once the themes emerged, all the students were given the option to review the findings; eight participants (at least one from each focus group) volunteered to review the findings for accuracy.

### d) Results: Findings from the Focus Group Discussions

*Research Question 1*

The focus groups revealed four themes when the students were asked to describe what they liked about the intervention course: seamless learning; integration of multimedia content; timely formative feedback; and fosters student participation.

- Seamless learning

The focus groups reported that smartphone-based learning motivated them to continue learning beyond the formal teaching hours. One student had this to say:

> "With the current on-campus lectures, once the lecturer leaves the classroom, that is it, most students hardly ever think of the course until when we have that class/lecture again the next week. But, with this intervention course, since the lectures were always on my mobile phone, I often found myself researching more about the topics taught whenever I had free time."

- Integration of multi-format content

Another aspect the students liked about the intervention course was that the course materials were presented in multiple formats (i.e., audio, video, and text).

> "I lose concentration easily when I read text ... I understand my teachers better when I am listening to them ... So, I was very excited to find out that the smartphone-based lesson had an audio version of the lectures. It was nice to be able to listen to the same lectures repeatedly on my phone ... this helped me recall the concepts."

- Timely formative feedback

The focus groups were happy that the smartphone-based course delivered prompt responses upon completion of the online assessments. One student expressed this sentiment as follows:

> "Sometimes we get our graded assignments at the end of the semester. This is frustrating because we don't know early on our problem areas, and when exam time comes, it's often too late to adequately master those concepts we failed in the quizzes. But the online quizzes in this smartphone-based lesson were good because I got feedback immediately and knew what areas to revise thoroughly."

- Fosters student participation

A prominent topic in the focus groups was that the online discussion forums helped shy students to express their views more freely.

> "I generally have a reserved personality, so in class, I find it a bit difficult to express my views among my other very talkative classmates. I liked the smartphone-based lesson because the online discussion forums allowed me to express myself anytime without feeling like I am competing for attention with my other chatty classmates."

*Research Question 2*

Most of the students were happy with the smartphone-based course. Nevertheless, when asked about the challenges they encountered while interacting with the intervention course, one particular focus group (alias – 'Group Four') had a few concerns worth mentioning: increased internet data consumption and technological inconveniences.

- Increased internet data consumption

The participants in 'Group Four' strongly emphasised that the smartphone-based lesson consumed an unusual amount of mobile internet data. Two students had this to say:

> "The rate of bundle consumption should be checked."
>
> "There should be free online learning bundles."

- Technological inconveniences

Additionally, 'Group Four' participants reported that completing some of the tasks in the smartphone-based lesson was difficult due to their smartphone's technical (hardware and software) limitations.

> "I think my phone has a small screen size because I found it tedious and time-consuming to type the 250-word forum essays."

> "My smartphone has low internal storage, so at times when I tried to access the course, the app would take forever to load... then when it finally loaded, it would soon crash, and I would have to start the process all over again, which was a bit frustrating and time-consuming."

*Research Question 3*

When asked to share their perceptions about *Lesson One,* which was delivered in a blended format and *Lesson Two,* which was fully online, the focus groups revealed that *Lesson One* was their preferred mode of study. The prominent theme that emerged when students were asked why they favoured *Lesson One* was, it was more effective at facilitating collaborative learning.

> "While the fully online Lesson Two helped me learn how to study on my own, at some point, I started yearning for the face-to-face [on-campus] interactions

with my peers and teacher... Lesson One was good because it had the best of both worlds. I could study online but also meet up in-person with my classmates and teacher to discuss the notes and other life stuff."

"I like studying on my own, but there are some topics I just wanted to discuss face-to-face with my friends. The online discussion forums were good, but some debate topics needed that instant live interaction and reactions that you can only get from in-person conversations. So, I preferred Lesson One format."

*Research Question 4*

When the students were asked if they would want their lecturers to incorporate a smartphone-based lesson into their course, the unanimous response was "Yes". The two main reasons for wanting their lecturers to integrate smartphones into their lessons were 1) it breaks the monotony of classroom-based learning and 2) the pre-recorded lectures were more convenient than the traditional lectures. Two participants echoed these sentiments as follows:

"Some of my courses are purely theoretical, so I get bored very quickly listening to the lecturer dictate the notes for an hour. A smartphone-based lesson means the lecturer can include in their pre-recorded lectures some multimedia content, for example, YouTube videos. From time to time, watching or listening to someone else explain the same concept can help raise my attentiveness."

"Sometimes, I can't get to class on time, maybe because I have woken up late or my mum needs me to run an errand. On these days that I miss the lectures, it's such a hustle because I first have to beg my friend to lend me their short notes to copy, and then I have to figure out how to teach myself the way the lecturer would. But with this smartphone-based course, my teachers can post their recorded lectures online, and I can watch those videos at any time without feeling the pressure of having to teach myself or having to understand my friend's short notes."

*Research Question 5*

Lastly, when asked what improvements could be made to the smartphone-based course, the students made suggestions that the course content should have more reference materials that would help them conduct independent research on the topics covered.

> "Usually, with the current classroom-based learning, if I want revision notes, I will go to the library and look for hard copy books. But with this smartphone-based course, since there is an online learning component, which I am not yet used to, I need help knowing how to search for relevant study materials online. It would be nice if the lessons had a section where I could access links to various open educational resources related to the topics covered."

> "The field of IT is constantly evolving, so I like to read beyond what the syllabus requires, just so that I'm up to date with what's going on. It would have been nice if the smartphone-based lesson had more reference materials, like let's say journal papers that provide in-depth information about the topic. For Lesson One, I only saw like two links for each topic so next time the lecturer could add like four more links."

## 7.4 Discussion

Overall, results from the three strands (qual-quan-qual) of this Phase 4 of the research show that smartphone-supported blended learning is an effective instructional method. All the students recommended that their lecturer continue using the blended approach, and 98% stated they would highly recommend the lesson to other students (see Appendix F). Although we only pilot-tested the smartphone-supported blended format in one unit of the lecturer's course, the results provide valuable lessons which can help other educators integrate smartphone-based lessons into their courses.

For example, in *Level 1 (design of the smartphone-based course),* the interactions with the lecturer provide the following insights:

- *Start very small:* As outlined in Chapter 2, it is better to view the course as a "work in progress" and transition into the new instructional format in stages. For this study, we adopted the beginner-friendly 'medium-impact blend' suggested by Alammary et al. (2014), and we blended two weeks' worth of course content. However, while redesigning the course, it became apparent that we had taken on too much work. Since the lecturer did not receive any workload reduction, finding the extra time for course development was quite overwhelming; consequently, the design phase prolonged beyond our expectations. In hindsight, we should have blended only one week's worth of course content, which was the strategy adopted by one of the instructors in the study by Napier et al. (2011).
- *Don't underestimate OERs:* As an early adopter of blended learning, in the pilot test phase, consider utilising only OERs in the online component, as opposed to creating your own online content from scratch. Allen and Seaman (2014) demonstrate that the quality of OERs is roughly equivalent to or sometimes even better than the traditional

educational resources. For the present study, we opted to create the pre-recorded lectures (audio-visual content) from scratch and then embedded a few OERs into these newly recorded lectures. However, this process proved to be taxing for the lecturer, given that online learning was a pedagogy they were not accustomed to. The design of the online component would have been more manageable if we had developed the online learning content in two phases (as described in Chapter 2, section 2.3.4). The first phase involves the lecturer exclusively exploiting OERs. Once they are confident they can design online courses, the second phase involves the lecturer designing (from scratch) their own digital learning content (and including OERs as needed).

- *Take advantage of free, open-source LMSs and web hosting services:* Most university-grade LMSs request a service fee; however, given the financial constraints experienced in public universities in sub-Saharan Africa, convincing university management to fund an individual experimental project is not an easy feat. Nonetheless, teachers can still create an online course using a free, open source LMS. One of the most popular free, open-source LMSs is *Moodle*. Furthermore, teachers should utilise a free hosting service to bypass the time-consuming process of installing and configuring their own Moodle server on a computer. For this study, we used Gnomio.com - a free hosting platform that allows teachers to create their own online learning content on Moodle. Hawi (2020) presents a short, informative tutorial on how to develop a Moodle-based course on Gnomio.
- *Change takes time – don't expect too much from university management:* As previously outlined in the literature, the university management is generally slow to adopt changes, especially when the change is initiated by an individual faculty, even if the proposed change has apparent advantages (Graham et al., 2013). If there are no institutional policies in place that allow the teacher to request time release or a reduction in workload

to prepare their blended course, Alammary et al. (2014) advise teachers to ensure any online teaching resources added into a traditional course result in a reduction of classroom contact hours. According to Graham et al. (2013, p. 4):

> "... many institutions (perhaps most) have BL courses because BL has been experimented with or adopted by faculty although the institution itself has not officially adopted it. BL has started in many places as a grass-roots effort, adopted by individual faculty interested in using both online and traditional strategies to improve student learning outcomes rather than promoted as a strategic institutional initiative".

Moving on to *Level 2 (testing of the intervention course with students)* and *Level 3 (student reflections post-intervention course)*, the results provide the following insights:

- *Video is the king of content format, but remember to keep it short and interactive:* The proliferation of smartphones has made streaming of videos more effortless and common (Cerwall et al., 2018). Accordingly, it was not surprising that the present study demonstrated video-based lectures were the most frequently accessed learning resource. However, because video can combine all other content types (text, audio, imagery and movement), there is a chance that it could lead to cognitive overload as it gets longer. Accordingly, Fyfield et al. (2019, p. 1) assert that "videos should be short, uncluttered, and restricted to one clearly identified learning goal". A common rule of thumb is to ensure instructional videos do not exceed ten minutes – this duration can be achieved through a process known as chunking or segmentation (Brame, 2015). Another important aspect to note is that "videos should be accompanied by learning activities, rather than watched passively" (Fyfield et al., 2019, p. 1). For example, to promote active learning and ensure video lectures lead to meaningful learning gains, teachers should provide students with guiding questions to consider while watching the videos (Brame, 2015). These questions can be presented separately or embedded within the video, such that students are automatically prompted to answer them at specific points in the video. *HapYak* is a popular software (compatible with most LMSs) that teachers can use to directly embed questions into their video lectures. Hawi (2020) demonstrates simple ways teachers can start recording their own videos using a smartphone.

- *Don't assume that all students are technologically savvy:* Whilst students may generally be skilful smartphone users, educators should provide technical support and train students to use their smartphones for formal education. The technical concerns raised by a few students during the focus group discussions included the mobile app crashing, hanging or taking a long time to load content. While these were valid concerns, Moodle LMS is a reasonably stable application. The students who raised these concerns were unaware that their smartphones kept hanging or crashing because too many applications ran in the background, resulting in decreased memory and processing speed. We had to advise the students to close unnecessary applications while using Moodle mobile app to ensure optimum processing capacity. Furthermore, the focus groups revealed that a few students had difficulties completing the online forum assessments, stating that typing the 250-word essays was time-consuming due to their smartphone's small screen size. In such a scenario, the students need to be advised that they can post the essay as a video, audio or even image of a handwritten assignment.
- *Students don't always want to be spoon-fed – they want to become independent learners:* Regarding this present research, introducing an online component to the traditional teacher-led lecture format meant that students needed to shift from predominantly passive learners to partially independent learners. However, such a

learning shift takes time, and there was a possibility that the students might struggle to make the change. To this end, the lecturer made sure that that pre-recorded lectures exhaustively covered the syllabus. Interestingly, despite the lecturer's thorough efforts, when focus groups were asked what improvements could be made to the smartphone-based course, the students suggested that the course content should have more reference materials to help them conduct independent research on the topics covered. Furthermore, most of the students stated they are already accustomed to using their smartphones to access informal learning content, so providing additional references for further reading (beyond the syllabus) would not drastically affect their study habits.

- *Students in collectivist cultures need a blend of embodied face-to-face learning and digital face-to-face learning:* a collectivist culture is one in which in-person social interaction is of paramount importance. Accordingly, even with the affordances of smartphone-based online learning (such as flexibility when it comes to attending lectures and self-paced learning), the majority of students who took part in this study stated they preferred *Lesson One*, which included an on-campus and online component, as opposed to *Lesson Two* that was fully online. Furthermore, the observation checklist showed that there was a high level of interaction between the lecturer and the students during the in-classroom sessions. The lecturer stated that this level of interaction with the students was not a normal occurrence[40]. Most of these student-lecturer conversations were not related to the course content but rather conversations about the students' personal life (growth and development). This implies that the smartphone-supported blended learning approach freed up on-campus sessions for the much-needed student mentorship. Even more interesting was the fact that the lecturer observed more

[40] As mentioned before, due to overcrowded lecture halls (i.e., extremely large-class sizes) in public universities of sub-Saharan Africa, student-lecturer interactions are usually difficult to schedule in the traditional classroom-based teaching format.

student-teacher interactions in the classroom than online. This increased interaction with the lecturer in-classroom (compared to the online interaction) suggests that students in collectivist cultures crave some level of embodied face-to-face interaction with the teachers. Regarding my postulation that students also require digital face-to-face interaction, perhaps more students felt the need to interact with the teacher in-person because we did not include any personal video messages from the lecturer in the LMS. Students mostly interacted with the teacher via text in the online discussion forums. Retrospectively, it would have been ideal if the lecturer occasionally uploaded a short personal video message to check in with the students during the out-of-class periods. Perhaps, seeing the lecturer could elicit the same feeling of connectedness the students have when interacting with the teacher in a physical classroom.

- *Offline access to content is crucial when implementing smartphone-supported blended learning:* In Chapter 4, I emphasised the importance of ensuring that smartphone-based courses have an offline feature integrated because learners typically use these devices across various contexts. If students feel they cannot use their smartphone to access course content anywhere or anytime, their desire to use the device for education may diminish, as was the case in the study conducted by Tossell et al. (2015). In this present research, the Moodle mobile app (mLMS) allowed students to download the content on their smartphones, which could later be accessed without internet connectivity. Whilst 'increased mobile internet data consumption' was an emerging theme during the focus group discussions, it was a great concern to only a few students. This implies that before breaking for the two-week out-of-class session, most students took advantage of the free university Wi-Fi and downloaded the course content before leaving the campus. In this vein, as an early adopter of smartphone-based blended learning, it is essential to ensure that the free, open source LMS the teacher selects has a mobile app function.

Unlike the mobile web, mobile apps have an offline mode option, meaning students do not require internet access to engage with learning content. Furthermore, the teacher should ensure they inform students about this feature and demonstrate how to use it (i.e., remind them to make use of free Wi-Fi hotspots to download the course content).

## 7.5 Strengths and Limitations of Phase Four

Whilst data gathered from the previous studies about student and lecturer perceptions are valuable, they are not enough to draw conclusions about the viability of smartphone-supported blended learning. Therefore, Phase 4 of this research aimed to build on the results of these previous studies by testing the effects of smartphone-supported blended learning in light of actual teaching and learning. In Phase 4, I worked closely with one of the lecturers at TMUC to restructure their course and make it smartphone-ready and then tested the smartphone-based course with the students. The aim was to practically evaluate how a student who owns only a smartphone and does not have access to a desktop PC or laptop can successfully participate in an online university course. This phase addressed the third and final research objective: *To develop a framework that provides a set of guidelines on how to successfully deliver a university course solely to a smartphone.*

An apparent strength of this phase is that it allowed me to identify and describe the strategies used and challenges encountered while pilot testing a blended learning instructional method in an institution that, at the time, had limited resources and experience to support the organised implementation of online learning. In other words, the findings of this phase showcase that smartphone-supported blended learning is achievable even when there is little funding, training and support available. I anticipate that by demonstrating the success of this pilot test in a resource-constrained environment, the level of support for smartphone-based online education initiatives will increase at TMUC and other public universities in sub-Saharan Africa.

Another strength of Phase 4 is that it led to the development of a framework entitled *Smartphone Only Learning Environment (SOLE)* that provides guidelines on how teachers can deliver their courses to a smartphone. I envision that the ideas shared in this framework will motivate educators worldwide to integrate smartphone-based lessons into their existing courses and help early adopters of blended learning in sub-Saharan Africa transition into this new pedagogy more smoothly. The framework is discussed in detail in Chapter 8. Here, some limitations are discussed next.

Despite the apparent success of the smartphone-supporting blended course in facilitating student learning, it had a few shortcomings. Firstly, there was no strategy in place to measure whether the intervention course influenced student performance. In other words, since the intervention course had no impact on the students' final course grade, we overlooked that establishing an informal performance metric was a great way to measure whether the new pedagogy had a positive or negative impact on the students' cognitive abilities. Since the students were newcomers (first year second-semester cohort), they likely entered the university with varying skills, abilities, and interests in the course topics. Therefore, before engaging with the intervention course, we should have administered a pre-test to measure the students' prior knowledge about the course topic. Instead, to measure the course's efficacy, we only administered a post-test quiz and an anonymous online feedback survey at the end of the course. In the feedback survey, the students were asked to indicate whether the course increased their understanding and level of interest in the topics covered. However, given that the students were already very excited to use their smartphones for learning, there was a possibility that they could have provided exaggerated responses in the feedback survey. Whilst the post-test quiz scores were encouraging, a performance comparison between the pre-test and post-test scores could have provided more robust empirical evidence that smartphone-supported blended learning can improve student performance.

The second limitation encountered in Phase 4 was beyond my control, but it is worth mentioning. For the present study, I pilot tested the proposed approach in one course. However, the initial intention was to collaborate with two lecturers (i.e., redesign two courses). The rationale for this decision was based on the premise that a comparison of the results from the two courses would give a more complete picture and potentially highlight areas of either contradiction or convergence, which may reveal areas for further study. Although two lecturers agreed to work with me to redesign their course, four months into the research, one lecturer could not continue with the study due to COVID-19 pandemic limitations. Furthermore, during the pandemic, it was impossible to find other willing participants as TMUC (and all universities in Kenya) eventually suspended all forms of learning for the better part of 2020 (i.e., March to November 2020). Nevertheless, as described throughout this chapter, I gained valuable insights from the one course I evaluated in this Phase 4.

## 7.6 Summary

Implementing a new learning and teaching approach can be intimidating, especially if one is an early adopter in a resource-constrained environment. Guided by a mixed-methods research strategy, this chapter describes the practical steps taken to convert a traditional classroom-based course into a smartphone-supported blended course at a small public university, TMUC, which at the time had limited resources and experience to support the institution-wide implementation of online education. The chapter elucidates the challenges encountered and valuable lessons learned from testing the redesigned course with first-year students.

In general, findings from the study indicate the students were delighted with the smartphone-supported blended course and anticipated that their lecturer would extend the approach to all units of the course. For the participant lecturer, a significant challenge they faced was finding the time to redesign and administer the course since they did not receive any workload reduction from their department chair. In consequence, developing the online learning content consumed more time than they had initially anticipated. A valuable lesson the lecturer took away from this experience was that as an early adopter of blended learning, it is better to keep it simple and start very small when designing the online learning content. Instead of recording the lectures from scratch, it is advisable to take advantage of OERs, which are roughly equivalent to and sometimes even better than the traditional educational resources. Another valuable insight gained from this study emerged during the focus group discussions. The participants revealed that even with the affordances of smartphone-based online learning (such as flexibility when it comes to attending lectures and self-paced learning), they still desire some level of embodied face-to-face learning. This is primarily because sub-Saharan Africa has a collectivist culture; hence, while digital face-to-face learning may be convenient, students in collectivist cultures still require physical, social interactions. This finding thus lends credence to my research hypothesis that blended learning (as opposed to fully online learning) is the ideal technology-enhanced strategy to employ in sub-Saharan Africa.

Overall, Phase 4 has demonstrated that smartphone-supported blended learning is practicable even when there is limited funding, training, and support available. With this knowledge in mind, I hope that the level of support for smartphone-based online education initiatives will increase across public universities in sub-Saharan Africa. Lastly, as previously expressed in the literature review, there has been no comprehensive set of practical guidelines to support educators who may be considering the use of smartphones in formal teaching and learning processes. The research undertaken in Phase 4 has closed this crucial literature gap; the results led to the development of a novel framework, *Smartphone Only Learning Environment (SOLE)*, that provides a checklist to guide faculty in best practices for delivering a smartphone-supported blended course. I anticipate that the ideas shared in this framework will shed much-needed light on how a student who owns only a smartphone and does not have access to a desktop PC or laptop can successfully participate in a technology-enhanced university course. The elements of this framework have been discussed in detail in the succeeding chapter.

# 8. THE SOLE FRAMEWORK

A practical guide to delivering a technology-enhanced university course within a **S**martphone-**O**nly **L**earning **E**nvironment

## 8.1 Background

To the best of my knowledge, a framework that provides guidelines on how to successfully deliver a blended university course solely to a smartphone does not exist. As highlighted in Chapters 1 and 2, recent studies into the use of smartphones in educational settings explore ways to adapt laptop or desktop PC content for viewing on smartphones but by far have not reached the depths possible (Cochrane & Farley, 2017; Farley et al., 2015; Kaliisa et al., 2019; Parsons, 2014; Pimmer & Pachler, 2014). The existing technology-enhanced learning frameworks (such as TPACK (Koehler et al., 2013), SAMR (Puentedura, 2012), FRAME model (Koole, 2009) and Pedagogical Model for Mobile Learning (Park, 2011)) that guide teachers on how to integrate technology into their courses are 'smartphone-friendly' not 'smartphone first' or 'smartphone-only'. The problem with these 'smartphone-friendly' frameworks is that they do not take into account the functional differences (e.g., the smaller screen size) that pedagogically set the smartphone apart from the desktop PC and laptop. As a result, what I have observed (as demonstrated in Chapter 4) is that technology-enhanced courses that are built on the principles of these existing frameworks almost always end up not being fully smartphone compatible (even though they claim to be), meaning that at some point students will require a desktop PC or laptop to complete their online-based assignments/coursework. Moreover, as mentioned in Chapters 3 and 6, while research on 'smartphone-first' technology-enhanced learning frameworks is rare and limited, research on faculty support regarding how to integrate smartphones into formal teaching and learning processes is even scarcer (Iqbal & Bhatti, 2020; Kaliisa et al., 2019; Pimmer et al., 2016).

Therefore, given the aforementioned literature gap, one of the main objectives of my research (as noted in Chapter 1) was to: *To develop a framework that provides a set of guidelines on how to successfully deliver a university course solely to a smartphone.* Accordingly, in this chapter, I introduce a novel framework entitled "*Smartphone-Only Learning Environment (SOLE)*" that outlines best practices for delivering a smartphone-supported blended university course. The SOLE framework views the smartphone as the sole device for study and specifically aims to help educators in sub-Saharan Africa integrate smartphones into their formal teaching and learning processes. Linking back to my research methodology, the context-specific stance of the SOLE framework is in harmony with the non-singular reality ontology of the Pragmatism paradigm adopted.

The recommendations highlighted in the SOLE framework regarding how educators could integrate smartphone-based learning into the curriculum have been derived from the findings of the preceding four chapters (phases) of this thesis. For instance, in Chapter 4, the feasibility studies demonstrated how, from a technical perspective, the smartphone could perform most educational tasks typically done on a laptop or desktop PC; hence, this Phase 1 of the research revealed the technical aspects to consider when delivering a smartphone-supported blended course. In Chapter 5, the quantitative student survey explicated how TMUC students prefer to use smartphones to support their learning; from this Phase 2, I derived recommendations regarding which learning activities could be delivered online instead of in-classroom (and vice-versa). In Chapter 6, the qualitative interviews revealed ways in which TMUC lecturers prefer to use smartphones to facilitate learning; from this Phase 3, I derived recommendations about how to integrate smartphone-based learning into the existing pedagogy, and also gained insight into how far to extend the teaching capabilities to ensure a smooth transition into smartphone-supported blended learning using the SOLE framework. In Chapter 7, the findings from the previous three phases were synthesised and situated with respect to a pilot study at TMUC, where I collaborated with a lecturer to develop and test a smartphone-supported blended course with the students; from this Phase 4, I derived recommendations on how teachers could implement smartphone-supported blended learning in a resource-constrained university environment. Figure 3.1 in Chapter 3 shows the sequence (trajectory) and relationship of the qualitative and quantitative research phases I designed to investigate smartphone-supported blended learning, which led to the development of the SOLE framework. Here, the dimensions of the SOLE framework are presented in the subsequent sections of this chapter.

## 8.2 Dimensions of the SOLE framework

### *8.2.1 Objectives of the Framework*

The SOLE framework aims to provide a set of practical guidelines on how to deliver a blended university course solely to a smartphone. To realise this aim, the following are the objectives of the framework:

1. Foster understanding of best practices for teaching specific content to students who use smartphones to support their formal education.
2. Demonstrate how smartphone-based technologies can be used to enhance, transform and deliver learning content.
3. Contribute knowledge regarding how smartphone-based learning enhances student learning outcomes and experiences.
4. Highlight the institutional and situational boundaries that early adopters of smartphone-supported blended learning could work within.

### *8.2.2 Building Blocks of the Framework: How to Interpret and Develop them*

The practical guidelines outlined in the SOLE framework are organised into four building blocks (as depicted in Figure 8.1 and Table 8.2). Within each block, I have included decision points that describe the knowledge teachers must possess to effectively build a smartphone-supported blended course. It is imperative to note that these decision points should be regarded as illustrative rather than exhaustive or fixed, so following the detailed discussion of the SOLE framework in section 8.3 of this thesis, the reader is encouraged to explore other possibilities.

While interpreting Figure 8.1, it is essential to take note of the hierarchical arrangement of the building blocks as they suggest how the development of the smartphone-supported blended course should progress:

1. *Be familiar with the educational context* – this is the first step. An awareness of the institutional and situational constraints of the environment a teacher works within is crucial as they determine whether integration of the technology is feasible. For example, if the students do not have easy access to the technology the teacher intends to use or if the university prohibits the use of that technology, then the teacher's efforts to integrate the technology into their pedagogy would be rendered futile. Similarly, the teacher must be familiar with the social, cultural, and economic setting of the community they work within because these three factors largely influence how learning occurs. In this regard, the decision points that emerge when building this block include (but are not limited to):
    - What institutional policies surrounding technology-enhanced learning need to be considered?
    - What is the ideal blended learning model to employ in resource-constrained environments?
    - What is the ideal blended learning pedagogy to use in collectivist cultures?

2. *Identify the course content to blend* – integrating technology into teaching is not an easy feat; it involves a great deal of planning and forethought about the content. For example, audio-only online lecture recordings might not suit mathematics courses but might be appropriate for English language courses. Therefore, once the teacher understands their context, the second step is to identify the parts of a course that do not work properly in the traditional format but would work better if shifted online and vice-versa. Without this knowledge, there is a risk that when incorporating technology into their course, the teacher could unnecessarily add extra online activities to an existing traditional classroom course, which could lead to the undesirable situation that Kaleta et al. (2007, p. 127) called the "course-and-a-half syndrome". In this vein, the salient decision points that emerge when building this block include (but are not limited to):
    - What type of courses are best suited for smartphone-supported blended learning?
    - What proportion of the course should be blended, and how should the blend (in-class and online components) be balanced?
3. *Develop the technology-enhanced learning resources* – once the teacher chooses the content to blend, the third step involves the teacher using digital tools to create and deliver the online learning content. Here, it is important to ensure that the online learning content is presented in a manner that advances student learning outcomes and experiences. For example, a teacher may decide that it is more convenient to use pre-recorded online videos to deliver lectures, as they enable students to study and understand the material at their own pace and anywhere (e.g., off-campus). Accordingly, some crucial questions to ask when building this block include (but are not limited to):
    - What LMS is ideal for creating and hosting the online learning resources?
    - How can the online lecture material be created (e.g., from scratch or via OERs), and how will this content be presented (e.g., what digital media formats will be

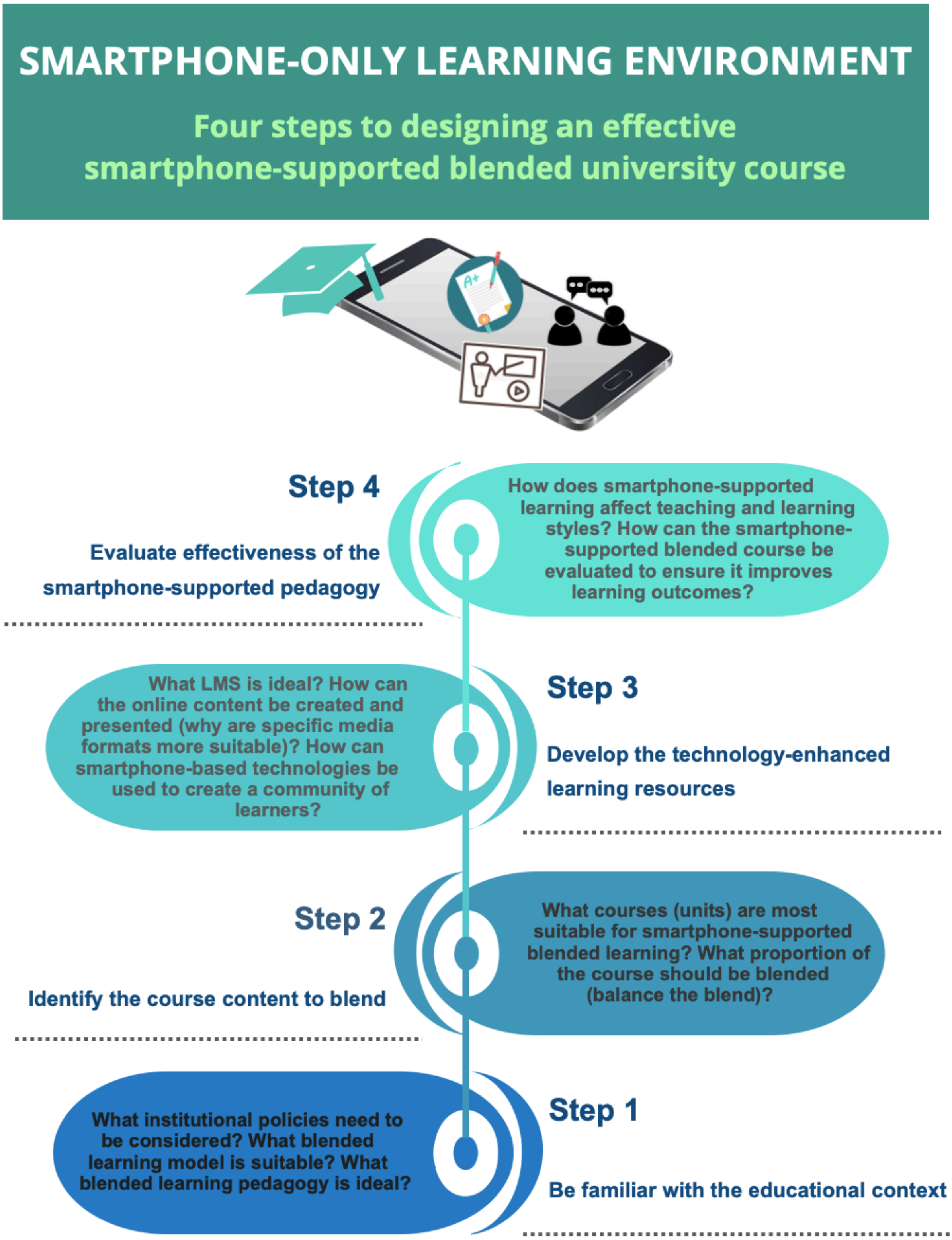
used – video, audio, text, or images)? Why are specific digital media formats more suitable when presenting learning content?

- How can smartphone-based technologies be used to create a community of learners to facilitate collaborative content creation?

4. *Evaluate effectiveness of the smartphone-supported pedagogy* – as previously outlined, education should not be about technology but rather what technology does to enhance pedagogy. Nonetheless, learning is influenced by the learning tool used (Kearney et al., 2012) – for example, the literature in Chapter 2 provided evidence that students nowadays learn differently because of the affordances of various technologies, namely social networks, augmented reality, virtual reality, and other multimedia content. To this end, in the fourth step, the SOLE framework requires the teacher to examine how smartphone-based learning impacts (i.e., impedes or enhances) teaching and learning processes. To demonstrate the significance of this step, I shall use the previously mentioned example of a teacher deciding to deliver lectures online as pre-recorded videos. Since these self-scheduled online lectures require students to become independent learners capable of planning their study time, the teacher must evaluate whether this asynchronous online teaching style enhances or impedes students' learning experiences. This evaluation is essential since not all students are comfortable being independent learners, meaning they may need the teacher to create a time plan to follow until such a time when they acquire the necessary skills for self-paced learning. Critical decision points that emerge when building this block include (but are not limited to):

   - How does smartphone-supported blended learning affect teaching and learning styles?
   - How can teachers evaluate their smartphone-supported blended course to ensure it improves student learning outcomes?

**Figure 8.1*:* The four building blocks of the SOLE Framework and the factors to consider when designing a smartphone-supported blended university course**



The other component to take note of when interpreting SOLE framework are the two stages of adoption namely, the *Exploration* stage and *Early Adoption* stage. These two stages describe the extent to which teachers can incorporate smartphones into their courses. Since the SOLE framework aims to provide guidelines to early adopters of blended learning in sub-Saharan Africa, where technology-enhanced learning is still in its infancy stages, both these stages are considered beginner-friendly. Therefore, to help teachers determine which adoption stage is suitable for them, I have developed a self-assessment checklist (see Table 8.1 and Figure 8.2) intended to help teachers assess their readiness to incorporate smartphone-based technologies into their pedagogy. The thirteen items in the checklist have been adapted from existing survey instruments by Olivares et al. (2021) and Martin et al. (2019), who developed the items after reviewing literature on faculty readiness to teach online.

The checklist presented in this research comprises three evaluation sections: 1) General Technical Competence, 2) LMS Competence, and 3) Time Availability. The 'general technical competence' scale measures teachers' ability to integrate common (mainstream) technologies into their teaching practices. Having a separate scale to specifically measure 'LMS competence' is necessary because, given the pervasive presence of digital technology, most teachers are likely to be skilled at using various digital tools. However, since most public universities in sub-Saharan Africa do not offer online courses, teachers may not be interacting with LMSs, even in their spare time (because there is no need). So, a high level of competency in the 'general technical competence' scale does not necessarily mean a teacher is competent in using an LMS. Similarly, having a separate 'time availability' scale is essential because a teacher can have a high level of capability in the other two competence scales (i.e., LMS and General Technical skills) but have insufficient time to design the online course. Furthermore, time availability was factored into this checklist since the literature in Chapter 2 revealed that most studies investigating teachers' perceptions about integrating technology (smartphones) into their teaching practices cite lack of time as a formidable barrier.

As described in Table 8.1, the section for general technical competence requires teachers to rate corresponding items on a 5-point Likert scale ranging from 1 (*no level of competence*) to 5 (*high level of competence*). Then, the section for LMS competence requires teachers to rate corresponding items on a 5-point Likert scale ranging from 1 (*no experience in the skill area*) to 5 (*extensive experience in the skill area*). In the section for time availability, teachers are required to rate included items on a 5-point Likert scale ranging from 1 (*never*) to 5 (*a great deal*). This means each item on the checklist can acquire a score between 1 and 5. The total score is calculated by summing up the scores of all the items in the corresponding section; higher scores indicate increased readiness in incorporating smartphone-supported blended learning. The values "1" to "5" in the checklist have been included to help teachers calculate their total scores. The mean score is calculated by dividing the total score by the total number of items. In Table 8.1, I have provided mean scores to help teachers determine which adoption stage is most suitable based on their total scores.

When using this checklist for self-evaluation, I encourage teachers to consider how the competency scores of each of the three scales (as opposed to the sum score of all thirteen items) determine the ideal adoption stage. This is because if all the thirteen items in the presented checklist were summed up, a teacher may end up with a moderately high score (e.g., 44 out of 65) and assume that they are ready to implement technology in their pedagogy. However, this overall score could have been boosted by a very high score in the general technical skills competency section, but the reality could be that the teacher does not have the required LMS competency or enough time to design a blended course. In Figure 8.2, I have provided a flowchart that maps the relationships between the three sections included in the checklist to further help teachers determine the ideal adoption stage. The symbol ‘ >= ’ in the flowchart means ‘greater than or equal to’.

Indeed, measuring faculty readiness to teach an online-based course cannot simply be narrowed down to a yes/no self-assessment checklist or readiness scores; other external factors (e.g., institutional support, cultural factors, and students’ competency levels) influence a teacher’s capacity to integrate technology into their course (Scherer et al., 2021). However, findings from Chapter 5 and Chapter 7 imply that students in sub-Saharan Africa already utilise smartphones to support their learning. Thus, one could assume that many students have the competencies to meaningfully participate in a smartphone-supported blended course. Moreover, considering the nascent nature of blended learning in sub-Saharan Africa, the SOLE framework is built on the assumption that most public universities will typically not have adequate technical support services or policies to guide faculty wanting to explore the idea of smartphone-supported blended learning. Therefore, initially, teachers will have to devise their own competency tools and begin engaging with smartphone-supported blended learning as an individual experimental project. To this end, while this checklist and corresponding scoring are not exhaustive, they serve as a starting point to help teachers ensure they integrate digital technologies they are conversant with and have access to. In other words, the competency tools presented in Table 8.1 and Figure 8.2 ensure teachers “don’t bite off more than they can chew” – especially since a blended course at the Early Adoption stage utilises more digital tools and will likely take longer to design than a course at the Exploration stage.

**Table 8.1*: Self-evaluation checklist for teachers to assess their readiness to design and deliver a smartphone-supported blended course***

| *Items (n =13)* | *5-point Likert Scale Rating* | *Ideal Adoption Stage based on Mean Scores* |
|---|---|---|
| **PART A: General Technical Competence** | | |
| A1. I can effortlessly create online quizzes, surveys, and opinion polls (e.g., using Kahoot, Top Hat, Socrative) for automatic review.<br>A2. I know how to effectively create and moderate student discussion forums on social media platforms (e.g., on Facebook, Twitter, or WhatsApp).<br>A3. I can easily create and edit audio-visual content (e.g., lecture videos or video tutorials) using a PC or smartphone.<br>A4. I am skilled at designing and creating interactive presentations using PowerPoint.<br>A5. I know how to use synchronous web-conferencing[41] tools (e.g., Adobe Connect, WebEx, Zoom, Skype) to facilitate collaborative learning activities (such as video-based group discussions). | 5 – High level of competence<br>4 – Moderately High level of competence<br>3 – Average level of competence<br>2 – Low level of competence<br>1 – No level of competence | Assuming the value "3" is the tipping point for each item then:<br>***Exploration Stage:***<br>Mean score of 1 to 2.9 (or total scores below 15/25).<br>***Early Adoption Stage:***<br>Mean score of 3 to 5 (or total scores from 15/25 onwards). |

[41] The items in Olivares et al. (2021, p. 121) survey instrument can further help to assess competency in using web-conferencing tools.

| *Items (n =13)* | *5-point Likert Scale Rating* | *Ideal Adoption Stage based on Mean Scores* |
|---|---|---|
| **PART B: LMS Competence** | | |
| B1. I can navigate through an LMS (e.g., Moodle, Blackboard, Canvas).<br>B2. I can publish and share documents, images, videos, or other resources within an LMS.<br>B3. I can create content of my own in an LMS (e.g., quizzes, webpages).<br>B4. I can create discussion forums and moderate student contributions in an LMS. | 5 – Extensive experience in the skill area<br>4 – Good experience in the skill area<br>3 – Some experience in the skill area<br>2 – Little experience in the skill area<br>1 – No experience in the skill area | Assuming the value “3” is the tipping point for each item then:<br>***Exploration Stage:*** Mean score of 1 to 2.9 (or total scores below 12/20).<br>***Early Adoption Stage:*** Mean score of 3 to 5 (or total scores from 12/20 onwards). |
| **PART C: Time Availability** | | |
| C1. I have time to explore how to use an LMS (note: at least two weeks is recommended[42])<br>C2. I have time to explore how to use the learning technologies listed in ‘Part A’ above.<br>C3. I have time to design and develop the online course content before delivery (note: at least four weeks is recommended).<br>C4. During, before or after the classroom session, I have time to facilitate the online learning activities (e.g., respond to student questions, moderate discussion forums, administer quizzes, or provide feedback on assignments). | 5 – A Great Deal<br>4 – Much<br>3 – Somewhat<br>2 – Little<br>1 – Never | Assuming the value “3” is the tipping point for each item then:<br>***Exploration Stage:*** Mean score of 1 to 2.9 (or total scores below 12/20).<br>***Early Adoption Stage:*** Mean score of 3 to 5 (or total scores from 12/20 onwards). |

[42] The recommendations mentioned here are based on my findings from the pilot study of a smartphone-supported blended course at TMUC (Chapter 7).

**Figure 8.2: Flowchart to determine which adoption stage (i.e., Exploration or Early Adoption) in the SOLE framework is ideal for a teacher**

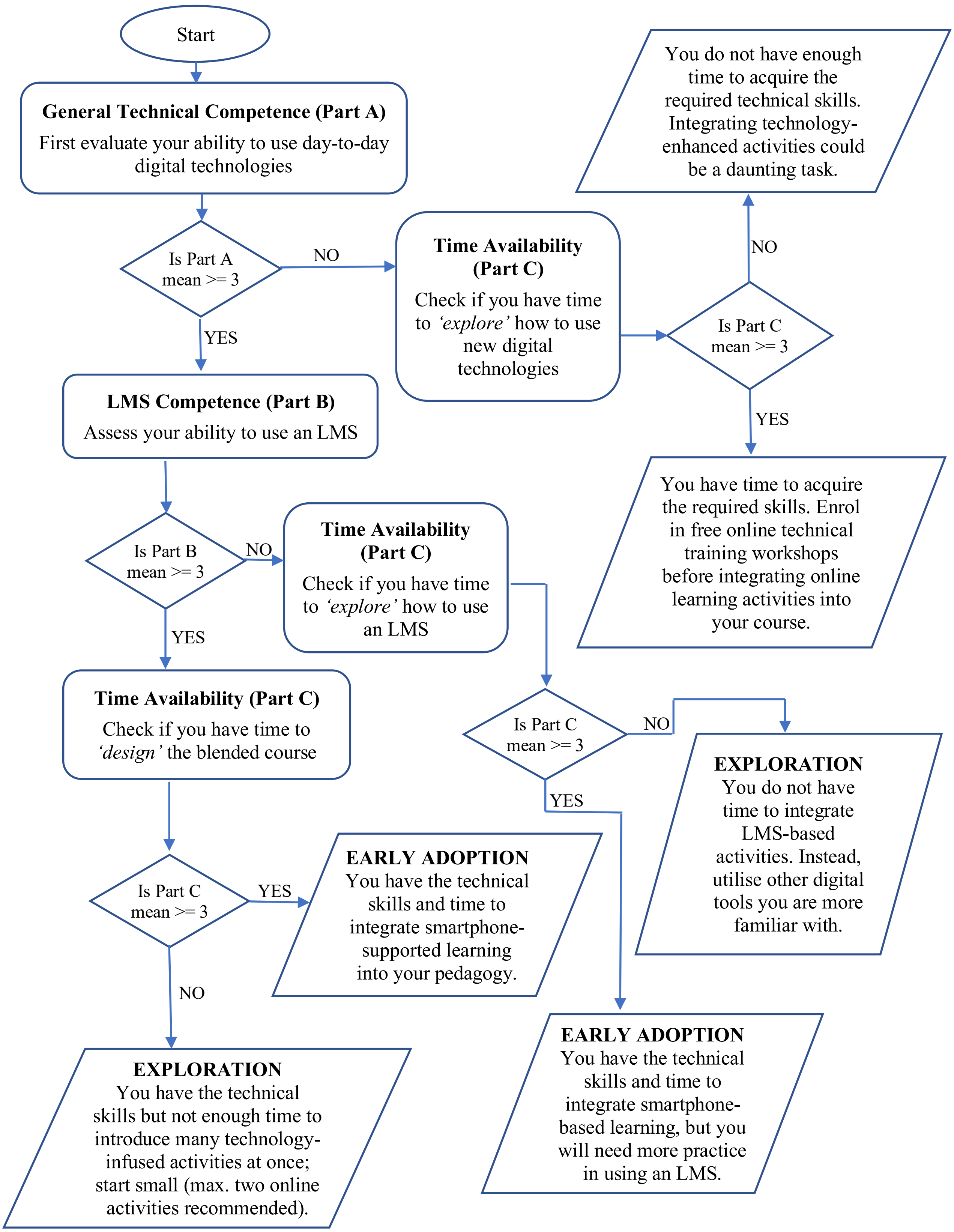


**Table 8.2: Translating the SOLE framework into practice**

| Building Block (Step) | Exploration Stage | Early Adoption Stage |
|---|---|---|
| **1. Be familiar with the educational context** | | |
| *1.1 Blended Learning Models:*<br>- Nature of change<br>- Effect on student<br>- Extent of change<br>- Level of blend | • Supplemental model<br>• Enhancing model<br>• Low-impact model<br>• Activity-level blending model | • Substitutive model<br>• Enabling model<br>• Medium-impact model<br>• Course-level blending model |
| *1.2 Blended Learning Pedagogy:* | • Micro-Flipped Classroom – traditional lectures persist, but the teacher incorporates various online-based assignments (e.g., graded discussions and low-stakes quizzes) inside the classroom environment to foster active learning. | • Fully-Flipped classroom – lectures are pre-recorded and accessed online (out-of-class), then assignments are completed in a physical classroom (on-campus). |
| *1.3 Institutional Policies:* | • Software Standards policies | • Course Scheduling policies<br>• Digital Intellectual Property rights<br>• Technical Training and Help policies<br>• Student Code of Conduct policies<br>• Student Privacy rights |
| **2. Identify the course content to blend** | | |
| *2.1 Type of Course:* | • A course that is typically assigned to multiple lecturers in an academic year.<br>• Ideal for courses with large student enrolments, particularly those in which frequent class discussions are crucial in assimilating acquired knowledge (e.g., Language courses and Psychology courses). | • A course that is often retaught multiple times by the same lecturer in an academic year.<br>• Ideal for courses (units) that typically require dictation of lecture notes and, Project-Based courses that require students to create e-portfolios (e.g., Design courses and Journalism courses). |

| Building Block (Step) | Exploration Stage | Early Adoption Stage |
|---|---|---|
| *2.2 Proportion of Course to Blend:* | | |
| - Learning activities (assignments, lectures, class discussions) | • Add only one (maximum two) online-based learning activity during classroom time (e.g., an online quiz, or an online-based group discussion). | • Blend a maximum of two weeks' worth of learning content (e.g., substitute one week's worth of online lectures for traditional lectures). |
| - Percentage (balancing the blend) | • Apply an 80/20 balance, i.e., 80% of the teaching and learning processes occur in-class, and 20% occur online, e.g., in large class sizes where providing timely feedback is challenging, administer online auto-graded quizzes to automate the marking process and provide instant feedback. | • Apply a 50/50 balance, whereby 50% of the teaching and learning process occur in-class and 50% occur online e.g., never lecture in the classroom what is in the pre-class (online) media. |
| **3. Develop the technology-enhanced learning resources** | | |
| *3.1 Learning Management System (LMS):* | • An LMS is not required; instead, utilise stand-alone mobile apps or web-based apps to present learning content. For example, student response systems (such as *Kahoot*, *Top Hat*, and *Socrative*) are great tools for conducting real-time peer group discussions and administering quizzes in which instant feedback on generated content is paramount. At this stage, mostly use digital tools that you are familiar with. | • An LMS is required; use one that is free and open-source, has a mobile app version (in addition to mobile web), and has an offline feature enabled (e.g., *Moodle*). Utilise a free web-hosting services (e.g., Gnomio.com) to bypass the time-consuming process of installing and configuring your own LMS server on your computer. |

| Building Block (Step) | Exploration Stage | Early Adoption Stage |
| --- | --- | --- |
| *3.2 Online Content Creation and Presentation:* | | |
| - Externally produced (e.g., OERs) or developed from scratch (e.g., PowerPoint lecture recordings) | • The nature of the online learning activities introduced at this stage (i.e., quizzes and opinion polls) requires designing the content from scratch. | • The online learning content can be externally produced or designed from scratch. However, I recommend designing the content in two phases:<br>- Phase 1 (externally produced): Exclusively use OERs in the online component. Continue this phase for at least two semesters before moving to Phase 2.<br>- Phase 2 (create from scratch): develop own digital learning content e.g., PowerPoint lecture recordings overlayed with instructor's voice or recordings showing instructor teaching at their desk. |
| - Media formats to use (e.g., audio, video, text, image, HTML) | • Interactive web-based technologies (e.g., HTML web pages) – this format is ideal for presenting the highly interactive learning activities (e.g., timed quizzes and opinion polls) typically embedded in a micro-flipped classroom. | • Video (e.g., MP4) – ideal for lectures, especially ones that cover complex topics that require visual demonstrations, e.g., using video to assist biology students in understanding the process of human breathing. The length of each instructional video should not exceed 10 minutes – this can be achieved through a process known as chunking or segmentation.<br>• Audio (e.g., MP3) – this is ideal for facilitating learning while on the go, as well as reinforcing level 1 of Bloom's Taxonomy – remembering. For example, while exercising or during a commute, an English language student can listen to an audio lecture that |

| Building Block (Step) | Exploration Stage | Early Adoption Stage |
| --- | --- | --- |
| | | teaches new vocabulary. The recommended maximum duration for each audio content is 15 minutes.<br>• Text (e.g., PDF) – suitable for presenting course objectives, learning outcomes, course outlines, and course policies since it is easier for students to refer to without needing to forward or rewind a video/audio.<br>• Image (e.g., JPEG or PNG) – useful for when the screen size of a student's smartphone makes it cumbersome to complete long essay-like assignments (e.g., above 500 words). In such cases, allow students to submit their coursework as images of the handwritten assignment. |
| *3.3 Creating an Online Community of Learners:* | • Use social media networks (e.g., Facebook, Twitter, WhatsApp, and Discord) to facilitate ad hoc collaborative content creation (group discussions) about course-related topics. | • An LMS is effective at providing a centralised location where students can create and share their personal profiles.<br>• To monitor students' progress in formal collaborative learning activities (e.g., online peer assessments), create discussion forums within the LMS.<br>• Use social media networks (e.g., Facebook, Twitter, WhatsApp, and Discord) to facilitate informal group discussions about course-related topics. |
| **4. Evaluate the effectiveness of the smartphone-supported pedagogy** | | |
| *4.1 Impact of Smartphone-based education on Teaching and Learning Styles:* | • Introduction of interactive online learning activities (e.g., low-stakes quizzes and opinion polls) in the classroom causes a shift from passive learning to active learning, therefore: | • Integration of self-scheduled online lectures causes the students to transition from dependent to partially independent learners and the lecturer to shift from sage to guide. Additionally, there is a switch from fully |

| Building Block (Step) | Exploration Stage | Early Adoption Stage |
| --- | --- | --- |
| | • Utilise mobile apps that encourage cooperative problem solving in the classroom (e.g., student response systems e.g., Kahoot, Top Hat or Socrative).<br>• Pre-class, leverage web-based learning tools that facilitate Just-in-Time Teaching (e.g., administer *WarmUps* – short, online-based assignments that prompt students to answer questions about an upcoming topic, thus enabling the teacher to include feedback about identified misunderstandings in the upcoming in-class lesson). | synchronous to partially asynchronous teaching, therefore:<br>• Use strategies that promote self-regulated learning, e.g., incorporate self-reflection tools such as rubrics, online peer assessments, or student-generated e-Portfolios into the course.<br>• To monitor student engagement in the asynchronous teaching environment, use technologies that advance active learning. For example, for the video-based lectures, embed guiding questions within the videos using *HapYak* application. Likewise, for the textual lecture material, use online annotation tools (e.g., *Hypothes.is* and *Perusall*) to influence comprehension and track student progress.<br>• For impromptu individual/small group tutoring requests from students during the off-campus period, consider using synchronous web-conferencing tools (e.g., Zoom and Skype) to facilitate digital face-to-face discussions instead of waiting for the on-campus session to resume. |
| *4.2 Quality Assurance Testing (course evaluation):* | • Administer student feedback surveys at the end of each technology-enhanced lesson. | • In addition to feedback surveys, administer pre- and post-tests to assess whether the smartphone-supported blended course improved student learning outcomes.<br>• Peer Review – ask colleagues (e.g., qualified educational designers and media specialists) to review the new course and provide a formal checklist outlining best practices for delivering the course. |

## 8.3 General Discussion of the Recommendations within the SOLE Framework

### *8.3.1 Step 1 – Be Familiar with the Educational Context*

As noted in section 8.2.2, this step requires the teacher to understand how institutional and situational constraints influence the pedagogical strategies used, and the choice of digital technologies. Accordingly, the SOLE framework aims to provide guidelines to early adopters of blended learning in sub-Saharan Africa, where technology-enhanced learning is still in its infancy stages. For example, it can be used by teachers who work in an institution where there is no official approval or implementation of blended learning, but there is limited institutional support for individual faculty wanting to explore the usage of smartphones in their courses. For example, these institutions could already be using smartphone-based technologies (e.g., SMS alerts) to relay administrative information to students, such as course announcements, post-course syllabus, grades and assignments. As such, the university management (e.g., department chairs and deans) may be partially open to the idea of smartphones as learning tools. Notable objectives to complete in this step include (but are not limited to):

a) Determine the ideal blended learning model to employ in resource-constrained environments

As mentioned before in the literature review, there is no 'one size fits all' blended learning model. Instead, there are various models, and each is determined by the context in which it is intended. For example, a blended learning model can be selected based on the following contextual factors: the effect it has on the student, nature of change, the extent of change, and level of the blend.

- *Effect it has on the student:* this involves designing blended learning programs based on how they impact student learning outcomes and experiences. Graham (2006) distinguishes between *enhancing*, *enabling,* and *transforming* blends. Enhancing blends are designed to augment the teaching and learning processes without radically altering the pedagogical style, i.e., the addition of an online activity can occur while students are in class. For example, to increase and make participation more efficient for large class sizes, instructors could add an online discussion forum (during the classroom sessions) that requires students to post questions or comment on a particular topic. Next, enabling blends focus on convenience and flexibility – the blended learning program is designed to satisfy the students' educational costs and time constraints. For example, courses could be designed so that classroom-based activities are significantly reduced (shifted online) to minimise the travel-related costs of on-campus learning and to also benefit students who have difficulty attending classes due to work/family commitments. Transforming blends are designed such that they radically alter how students learn. These types of blended learning programs require students to not only use the technology to absorb learning content but also use it to actively construct knowledge and engage in intellectual activities. For example, trainee medical students working in hospitals in rural areas could be having difficulties connecting with their remote mentors. Therefore, to facilitate in situ learning (even without a mentor), the students could be equipped with smartphones preloaded with applications containing point-of-care and drug information content. In such a scenario, these medical students will be required to learn how to use their smartphones during clinical rotations for clinical decision-making and to answer clinical questions at point-of-care.

Based on the flowchart presented in Figure 8.2, teachers at the Exploration stage generally do not have sufficient time or LMS competency to develop a robust blended course; hence, the enhancing blend is ideal as it does not radically alter the predominate pedagogical style. For example, it may involve only adding online auto-graded quizzes to the existing traditional classroom-based course, which would mean students get instant feedback on their performance. However, at the Early Adoption stage, teachers generally have more time and higher levels of technological knowledge; hence, the teacher can flirt with the enabling blends whereby there is a moderate change in how traditional learning occurs. For example, substituting pre-recorded audio-visual lectures for traditional classroom lectures would mean students do not have to physically attend classes.

- *Nature of change:* this refers to how online activities are introduced into the conventional course. For example, the change could be *supplemental,* whereby activities that use smartphone-based technologies are added to the traditional classroom activities without eliminating existing activities. The supplemental model has similarities with the enhancing blend, as there is no radical change in the existing pedagogy. In this vein, this supplemental model would also be appropriate for teachers at the Exploration stage of smartphone-supported blended learning. Conversely, the nature of change could be *substitutive*. In this model, existing classroom-based activities are replaced with online activities. The motivation behind this model is that some course objectives are better realised if the learning activities are facilitated online. The substitutive model is similar to the enabling blend as the focus is on fostering flexible teaching and learning. Accordingly, the substitutive model would be ideal for teachers at the Early Adoption stage.
- *Extent of change:* this refers to how much of the conventional course is transformed into a blended format. The extent could be described as *low-impact*, *medium-impact,* or *high-impact*. In the SOLE framework, the low-impact model suggests adding a maximum of two online-based learning activities to the conventional course,

e.g., an online quiz and/or an online forum discussion activity. The low impact blend is similar to the supplemental and enhancing models as the underlying motivation is to augment the predominate pedagogy (i.e., it adds an extra activity to a conventional course without eliminating existing activities). Therefore, a low-impact model would be an ideal choice for teachers who are at the Exploration stage of smartphone-supported blended learning. In contrast, the medium-impact model would be ideal for teachers at the Early Adoption stage of the SOLE framework because the model gives the teacher leeway to deliver a larger proportion of the course content online. For example, the teacher can replace in-person activities with digital activities as the (pedagogical) need arises – there is no limit to the number of activities. However, at this Early Adoption stage, I recommend blending at most two weeks' worth of course content to prevent work overload and allow the teacher time to adjust to the new pedagogy. The medium-impact model has similarities with the enabling and substitutive models because the underlying motivation for its design is that some learning outcomes are better realised if the learning activities are facilitated online. Lastly, the high-impact model is an advanced blended learning model where the blended course is developed from scratch, which means there is no existing traditional course from which to replace or add online learning activities. The blended course is developed from the outset using the course learning outcomes as the foundation. Alammary et al. (2014) argue that while building from scratch has a higher risk of failure since the instructor would be introducing an untried course to the students, blending at the course learning outcomes level allows for more effective integration of the online and face-to-face components. Nonetheless, the high-impact model is beyond the scope of the SOLE framework; hence it shall not be explored further.

- *Level of blending:* this involves designing blended learning programs based on the curriculum structure. For example, Graham (2006) distinguishes between *activity-level*, *course-level*, *program-level* and *institutional-level* blends. As explained in Chapter 2, activity-level blending is when a single lesson activity contains both embodied face-to-face and online instruction (the activities are not independent of each other). For example, administering an online quiz and then discussing the answers in a physical classroom. This model is similar to the low-impact model as only a single learning activity is blended. Therefore, it is ideal for the Exploration stage, since based on Figure 8.2 analysis, teachers at this stage usually have limited time to incorporate technology-enhanced teaching strategies. Next, the course-level model entails blending a combination of distinct face-to-face and online activities used as part of the course. The blend involves multiple activities, and these activities can be independent of each other. For instance, it could involve a teacher delivering all unit lectures online so that group-based assignments can be completed in class (on-campus). At this level, the in-class and online learning activities can overlap each other in time or can be sequenced chronologically. The course-level model is similar to the medium-impact blend since multiple activities (more than two) are blended. It is an ideal blend to implement at the Early Adoption stage since Figure 8.2 demonstrates that teachers at this stage typically have more time and a higher level of technical knowledge – hence they have more latitude with respect to course redesign. The program-level and institutional-level models are beyond the scope of the SOLE framework as they require institution-wide implementation of blended learning. In other words, these models require the university management to commit to integrating blended learning across all its programs (certificate, diploma and/or degree). For example, some universities implementing the program-level and/or institution-level blended models have a requirement that for a student to be allowed to graduate, they must experience and complete at least one online course.

Certainly, only one of the aforementioned models can be used to design a blended course. However, to facilitate transferability of the course to multiple contexts, I suggest teachers tailor their blended courses in such a way that they take into account some or all the four contextual factors discussed – effect on the student, nature of change, the extent of change and level of the blend. For example, at the Exploration stage, if a course is blended at the activity-level, then it would also be applicable in a scenario where a low-impact blend is ideal since only a single activity is blended in both types of models. Similarly, suppose the teacher uses a supplemental model, then the course can be implemented in a context where an enhancing blend is suitable since the intention for both models is to add online activities to a traditional classroom-based course without eliminating existing learning activities.

b) Identify the ideal blended learning pedagogy to use in collectivist cultures

Indeed, there are several blended learning strategies (TeachThought, 2019), but not all are applicable in the sub-Saharan African context. For example, in the Enriched Virtual Blended Learning pedagogy, the majority of the learning activities are conducted online, and students only physically meet their teacher intermittently or as needed (TeachThought, 2019). However, as mentioned in Chapter 7 when discussing the lessons learnt from the pilot study, *"Students in collectivist cultures (such as those in sub-Saharan Africa) need a blend of embodied face-to-face learning and digital face-to-face learning"*. Most of the pilot study participants stated that while smartphone-supported learning afforded them flexibility in attending lectures, during some online forum discussions, they started craving the *"... instant live interaction and reactions that you can only get from in-person conversations"*. Therefore, the SOLE framework suggests that the Flipped Classroom pedagogy is the most suitable strategy for public universities in sub-Saharan Africa. In a Flipped Classroom, the lectures are delivered online (outside the class), and then during class time, the content is explored further through problem-solving techniques and group discussions. Thus, this strategy ensures that the students experience the benefits of online learning without losing the on-campus social interactions they are accustomed to. The Flipped Classroom differs from the Enriched Virtual Blended Learning pedagogy in the balance of the online versus in-classroom activities. In the Flipped Classroom, the in-class and online activities are generally weighted equally.

At the Exploration stage, this strategy is described as a *Micro-Flipped Classroom* because the level of the blend at this stage is low impact, i.e., teachers are only adding one or two online activities, and the students still need to attend classroom-based lectures. In other words, a Micro-Flipped Classroom is a pedagogical model that "allows a professor to be able to continue to lecture while incorporating a variety of interactive models inside of the classroom environment" (Borchardt & Bozer, 2017, p. 2). However, at the Early Adoption stage of the SOLE framework, the pedagogy is described as *Fully-Flipped Classroom* because all lectures are shifted online. In the Fully-Flipped Classroom, what typically took place in the traditional face-to-face classroom (e.g., lectures) must now take place outside the classroom and, assignments (such as the group-based discussions) that typically took place after-class must then take place in-classroom.

c) Determine which institutional policies need to be considered

As noted in the literature review, the most effective blended learning systems involve collaborations between teachers and university management. A disconnect between the goals of the faculty members and those of the university management can inhibit the growth of the innovation, even if both parties favour smartphone-supported blended learning. In this vein, teachers need first to familiarise themselves with the existing institutional policies. Key questions to explore when building this knowledge construct include: Are there any policies on change management (e.g., policies on ‘classroom release time’ that allow flexible course scheduling or a reduction of teaching workload)? Are there any policies on university management’s expectations for teachers who informally adopt technology-enhanced learning strategies (e.g., policies that address whether online-based assessments should contribute to a student’s final grade or policies outlining the types of digital technologies students are allowed to use to support their learning – for instance, can they use social media)? Lastly, are there policies outlining the types of support systems (human, technical and/or financial) the university management can offer learners and teachers as it pertains to smartphone-supported blended learning (e.g., is there ‘seed money’ or awards given to faculty members who proactively attempt to integrate blended learning into their pedagogy, of course with the intention to enhance students’ learning experiences? Or, besides providing a free, stable Wi-Fi connection, is university management willing to negotiate with internet service providers to subsidise mobile data costs for students)?

Needless to say, if blended learning is not already formally implemented (as is the case in most public universities in sub-Saharan Africa), it is highly likely that there may not be any institutional policies related to online teaching and learning issues. However, some policies about online learning are generic, meaning they are not tethered to specific institutions, and there is an unspoken assumption that any teacher wanting to integrate online learning into their pedagogy ought to be aware of them. In the SOLE framework (Table 8.2), I have listed some noteworthy generic policies. Perhaps, when institutions fully integrate smartphones into the curriculum, the generic policies I have suggested here could become part of the institutional policies on smartphone-based online learning. It should be noted that the policies outlined in Table 8.2 are by far not exhaustive but can be viewed as the baseline when engaging with smartphone-supported blended learning. Observably, there are more policies to consider at the Early Adoption stage than in the Exploration stage. This is because the blended learning model used at the Early Adoption stage is medium-impact (i.e., significantly alters the conventional classroom-based pedagogy). In contrast, the blended learning model used in the Exploration stage is low-impact (i.e., there are minimal modifications to the conventional classroom-based course); hence fewer online learning policies need to be considered. Below are the descriptions of the outlined online learning policies[43]:

- Software Standards Policy – this policy requires that teachers use digital technologies (mobile applications) that work on all students' smartphones. For instance, it is important to investigate the kind of operating system running on the students' smartphones because some applications may not be compatible. For example, in Chapter 4, I described the technical problems I encountered when I tried to launch *Citationsy* mobile app on an Android smartphone, despite the same application running smoothly on an iOS smartphone. However, the results in Chapter 5 (TMUC Student Survey) revealed that 99% of the students owned a smartphone with an Android operating system. Therefore, one can argue that *Citationsy* would not be an ideal mobile app to use in a smartphone-supported blended course at TMUC as most of the students do not have iOS-supported smartphones.
- *Course Scheduling Policy* – provides the criteria and process of how classroom contact hours may be reduced when some teaching components are moved online. As outlined in Table 8.2, this policy is applicable in the Early Adoption stage. However, it is imperative to note that it may be somewhat onerous to effectuate. For example, the

[43] Policies in the Exploration stage are also applicable in the Early Adoption stage.

department chairs may be reluctant to provide ‘classroom release time’ (i.e., a reduction in contact hours) because they may view this as a reduction in workload. Additionally, as mentioned in the literature, this reluctance could be because university management is generally slow to adopt changes, especially when an individual faculty initiates the change. Another reason could be that scheduling for a blended course is a complex process that requires careful consideration and ample time. According to Wallace and Young (2010, p. 9) *“while quantifying the time that instructors spend in class is relatively easy, negotiating an acceptable figure for online or blended courses, along with other often contentious issues relating to faculty workload in online courses, will be more of a challenge”*. However, the social distancing policy effectuated because of the COVID-19 pandemic has demonstrated that with sufficient motivation, approaches for solving classroom scheduling problems (e.g., reducing on-campus lectures) can be (and have been) developed. Nonetheless, at the Early Adoption stage, if there are no institutional policies outlining how teachers can request classroom release time, Alammary et al. (2014) advise teachers to ensure any online teaching resources integrated into a traditional course result in a reduction of classroom contact hours.

- *Digital Intellectual Property Rights* – this policy outlines how the ownership of the course content in the online learning environment is distributed. For example, it addresses the following: where does ownership for blended learning courses reside – within the academic departments or does the institution own all property if it is hosted on the university LMS or, does the teacher retain some rights to the online course materials developed? This policy should also cover the students’ contribution to the course, e.g., it should clearly state ownership rights for student-created work (such as e-portfolios). Moreover, given that online learning gives students easy access to educational resources, implementing this policy is crucial as it helps students understand and avoid plagiarism (the improper use of other people's digital intellectual property). Students should be made aware that course materials (e.g., the lectures recorded by the teacher and all content in the online discussion forums) are for class purposes only and that distribution of these materials to outsiders is a violation of the digital intellectual property rights and/or privacy rights of the owners of those materials.

- *Technical Training and Help Policy* – outlines how students will be trained to use the learning technologies adopted in the blended course, as well as how they can receive help for technical difficulties. As mentioned in Chapter 7 while discussing the lessons learnt from the pilot study at TMUC, *"Don't assume that all students are technologically savvy"*. While students may generally be skilful smartphone users, teachers should provide technical support and train students to use their smartphones for formal education. After all, how technology is used in the informal space differs from its use in a formal educational context (Merchant, 2012; Spector et al., 2014; Tossell et al., 2015). During this research's pilot study (Chapter 7), a Chat Activity on Moodle LMS was set up, where the students could ask for technical help (e.g., site accessibility issues or lesson navigation queries). This was a feasible approach as the class size was small (n = 25); hence, the lecturer could personally handle the requests. However, a teacher will likely need some technical assistants for larger class sizes (e.g., upwards of 50 students). If the institution the teacher works in does not yet provide technical assistance for early adopters of smartphone-supported blended learning, teachers could adopt the practical approach suggested by Waterhouse and Rogers (2004) that involves establishing a 'personal technology help desk' that is managed by students with advanced technical skills. These student assistants can coordinate with the teacher to help the less technical students. As demonstrated in Chapter 7, in the collectivist cultures of sub-Saharan Africa, where collaborative learning activities are highly regarded, establishing a community of learners in which students help each other would not be difficult to set up.

- *Student Code of Conduct Policy* – this policy outlines how students are expected to conduct themselves in the blended learning environment. In particular, it addresses attendance (i.e., student participation in required learning activities). Given that there is a combination of online and in-classroom learning activities, it is natural for the students to initially be somewhat confused about how to balance the blend. For example, owing to the 'newness' of the online learning strategy and its apparent flexible learning benefits, students may become overly excited and focus more on the online component, leading to poor in-classroom attendance. Therefore, as explained in Chapter 6, the teacher must establish clear expectations for student responsibilities during in-class and pre-class sessions. The teacher must inform students that the online portion of the blended course complements the in-classroom sessions. Moreover, to manage attendance, the teacher can create and provide a schedule at the beginning of the semester indicating how often students are expected to attend in-classroom sessions. Establishing a schedule early on enables the students to manage their study time more efficiently and allows teachers to hold students accountable for not attending in-classroom sessions. Similarly, to facilitate self-directed learning and ensure students engage with the online learning activities, teachers should ensure that the activities are graded. Research on effective blended learning programs indicates that students take the online component more seriously if the learning activities count towards their final course grade (Mestan, 2019).
- *Student Privacy Policy* – entails taking all precautions to restrict access to the course site such that outsiders cannot view the resources that reside within it. This can be achieved by ensuring that student accounts within the LMS are password protected.

Furthermore, seeing as many smartphone mobile apps nowadays tend to track user activity for data mining purposes, it is imperative to check that the third-party mobile apps integrated with the LMS allow students to opt-out of this feature. If the teacher plans on using social media apps (such as Facebook or Twitter) to conduct class discussions, then it is prudent to inform students that they (teacher) are unable to provide a guarantee of absolute confidentiality, given the highly public nature of these social media platforms. For more practical examples of general online learning policies to consider, the reader is directed to the article by Waterhouse and Rogers (2004).

### *8.3.2 Step 2 – Identify the Course Content to Blend*

A teacher might be an expert in their domain; however, a lack of deep understanding of what parts of the content should or should not be delivered online could lead to what Kinchin (2012) referred to as "technology-enhanced non-learning". For example, the teacher could end up creating an entire course based on text-based online lectures, yet in-person (on-campus) student discussions may be a more appropriate medium for certain topics. Therefore, this step requires a teacher to identify the parts of a course that do not work properly in the traditional format but would work better if shifted online and vice-versa. Moreover, this step asks the teacher to determine how much content can be blended. Previously discussed literature (Alammary et al., 2014; Kenney & Newcombe, 2011; Mestan, 2019) suggest that it is better to 'start small' and view the blended course as a 'work in progress'. In other words, the replacement or shifting of existing activities from in-classroom to online mode should occur incrementally. In the ensuing paragraphs, I have further explained how to execute this step.

a) Determine what courses or units are most suitable for a smartphone-supported blended learning strategy

From the outset, mitigating the issue of overcrowded lecture halls and the lack of desktop PCs on-campus; and ensuring learner flexibility and convenience (time and monetary) in regard to attending lectures have been the underlying motivation for advocating for smartphone-supported blended learning. Therefore, at the Early Adoption stage, the most suitable courses to implement this strategy would be the courses (or units) that usually require the teacher to dictate the lectures. Instead of dictating the course notes in a physical classroom, which arguably takes up a large chunk of the allocated class time (as was reported in Chapter 6), the teacher can pre-record these lectures and host them online for students to view anytime, anywhere. Moreover, at the Early Adoption phase, project-based courses requiring students to generate e-portfolios could suit the proposed approach. For example, a teacher can request journalism students to use *WordPress* mobile app to create, showcase and store their news-writing assignments. The evaluation of the OERu course in Chapter 4 demonstrated that creating e-portfolios (e.g., personal blog sites) on a smartphone is possible. Certainly, designing a blended course at the Early Adoption phase will take a significant amount of time and effort on the teachers part; therefore, I recommend that the course being redesigned (made smartphone-ready) should be one that the teacher teaches multiple times. This ensures that the time invested in designing the blended course is worth it – the teacher will not have to redesign the course each semester; instead, they will only be updating the content.

At the Exploration stage, since lectures are still delivered in the classroom, smartphone-supported blended learning would be ideal for courses that have large class sizes, and class discussions are crucial in assimilating acquired knowledge. As mentioned before, overcrowded lecture halls is a crippling issue in public universities in sub-Saharan Africa. The overcrowding in lecture halls makes it logistically impossible for teachers to conduct student-led class discussions. However, using smartphone-based student response systems (e.g. *Kahoot*, *TopHat* and *Socrative*), teachers can facilitate class discussions through online opinion polls and low-stakes online auto-graded quizzes. Furthermore, since at the Exploration phase only one or two activities are shifted online, this phase would be an ideal starting point for courses that are usually taught by multiple teachers in an academic year.

b) Determine what proportion of the course to blended

In the literature review, I asserted that one of the main challenges teachers face when implementing blended learning is balancing the blend. Therefore, it is pertinent to address this issue in the SOLE framework. At the Exploration stage, since only one or two online learning activities are integrated into a single traditional lecture (i.e. micro-flipped classroom), I recommend that teachers adopt an 80/20 balance. This means that 80% of classroom time will be focused on delivering the traditional lecture; the remaining 20% of classroom time will be dedicated to online-based assignments (e.g. online forum discussions and low-stakes quizzes). For example, in large class sizes where providing timely feedback on a low-stakes quiz is challenging, a teacher can administer online quizzes to automate the marking process and provide instant feedback during the lecture.

However, at the Early Adoption stage, since the pedagogy implemented is the Fully-Flipped Classroom, where the in-class and online components are weighted equally, I recommend teachers adopt a 50/50 balance, as was the case in the study conducted by Thai et al. (2017). This means, 50% of the teaching and learning process occur in-class, and 50% occur online (out-of-class). Teachers can maintain this balance by ensuring that they never lecture in the classroom what is in the pre-class (online) media. Nevertheless, this does not mean that the two components should deliver different content. On the contrary, the blended course should be designed in such a way that the in-classroom sessions are used to explore in more depth the online lecture material (e.g., through student-led group discussions and other problem-solving techniques). According to Mestan (2019, p. 75),*"If the online and class content is not integrated, then students are less likely to engage with the online content… It can be tempting for academics to try to cover more material by having the online and class environments focus on different content, but [research suggests] this may not appear effective in engaging students. Rather … the class and online environments are better distinguished by engaging differently in the same material"*. Lastly, concerning how much of the course should be blended at the Early Adoption stage, I recommend starting with one week's worth of course content. As highlighted in Chapter 7, blending two weeks' worth of content is doable; however, if the teacher does not receive a reduction in workload in order to prepare the blended course, two weeks may be somewhat ambitious. For more general guidelines on effectively implementing a Flipped Classroom pedagogy, the reader is directed to the previously discussed GEEFL chart (see Table 2.6).

### *8.3.3 Step 3 – Develop the Technology-Enhanced Learning Resources*

As described in section 8.2.2, this step requires teachers to create and deliver online learning resources. Here, the teacher must identify the appropriate digital tools to use to transform learning content in a manner that advances student learning outcomes. For example, a teacher may know what parts of the course should or should not be blended (Step 2 of the SOLE framework). However, suppose they do not know which technology is best suited for addressing specific content. In that case, they may end up creating an entire online course based on text-based PDFs, yet video-based lectures may be more appropriate. Thus, notable objectives to complete in this step include (but are not limited to):

a) Determine the ideal LMS

Arguably, at the Exploration stage, an LMS is not required. Since this phase includes one or two online activities embedded within a traditional lecture, stand-alone mobile apps can be used. At this stage of implementation, the assumption is that the teacher is still not accustomed to using technology in their teaching. Hence, using an LMS right away may be somewhat of a steep learning curve – a sentiment demonstrated by the novice group in the survey conducted by Olivares et al. (2021) that evaluated faculty readiness to use an LMS. Given the newness of smartphone-supported blended learning, it is imperative for teachers at the Exploration stage to use digital technologies that they are already familiar with. If the intention is to create an online discussion forum, literature has demonstrated that existing social media platforms like WhatsApp, Facebook, and Twitter can facilitate class discussions (Farley et al., 2015; Kim et al., 2015; Pimmer et al., 2012; Rambe & Bere, 2013). Suppose the teacher's intention is to conduct real-time peer group discussions in the classroom and administer low stakes quizzes or conduct opinion polls that require instant feedback on generated content, smartphone-based student response systems (such as *Kahoot*, *Top Hat* and *Socrative*) would be great tools to use.

An LMS is suitable when the online portion of the blended course has the same weight as the classroom component (as is the case in the Fully-Flipped Classroom implemented at the Early Adoption stage of the SOLE framework). In such a scenario, the teacher would use an LMS as it helps to consolidate a wide range of online learning resources in one location. For example, in the LMS, a teacher can create and deliver online lectures, review student work, administer assignments and quizzes, calculate and report grades, track student progress, and facilitate collaborative activities through the online forums. An LMS can also allow teachers to help students manage their self-paced study time by populating the students' calendars with required tasks for the week, month or semester. Indeed, university grade LMSs require significant financial investment, and given the experimental nature of smartphone-supported blended learning, convincing university management to provide funding will likely be a challenge. Therefore, at this stage (Early Adoption), teachers should ensure they use a free, open-source LMS and a free web-hosting service to bypass the time-consuming process of installing and configuring their own LMS server on their computer. Furthermore, to facilitate seamless learning across locations with intermittent internet connectivity, the chosen LMS must have a mobile app version as these apps typically provide an offline feature. In Chapter 4 and Chapter 7, I have discussed at length why an m-LMS with an offline feature is key to ensuring the smartphone-supported blended learning strategy delivers the expected student learning outcomes and experiences.

b) Decide how the online learning content will be created and presented (identifying which media formats are suitable for content learning)

An apparent upside of using an LMS to host learning content is its ability to allow the teacher to create and present content in multiple formats. For instance, at the Early Adoption stage, the online lecture material can be presented in video, audio or text format. However, while presenting lecture material in multiple formats allows students to select the format that suits their individual learning styles, it is important to note that not all digital content formats are suitable for addressing learning content. For example, audios (podcasts) might be good for teaching language courses; however, they are inappropriate for teaching topics that require visual demonstrations.

Furthermore, when designing the online lecture material, it is imperative for teachers to critically think about the following questions: what can a student really effectively learn anywhere, anytime? What is the impact of mobility on learning (Farley et al., 2015)? What cognitive processes do learners use when learning on the go (Ally, 2013)? This is because the smartphone's highly portable nature allows students to physically move their learning environments (more so than with laptops or tablets). As such, smartphone-based learning naturally exposes students to unplanned environmental distractions (e.g., attentional distractions, noise, changing audio-visual stimuli, differing comfort levels and differing visibility levels) (Terras & Ramsay, 2012; Tossell et al., 2015). These interruptions negatively affect learner engagement since impromptu breaks between tasks decrease prospective memory retention and extend task completion (Finstad et al., 2006; Trafton et al., 2005). For example, while most students prefer video-based lectures, they may not be the ideal format for learning while 'on the move' (e.g., while on a field trip at a science museum). This is because video-based lectures typically require both visual and auditory cognition, yet the field trip at the science museum needs the students to be visually attentive to their surroundings. In Table 8.2, I have provided examples of scenarios where specific digital media formats are ideal.

Once the teacher decides which content formats are appropriate for addressing learning content, the next important step is to determine how the online content will be created. At the Exploration stage, since the online component of the micro-flipped classroom makes up only a tiny portion of the blended course (20%), it is advisable to create the learning content from scratch so as to maintain the 'personal touch' that a traditional classroom-based course typically offers. At this stage, the students are still dependent learners who see the teacher as the 'sage on the stage' (i.e., they rely heavily on the teacher to regulate and schedule their learning). Hence, the use of externally produced learning content may make them feel somewhat disconnected from the teacher, which could disrupt their learning processes. Moreover, since at the Exploration stage the online learning activities primarily comprise low stakes quizzes and technology-mediated class discussions, the content can easily be developed from scratch.

However, at the Early Adoption stage, teachers can choose to use OERs, in addition to creating lecture material from scratch. Whilst teachers may feel that creating lecture material from scratch may give the blended course a more ‘personal touch’, given the newness of blended learning strategy in most public universities in sub-Saharan Africa, it is imperative that I reiterate the lesson learnt from conducting the pilot study at TMUC (Chapter 7), *“Don’t underestimate OERs”*. Creating an effective blended course is time-consuming as it requires a lot of planning and forethought (even if the teacher is an experienced practitioner) (Mestan, 2019). Therefore, at the Early Adoption stage, teachers wanting to deliver lecture material via a smartphone could transition in two stages: the first stage involves exclusively using externally produced lecture content (OERs); in stage two, once the teacher becomes accustomed to the new pedagogy, they can proceed to create the lecture material from scratch (as well as incorporate OERs). To begin working with OERs teachers can utilise the resources provided by: The Open University, Massachusetts Institute of Technology, Stanford University and Delft University of Technology. Other notable institutions that provide access to a variety of high-quality OERs include edX.org, OERu.org and P2PU.org.

c) Determine which smartphone-based technologies can be used to create an online community of learners to facilitate collaborative content creation

Garrison and Kanuka (2004, p. 97) assert that “what makes blended learning particularly effective is its ability to facilitate a community of inquiry... that balances the open communication and limitless access to information on the Internet”. That being said, culture to a large extent will influence the effectiveness and success of the established community of inquiry. For example, studies conducted within individualistic cultures suggest that creating an online community of learners may be a daunting task because students in these contexts tend to prefer learning activities that do not require much social interaction. For example, in an Australian study conducted by Mestan (2019, p. 81), *"Unit coordinators reported that… Getting students to do group work via the internet was "a bridge too far". Group wiki sites did not garner participation and students rarely engage in lively online discussion. A unit coordinator observed about their unit's online student forum that: 'it's not like they're using it as a platform to have interesting discussions about the subject material, rather those who do post, usually ask specific administrative questions'"*. On the contrary, establishing an online community of learners in collectivist cultures (such as those in sub-Saharan Africa) may not be a significant challenge. Technologies that increase social interactions are often embraced in these communities, as was described in the studies by Silver et al. (2019) and Poushter (2016). Moreover, the preference for collaborative learning was evident in the pilot study I conducted at TMUC (Chapter 7), which revealed that students extensively contributed to the online discussion forums, implying that students in collectivist cultures crave learning activities that require much social interaction. However, the out-of-class learning experience facilitated by the Flipped Classroom pedagogy may lead to a psychological feeling of isolation. Therefore, it is crucial to create a community of learners not only face-to-face (in-classroom) but also online. To this end, in Table 8.2, I have suggested ways teachers can utilise smartphone-based technologies to create and manage an online community of learners both at the Exploration and Early Adoption stages.

### *8.3.4 Step 4 – Evaluate Effectiveness of the Smartphone-Supported Pedagogy*

Given the apparent benefits of digital technologies in people's daily lives, it is easy to assume, consciously or not, that the inclusion of smartphones into university teaching will naturally cause and/or enhance learning. However, *"no technology can automatically benefit education … when a new technology emerges … teachers have the responsibility to discover and then reveal [its associated] learning opportunities along with [its] potential to transform educational practice"* (Spector et al., 2014, p. vii). Consistent with Spector et al. (2014) sentiments, the present research has demonstrated that technology integration involves collective inquiry and action research; teachers must continuously review their practices to ensure their technology-enhanced pedagogies cause and enhance learning. Therefore, no matter what stage a teacher is in (i.e. Exploration or Early Adoption), this step emphasises the need for periodic quality assurance testing of the smartphone-supported blended course. As a starting point, this step requires the teacher to examine how the introduction of smartphone-based learning strategies impact (i.e., impede or enhance) any pre-existing teaching and learning styles. With this awareness, the teacher better understands how to adjust the content based on students' prior knowledge (competence) as well as adapt content based on their own personal beliefs, values, assumptions, and theories about teaching and learning. According to Koehler et al. (2013), teachers with this kind of knowledge base are more likely to design effective technology-enhanced courses. Thus, in the following paragraphs, I have elaborated on how smartphone-supported blended learning strategy could affect teaching and learning in public universities of sub-Saharan Africa. I have also suggested ways teachers could conduct a quality assurance test to ensure the course improves student learning outcomes.

a) Examining the impact of smartphone-supported blended learning on the existing teaching and learning styles

The lack of resources to facilitate technology-enhanced learning means classroom-based learning is still the primary mode of study in most public universities in sub-Saharan Africa. However, as highlighted in Chapter 3, due to limited funding, public universities in this region often do not have the necessary physical infrastructure (i.e., large lecture halls) to support the large number of students who enrol in these institutions. As a result, many of the lecture halls tend to be overcrowded. Furthermore, the lack of financial resources in rurally based public universities negatively impacts ICT provision such that even the most basic presentation software (e.g., projectors, microphones and speakers) is not readily available to teachers. Unfortunately, student participation in large class sizes is typically limited because facilitating class discussions without the help of digital technologies is usually a great challenge for the teachers. As a result, teachers naturally adopt a lecture-based teaching style, and students become dependent learners who passively absorb content. However, the introduction of smartphone-supported blended learning will inevitably require the students to adopt new learning and teaching styles. For example, at the Exploration stage, the introduction of online class discussions (e.g., opinion polls) into the conventional classroom-based lecture means that students will shift from being passive learners who rely on the teacher to regulate their learning to active learners capable of constructing new knowledge. At the Early Adoption stage, the self-scheduled pre-recorded lectures will force the students to partially learn on their own, making them independent learners in this respect.

For the teachers at the Early Adoption phase, the introduction of smartphone-supported blended learning will shift their role from ‘sage on the stage’ to ‘guide on the side’. Here, it should be noted that the Fully-Flipped Classroom pedagogy (i.e., the shift from fully synchronous to partially asynchronous teaching) does not weaken the role of the teacher. Once the online learning content is created, the role of the teacher is to: guide the students through the coursework; facilitate higher learning activities such as peer-to-peer instruction and inquiry-based learning; and provide mentoring and tutoring sessions as needed (Sun et al., 2017). Furthermore, as a ‘guide on the side’, the teacher’s role entails using strategies that: 1) foster self-regulated learning in order to help students become independent learners and 2) promote active learning in the online learning environment. For teachers at the Exploration stage, smartphone-supported blended learning will shift their pedagogy from the conventional lecture-based teaching style to student-centred teaching. This means the teacher will need to incorporate online activities that promote active learning and collaborative learning. Table 8.2 describes the various ways teachers can incorporate these new teaching strategies and provides examples of digital technologies to use to ease the transition.

b) Ways to conduct quality assurance tests to ensure the smartphone-supported blended course improves student learning outcomes

Whilst refinements will likely be made during implementations as a result of informal observations by the teacher, feedback from students and/or information obtained in training workshops, it is possible to evaluate (to some extent) the effectiveness of the smartphone-supported blended course before testing it with the students. Evaluating the course before rolling it out to the students is essential as it minimises the number of refinements made during implementation – multiple adjustments during implementation disrupt learning activities and are often time-consuming. For example, prior to implementation, teachers can ask colleagues (in particular, educational designers and media specialists) to review their smartphone-supported blended courses. An educational designer would be a valuable mentor as they can assist with course design (e.g., comment on the structure of the blended units or provide guidance on how online and in-person aspects can be integrated); they can also offer advice on the proper use of educational technologies (e.g., review the appearance and functionality of the m-LMS). Accordingly, a media specialist can assist with the technical creation of course materials (e.g., suggest the appropriate digital platforms to use, and provide guidance on what type of content should be hosted online). Ultimately, *"Blended learning is a 'collegial'* *process. Working with other faculty [i.e., establishing a community of practice] builds up confidence, maintains energy and minimises mistakes"* (Kenney & Newcombe, 2011, p. 54). Furthermore, through these support groups, teachers can develop formal checklists that outline best practices for teaching smartphone-supported blended courses and use the same checklists to assess the effectiveness of their blended courses.

## 8.4 Evaluation of the SOLE Framework: Comparing its Recommendations (Guidelines) to Other Well-Established Technology Integration Models

The recommendations in the SOLE framework (see Table 8.2) aim to guide teachers to effectively integrate smartphones into their teaching practices. However, given the experimental nature of the proposed smartphone-supported blended learning strategy, I deemed it necessary to compare the framework's recommendations to existing well-established (tried-and-tested) technology integration frameworks. This approach allowed me to evaluate whether the SOLE framework is built upon a stable theoretical foundation and thus can withstand scrutiny over time. Indeed, with SOLE being specific to the sub-Saharan African context, some recommendations may not apply in other contexts, especially those in the developed world where smartphones are still adjuncts to the desktop PC and laptop. Nevertheless, as I previously mentioned in Chapter 3, the Pragmatist researcher bases their assumptions on the premise that there needs to be a sufficient degree of mutual understanding with not only the target population but also with the readers and reviewers of the research, who may be outside the research context (i.e. intersubjectivity). In this vein, there are two internationally recognised models for technology integration: 1) TPACK (Technological Pedagogical Content Knowledge) and 2) SAMR (Substitution, Augmentation, Modification, and Redefinition). For this evaluation, I chose to compare the SOLE framework to the TPACK model; my rationales for this selection are presented in the succeeding paragraphs.

TPACK describes the primary forms of knowledge required by teachers for successful integration of technology in teaching – content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK) and contextual knowledge (XK) (Mishra, 2019). More important to the model are the interactions between and among these primary bodies of knowledge, represented as PCK (pedagogical content knowledge), TCK (technological content knowledge), and TPK (technological pedagogical knowledge) (Koehler et al., 2013; Mishra, 2019). Ultimately, the purposeful blending of all these aspects of knowledge (technological pedagogical content knowledge – TPCK) enhances student learning experiences with technology.

Although SAMR, developed by Puentedura (2012), is another popular model teachers use when integrating technology in the classroom, it is somewhat technocentric. SAMR provides a high-level understanding of the degree of technology use across four levels of integration but does not sufficiently emphasise the role of pedagogy, content, and context in the integration process (Hamilton et al., 2016). While my research views technology (smartphone) as a key driver for educational change, it also acknowledges that work in educational technology cannot focus solely on technology; the technology should be led by pedagogy. Accordingly, the SOLE framework is also built upon this premise. For this reason, I chose not to use the more technocentric SAMR model in this evaluation. Furthermore, literature has demonstrated that the SAMR model may be somewhat confusing for early adopters of technology-enhanced learning. According to Hamilton et al. (2016, p. 435), "there exists limited explanations or details regarding how to understand, interpret, and apply the SAMR model – in part or whole"; Hamilton et al. further add that this lack of theoretical explanations has led to vastly inconsistent representations and misunderstandings of the SAMR model.

Conversely, TPACK is well represented in peer-reviewed literature and "has provided a rich foundation for research on the effective use of technology in teaching and learning" (Saubern et al., 2020, p. 1). According to Mishra (2019, p. 76), *"The TPACK framework has had a strong influence on research and practice in teacher education and professional development and inspired extensive research and scholarship. Since 2009 there have been over 1200 journal articles and book chapters, over 315 dissertations and 28 books with TPACK as the central construct"*. Even so, it is prudent to acknowledge that the TPACK model also has some shortcomings and is arguably still a work-in-progress, especially when it comes to defining and delineating the TPK, TCK and TPCK constructs (Graham, 2011; Kinchin, 2012; Saubern et al., 2020). Nevertheless, compared to the SAMR[44] model, TPACK provides a more straightforward explanation of the synergy between pedagogy and technology. For this reason, the TPACK model provided a stable enough theoretical foundation upon which I could evaluate the theoretical underpinnings of the SOLE framework.

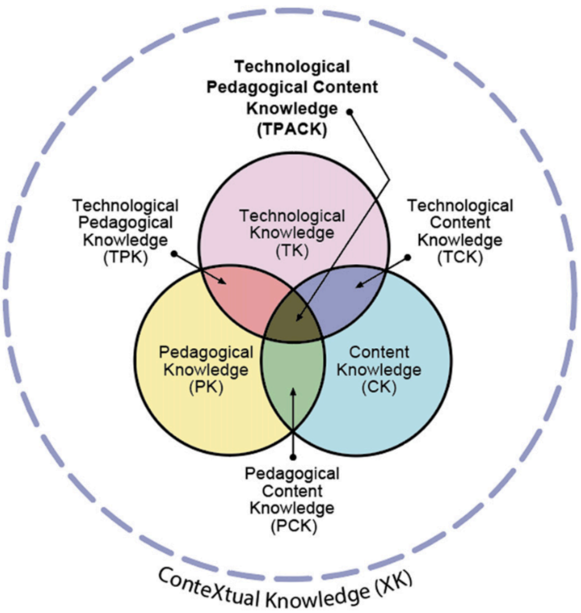
### *8.4.1 Aligning the Recommendations of the SOLE framework with the Knowledge Constructs of the TPACK Model*

Figure 8.3 shows the eight kinds of knowledge teachers using the TPACK model must possess to integrate technology in the classroom. However, in this evaluation, I shall focus on showing evidence of the intersecting aspects of the TPACK model – PCK, TCK, TPK, and TPCK. These intersections or overlaps (as opposed to the primary constructs – content, pedagogy, and technology) are critical for technology integration as they represent more profound levels of understanding. For example, a teacher may have sufficient knowledge of the LMS (TK) and

[44] For a thorough review of the challenges of the SAMR model in the integration of educational technology, the reader is directed to the literature cited by Hamilton et al. (2016).

about the subject matter to be taught or learnt (CK); however, if they do not understand which technology is best suited for addressing the subject matter (TCK), then they may end up creating an entire online course based on text-based PDFs, yet video or online discussion forums may be more appropriate mediums in certain learning activities. Similarly, a teacher may technically know how to use an LMS (TK), but if they do not understand how the technology could impact (impede or enhance) teaching and learning processes (TPK), integrating technology in the classroom could lead to what Kinchin (2012) referred to as "technology-enhanced non-learning". On the same note, a teacher could be an expert in their domain (CK), but if they do not understand how to represent the instructional materials in multiple ways (PCK), integrating technology into their teaching will be a significant challenge. The outer circle, XK (contextual knowledge), is equally important in this evaluation as it encompasses all the other knowledge constructs. Definitions of the aforementioned TPACK knowledge constructs (i.e., XK, PCK, TCK and TPK) are presented in the next paragraphs, where I discuss how the four building blocks of the SOLE framework align with the TPACK model.

**Figure 8.3: TPACK model and its knowledge constructs (Mishra, 2019, p. 77)**



a) Evidence of XK construct in the SOLE framework

XK (contextual knowledge) is an understanding of how institutional and situational constraints influence the choice of digital technologies, the pedagogical strategies used, and the content format. By making smartphones instead of desktop PCs or laptops the technology basis for advancing blended learning in sub-Saharan Africa, the SOLE framework demonstrates evidence of XK in that it acknowledges that the latter technologies are not readily available to students (and institutions) in the region. Furthermore, by suggesting teachers adopt blended learning instead of e-learning (fully online learning), SOLE demonstrates that its recommendations consider that culture to a large extent influences how learning occurs. As noted earlier, sub-Saharan Africa personifies a collectivist culture where embodied face-to-face learning is indispensable; hence, e-learning which requires students to complete entire courses online, would not be an ideal instructional strategy in this region. Additionally, by suggesting that teachers introduce online-based learning into their pedagogy, SOLE acknowledges that some students (especially the rurally based) may not always be able to physically attend on-campus lectures due to location remoteness and socioeconomic constraints (e.g., insurmountable travelling costs and competing work/life commitments). In general, evidence of the XK theme is most prominent in the first building block (Step 1) of the SOLE framework.

b) Evidence of PCK construct in the SOLE framework

PCK (pedagogical content knowledge) is an understanding of how to present instructional materials in multiple ways. Accordingly, the second building block (Step 2) of the SOLE framework requires teachers to determine which course content could be presented in a blended format. This shows evidence of PCK since in determining which content can be blended, teachers will have to contemplate which parts of the course do not work properly in the traditional format but would work better if shifted online and vice-versa. In this pursuit, teachers will gain more insight into which instructional delivery methods are suitable for teaching specific content.

c) Evidence of TCK construct in the SOLE framework

TCK (technological content knowledge) is an understanding of how content topics can be represented in multiple ways using digital tools. This knowledge construct is most prominent in the third build block (Step 3) of the SOLE framework. There, I describe how teachers can use various digital media formats (e.g., video, audio, text, image) to create, enhance, transform and deliver learning content. SOLE framework even goes a step further and describes which digital tools are best suited to address specific subject matter. For example, I recommend using audio (podcasts) to teach foreign language vocabulary since pronunciation is crucial in language learning. On the same note, I recommend the use of social media networks (e.g., Facebook and WhatsApp) to coordinate class discussions as they serve as the quickest ways to facilitate ad hoc collaborative content creation. In these ways, SOLE fosters teachers' technological content knowledge.

d) Evidence of TPK construct in the SOLE framework

TPK (technological pedagogical knowledge) is an understanding of how specific digital technologies impact (i.e., impede or enhance) teaching and learning processes. Evidence of TPK is prominent in the fourth building block (Step 4) of the SOLE framework. There, I have explained how the introduction of specific digital tools may alter the existing teaching and learning styles of students and teachers in sub-Saharan Africa. For example, I have described how the use of student response systems (e.g., Kahoot) will likely increase student participation, thereby promoting active learning during classroom-based lectures; I have also described how the use of video annotation software (e.g., HapYak) could increase student engagement with pre-recorded online lectures thereby facilitate self-regulated learning. Furthermore, I have provided examples of how teachers could evaluate their technology-infused lessons to ensure they improve student learning outcomes.

e) Evidence of TPCK construct in the SOLE framework

TPCK (technological pedagogical content knowledge) is an understanding of how to effectively teach content using specific instructional strategies and technologies. As noted earlier, TPCK is the integration of all the other forms of knowledge in the TPACK model; hence, it is embodied when the other constructs overlap during teaching (Angeli & Valanides, 2009). In this vein, by virtue of demonstrating evidence of the other forms of knowledge constructs (i.e., PCK, TPK, TPK and XK) within the SOLE framework, I have shown that the framework aligns with the central construct TPCK. In general, SOLE demonstrates evidence of TPCK in that it outlines how teachers can leverage smartphone-based technologies and blended instructional strategies to present learning content.

The above evaluation shows evidence that the SOLE framework aligns with the knowledge constructs of the well-established TPACK model. Thus, I conclude that SOLE is built upon a stable theoretical foundation and can guide teachers to effective technology integration in the classroom. According to Graham (2011, p. 1955), the crucial building blocks for theory development include: *"(1) identifying 'what' factors, constructs, or concepts should be considered in explaining the phenomena of interest, (2) exploring 'how' the elements in the theory are related, and (3) articulating 'why' the factors and relationships merit attention and interest in the larger context."* To this end, in explaining the theoretical underpinnings of the

SOLE framework, I have (1) outlined *what* knowledge concepts have been considered, i.e., technological knowledge, content knowledge, pedagogical knowledge and contextual knowledge, (2) described *how* these four knowledge concepts are related and (3) articulated *why* these knowledge concepts and the relationships between them are of particular interest to early adopters of technology-enhanced learning strategies. I hope future researchers looking to study, improve or extend the boundaries of the SOLE framework find the explanations herein easy to interpret.

## 8.5 Summary

In sub-Saharan Africa, smartphones are the most accessible technology, and literature shows that university students are already using these devices to support their learning. Notwithstanding, there is a gap in the literature – the lack of research on how teachers can integrate smartphones into their formal teaching practices. This chapter has helped narrow down this gap by introducing a novel framework entitled *Smartphone Only Learning Environment (SOLE)*, which provides a set of practical guidelines on how teachers can effectively deliver a blended university course solely to a smartphone. The framework's dimensions represented as four building blocks and their related themes have been defined, and examples of how teachers can begin to build the blocks have been provided and supported with clear rationales. Furthermore, to test validity, the recommendations presented in the SOLE framework have been compared against the well-established (tried-and-tested) technology integration framework, TPACK. This comparison reveals that SOLE is indeed built upon stable theoretical underpinnings. To this end, this chapter has addressed the third and last research objective of this thesis *'To develop a framework that provides a set of guidelines on how to successfully deliver a university course solely to a smartphone'*. The themes presented in the SOLE framework represent the meaning I made of the data gathered throughout this research;

nevertheless, other interpretations are possible and encouraged. I hope teachers and researchers find the framework discussed herein useful and applicable in their relevant contexts. In the next–and final–chapter, I will draw conclusions from the research findings and discuss their contributions, limitations, and implications, along with suggestions for future research.

# 9. CONCLUSION

*"Despite this widespread adoption of smartphones among the youth, its usage in higher education is still a novice idea, specifically in developing countries" (Iqbal & Bhatti, 2020, p. 1).*

Bearing in mind that in developing countries (such as those in sub-Saharan Africa), smartphones are the most practical gateway to the affordances of technology-enhanced learning, the above statement is indeed very disconcerting. Given the scarcity of desktop PCs and laptops in the region, the conscious or unconscious dismissal of smartphones as serious tools to support education should not be transferred to the sub-Saharan African university context. While the idea of smartphone-based learning has not been entirely neglected, literature regarding this topic typically investigates whether smartphones are a source of distraction for students. Rather than follow the same trajectory, my research sought to investigate how university students can use their smartphones to meaningfully participate in a blended course. To the best of my knowledge, my research provides the first comprehensive view of formal smartphone-supported learning in public universities of sub-Saharan Africa. To address the principal research question, *'What learning and teaching strategies are effective in facilitating the use of a smartphone as the sole device for formal study in university courses?',* the findings across the four phases of the research were synthesised into a framework entitled, Smartphone-Only Learning Environment (SOLE). This framework provides practical guidelines on how teachers in developing countries of sub-Saharan Africa can deliver a blended university course to students whose sole device for study is a smartphone. The discussions in the previous chapter have described how teachers can begin to engage with the SOLE framework.

In this final chapter, the findings that address each of the research objectives and the conclusions reached through synthesis across the four phases of the research are first summarised. Next, the research contributions are discussed, and the limitations of the research as a whole are considered. The implications of the research are then presented, and future research directions are explored. The chapter concludes with my final thoughts on the use of smartphones in higher education.

## 9.1 Summary of the Research Findings

This research set out to explore how a student who owns only a smartphone and does not have access to a desktop PC or laptop can successfully participate in a technology-enhanced (blended) university course. A mixed-methods case study approach entailing four phases was used to investigate this phenomenon. The phases involved a quantitative feasibility study, a quantitative cross-sectional survey phase, a qualitative interview phase and finally, a mixed-methods pilot study. Three research objectives guided the research.

The first research objective concerned the technical aspects of a smartphone that make it a contender as a serious (formal) learning tool in higher education. Through a feasibility study, I found that the typical low-to-mid range value smartphones have the technical capacity (e.g., a suitable screen size, adequate storage and processor capacity, and sufficient bandwidth) to deliver a technology-enhanced university course. Therefore, I concluded that smartphone-supported blended learning could be shaped to be a relevant and sustainable strategy.

The second research objective concerned the role of students, teachers, and institutions in delivering a smartphone-supported blended course. Regarding students' central role, findings from the quantitative survey at TMUC revealed that students undoubtedly have access to smartphones and are already using them to support their learning. Therefore, when considering the integration of technology-enhanced learning, I concluded that the device replacement (smartphones instead of laptops and desktop PCs) should be effectuated on the students' side. In other words, the students are responsible for providing the technology (smartphones). Pertaining to the teachers' role, findings from the qualitative interview with TMUC lecturers revealed that teachers are willing to formally integrate smartphones into their courses if provided with proper guidance and training. Hence, I concluded that it is the teacher's responsibility to create smartphone-ready learning content and ensure that student-created learning content is smartphone-friendly. As far as the role of the institutions is concerned, whilst I did not interview university management, the interactions I had with students and lecturers at TMUC revealed some ways institutions could support smartphone-based learning. Firstly, institutions can partner with mobile internet service providers to subsidise mobile data costs for the students. Secondly, institutions should establish clear policies (e.g., online learning policies, change management policies and course scheduling policies) that outline the university management's expectations for teachers who adopt smartphone-supported blended learning.

The last research objective concerned developing a framework that provides practical guidelines on how teachers can deliver a blended university course to a smartphone. Findings from the pilot study of a smartphone-supported blended course demonstrated that a student could indeed participate in a blended university course using their smartphone as the technology basis. Thus, considering sub-Saharan Africa's resource-constrained higher education landscape (e.g., overcrowded lecture halls and limited technological support), I concluded that the flipped classroom pedagogy is ideal. Furthermore, to ease the transition into the new technology-enhanced teaching approach, I suggested teachers leverage OERs along with building their courses from scratch.

## 9.2 Research Contribution

The impetus for this research was the frustration I experienced while teaching a computer programming course at two technologically underserved public universities in Kenya. Considering the high student enrolment in most public universities in Kenya, the computer laboratories were few and underequipped. Consequently, ensuring that all the students had access to computing resources was difficult and, most times, impossible. Amid this crisis, I discovered that the students (especially those from lower-income households) were using computer programming mobile apps (from the Android App store on their smartphones) to support their learning. This discovery led to my fascination with smartphone-based learning. However, through my reading to learn more about this concept, I did not find anything useful regarding the use of smartphones as learning tools in a formal university context. Thus, motivated to explore this literature gap and find solutions for my students, I began my investigation. Now, at the conclusion of my investigation, the following are the significant contributions that this research has made:

### *9.2.1 Provides evidence that smartphones can become the technology basis for blended learning in higher education*

Presently, blended university courses are still primarily designed with an unspoken assumption that students will use desktop PCs or laptops. Moreover, at the time of this research, public universities in sub-Saharan Africa had been very slow to engage with blended learning due to extreme government budget cuts that led to a general lack of technological resources (e.g., desktop PCs and laptops) within the institutions. However, this research has demonstrated that a student who owns only a smartphone and does not have access to a desktop PC or a laptop can successfully participate in a technology-enhanced (blended) university course. To the best of my knowledge and considering the findings of the systematic review on smartphone-based learning conducted in Chapter 2, my research is the first to use smartphones to facilitate blended learning in a formal university setting in sub-Saharan Africa. Thus, it could provide a foundation for future research in this area.

Additionally, a major contribution of this research was to confirm that through the practice of 'Bring Your Own Device (BYOD)', smartphone-supported blended learning is practicable even when there is limited institutional funding and support available. By demonstrating that universities can leverage the high levels of smartphone ownership among students to facilitate blended learning, this research may foster a paradigm shift — from smartphones as informal (supplementary) learning tools to smartphones as formal (primary) learning tools in higher education.

### *9.2.2 Introduces a novel framework (SOLE) that aims to guide the integration of smartphone-supported blended learning in university curricula*

Prior to this research, a framework that provided guidelines on how to successfully deliver a blended university course solely to a smartphone did not exist. Recent studies into the use of smartphones in educational settings have explored ways to adapt laptop or desktop PC content for viewing on smartphones but by far have not reached the depths possible. Consequently, this research argued that despite the apparent benefits of using smartphones in education, faculty and university management have been reluctant to adopt smartphones as formal, primary learning tools due to the lack of comprehensive guidelines on how to effectively integrate smartphones into existing curricula. The present research has helped close this crucial literature gap by presenting a novel framework entitled *Smartphone-Only Learning Environment (SOLE)* that provides a detailed checklist to guide teachers in best practices for delivering a smartphone-supported blended course. Although the SOLE framework was developed from the findings of a single case study in Kenya, it is built on a flexible theoretical foundation. Hence, educators in developing countries with a similar context to Kenya (or who have learners who study under the same restrictions) can adopt the proposed teaching and learning strategies with little fine-tuning.

### 9.2.3 Demonstrates the significance of using contextually sensitive educational technologies and pedagogies in sub-Saharan African

This research indicates that the dismissal of smartphones as serious tools to support education should not be transferred to the sub-Saharan African university context. Technology adoption in sub-Saharan Africa is progressing very differently from what is observed in the developed world. While the developed world gradually moved from desktop PC to smartphone technology, sub-Saharan Africa has moved directly to smartphones and bypassed PC ownership. Notwithstanding, as the pioneers of technology-enhanced learning, the developed world transitioned from classroom-based learning to blended learning by way of PCs. Due to the apparent successful history of technology-enhanced learning in universities in the developed world, public universities in sub-Saharan Africa are striving to follow the same trajectory used in developed countries. However, this research posits that because of the significant scarcity of PCs in sub-Saharan Africa, following the blended learning adoption patterns of the developed world has significantly stunted the advancement of blended learning in the region. This research has presented evidence showing that sub-Saharan Africa is arguably 15 years behind in adopting technology-enhanced learning strategies compared to the developed world. To this end, the research propounds that smartphones are the ideal educational technology to use in public universities of sub-Saharan Africa and demonstrates that continuing to consider PCs as the technology basis for online learning in this region is self-defeating.

Furthermore, the research identifies that a collaborative form of blended learning, as opposed to fully online learning, is the ideal technology-enhanced pedagogy to implement in sub-Saharan Africa. Considering the COVID-19 social distancing policy, more universities are progressively providing fully-online courses. While fully online learning may be accepted by many in the individualistic cultures observed in the developed world, where students are comfortable with learning activities that do not require much social interaction, it is not suitable for the collectivist culture of sub-Saharan Africa. This research illustrated that despite the affordances of smartphone-based online learning, students in collectivist cultures need a blend of embodied face-to-face collaborative learning and self-paced online learning. Findings from the pilot study revealed that after only two weeks of studying online via their smartphones, the research participants started to crave on-campus social interactions. In this vein, this research contributes to the body of knowledge regarding context-sensitive pedagogies.

### *9.2.4 Confers a deeper understanding of lecturer perspectives on smartphone use in higher education in sub-Saharan Africa*

Literature regarding the affordances of smartphone-based learning mostly focuses on exploring the student perspectives. Consequently, there is a significant gap in the literature concerning teachers' perceptions of formal smartphone usage in higher education – and the little research that explores teacher perspectives mainly focuses on investigating whether the smartphone's socialising features make the device a source of distraction for students. Against this background, instead of only focussing on students' perceptions, this research recognised teachers as the gatekeepers to technology integration in the classroom and explored their attitudes towards smartphone-supported blended learning. Additionally, rather than focusing on investigating whether the smartphone is a source of distraction, my research sought to gather insights from the lecturers about how the smartphone can meaningfully facilitate formal teaching and learning processes. Thus, this research has contributed another perspective about smartphone-based learning.

Furthermore, the interviews with lecturers provided evidence that in sub-Saharan Africa, smartphones exert a far-reaching influence that goes beyond the social context. The constructive dialogue that emanated from the interviews suggests that due to the lack of conventional computing platforms (desktop PCs and laptops), lecturers in sub-Saharan Africa are already (informally) requiring students to use smartphones to support their learning. In other words, the interview data imply that teachers in sub-Saharan Africa perceive the smartphone as an indispensable tool for students to access educational information on the internet. In this vein, I argue that literature suggesting that the smartphone is potentially a distraction for students mainly stems from the developed world where desktop PCs and laptops are the primary devices used in formal study. Accordingly, my research serves as a starting point for educators in sub-Saharan Africa to have critical and informative discussions about formal smartphone-supported blended learning, consequently contributing to the existing limited body of knowledge regarding the topic.

## 9.3 Limitations of the Research

Certain limitations need to be acknowledged regarding the present research. The shortcomings particular to each phase of research have been discussed in the results chapters so that their implications could be considered in drawing conclusions about the individual studies conducted in this research. In reflecting on the body of work as a whole, other limitations need consideration.

Firstly, the research is a cross-sectional case study involving a specific set of participants at a specific location and at a particular point in time. Due to logistical constraints of undertaking first-hand research in sub-Saharan Africa, thousands of kilometres away from my place of study (New Zealand) and limited funding and time constraints associated with the PhD research plan, it was not feasible to perform case study research in multiple universities. Indeed, I acknowledge that the transferability of findings is strengthened in multi-context case study research. For this reason, substantial effort was put into enfolding the case study findings with extant literature from similar contexts to support the strength of evidence for the claims made in this research and build confidence in transferability. Furthermore, to enable others to build on my work, careful consideration went into providing clear rationales for my research methods. Notwithstanding, the reader is reminded that the findings of this case study research should be cautiously interpreted.

Secondly, the perspective provided by this research is seen through the lens of my interpretation. In Chapter 3 of this thesis, I have demonstrated the careful and systematic approach I took to account for and limit researcher bias and reactivity. Nevertheless, the Pragmatist philosophy adopted in this thesis holds the belief that it is difficult to separate a researcher's actions from their past experiences and the beliefs that have originated from those experiences. This means the researcher's preunderstanding, philosophical views, and bias will (to some extent) influence data collection, analysis and findings. Therefore, even though peer debriefing in the form of supervision allowed my assumptions to be challenged and multiple perspectives included in the analysis, it is prudent to note that this research is still just one possible interpretation of the data. The real test of the validity of the conclusions I have drawn will be in the resonance they have with readers (who may be outside the research context) and with other future research. For this reason, careful consideration went into underpinning ‘what works’ with ‘why it works’ – to allow readers and other researchers to draw their own conclusions.

## 9.4 Implications of the Research

This research contributes knowledge towards fostering formal education via technology-enhanced teaching and learning in exceptionally resource-constrained university environments. While not a panacea, the research makes a valuable contribution to university students, university lecturers, university management, and academic researchers across sub-Saharan Africa. Specifically:

- For students in sub-Saharan Africa, a smartphone-based university course will increase access to higher education. As mentioned in Chapter 1, the current classroom-based mode of learning in public universities of sub-Saharan Africa limits many students from fully participating in courses. For instance, given that the collectivist culture is more prominent in the rural areas of sub-Saharan Africa, rurally based students have a filial duty to contribute to the family’s income. As a result, these students are often unable to complete the required lecture hours, leading to diminished learning experiences. Eventually, a significant number of these students end up dropping out because the diminished educational experience is often seen as not worth the economic strain it puts on the family’s already small income. However, since smartphone-supported blended learning introduces online lectures, the students can access lecture material remotely at their convenience; hence, one more barrier to full participation in higher education will be removed for these rurally based learners.

- Next, the SOLE framework developed in this research has implications for university lecturers, who stand to gain further knowledge on how to teach and deliver existing courses to a smartphone. Given the nascent nature of the proposed smartphone-supported blended learning strategy, this framework could form the basis of ongoing curriculum and professional development initiatives and inform practices regarding the use of smartphones in public universities in sub-Saharan Africa. Therefore, subsequent studies are encouraged to extend (or challenge) the boundaries of the SOLE framework. A shared (collective) understanding of the appropriate and effective use of smartphones in formal higher education is the first step to ensure the eventual integration of smartphones into the curricula.
- For university management, this research serves as a starting point for critical and informative discussions on smartphone-supported blended learning policies. For instance, given the maintenance costs of university-grade LMSs, discussions about supporting teachers by providing an institution LMS are necessary. Furthermore, ongoing discussions on how students use smartphones to support their learning are essential. The systematic review in Chapter 2 demonstrated that very little is known about how students use smartphones to support their educational activities. Literature asserts that this inability to understand the myriad of ways students use smartphones to support their learning has often led university management to prohibit the adoption of smartphones as formal learning tools. However, by highlighting the factors influencing students' use of smartphones for education in Chapter 5, the present research helps university management gain insight into what smartphone-based learning activities can be integrated into the curriculum. Last but not least, it is envisaged that online-based learning through smartphones will help university management in sub-Saharan Africa mitigate the crippling issue of overcrowded lecture halls. Taking Kenya as an example

of a country in sub-Saharan Africa, Appendix C demonstrated that despite having a population average of about 500,000, most rural-defined counties have only one public university. Given that public universities are the only affordable gateway to higher education for the rural population, most of these institutions are often overcrowded. Fortunately, smartphone-supported blended learning means students do not have to always physically attend lectures, thereby decreasing the strain on university facilities.

- Finally, I anticipate that the implementation of this research might prompt educational researchers to uncover new theories about the structured use of social media networks as learning tools. As mentioned earlier, the collectivist culture embodied in sub-Saharan Africa plays a vital role in learning, meaning collaborative online learning activities (such as those supported by social media) would be highly regarded in this culture. Indeed, the use of social media in university education is not a novel idea. Several studies illustrate the benefit and ability of social media to augment learning. Moreover, literature shows that most people now access social media networks through their smartphones. Even so, much of what has been explored regarding smartphone-supported social learning is in the informal space and is yet to be fully integrated into formal university education. However, if smartphones are to be considered serious tools for learning, there needs to be a clear distinction between the unstructured and structured use of social media as a learning tool. This research, therefore, acts as a springboard for further research on how the smartphone's socialising features can be integrated into university curricula.

## 9.5 Recommendations for Future Research

As an initial study on the use of smartphones as the technology basis for blended learning in higher education, the findings of this research suggest areas that can be built on to enhance our understanding of smartphone-supported blended learning. I have commented on some of these throughout this thesis (particularly when discussing the weaknesses of the different phases of the research). Now, upon reflecting on the overall body of work, I present additional recommendations for future work.

Firstly, future studies should work with lecturers over an extended period of time to see how they cope with going through a transition towards smartphone-supported blending learning. These longitudinal studies could uncover new knowledge about how smartphone-supported learning impacts teachers' job satisfaction levels.

Secondly, future research should explore the idea of delivering online courses via free, open environments such as Discord. As mentioned in Chapter 2, the COVID-19 era has ushered in the fourth generation of technology-enhanced learning, which comprises learning through synchronous cloud-based collaboration tools. The COVID-19 social distancing policy has increased the demand for virtual collaborative learning spaces and the need for video live meetings. Consequently, higher learning institutions are increasingly moving beyond a focus on information delivery via the walled garden type LMS to open environments such as Zoom and Microsoft Teams due to their impressive ability to facilitate live collaborative learning activities (compared to the existing LMSs). Current smartphones are compatible with these open environments; hence studies describing how teachers can host a smartphone-supported blended course on these platforms are needed.

The third recommendation is that future studies should examine how to integrate existing LMSs with mobile apps, such that sharing of data across multiple applications occur automatically within a single environment. Undoubtedly, it is through mobile apps that smartphones can now perform most tasks typically done on desktop PCs and laptops. Therefore, in the delivery of a smartphone-supported blended course, it is essential that these mobile apps seamlessly communicate with the LMS. However, as observed in Chapter 4, currently, most mobile apps run independently of an LMS. Consequently, the constant switching between LMS and different mobile apps used for learning becomes cumbersome – future projects could look into how to minimise this inconvenience.

Lastly, future studies could build on the findings of this research by utilising the SOLE framework in multiple contexts. The recommendations I have highlighted in the SOLE framework are based on a pilot study conducted in one rurally based Kenyan public university. While most public universities in rural Kenya (and other developing countries in rural sub-Saharan Africa) share the same characteristics, subtle differences in institutional culture and traditions exist. These differences could influence how smartphones are introduced into the curriculum. Therefore, it would be interesting to compare experiences from the cohort of students and lecturers represented in this study with students and lecturers in different contexts. Evaluating how the SOLE framework functions in multiple educational settings will enrich our understanding of the various ways smartphones can be integrated into curricula. Furthermore, the collective knowledge from different contexts could lead to new approaches and theories that advance technology-enhanced learning in exceptionally resource-constrained university environments.

## 9.6 Final Thoughts

> *"In many developing regions, participation in online education is still constrained by technological infrastructure barriers, commonly called the digital divide. However, the rapid spread of smartphones has turned digital learning into a much more viable proposition in recent years. Mobile broadband technology is quickly penetrating even remote rural regions, providing Internet access to the people that live there". (Trines, 2018, para. 6)*

Within the context of a rurally based Kenyan public university, this study has demonstrated that the structured use of smartphones can accelerate the adoption of technology-enhanced learning and, by extension, formal online education in the developing countries of sub-Saharan Africa. Educational innovations typically, and likely by necessity, begin at an initial stage of individual experimentation. Therefore, the case study presented in this thesis should not be viewed as an all-encompassing strategy to combat the adverse effects of the digital divide in higher education but as a contribution to the dialogue needed to advance blended learning in technologically-constrained environments. As smartphone technology continues to evolve rapidly, it is clear that there is much more to learn in this research field of *'smartphone-supported blended learning'*. However, I hope that the meaning derived from this research gives us a theoretical basis from which to go forward. I believe that the insights generated from my research will benefit many university students and ensure that more inclusive, empowering approaches are used in future online education initiatives directed towards the sub-Saharan African context.

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# APPENDICES

## Appendix A: Ethics Committee Letter of Approval

Date: 28 October 2018

Dear Roxanne Hawi Okore

Re: Ethics Notification - **4000020261** - **From gimmick to game-changer: A study on the use of smartphones to expand access to higher education in developing countries.**

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

**A reminder to include the following statement on all public documents:**
*"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.*

*If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, email humanethics@massey.ac.nz."*

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

**Research Ethics Office, Research and Enterprise**
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand **T** 06 350 5573; 06 350 5575 **F** 06 355 7973
**E** humanethics@massey.ac.nz **W** http://humanethics.massey.ac.nz

Human Ethics Low Risk notification

Professor Craig Johnson
Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

**Research Ethics Office, Research and Enterprise**
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand **T** 06 350 5573; 06 350 5575 **F** 06 355 7973
**E** humanethics@massey.ac.nz **W** http://humanethics.massey.ac.nz

# Appendix B: Research License from NACOSTI, Kenya

**THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013**

**The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.**

**CONDITIONS**

1. The License is valid for the proposed research, location and specified period.
2. The License and any rights thereunder are non-transferable.
3. The Licensee shall inform the County Governor before commencement of the research.
4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
5. The License does not give authority to transfer research materials.
6. NACOSTI may monitor and evaluate the licensed research project.
7. The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice.

National Commission for Science, Technology and innovation
P.O. Box 30623 - 00100, Nairobi, Kenya
TEL: 020 400 7000, 0713 788787, 0735 404245
Email: dg@nacosti.go.ke, registry@nacosti.go.ke
Website: www.nacosti.go.ke

**REPUBLIC OF KENYA**

NACOSTI

**National Commission for Science, Technology and Innovation**

**RESEARCH LICENSE**

**Serial No.A 25910**

**CONDITIONS: see back page**

**THIS IS TO CERTIFY THAT:**
***MS. ROXANNE HAWI OKORE***
**of MASSEY UNIVERSITY, 0-4442 Palmerston North,has been permitted to conduct research in *Homabay, Migori Counties***

**on the topic: *FROM GIMMICK TO GAME CHANGER: A STUDY ON THE USE OF SMARTPHONES TO EXPAND ACCESS TO HIGHER EDUCATION IN DEVELOPING COUNTRIES.***

**for the period ending:**
***27th June,2020***

**Permit No : NACOSTI/P/19/68566/31642**
**Date Of Issue : 23rd July,2019**
**Fee Recieved :Ksh 2000**

...............................
***Applicant's Signature***

...............................
***Director General***
***National Commission for Science, Technology & Innovation***

NACOSTI

**NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION**

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Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/19/68566/31642**

Date: **23rd July, 2019**

Roxanne Hawi Okore
Massey University
**NEW ZEALAND.**

**RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on ***"From gimmick to game changer: A study on the use of smartphones to expand access to higher education in developing countries."*** I am pleased to inform you that you have been authorized to undertake research in **Homa Bay and Migori Counties** for the period ending **27th June, 2020.**

You are advised to report to **the County Commissioners, and the County Directors of Education, Homa Bay and Migori Counties** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

**GODFREY P. KALERWA., MSc., MBA, MKIM**
**FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner
Homa Bay County.

The County Director of Education
Homa Bay County.

The County Commissioner
Migori County.

The County Director of Education
Migori County.

# Appendix C: List of Public Universities in Kenya

| Year Chartered | University Name | County | Rural-Urban Population |
|---|---|---|---|
| **1970** | University of Nairobi | Nairobi | ▪ Urban: 4,397,073 |
| **1984** | Moi University | Uasin Gishu | ▪ Rural: 652,981<br>▪ Urban: 510,205 |
| **1985** | Kenyatta University | Nairobi | ▪ Urban: 4,397,073 |
| **1988** | Egerton University | Nakuru | ▪ Rural:1,115,122<br>▪ Urban: 1,047,080 |
| **1991** | Maseno University | Kisumu | ▪ Rural: 714,668<br>▪ Urban: 440,906 |
| **1994** | Jomo Kenyatta University of Agriculture & Technology (JKUAT) | Nairobi | ▪ Urban: 4,397,073 |
| **2007** | Masinde Muliro University of Science & Technology (MMUST | Kakamega | ▪ Rural: 1,682,239<br>▪ Urban: 185,340 |
| **2007** | Technical University of Mombasa | Mombasa | ▪ Urban: 1,208,333 |
| **2009** | Maasai Mara University | Narok | ▪ Rural: 1,057521<br>▪ Urban: 100,352 |
| **2012** | Chuka University | Meru | ▪ Rural: 1,406,796<br>▪ Urban: 138,918 |
| **2012** | Dedan Kimathi University of Technology | Nyeri | ▪ Rural: 679,083<br>▪ Urban: 80, 081 |
| **2013** | Jaramogi Oginga Odinga University of Science & Technology | Siaya | ▪ Rural: 907,766<br>▪ Urban: 85,417 |
| **2013** | Karatina University | Nyeri | ▪ Rural: 679,083<br>▪ Urban: 80, 081 |
| **2013** | Kisii University | Kisii | ▪ Rural: 1,115,450<br>▪ Urban: 151,410 |
| **2013** | Laikipia University | Laikipia | ▪ Rural: 391,200<br>▪ Urban: 127,360 |
| **2013** | Meru University of Science & Technology | Meru | ▪ Rural: 1,406,796<br>▪ Urban: 138,918 |
| **2013** | Multimedia University of Kenya | Nairobi | ▪ Urban: 4,397,073 |
| **2013** | Pwani University | Mombasa | ▪ Urban: 1,208,333 |
| **2013** | South Eastern Kenya University (SEKU) | Kitui | ▪ Rural: 1,082,168<br>▪ Urban: 54,019 |

| Year Chartered | University Name | County | Rural-Urban Population |
|---|---|---|---|
| **2013** | Technical University of Kenya | Nairobi | ▪ Urban: 4,397,073 |
| **2013** | University of Eldoret | Uasin Gishu | ▪ Rural: 652,981<br>▪ Urban: 510,205 |
| **2013** | University of Kabianga | Kericho | ▪ Rural: 808,239<br>▪ Urban: 93,538 |
| **2015** | Kaimosi Friends University College | Vihiga | ▪ Rural: 531,629<br>▪ Urban: 58,384 |
| **2015** | Kibabii University | Bungoma | ▪ Rural: 1,480,458<br>▪ Urban: 190,112 |
| **2016** | Co-operative University of Kenya | Nairobi | ▪ Urban: 4,397,073 |
| **2016** | Kirinyaga University | Kirinyaga | ▪ Rural: 474,187<br>▪ Urban: 136,224 |
| **2016** | Machakos University | Machakos | ▪ Rural: 1,007,854<br>▪ Urban: 414,078 |
| **2016** | Murang'a University of Technology | Murang'a | ▪ Rural: 938,213<br>▪ Urban: 118,427 |
| **2016** | Rongo University | Migori | ▪ Rural: 949,236<br>▪ Urban: 167,200 |
| **2016** | Taita Taveta University | Taita-Taveta | ▪ Rural: 246,897<br>▪ Urban: 93,774 |
| **2016** | Tom Mboya University College | Homa-Bay | ▪ Rural: 1,018,871<br>▪ Urban: 113,079 |
| **2016** | University of Embu | Embu | ▪ Rural: 532,675<br>▪ Urban: 75,924 |
| **2017** | Bomet University College | Bomet | ▪ Rural: 847,718<br>▪ Urban: 27,971 |
| **2017** | Garissa University | Garissa | ▪ Rural: 630,463<br>▪ Urban: 210,890 |
| **2017** | Tharaka University College | Tharaka-Nithi | ▪ Rural: 360,434<br>▪ Urban: 32,743 |
| **2017** | Turkana University College | Turkana | ▪ Rural: 786,185<br>▪ Urban: 140,791 |

The population distribution data is from the 2019 Census (City Population, 2020)

# Appendix D: Student Survey Questionnaire

## Information Sheet for Students

My name is Roxanne Hawi. I am a Ph.D. student at School of Fundamental Sciences, Massey University, New Zealand. My research explores **how a student who owns only a smartphone and does not have access to a laptop or desktop PC can still successfully participate in a university course.** I am doing my PhD research under Associate Professor Eva Heinrich and Dr. Sunil Lal.

### The Survey

In this survey, I seek to find out how you (the student) perceive the **Smartphone** in regard to its ease of use and effectiveness as a learning tool. Further, the survey asks for some background information about your experience in using **Smartphones**, as well as the advantages and/or disadvantages of using these devices for education. The survey will also collect the following data: age, gender, education program, year of study and type of mobile phone owned. Your personal information (e.g., name, student ID, etc.) will not be collected; **this survey is completely anonymous**. Your email address was strictly used to register you to this site so that you can access the survey. I assure you it will not be shared to any external parties. Upon survey completion, all your personal information in the site will be deleted. The results of the survey will be presented at conferences and in journals. You may receive a brief report on the findings of the study upon request.

I hereby invite you to participate in this study. **Participation is voluntary and you have a right to withdraw from the study at any time**. If you choose to withdraw, your personal information (email address and phone number) will be removed from the site. If you choose to continue, please note that you must answer all the questions for you to be able to submit the survey. Lastly, if you have any concerns about the conduct of this research, I am your first point of contact – email: R.hawi@massey.ac.nz. However, in case you want to raise your concerns with someone other than myself, you may contact my supervisors – email: e.heinrich@massey.ac.nz and s.lal@massey.ac.nz. Alternatively, you may contact the director of Massey Ethics committee, Professor Craig Johnson, email: humanethics@massey.ac.nz.

| A | DEMOGRAPHIC QUESTIONS | | | | | |
|---|---|---|---|---|---|---|
| A1 | Gender | ○ Male | ○ Female | | | |
| A2 | Age (years) | ○ 18-20 | ○ 21-25 | ○ 26-30 | ○ 31-40 | ○ 41+ |
| A3 | I am currently a student of | ○ School of Education<br>○ School of Business and Economics<br>○ School of Biological and Physical Sciences<br>○ School of Art and Social Sciences<br>○ School of Agriculture and Food Security<br>○ School of Mathematics and Statistics | | | | |
| A4 | Year of study | ○ First | ○ Second | ○ Third | ○ Fourth | |
| A5 | I own a mobile phone | ○ Smartphone | ○ Feature phone | ○ Basic phone | ○ None | |
| A6 | My Smartphone Operating System is ( | ○ Android | ○ Apple iOS | ○ WinOS | ○ Other | |
| A7 | My skill in using Smartphone is | ○ Expert User | ○ Good User | ○ Limited User | | |
| A8 | My choice device for education | ○ Smartphone | ○ Laptop | ○ Desktop PC | ○ Tablet | |
| A9 | I am aware of the following FREE online learning resources | ○ Open Educational Resources<br>○ MIT Open Educational Resources<br>○ Massive Open Online Courses (MOOCS) | ○ Coursera<br>○ edX<br>○ None | | | |

| B | Do you like the idea of using your **Smartphone in University Education** for the following **Activities?** | | | | | |
|---|---|---|---|---|---|---|
| B1 | Using mobile apps (applications) for learning | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B2 | Taking notes during lectures | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B3 | Reading e-books | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B4 | Using online resources | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B5 | Searching for educational resources | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B6 | Viewing Video or Audio recorded lectures | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |

| | | | | | | |
|---|---|---|---|---|---|---|
| B7 | Taking assessments, quiz, surveys, and polling | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B8 | Submitting assignments | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B9 | Asking the lecturer questions | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B10 | Communicating with friends for educational help | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B11 | Using Social Networking for learning (Facebook, Twitter, WhatsApp etc.) | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B12 | Collaborating online for learning | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| B13 | Collaborating with faculty for educational help. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |

| **C** | Do you like the idea of using your **Smartphone in University Education** for the following **Activities?** | | | | | |
|---|---|---|---|---|---|---|
| C1 | Learning how to use my Smartphone for my education is easy for me. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C2 | I have the knowledge necessary to use my Smartphone for my education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C3 | Using my Smartphone for my education is effortless. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C4 | I have the resources necessary to use my Smartphone for my education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C5 | Considering its benefits, my Smartphone cost is acceptable for my university education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C6 | Using my Smartphone for my university education increases my productivity. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C7 | My Smartphone assists me in my university assignments. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C8 | I regularly use my Smartphone to access helpful learning content from the Internet to aid my university education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C9 | I get pleasure using my Smartphone for my education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |

| | | | | | | |
|---|---|---|---|---|---|---|
| C10 | My Smartphone lets me learn anywhere and anytime. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C11 | I use my Smartphone to communicate with my university classmates for educational help. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C12 | I collaborate with my university classmates using my Smartphone for my education needs. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C13 | My Smartphone is the first device I use to contact my classmates for educational help. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C14 | My family is supportive of the use of my Smartphone for my education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C15 | My university lecturers and supervisors encourage me to use my Smartphone for my education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C16 | My Smartphone gives me flexibility in learning when I access online content for my university education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C17 | My Smartphone is central to my daily life. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C18 | As a student, leaving my Smartphone at home would force me to go back home and pick it up. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C19 | The use of my Smartphone has become a habit in my education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |
| C20 | I plan to continue using my Smartphone for my education. | ○ Strongly Agree | ○ Agree | ○ Neutral | ○ Disagree | ○ Strongly Disagree |

# Appendix E: Timed In-Classroom Quiz for Lesson 1 (20 minutes/20 Questions)

**1. What is the Internet?**

Select one:

- ○ The same as the world wide web
- ○ A network of independent but connected devices all over the world
- ○ Google

**2. What is the world wide web?**

Select one:

- ○ A network of independent but connected devices all over the world
- ○ An undercover agency of spies
- ○ The collection of interlinked website documents
- ○ The same as the Internet

**3. What is a URL or Uniform Resource Locator?**

Select one:

- ○ The international system for data recovery
- ○ A system for recovery for windows documents
- ○ An address for accessing specific web data located on a server

**4. What are the three parts of a URL?**

Select one:

- ○ File, computer, app
- ○ Protocol, domain, path
- ○ Path, app, file
- ○ Domain, function, app

**5. What is meant by IP or Internet Protocol?**

Select one:

- ○ An addressing system for the postal service
- ○ An addressing system that finds paths to distant computers
- ○ An addressing system only for google

**6. What is the domain?**

Select one:

- ○ The location of the data in hierarchy of folders on the server
- ○ Collection of interlinked website documents
- ○ The name of the server that hosts the data
- ○ The standard for communication between browsers and servers

**7. What is a protocol (as far as the Internet is concerned)?**

Select one:

- ○ The standard for communication only via email
- ○ The standard for communication between computers
- ○ The standard for communication between browsers and servers
- ○ The standard for communication on a phone line

**8. What is the domain for this url http://snap.massey.edu/Logo7.png?**

Select one:

- ○ http:
- ○ snap
- ○ snap.massey.edu
- ○ Logo7.png

**9. What are the two main types of networks?**

Select one:

- ○ LAN & WAN
- ○ INTERNET & LAN
- ○ PAN & LAN
- ○ WWW & WAN

**10. WorkSource computers are connected via a certain type of computer network. Which one?**

Select one:

- ○ WAN
- ○ LAN
- ○ Dial-up
- ○ INTERNET

**11. Check off 3 Internet Browsers**

Select one or more:

- ○ Google Chrome
- ○ Internet Navigator
- ○ Google Dome
- ○ FireWolf
- ○ Internet Explorer
- ○ FireFox

**12. What is the name of this area of an Internet Browser?**


Select one:

- ○ WWW zone
- ○ Website area
- ○ Status bar
- ○ Address bar

**13. Check off 3 search engines**

Select one or more:

- ○ Apple
- ○ Gmail
- ○ Yahoo
- ○ YouTube
- ○ Google
- ○ Bing

**14. The Internet was originally developed by whom?**

Select one:

- ○ A Corporation
- ○ The U.S Department of Defense
- ○ Computer Hackers
- ○ University of Michigan

**15. Clicking on a hyperlink can take you to which of the following locations?**

Select one:

- ○ Another place in the document you have open
- ○ Another website
- ○ To another document other than the one you have open
- ○ All choices are correct

**16. When was the first Internet started?**

Select one:

- ○ 1987
- ○ 1983
- ○ 1969
- ○ 1991

**17. Which of the following is the most appropriate analogy to a Firewall?**

Select one:

- A security guard controlling who can enter a house.
- An attendant sitting at an information desk
- An employee monitoring inventory
- A consumer keeping a watchful eye on a product's price

**18. XYZ marketing has been hired to provide branding services for ABC Corporation. ABC allows XYZ to use their ______ to access important information about their company.**

Select one:

- Virtual Private Network
- Intranet
- Wide Area Network
- Extranet

**19. Which of the following statements best describes an organisation's intranet?**

Select one:

- A public, internal, local area network to access information across some parts of the organisation
- A public, external corporate network to access information across the entire organisation.
- A private, internal, wide area network to access information across the entire organisation
- A private, internal, corporate network to access information across the entire organisation

**20. Select the advantages of a LAN**

Select one or more:

- Software & files can be shared
- Peripherals can be shared
- Initial setup is expensive
- It is easily expandable
- The smaller the network the more expensive it becomes

## Appendix F: Additional Results for the Feedback Survey in Lesson One and Lesson Two

| **Key:** SA – Strongly Agree; A – Agree; N – Neutral; D – Disagree; SD – Strongly Disagree; E – Excellent; VG – Very Good; G – Good; F- Fair; P – Poor | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Survey Items** | **Lesson One Responses n = 25 (%)** | | | | | **Lesson two Responses n = 23 (%)** | | | | |
| | **SA** | **A** | **N** | **D** | **SD** | **SA** | **A** | **N** | **D** | **SD** |
| 1 I think the lesson objectives were clear. | 80 | 16 | 0 | 4 | 0 | 78 | 22 | 0 | 0 | 0 |
| 2 The lesson lectures (and notes) were clear and well presented. | 88 | 8 | 4 | 0 | 0 | 83 | 17 | 0 | 0 | 0 |
| 3 The assignments were appropriate for the level of this lesson. | 76 | 20 | 4 | 0 | 0 | 65 | 35 | 0 | 0 | 0 |
| 4 The lesson increased my interest in the subject. | 68 | 28 | 0 | 4 | 0 | 83 | 17 | 0 | 0 | 0 |
| 5 The lesson corresponded to my expectations. | 68 | 24 | 0 | 4 | 4 | 61 | 39 | 0 | 0 | 0 |
| 6 The lesson provided an appropriate balance between instruction and practice. | 76 | 24 | 0 | 0 | 0 | 74 | 26 | 0 | 0 | 0 |
| 7 The lesson was organised in a way that helped me learn. | 72 | 24 | 0 | 4 | 0 | 74 | 26 | 0 | 0 | 0 |
| 8 I would recommend this lesson to other students. | 84 | 12 | 0 | 4 | 0 | 91 | 9 | 0 | 0 | 0 |
| 9 What overall rating would you give lesson 1? | **E** 76 | **VG** 16 | **G** 4 | **F** 0 | **P** 4 | **E** 96 | **VG** 0 | **G** 4 | **F** 0 | **P** 0 |