EFFECTS OF CONNECTIVISM PRACTICES IN MOBILE LEARNING ENVIRONMENT ON YEMENI HIGHER EDUCATION STUDENTS' COGNITIVE ENGAGEMENT, SELF-REGULATED LEARNING, AND PERFORMANCE

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by

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LIST OF ABBREVIATIONS

AUT	Autonomy
OPN	Openness
DIV	Diversity
INT	Interactivity
SRL	Self-Regulated Learning
CE	Cognitive Engagement
MLE	Mobile Learning Environment
M-Learning	Mobile Learning
CMLE	Connectivist Mobile Leaning Environment
ICT	Information Communication Technology
OER	Open Educational Resources
AI	Artificial Intelligence
ML	Machine Learning
IMD	Intelligent Mobile Devices
MLMS	Mobile Learning Management System
SCT	Social Cognitive Theory
PBL	Problem-Based Learning
IT	Information Technology
ITeS	Information Technology enabled Services
SESRL	Self-Efficacy for Self-Regulated Learning
SEM	Structural Equation Modeling
PLS	Partial Least Square
GC	Google Classroom
OS	Operating System
SD	Standard Deviation
AVE	Average Variance Extracted
CR	Composite Reliability
VIF	Variance Inflation Factor
PC	Path Coefficient
VAF	Variance Accounted Formula
LDC	Least Developed Countries

KESAN AMALAN CONNECTIVISM DALAM PERSEKITARAN PEMBELAJARAN MOBIL TERHADAP PENGLIBATAN KOGNITIF, PEMBELAJARAN REGULASI KENDIRI, DAN PRESTASI PELAJAR PENGAJIAN TINGGI DI YAMAN

ABSTRAK

Kajian ini berhasrat untuk menguji satu model penyelidikan yang dibangunkan berdasarkan sorotan literatur berkenaan prinsip-prinsip *connectivism* bagi memahami perkaitan antara amalan-amalan *connectivism* (autonomi, kepelbagaian, keterbukaan dan interaktiviti) dengan prestasi pelajar melalui pemboleh ubah mediator strategi pembelajaran sosial yang diwakilkan oleh pembelajaran regulasi kendiri dan penglibatan kognitif dalam persekitaran pembelajaran mobil. Kajian ini melibatkan seramai 218 pelajar sarjana muda yang mengikuti pengajian sepenuh masa di sebuah universiti awam di Yaman. Dapatan kajian menunjukkan perhubungan positif antara ke empat-empat amalan *connectivism* iaitu autonomi, kepelbagaian, keterbukaan dan interaktiviti dengan prestasi pelajar dalam persekitaran pembelajaran mobil. Juga, perhubungan yang signifikan telah diperolehi antara tiga amalan *connectivism* iaitu autonomi, keterbukaan dan interaktiviti dengan kedua-dua konstruk mediator iaitu penglibatan kognitif dan pembelajaran regulasi kendiri. Walaubagaimana pun, tiada perhubungan signifikan yang ditemui antara amalan kepelbagaian dengan dua konstruk mediator tersebut. Seterusnya, penglibatan kognitif dan pembelajaran regulasi kendiri didapati mempengaruhi prestasi pelajar dalam persekitaran *connectivism* pembelajaran mobil. Sementara itu, dapatan mengesahkan bahawa model yang dicadangkan dalam kajian ini mempunyai keupayaan prediktif yang tinggi untuk mengukur hasil persekitaran pembelajaran mobil. Dapatan kajian ini

menyumbang kepada asas teoretikal *connectivism* dengan memperkenalkan satu model penilaian yang baru berdasarkan perspektif teori era digital, khususnya semenjak pandemik Covid-19 yang memberikan satu cabaran baru kepada dunia pendidikan, di mana institusi-institusi pendidikan dan para pendidik seluruh dunia perlu menggunakan teknologi maklumat dan komunikasi secara optimum dalam melaksanakan proses pengajaran dan pembelajaran mereka.

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ABSTRACT

This study tested a research model developed based on a literature review of connectivism principles for understanding the relationship between the connectivism practices (autonomy, diversity, openness, and interactivity) and the students' performance through the mediation of social learning strategies represented by self-regulated learning, and cognitive engagement in the mobile learning environment. The sample involved 218 participants, full-time undergraduate students from a public university in Yemen. The finding revealed a positive relationship between the four connectivism practices, namely, autonomy, diversity, openness, and interactivity with the participants' performance in a mobile learning environment. Similarly, significant relationships were found between three connectivism practices, i.e., autonomy, openness, and interactivity with the mediator's constructs of cognitive engagement and self-regulated learning. However, no significant relationship was found between diversity and the two mediating constructs. Furthermore, cognitive engagement, and self-regulated learning were found to influence higher education students' performance in a connectivist mobile learning environment. Meanwhile, the result confirmed that the proposed model had a high predictive ability to measure the outputs of the connectivist mobile learning environment. The finding from this study contributed to the theoretical foundations of connectivity by introducing a new evaluation model from the perspective of digital age theory, especially since the pandemic of Covid-19

that placed the global order for education under a completely new challenge, where both educational institutions and educators around the world had to use optimum information and communication technology in their teaching and learning process.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Online learning is an effective environment where learner-centered educational techniques provide opportunities for significant developments using technology (Mayer, 2019; Moore, Dickson-Deane, & Galyen, 2011). These opportunities support students in changing their way of thinking and learning with advanced technology (Greenhow, Graham, & Koehler, 2022; Siemens, 2005). Online learning includes all learning associated with the internet (such as mobile learning (m-learning), online communities, e-gaming, and learning management systems) for learning engagement (Anderson, 2008; Mayer, 2019).

Previous studies such as Elazony, Khalifa, Nouh, and Hussein (2018) and Note-Gressard and Menchaca (2011) indicated that online learning provides a learning experience and a rich environment to construct knowledge within a social learning community, as well as increases access to technology. Furthermore, it offers unique opportunities for fostering the quality of education in least-developed countries (LDCs) (Aldholay, Isaac, Abdullah, Alrajawy, & Nusari, 2018). This learning environment has led to a necessity for finding new online learning and teaching theory (Siemens, 2005). Such learning theory must recognize the change in communication from an era of limited content and resources to a period of open and rich content in which learning resources are diverse and extensive (Anderson, 2008).

Connectivism is the modern proposed learning theory in the digital age that needs to be studied to determine if it can be used in teaching and learning. This

learning theory deals with learning tendencies, technology and networks, and the diminishing lifespan of knowledge (Downes, 2019; Hendricks, 2019). Therefore, connectivism is one of the essential focus areas of research in e-learning and m-learning in the educational domain (Boyraz & Ocak, 2021). Meanwhile, mobile technology continues to develop and spread as media, tools, and services converge (Kwon & Kim, 2021). Mobile devices such as tablets and personal smartphones are becoming increasingly popular in mobile technology and are known as "the largest information platform in the history of humankind"(Rosenberg, 2011, p. 12).

Today's mobile market has nearly four billion subscribers, with 351 million mobile broadband subscriptions living in LDCs, furthermore, mobiles are increasingly the access point for learning and communications tools, information, and instructional materials, especially for higher education students (Courtenay & Doreen, 2021). According to Becker et al. (2017), mobile devices' pervasiveness is changing how learners interact with content and their environment. Also, mobile learning enables learners to access instructional materials, often across multiple devices they use to practice communication, collaboration, and creating content. This convenience in handling is driving demand for this strategy, with the potential for new mobile devices and enhanced delivery models that can increase access to education resources. Khasyyatillah and Osman (2022) and Parsons and MacCallum (2017a) argued that mobile learning has no specific learning theory. Furthermore, theories for mobile learning are still developing and seem to focus on investigating the practical uses of mobile technology in various contexts. Meanwhile, the novelty of implementing mobile technology into education has forced mobile learning researchers to utilize and analyze different learning approaches in different mobile learning environments (Bernacki, Greene, & Crompton, 2020a). The proliferation of

the internet and mobile devices makes the current learning systems a set of interconnected practices and activities that provide learning opportunities for everyone. Accordingly, there is a need for an effective learning model that can conceptualize this technology's potential methodically (Al-Shehri, 2011; Boyraz & Ocak, 2021; Shaw, 2014). Connectivism is one step in this direction, notably through exploring its characteristics outlined by Downes (2007,2012), such as autonomy, openness, diversity, and interactivity (Mackness, Mak, & Williams, 2010). Moreover, the increase in communication, engagement, flexibility, convenience, and interactivity are all factors that make mobile learning more attractive to higher education students (Al-Emran, Mezhuyev, & Kamaludin, 2020) Also, "handheld mobile and integrated devices continue to develop and become the effective tools for communication, learning, and peer networking" (Downes, 2017, p. 607). In addition, new educational research is needed for analytics theory and methodology to enhance traditional teaching methods and fill the "theory-practice gap" (Brown et al., 2020). Thus, researchers need to understand the influence of connectivism by leveraging the characteristics of connectivism theory via networking technologies to demonstrate evidence of how technology in a connectivist framework impacts our learning performance. Moreover, it is urgent to obtain demonstrable proof of the theory's underlying phenomenon, its hypothesis and beliefs, and its observable effect on learners (Corbett & Spinello, 2020). As well as how it can be applied in the mobile learning environment, particularly after the confusion caused by the unexpected and quick transformation in the world education system during the Covid-19 pandemic (Boyraz & Ocak, 2021).

1.2 Background of Study

In LDCs, the limited use of ICT in education influences higher education students' performance negatively. These limitations in their access to information and learning resources impede the adoption of modern teaching methods, reduce opportunities for skill development, and increase educational inequality. However, addressing this digital divide and integrating ICT effectively in education can help improve students' performance and prepare them for the digital age (Al-Mamary, 2022; Alghushami, Zakaria, & Mat Aji, 2020)**.**

Mobile technology can improve education in LDCs by providing access to educational resources, offering flexible learning opportunities, supporting teacher professional development, bridging language barriers, fostering digital skills development, and providing affordable and scalable solutions. Mobile technology bridges the educational gap between LDCs and the more developed regions, empowering students with knowledge and skills for a better future (Kim, 2020; Rashid, 2019). In addition, mobile technology allows features such as collaboration, personalization, and interactivity, because of its size, weight, and portability (Ghallab, 2020), by providing a wide range of apps and resources for sharing information that students can use to network and acquire new knowledge (Chukwuere & John, 2021). While the use of mobile device tools and technologies in higher education is becoming critical as part of the daily routines of students and teachers (Alexander et al., 2019). On the other hand, mobile learning supports a flexible learning process, where learners can choose the time, place, and pace when they learn. Consequently, they enjoy autonomy over the learning content and diversity in their learning activities (Criollo-C, Guerrero-Arias, Jaramillo-Alcázar, & Luján-Mora, 2021).

According to Khan, Abdou, Kettunen, and Gregory (2019) and Kim (2020), higher educational institutions (HEIs) in LDCs need to take this flexible learning process opportunity of mobile technology that is already an integral part of the student's daily life. Where this technology can be harnessed to design innovative, creative educational environments to enhance and improve their learning experiences and academic performance. However, researchers and educators face a challenge in defining how these new roles of mobile technology will influence the existing education system in teaching and learning and evaluate its outcomes through a particular theoretical framework (Cakmak, 2019). At the same time, Downes (2019) indicated that learning technology that emphasizes autonomy, diversity, interactivity, and openness will be more effective in being represented as practices for the connectivism theory.

Although there have been much of similarities between connectivism practice and mobile learning as emerging phenomena, mobile learning concerning connectivism practice and the effects of the interaction of learners with smart mobile devices on their academic performance is yet to be tested (Boyraz & Ocak, 2021; Hung, 2014; Kloos et al., 2010; Waard et al., 2011). Where connectivism offers a theoretical framework to understand how students learn within learning networks. As well as, the connectivist perspective can inform teaching practices that support learning via connections (Dunaway, 2011; Hazeldine, 2020). Downes (2012) identified four elements (autonomy, openness, diversity, and interaction) that affect online learning. These four principles may have theoretical origins that can be used as criteria for selecting and designing instructional technology in practice (Downes, 2019). Connectivism also provides an ideological framework that can impact how professionals in the field of higher education design and develop instructional

materials and technology. Thus, successful learning materials should be designed and developed using connectivism's principles for usage in mobile learning systems (Alshalabi, Hamada, & Elleithy, 2013; Boyraz & Ocak, 2021; Utecht & Keller, 2019). In addition, leveraging to understand the principles of connectivism, its impact, and how the technology in a connectivist framework is rewiring our brains need more academic research to establish it as a digital age learning theory (Corbett & Spinello, 2020). Therefore, the researcher in this study attempts to link mobile learning and the practice of connectivism to measure the effect of connectivism practice-based mobile learning environment on academic performance among higher education students.

1.3 Problem statement

Higher education institutions in LDCs face challenges in meeting learners' needs. Some of these challenges are related to pedagogical, technical, and environment in implementing e-learning. Infrastructure represents part of these technical challenges, including the high cost of Internet and power disruptions (Adnan & Anwar, 2020; Oyerinde, 2014). Furthermore, Information Communication Technology (ICT) in the educational system has not been included or used in many developing and LDCs (Akarowhe, 2017). This technology deficiency in education caused problems for students and teachers, particularly during the COVID-19 pandemic (Adedoyin & Soykan, 2020). Developed countries, during the pandemic, have adjusted their technological infrastructures to transition from face-to-face education to e-learning mode. In contrast, LDCs were not ready for this transition (Zarei & Mohammadi, 2021), which led to the poor academic performance of students (Adedoyin & Soykan, 2020; Akarowhe, 2017).

According to Becker et al. (2017), socioeconomic, gender, ethnicity, or resource differences might also affect students' academic performance. Moreover, the

cost of college and course materials also contributes to the performance gap (Alexander et al., 2019). Therefore, some researchers believe that the performance gap might be addressed through efforts that include open educational resources, digital courseware platforms, and emerging learning pathways using mobile devices. Accordingly, Santos and Celis (2020) stated that the lecture delivery method is one of the most influential factors affecting the student's academic performance. Furthermore, digital technology, such as online courseware and open educational resources (OER), has made it easier to engage students in learning and helped to close the gap in academic performance between groups of higher education students (Alexander et al., 2019; Becker et al., 2018). In addition, Talan (2020) stated that mobile learning positively and broadly affects learning performance among higher education students.

Mobile devices (i.e., smartphones, tablets, laptop computers, electronic readers, and media players) have become increasingly popular and integral to people's everyday lives (Rikala, 2015). Particularly on college campuses as an educational tool (Brooks, 2015), as mobile learning is perceived as an extension of distance learning and e-learning (Aldholay, Isaac, Abdullah, & Ramayah, 2018; Ribeiro, 2019). However, although the mobile device is one significant feature of mobile learning, many studies emphasize that mobile learning is not merely learning through using mobile devices only. It is also across different contexts (i.e., social and content interactions) (Pillai & Sivathanu, 2018; Rikala, 2015; Wu & Cui, 2022).

In this aspect, the higher education system in Yemen, as one of the LDCs, faces many challenges, such as limited resources, weak infrastructure, and an increased student population (Aldholay et al., 2018). Furthermore, the quality of education needs to be concerned and improved at all levels and make it similar to the

best in the world. However, despite attempts to integrate ICT into the education system, formal and private higher education systems remain based mainly on traditional teaching practices that do not allow students to interact with the material (Alkamel & Chouthaiwale, 2020). Therefore, this is reflected in a lack of connectivity skills and student performance (Asaad, 2019; Isaac, Aldholay, Abdullah, & Ramayah, 2019; Muthanna, Alduais, & Ghundol, 2022).

Moreover, Intelligent Mobile Devices (IMD) are becoming increasingly ubiquitous among educators and students in Yemen's higher education institutions. Also, they are familiar with these mobile gadgets and their importance in online learning (Tuparov, Alsabri, & Tuparova, 2015). However, despite students' positive attitudes toward mobile learning, academics and universities do not effectively incorporate this technology into their teaching resources (Alrajawy, Isaac, Ghosh, & Al-Shibami, 2018; Ragawi & Zahary, 2017). On the other hand, researchers have emphasized the need for developing or adapting a learning theory for mobile learning to evaluate the use of mobile technologies since there is no particular theory for this type of learning (Alamri & Bano, 2021). Such technologies are essential to help learners better access quality education (Mayer, 2020; Rajasingham, 2011). Therefore, this study aimed to design and develop a research framework model from the perspective of theory incorporating a mobile learning environment and measure its influence on higher education students' performance. Connectivism provides a valuable framework through teaching and learning using network technologies that can be better comprehended and managed (Corbett & Spinello, 2020; Goldie, 2016) in online courses to increase motivation and student performance (Rice, 2018a). However, connectivism is still a relatively modern theory of learning. Therefore, scholars must conduct additional researches to realize its implications in the field of

education (Mohamed, Ubaidullah, & Yusof, 2018), particularly in a mobile learning environment or investigating its effects based on Downes's four principles (autonomy, diversity, openness, and interactivity) among higher education students (AlDahdouh, 2019). Furthermore, adopting the connectivism theory to guide mobile learning practices in formal education will enable teachers in curriculum development and its implementation and evaluation of performance (Mittal, Chaudhary, & Alavi, 2020). Such knowledge reflects a community response to complex phenomena and knowledge in the network derived through a process of interaction (Downes, 2019; Siemens, 2018; Tschofen & Mackness, 2012). Connectivism constitutes a point of view that encourages the development of self-regulated learning (Bartolomé & Steffens, 2011). However, adopting the connectivism pedagogical approach using a mobile learning environment as a modern personal learning environment is challenging and needs more research in the foreseeable future (Conradie, 2014; Santoianni, 2021). According to Stroud (2019), there is a significant positive relationship between learner performance and cognitive engagement using self-regulation strategies in the network learning environment. According to Wang, Chen, and Anderson (2014), Connectivist Interaction and Engagement (CIE) framework expounds on the interactions and cognitive engagement in connectivist learning contexts. However, more empirical studies are needed in diverse networked learning contexts to further refine and validate such critical concepts of connectivism as autonomy, diversity, openness, and interactivity (Goldie, 2016; Jung, 2019). Therefore, this study investigates the effect of the four principles of connectivism practices (autonomy, diversity, openness, and interactivity) on students' performance through cognitive engagements and self-regulated by using a mobile learning environment among higher education students.

1.4 Research objectives

1. To investigate the significant effects of connectivism practices (autonomy, openness, interactivity, and diversity) on students' cognitive engagement in a mobile learning environment.

2. To investigate the significant effects of connectivism practices (autonomy, openness, interactivity, and diversity) on students' self-regulated learning in a mobile learning environment.

3. To investigate the significant effects of connectivism practices (autonomy, openness, interactivity, and diversity) on students' performance in a mobile learning environment.

4. To investigate the significant effects of connectivism practices (autonomy, openness, interactivity, and diversity) on students' performance in a mobile learning environment through cognitive engagement and self-regulated learning factors.

5. To investigate the significant effects of cognitive engagement and self-regulated learning on students' performance in a mobile learning environment.

1.5 Research questions

1. What are the significant effects of connectivism practices (autonomy, openness, interactivity, and diversity) on students' cognitive engagement in a mobile learning environment?

2. What are the significant effects of connectivism practices (autonomy, openness, interactivity, and diversity) on students' self-regulated learning in a mobile learning environment?

3. What are the significant effects of connectivism practices (autonomy, openness, interactivity, and diversity) on students' performance in a mobile learning environment?

4. What are the significant effects of connectivism practices (autonomy, openness, interactivity, and diversity) on students' performance in a mobile learning environment through cognitive engagement and self-regulated learning factors?

5. What are the significant of cognitive engagement and self-regulated learning on students' performance in a mobile learning environment?

1.6 Research hypotheses

H1. There is a significant effect between students' autonomy and cognitive engagement in a mobile learning environment.

H2. There is a significant effect between students' autonomy and their performance in a mobile learning environment.

H3. There is a significant effect between students' autonomy and their performance through cognitive engagement in a mobile learning environment.

H4. There is a significant effect between students' autonomy and self-regulated learning in a mobile learning environment.

H5. There is a significant effect between students' autonomy and their performance through self-regulated learning in a mobile learning environment.

H₆. There is a significant effect between students' openness and cognitive engagement in a mobile learning environment.

H₇. There is a significant effect between students' openness and their performance in a mobile learning environment.

H₈. There is a significant effect between students' openness and their performance through cognitive engagement in a mobile learning environment.

H₉. There is a significant effect between students' openness and self-regulated learning in a mobile learning environment.

H₁₀. There is a significant effect between students' openness and their performance through self-regulated learning in a mobile learning environment.

H₁₁. There is a significant effect between students' diversity and cognitive engagement in a mobile learning environment.

H₁₂. There is a significant effect between students' diversity and their performance in a mobile learning environment.

H₁₃. There is a significant effect between students' diversity and their performance through cognitive engagement in a mobile learning environment.

H₁₄. There is a significant effect between students' diversity and self-regulated learning in a mobile learning environment.

H15. There is a significant effect between students' diversity and their performance through self-regulated learning in a mobile learning environment.

H16. There is a significant effect between students' interactivity and cognitive engagement in a mobile learning environment.

H17. There is a significant effect between students' interactivity and their performance in a mobile learning environment.

H18. There is a significant effect between students' interactivity and their performance through the cognitive engagement in a mobile learning environment.

H19. There is a significant effect between students' interactivity and self-regulated learning in a mobile learning environment.

H20. There is a significant effect between students' interactivity and their performance through self-regulated learning in a mobile learning environment.

H21. There is a significant effect between cognitive engagement and students' performance in a mobile learning environment.

H22. There is a significant effect between self-regulated learning and students' performance in a mobile learning environment.

Figure 1.1 depicts the hypothesized model of this study.
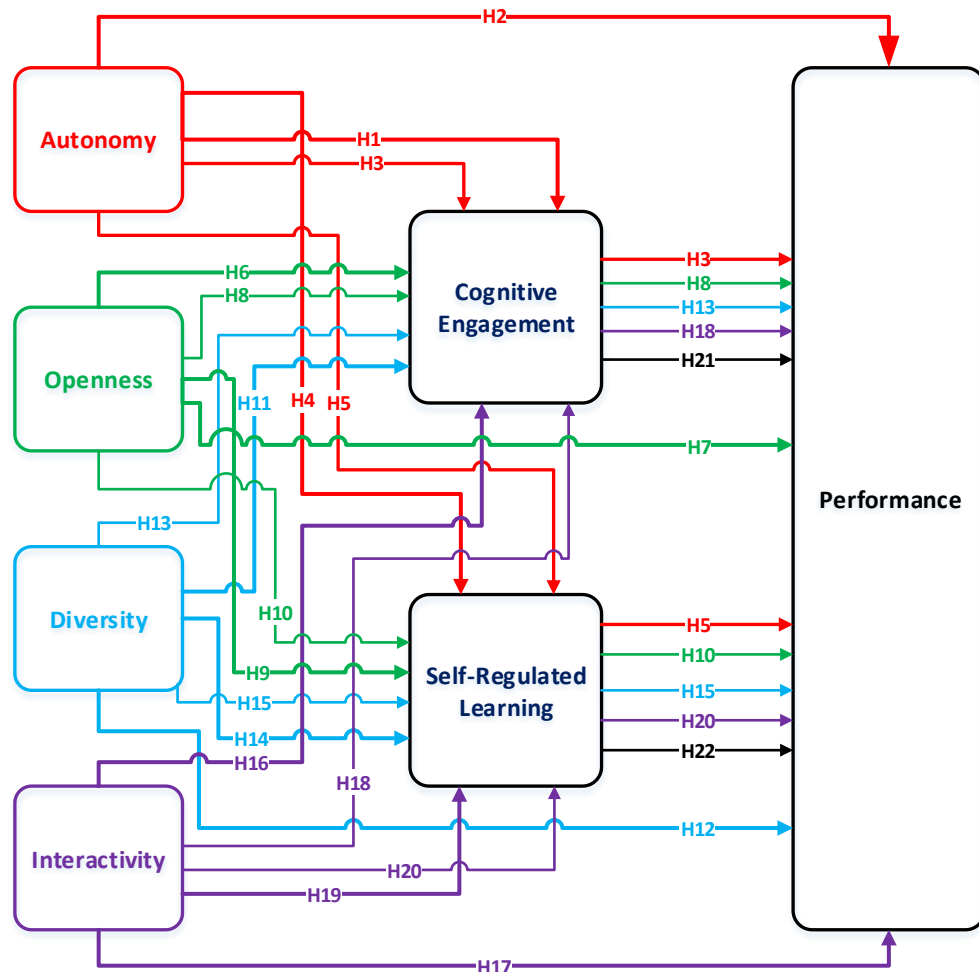
Figure 1.1 Hypothesized model

1.7 Theoretical framework

Connectivity is building communities of practice for learning and interaction through multiple forms of media (Wenger, 2000). Mobile devices provide a digital learning medium and communities of practice that make learning together possible through technology (Wenger, White, & Smith, 2009). Although mobile learning does not rely on any particular learning theory, there is a pressing need for a theory-based paradigm that may be employed for mobile learning (Al-Shehri, 2011; Alamri & Bano, 2021; Mahande & Surjono, 2016).

Park (2011) stated that "the most serious issue faced by mobile learning is the lack of a solid theoretical framework which can guide effective instructional design

and evaluate the quality of programs that rely significantly on mobile technologies"
(p. 83). According to Chen and Bryer (2012), mobile technology as a digital
environment, professional learning networks, and communities of practice are all
rooted and supported by social learning theories and lead to the theory of
connectivism. Meanwhile, connectivism theory is the modern learning theory that
guides mobile learning and applies design for mobile learning, too, expanding the use
of social media and connectedness through the use of a mediating technology such as
mobile devices as a medium in acquiring knowledge and learning (Shaw, 2014).
Mosawy's (2018) observation confirmed that connectivism as an educational theory
promotes the inclusion of technology to improve cognition and the process of
knowledge acquisition.

Connectivism is a digital-age learning theory based on online learning through
a network. It focuses on the technological effort that enabled knowledge acquisition
and is a successor to constructivism and behaviorism theories (Siemens, 2005). As
knowledge is embedded in the mesh of network learning, the learner can acquire
knowledge formed through interaction and communications between the network
entities through this interaction (Downes, 2007).

Downes (2012) has identified interactivity, autonomy, openness, and diversity
as the main components of connectivism conducive to students learning in connective
knowledge networks, based on the connectivism principles concept identified by
Siemens (2006). Several studies support the principles of connectivism in practice
(interactivity, autonomy, openness, and diversity) as critical elements of learning to
support existing learning practices, especially for mobile learning (MacCallum, Day,
Skelton, & Verhaart, 2017; Mackness et al., 2010; Masethe, Masethe, & Odunaike,
2017). For example, Tschofen and Mackness (2012) discussed interactivity,

autonomy, openness, and diversity as the four fundamental learning principles in connectivism. In this context, autonomy is seen as the ability of learners to direct themselves according to their values, purposes, or goals. Meanwhile, diversity is the degree of differences and interactivity offered by various digital communication modes among learners as a point relevant to mobile learning. Openness is an essential principle of connective learning, notably mobile learning, which is formed mainly by sharing resources, ideas, expertise, communication and the creation of new information and insights among learners through networks. Likewise, interactivity is a form of practical learning that prioritizes nodes formed by actions, observation, and experiences rather than theory or pure logic.

Yeh and Singhateh (2013) studied connectivism practices incorporating social software technologies and knowledge management practices. The practices of connectivism, therefore, are defined as "those practices that use technology both as enabler or enhancer for informal and social learning in the workplace, through the use of social software technologies and knowledge management practices, to foster collaboration, sharing, and exchange of information and knowledge"(p. 222). These social-constructivist educational theories fit particularly well with the possibilities of mobile technology (Bray & Tangney, 2016). Moreover, social learning theory guides mobile learning environments where learners engage with each other in social interaction, develop their social identity within the group, and learn through those interactions (Cain & Fanshawe, 2020; Lohr & Chang, 2005; Wenger, 2000).

Bandura developed the Social Learning Theory (1977) through experiencing success as a foundation of social cognitive theory. This theory emphasizes learning in a social setting that posits mutual interactions between personal, behavioral, and social-environmental factors. Bandura extended his theory to include how people try

to control important events in their lives by self-regulating their thoughts and actions. As Bandura (1986) explained, "another distinctive feature of the social cognitive theory is the central role it assigns to self-regulatory functions. People do not behave according to the preferences of others. Instead, their behavior is motivated and regulated by internal standards and self- assessment reactions to their actions"(p. 20).

Self-regulation comprises interrelated interaction processes and is described as regulation that is shared socially (Hadwin & Oshige, 2011). Järvelä, Näykki, Laru, and Luokkanen (2007) used Self-Regulated Learning Theory "as a theoretical framework to develop those learning activities that give potential to individual and collaborative learning so that it stimulates active minds and interactions on individual and social levels" (p. 72). Mobile learning promotes self-regulated learning processes (Jinot, 2019), offers a flexible way of learning with a large degree of freedom, and is considered an idealistic interactive, and supportive tool (Ally, 2005; Järvelä et al., 2007). Learning control is based on student self-regulation or autonomy (Liaw, Hatala, & Huang, 2010). Consequently, mobile and self-regulated learning have an openness rooted in technology (Deed & Lesko, 2015).

Earlier, the social-cognitive theory of self-regulation comprised three sub-processes: self-observation, self-reaction, and self-judgment (Zimmerman, 1989). Broadening this classical view emphasizes the cyclical nature of self-regulation to include pre-and post-task activities (Schunk, 2012). Likewise, connectivism also involves sub-stages: awareness and receptivity, pattern recognition, connection formation, meaning-making, contribution and engagement, and praxis (Siemens, 2006). These stages can dramatically enhance students' engagement in learning activities and their interaction in a mobile learning environment (Chinomona, 2019).

Many studies argue that learning is an authentic environment that provides a cognitive tool, and mobile learning provides learners greater access to relevant information. Meanwhile, cognitive engagement is learners' focused effort to effectively understand what is being taught, including self-regulation and metacognitive behaviors (Fredricks, Blumenfeld, & Paris, 2004; Koole, 2009). However, cognitive engagement is aligned with the guidelines of the social cognitive theory (Burney, 2008; Ouyang & Dai, 2022), indicating how well students achieve desirable academic and social outcomes. This provides valuable evidence for the quality of a course, learning activity, or instructional-based technology-mediated (Henrie, Halverson, & Graham, 2015). In this context, the critical analytics perspective on integrating learning theories and mobile learning, as well as the tools they provide, will be indispensable to bring to full fructification the many favorable directions for future research and education (Bernacki, Crompton, & Greene, 2020b).

Consequently, the connectivism learning theory can be paired with the social cognitive theory to create socially networked environments emphasizing collaboration and community-oriented activities to achieve students' learning goals (Hosen et al., 2021; Tu, Sujo-Montes, Yen, Chan, & Blocher, 2012). Therefore, this study adopted the theoretical framework guided by connectivism and social cognitive learning as relevant theories regarding the mobile learning environment.

1.8 Conceptual framework

The conceptual framework of this study is built based on the theoretical foundation of connectivism theory. This theoretical perspective explains the learning process in the current digitally-networked age (Downes, 2007, 2008; Siemens, 2005, 2006). The existential standing of connectivism is that knowledge exists in the form of distributed knowing; such knowledge is created collaboratively, stored, and spread

across the nodes of networks (Downes, 2012). Network learning fosters autonomy, diversity, openness, and interactivity for learners. Autonomy refers to the learners' ability to control their own learning process and make decisions about what and how they want to learn. Openness emphasizes the importance of open educational resources and technology to facilitate learning. Diversity recognizes the importance of different perspectives, backgrounds, and experiences in shaping learning outcomes. Interactivity emphasizes the importance of social learning, where learners interact with each other and with experts to create new knowledge (Downes, 2007, 2012).

Moreover, merging the mobile learning environments and connectivism provides opportunities for knowledge construction relevant to network learning, up-to-date, and applicable (Chan, Fisher, & Sauer, 2011; Ozlem, 2013). It comprises mobile electronic devices, applications, operating systems, mobile terminals, and network environments (Li , Lang, & Lu, 2018). In this study, the mobile learning environment comprises mobile devices used by students and instructors. Google Classroom is used to manage mobile learning activities and access educational materials anywhere and anytime they like via different operating systems such as Android, Mac OS, and Windows mobile.

The conception of mobile learning has vigorous roots in theories of social constructivism, connectivism, and communities of practice (Valconi, 2018). Social cognitive theory plays the primary role in explaining the mediation of social learning networks, such as a learning process embodied through cognitive engagements and self-regulated learning. Furthermore, it suggests that learning occurs through observing, modeling, and imitating others (Bandura, 1986). Consequently, cognitive engagement is essential in a mobile learning environment, as students need to participate actively in the learning process. Likewise, self-regulated learning is also

significant, as students monitor their learning progress and adjust their strategies accordingly (Ahrari, Zaremohzzabieh, & Samah, 2017; Sha, Looi, Chen, & Zhang, 2012b).

Previous studies conclude that cognitive engagement in social learning communities is enhanced when learners actively discuss ideas, debate points of view, and critique each other's work. In addition, it is more likely observed when they work with peers on novel tasks that have personal meaning (Guthrie & Wigfield, 2000; Helme & Clarke, 2001). Meanwhile, and in line with the influence of the connectivism concept in social learning networks, there is also a growing body of studies indicating the influential roles that self-regulated learning and cognitive engagement strategies play in students' academic performance (Dotterer & Lowe, 2011; Dupeyrat & Mariné, 2005; Pintrich & Schrauben, 1992). Unfortunately, only a few studies indicate the ability of network learning through a connectivist learning environment to increase student performance (Rice, 2018a).

Performance is a multi-dimensional concept on the most primary level. However, the learning process is part of the performance," which should be measured as the dependent variable (Sonnentag & Frese, 2002). Furthermore, performance is influenced by several factors based on the type of learning environment (Shamaki, 2015), including in a connectivist learning environment (Ozlem, 2013), or related to online social networking (i.e., interactivity and engagement) (Ainin, Naqshbandi, Moghavvemi, & Jaafar, 2015), students' emotions, and self-regulated learning (Mega, Ronconi, & De Beni, 2014). The conceptual framework in this study combines connectivism principles and social cognitive theory to improve students' performance in mobile learning environments. The use of mobile devices provides learners with greater autonomy, openness, diversity, and interactivity, while cognitive engagement

and self-regulated learning enable learners to monitor and control their learning process. Therefore, this study developed a contextually based research framework that attempts to measure the influence of these combined factors on learners' academic performance (see Figure 1.2). The relationships of the research conceptual framework actors are explained in detail in chapter two.
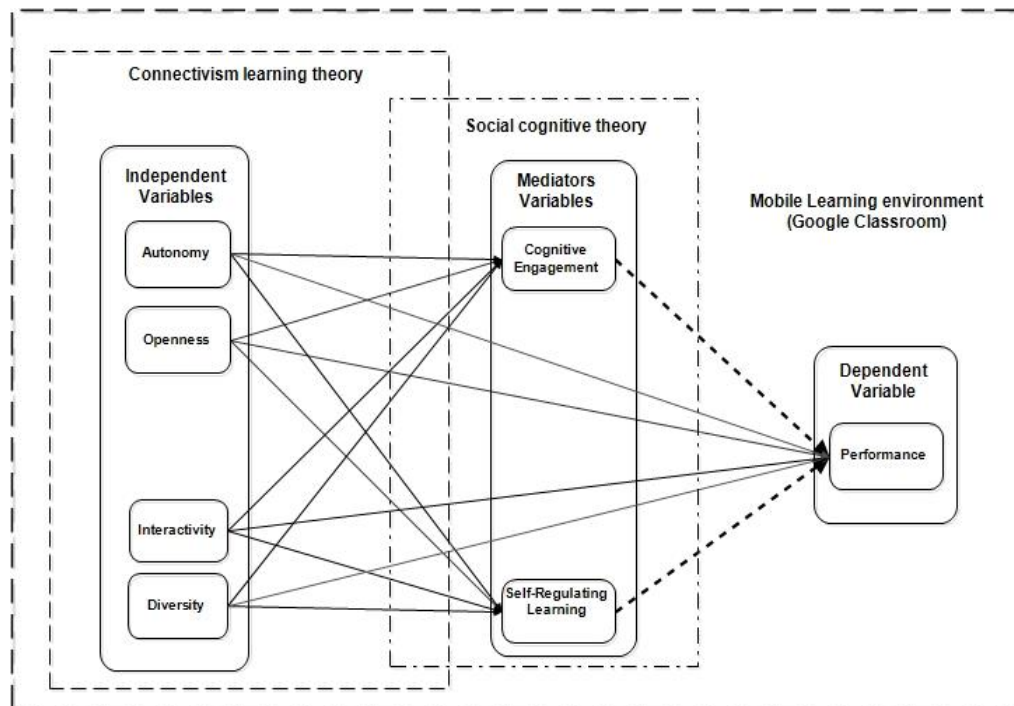
Figure 1.2 Conceptual framework

1.9 Significance of the study

Mobile technologies are widely used in higher education by teaching staff and students. Today, students and teachers rely on mobile devices as an essential part of the learning process. As mobile devices become more accessible, powerful, and ubiquitous in many countries, learning opportunities become limitless, particularly in developing and LDCs that face many challenges in integrating technology into their learning systems (Alexander et al., 2019; Kim, 2020). Nowadays, mobile learning is becoming unavoidable especially due to the Covid-19 pandemic that has affected educational systems worldwide. Many countries worldwide have been forced to close

their educational institutions to limit the spread of this pandemic and transfer education online. As a result, the worldwide education system faced unprecedented challenges in modern history to ensure student teaching continuity. Thus, mobile learning becomes an essential educational technology component in higher education so that the teaching and learning process is not affected. Accordingly, several researchers have reported that there is no established theoretical framework to measure the influence of adopting mobile technologies in the learning process based on connectivism (Al-Shehri, 2011; Rice, 2018b; Shaw, 2014). In the same context, a literature review has shown that no empirical studies have been undertaken to determine the importance and limitations of the connectivism effects on learning and education and its characteristics as a "digital age" learning theory with the mobile learning process. This study made theoretical and practical contributions by exploring connectivism practices in a mobile learning environment and their influence on higher education students' performance. Hence, the significance of this study is to establish a theoretical measurement model from the viewpoint of connectivism theory as a digital age learning theory and to measure the effects of its practice in the mobile learning environment and its impact on the academic performance of the network's learners. Connectivism is still a relatively modern theory of learning. Therefore, scholars need to conduct additional research to realize its implications for the field of education (Corbett & Spinello, 2020; Mohamed et al., 2018). Thus, research and testing are required on the connectivism practices, especially autonomy, diversity, openness, and interactivity, and their relationships based on empirical work (Jung, 2019).

1.10 Operational definitions

1.10.1 Autonomy

Autonomy is the ability to take responsibility for one's learning (Benson, 1997), to define one's strategies, needs, and goals as a learner, and to be able to review and change approaches and processes for optimal learning (Thanasoulas, 2000). Autonomy is the individual nodes of the networks' autonomous or the actions of the individual determined regarding the interests and needs of the group based on their own volition (e.g., in collaboration case), that acts according to individually defined values or principles (Downes, 2012). In addition, individual learners' ability to make decision-making as a part of the learning process and their capacity to know more than the current known (Siemens, 2005). In this study, autonomy refers to the ability of each learner to manage his learning process based on personal knowledge, values, beliefs, perspectives, decisions, and individual needs, via Google Classroom and their Google account. Autonomy will be measured using a questionnaire adapted from Firat (2016).

1.10.2 Openness

Openness means doing something openly and publicly, being able to share and observe it. Openness also means that novices and experienced ones can merge, communicate and interact with each other (e.g., online) or in the same space (Downes, 2012). It is the process of connecting specialized human and non-human nodes or information sources to foster learning (Siemens, 2005). Openness in this study refers to the online tools that eliminate the boundaries in terms of facilitating or providing access to information that may reside in unrelated fields or domains and is increasingly shared among students in a mobile learning environment via Google

Classroom. Openness will be measured using a questionnaire adapted from Yusof, Jumahat, Mohamed, and Ubaidullah (2015).

1.10.3 Diversity

Diversity is basically a way to create additional groups of contributors within a network (Downes, 2012), and it is also considered a kind of interactivity offered by various mediums of digital communication (Baym, 2015), including "intelligence" among the learners (Taylor & Sobel, 2001). Learning and knowledge are based on diversity of thought, learning skills and connections between fields, ideas, and concepts (Siemens, 2005). Diversity in this study refers to the students' varied majors based on their different faculties, assumptions, differing points of view, and opinions achieved from the course content in a mobile learning environment via Google Classroom. The questionnaire employed in this study was adapted from Yusof et al. (2015).

1.10.4 Interactivity

Interactivity is the knowledge produced in the network as a result of connectedness. Such knowledge reflects a community response to complex phenomena understanding in the network, gained as a result of interaction, rather than in the process of propagating the properties of one object to other objects (Downes, 2012). These are all connectivist learning activities and connections required to facilitate learning (Siemens, 2005). In this study, interactivity refers to the interaction between students and others with content and information occurring continuously and without restriction in the mobile learning environment that supports interaction and communication among the learners. Specifically, it refers to the result of the interaction between students, instructors, content, and the media in the mobile