THE RELATIONSHIP BETWEEN MOBILE LEARNING AND ACADEMIC ACHIEVEMENT IN A COMMUNITY COLLEGE SYSTEM ONLINE ENVIRONMENT

by

Daniel Patrick Grenier

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements of the Degree

Doctor of Education

Liberty University

2018

THE RELATIONSHIP BETWEEN MOBILE LEARNING AND ACADEMIC ACHIEVEMENT IN A COMMUNITY COLLEGE SYSTEM ONLINE ENVIRONMENT

by Daniel Patrick Grenier

A Dissertation Presented in Partial Fulfillment

Of the Requirements of the Degree

Doctor of Education

Liberty University, Lynchburg VA

2018

APPROVED BY:

Daniel Baer, Ph.D., Committee Chair

L. Thomas Crites, Ed.D., Committee Member

Thomas Bock, Ph.D., Committee Member

ABSTRACT

This study poses the question: Is there a relationship between student use of mobile technology in an online environment and student achievement expressed by final grades? The purpose of this study is to examine the relationship between mobile learning (m-learning) using mobile technology and academic achievement in terms of final grades in an online environment. The literature on m-learning indicates the freedom and flexibility of the m-learner constitutes a new paradigm in education. The untethered nature of m-learning means students can access course content anywhere, anytime. Studies have focused on the use of specific technologies in learning environments; this study uses a bivariate correlation method to cut across disciplines and measure the magnitude of mobile technology use as a function of degree of access to course materials while mobile. The degree of mobility and GPA were captured through an anonymous survey with analysis designed to discover the relationship between the variables. This study fills an important gap in assessing the impact of m-learning on academic achievement. Overall results did not show a significant relationship between m-learning and academic achievement. Results indicate that a larger study to include location context and quality of institutional support for mobility would better understand the impact of m-learning on academic achievement in the online environment.

Keywords: m-learning, mobile technology, e-learning, distance education, constructivism.

Dedication

For my wonderful wife, Suki, whose love, patience, support, and encouragement made this long journey possible. I thank God for her and all His blessings on us.

Acknowledgments

This effort would not have been possible without the assistance and encouragement of Dr. Timothy Merrill, J. Sargeant Reynolds Community College; Dr. Susan Crosby, Blue Ridge Community College; Mr. Steven Felker, Thomas Nelson Community College; Mr. George Still, Danville Community College; Ms. Damay Bullock, Paul D. Camp Community College; and Mr. Christopher Wikstrom, Patrick Henry Community College. I am also indebted to Amanda Lockhart and Brian Belardi, Hanover Research; and Dr. Eden Dahlstrom, EDUCAUSE, for their kind assistance with survey development. I would like to acknowledge Mr. Ken Williams, Colonel Mike Henry (USA), and Mr. Jeff Springer at the Joint Chiefs of Staff for their support, encouragement, and flexibility in allowing me to accomplish this study. I'd also like to thank John "Hoot" Gibson for his invaluable help, Dr. Scott Watson, Dissertation Research Consultant, Dissertation Committee members Dr. Tom Bock and Dr. Thomas Crites for their help and expertise, and finally, Dr. Dan Baer, Committee Chair, for his help, forbearance and kind mentorship.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

California Critical Thinking Disposition Inventory Scale (CCTDI)

Conversational Rating Scale (CRS)

Dependent Variable (DV)

EDUCAUSE Center for Applied Research (ECAR)

Electronic Learning (e-learning)

Family Educational Rights and Privacy Act (FERPA)

Framework for Rational Analysis of Mobile Education (FRAME)

Global Positioning System (GPS)

Grade Point Average (GPA)

Gulf Cooperation Council (GCC)

Hypothesis (H)

Identification (ID)

Independent Variable (IV)

Information and Communications Technology (ICT)

Institute of Education Sciences (IES)

Institute of Electrical and Electronics Engineers (IEEE)

Institutional Review Board (IRB)

Integrated Postsecondary Education Data System (IPEDS)

International Telecommunications Union (ITU)

Internet Protocol (IP)

Learning Management System (LMS)

Long Term Evolution (LTE)

Margin of Error (MOE)

Mobile learning (m-learning)

Mobile Seamless Learning (MSL)

Modified Gain Ratio (MGR)

National Center for Education Statistics (NCES)

Personal Computer (PC)

Personal Digital Assistants (PDA)

Principal Investigator (PI)

Quality Matters (QM)

Research Question (RQ)

Statistical Product and Service Solutions (SPSS)

Stratified Random Sample (SRS)

Student Mobile Information Prototype (SMIP)

Tablet learning (t-learning)

Technology Acceptance Model (TAM)

Technology Adopter Category Index (TACI)

Thomas Nelson Community College (TNCC)

Ubiquitous learning (u-learning)

Unified Theory of Acceptance and Use of Technology (UTAUT)

Virginia Community College System (VCCS)

Wireless, Mobile and Ubiquitous Technology in Education (WMUTE)

CHAPTER ONE: INTRODUCTION

Overview

Mobile learning (m-learning) is transforming what, when, and where educational content is delivered to the online student. Assessing the impact of m-learning on academic achievement is problematic due to the ever-changing nature of mobile technology. This study fills a gap in the literature by correlating the use of mobile technology with a summative assessment in an online community college environment. The study employs a bivariate correlation methodology to examine the strength and direction of the use of mobile technology on final grades in an online course environment (El-Hussein & Cronje, 2010).

Background

M-learning offers a new learning environment and context because of the advance of mobile, wireless technologies (Pereira & Rodrigues, 2013). M-learning has become more prevalent partly because of the wide-spread availability of mobile technology throughout society. As of 2016, there were seven billion people worldwide (95% of the global population) with access to a mobile-cellular network. Approximately half of the world's population uses the Internet, but a digital divide exists between developed countries with 2.5 billion users versus lesser developed countries with one billion users (International Telecommunications Union, 2016). Increased subscriptions are led by demand in developing countries, primarily in China and India (International Telecommunications Union, 2014). Mobile commerce is increasing primarily due to the popularity of mobile devices, consumer online buying and selling, and more security online (Chang, Williams, & Hurlburt, 2014). Poushter (2017) surveyed 14 advanced economies in 2016 and found almost all people reported owning a mobile phone, but those who owned a smartphone ranged from 46% in Greece to 80% in Sweden, with the U.S. at 77%, which is double the rate from 2011 (Poushter, 2017).

The Adobe 2017 Mobile Maturity Survey of over 4,000 consumers in Europe and the United States found that 92% use smartphones as their primary communication device. The survey found average users checking their smartphones 85 times per day with Americans collectively checking their phones a total of eight billion times a day (Adobe, 2017).

Mobile technology ownership has steadily increased over the last 10 years with laptops and smartphones leading the trend. Students are ready to incorporate the use of mobile devices for education and are looking for institutions and their teachers to provide opportunities and motivation (Dahlstrom, 2013). The Pearson Student Mobile Device Survey (2014) revealed that students find mobile tablets appealing, but primarily use laptops and smartphones for academics (Harris Poll, 2014). The 2015 Pearson Student Mobile Device Survey (2015) surveyed over 1,200 students and revealed that laptops and smartphones were still the most common devices for academic use, with laptops at 87%, smartphones at 64%, and tablets at 40% (Harris Poll, 2015).

The 2016 ECAR Student and Technology Research Study (Dahlstrom, 2016) found this trend continuing with smartphone and laptop academic use predominating in at least one course. The most recent ECAR Undergraduate Student and Technology Survey (Brooks & Pomerantz, 2017) surveyed 124 institutions and 43,559 undergraduate students. The survey showed that 29% own a desktop and 24% use it for most or all of their courses while 95% own a laptop and 89% use it in most or all of their courses. Although 97% own a smartphone, only 41% use it in most or all of their courses (Brooks & Pomerantz, 2017).

In a meta-analysis of m-learning trends, Wu et al. (2012) found most research studies on m-learning focused on effectiveness and system design. The meta-analysis noted most studies used surveys and experimental methods and found m-learning study outcomes were positive.

The rapid advance in communication technologies has made mobile devices more available, convenient, and inexpensive. Each successive generation of device offers more functionality and applications for a variety of uses. As a result, research on m-learning has increased significantly, and these developments have led educators to employ mobile devices in teaching practice (Wu et al., 2012).

Mobile communications allow networks to provide extremely flexible access to individualized learning that is distinct from previous PC-based platform functionality (Rajasingham, 2011). The New Media Consortium Horizon Report for Higher Education (Johnson et al., 2013) forecasted that tablet computing will continue to increase in use and function, in and out of the classroom. The advantages of higher resolution, larger screens, and touch-screen technology make tablets powerful tools for m-learning. The variety and usefulness of many applications tailored to education in many universities make the increased use of these mobile devices a likely outcome in the near-term horizon. Institutions are increasingly designing "apps" to allow student access to administrative and educational content (Johnson et al., 2013).

Since m-learning is focused on the learner, the conceptual framework for this study is most aligned with constructivism. Constructivism understands learning as a progression of learner-centered integrations of existing knowledge with new information to form new, meaningful knowledge. The central idea is the learner as an active agent in the learning process versus a passive receiver of educational content (Lowenthal & Muth, 2009). The primary practical concern of constructivism is the construction or creation of meaning in the learning process. The resulting knowledge may or may not have a direct correlation to objective reality, and some Constructivists hold the extreme contention that knowledge does not correspond to an external reality and only exists in the mind of the knower (Splitter, 2009). Constructivist theory aligns with m-learning since the perceived advantage of m-learning is student control of the time, context, and manner of the learning experience. Jantjies and Joy (2014) noted in their study of a constructivist approach through m-learning that while the experience was advantageous to student construction of knowledge, some students were led to a blended environment through their use of mobile technology.

The EDUCAUSE Center for Applied Research (ECAR) Study of Undergraduate Students and Technology showed that learner use of mobile technology has risen substantially, and students believe this technology is crucial to academic success (Dahlstrom, 2013). The trend for student use of mobile technology continues to increase with numerous students using mobile devices for academic purposes (Dahlstrom & Bichsel, 2014). Student perceptions notwithstanding, research is necessary to assess the correlation between mobile technology and learning in an online environment.

Mobile technology provides a student-centered learning environment that allows an "anytime, anywhere" access to educational content (Rajasingham, 2011). This new online context deserves study to determine if it is an enhancement to learning by correlating m-learning to academic achievement. M-learning is evolving because of the continued adoption of mobile technology capabilities in both the student body and community at large. M-learning has changed how, where, and when educational content is delivered in the online environment. Evaluating the connection between m-learning and academic achievement is problematic due to the constant change in mobile technology. This study examines the correlation between the use of mobile technology and academic achievement represented by course grade point average (GPA) in the Virginia Community College System (VCCS) online environment.

Problem Statement

There is a lack of research on the use of mobile technology for achieving desired learning outcomes (Al Zahrani & Laxman, 2015; Koszalka & Ntloedibe-Kuswani, 2010; Rajasingham, 2011). There is extensive research related to user perceptions and device usage, but in order to justify the necessary investment in time and funds to implement m-learning, more empirical evidence is needed to measure the effectiveness of mobile technologies in educational achievement (Lacey, Gunter, & Reeves, 2014; Richardson, Richardson, Dellaportas, & Perera, 2013). There are various studies devoted to assessing the effectiveness of mobile technology in the face-to-face environment (turning the environment into a form of blended instruction), both at the secondary and higher education levels, but there is not enough research assessing m-learning in the online environment (Baloch, Abdulrhaman, & Ihad, 2012; Huang, Lin, & Cheng, 2010; Looi et al., 2014; Mileva, 2011; Shih, Chuang, & Hwang, 2010; Yang, Chen, Kinshuk, Sutinen, Anderson, & Wen, 2013; Yang, Hwang, Hung, & Tseng, 2013; Powell & Mason, 2013; Zhang, Song, & Burston, 2011). The problem is research on the effectiveness of mobility in the online environment lacks a study of the correlation to summative assessment.

Purpose Statement

The purpose of this study is to examine the relationship between m-learning using mobile technology and academic achievement in terms of final grades in an online environment. The study examines volunteer participants in the VCCS online population. The study correlates m-learning to academic achievement in the form of final grades while considering age, race, and gender as control variables (Creswell, 2012). The m-learning independent variable is the degree of use of mobile technology to access course materials. The dependent variable will be semester final GPA as an indicator of academic achievement. The sub-groups of age, gender, and race will be considered and if significant, will be controlled during analysis in order to focus on the correlation of the mobility variable (Szapkiw, 2013). For the purposes of this study, the word *gender* is being used in the traditional sense to indicate male or female and is dependent upon the participant for gender identification. Howell (2011) noted that the use of independent and dependent variable labels in correlation studies will often depend on which variable is the predictor and which variable is the criterion. Howell used the example of a survey to measure depression and stress where both could be a function of the other and be considered dependent variables depending on the purpose of the study (Howell, 2011). In this study, mobile technology use cannot be considered a function of final grades.

Significance of the Study

Studies on mobile technology use in higher education have been impacted by the ever-changing nature of mobile technology, making assessment of the correlation of this technology to measurable academic achievement problematic (Wu et al., 2012). This study correlates the use of mobile technology with summative assessment in the form of final grades in an online community college environment. This is a significant setting since many non-traditional students use an online environment to facilitate a return to higher education or balance education with jobs and family (Office of Institutional Research and Effectiveness, 2012). Since the impact of mobility has not been clearly established through summative assessment correlated to the degree of student mobility, it is difficult to construct efficient and effective online content. Understanding the relationship of m-learning to academic achievement will assist administrators and instructors in curriculum design and course delivery.

Research Questions

RQ1: Is there a relationship between student use of mobile technology in an online environment and student achievement expressed by grade point average?

RQ2: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race?

RQ3: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender?

RQ4: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age?

Definitions

1. *Electronic Learning (E-learning)* - The term *e-learning* has had a wide range of definitions that have included various technologies, practices, and pedagogical theories. In addition to an online context, definitions have encompassed a variety of computer-based platforms, delivery approaches, and multi-media applications across all branches of learning. For the purposes of this study, e-learning is defined as the delivery of educational content through a flexible, computer-based online environment (Nicholson, 2007).
2. *Mobile Learning (M-learning)* - M-learning is characterized by the mobility of technology, the mobility of the learner, and the mobility of learning (El-Hussein & Cronje, 2010; Franklin, 2011; Rajasingham, 2011). Sharples et al., (2007) characterized m-learning as learning when away from the typical learning environment or when using a mobile device. The e-Learning

Guild's definition provides more detail by stating that individuals can be more productive through m-learning exchanges using the mediation of a mobile device (Rajasingham, 2011). The essential nature of m-learning is succinctly described as learning at anytime and anywhere (Wong & Looi, 2011).

3. *Cloud Computing* - Cloud computing refers to a model that allows universal, expedient, on-demand access to shared computing resources (e.g. applications, services). The fundamental characteristics of cloud computing include on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. Cloud resources are quickly provided with minimal management or provider-user interface (Mell & Grance, 2011).
4. *Ubiquitous Learning (U-learning)* - This type of m-learning leverages context-aware sensor technology to interact with the user. For example, the mobile device might sense the location of the user and make images available showing the location's history and evolution. Another application might make use of the camera and add informative data to the shops or businesses in the image. Context-aware technology can be used to supplement instruction in assessing responses to the sensed environment (Yu, 2012).

CHAPTER TWO: REVIEW OF THE LITERATURE

Overview

The way individuals live, work, play, and learn is affected by increasing mobility (Rajasingham, 2011). In 2016, 95% of the global population (approximately seven billion people) had access to a mobile-cellular network. Long Term Evolution (LTE) networks connect almost billion people, thus improving the quality of Internet use (International Telecommunications Union, 2016). Increased subscriptions are being led by demand in developing countries, primarily in China and India (International Telecommunications Union, 2014). The increase in mobile commerce is driven by the popularity of mobile devices, consumer buying and selling online, and more online security (Chang et al., 2014). Pew Research (Poushter, 2017) found that among 14 advanced economies surveyed in the spring of 2016, nearly all people reported owning a mobile phone, but those who owned a smartphone varied substantially from 46% in Greece to 80% in Sweden, with the U.S. at 77%, which was double the ownership rate from 2011 (Poushter, 2017)

As mobile technology becomes more ubiquitous and cloud-based computing proliferates, users are no longer tied to a particular device or location when accessing online services (Cook & Sonnenberg, 2014). Mobile learning (m-learning) is therefore becoming more prevalent in online access to educational content (Rajasingham, 2011). A study involving 460 university students in Spain to assess the penetration of mobile technology in the online environment found that 25% of student accesses to the Learning Management System (LMS) were accomplished with mobile technology; 75% of these students used the devices for learning purposes. The study found that 80% of the students had smartphones, 90% had tablets, and 84% had an iPod (Lopez Hernandez & Silva Perez, 2014).

The EDUCAUSE Center for Applied Research (ECAR) Study of Undergraduate Students and Technology indicated smartphone use among undergraduates increased significantly in the last decade; students believe technology is essential to academic success; students expect anytime, anywhere access to course content; and students want to use personal devices inside and outside the classroom (Dahlstrom, 2013). In 2014 and 2015, the trend continued with more students owning and using mobile technology than in previous years of the study (Dahlstrom & Bichsel, 2014; Dahlstrom, Brooks, Pomerantz, & Reeves, 2016).

The Pearson Student Mobile Device Survey (Harris Poll, 2015) conducted by Harris Poll found that students continue to have a high interest in using mobile tablets for academics and believe these devices will be important for future learning. However, laptops and smartphones are still the devices of choice for academics, both in and out of the classroom, and the desire to use mobile devices more often in the classroom rebounded from a slump in 2014. The survey found that nine in 10 students use a laptop and 8 in 10 use a smartphone. Pertinent to this study, the survey found 89% of students use a laptop and 64% use a smartphone two or three times per week for college work – up from 56% in 2014 (Harris Poll, 2015). Although 97% of students in the ECAR 2017 survey owned a smartphone, only 41% used it in most or all of their courses, and 47% rated them as very/extremely important to academic success (for those who use smartphones in at least one course) (Brooks & Pomerantz, 2017).

The m-learning experience takes the content of learning to the learner and grants more control and access. M-learning can provide an educational experience in countries that have been historically unable to supply the infrastructure needed to provide other types of educational experiences (Traxler, 2010). M-learning is transforming traditional educational practice by integrating learning objects into the daily lives of learners – although most e-learning content is still evolving to make the best use of mobile technology (Pereira & Rodrigues, 2013).

M-learning can be defined as any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners, and mobility of learning (Beseda, Machat, & Palecek, 2012; El-Hussein & Cronje, 2010). M-learning is characterized by technological mobility, instability, and uncertainty, as theoretical, andragogic and organizational structures of m-learning are still being developed. This development represents a similar evolution that television went through in its early days; the medium could not just rely on how radio delivered content. E-learning could not directly transfer face-to-face practice to the web, and m-learning is experiencing the same lesson (Little, 2013). M-learning is constructivist and learner-centered, not teacher-centric; it is nomadic and engages students in learning-related activities in diverse physical locations (El-Hussein & Cronje, 2010). As a result, advances in Internet and wireless applications are considered extensions of the framework provided by traditional e-learning environments to support constructivist, self-directed, interactive learning. However, mobile communications allow networks to deliver just-in-time, just-for-me access to personalized education that is different from previous actualizations of PC-based platforms (Franklin, 2011).

The future of m-learning will likely be even more pervasive with the proliferation of smart systems and the mobility of learners. Learners will be using multiple devices to access educational content with the next generation of mobile technology having virtual input and output functionality. Mobile technology is increasingly cloud-based, where storage and access are not necessarily co-located with the instructor or the institution (Ally & Prieto-Blazquez, 2014).

More research is needed to demonstrate the effectiveness of m-learning on educational outcomes, and more evidence is required to show sustained successful application of mobile technology for achieving optimum learning results and alignment between learner/teacher expectations (Lacey et al., 2014; Rajasingham, 2011). Although there is extensive research related to user perceptions, there is a gap in research measuring the effectiveness of mobile technologies in educational achievement (Koszalka & Ntloedibe-Kuswani, 2010; Lacey et al., 2014), and the influence of m-learning on academic outcomes (Richardson et al., 2013).

This literature review was conducted using search services provided by the Liberty University Library Summon function and related educational databases. Articles were canvassed for relevancy and cataloged according to themes applicable to the study.

Theoretical Framework

Philosophical beliefs and considerations that relate to the m-learning context include: ontological – the reality of the m-learner (in the process of learning) is significantly different from the face-to-face or tethered e-learner; epistemological – Piaget's assimilation and accommodation (and eventual equilibration) in knowledge acquisition operate differently for m-learners vs. face-to-face and traditional e-learners; axiological – the freedom (as a value) of the m-learner in knowledge construction is a further step towards true learner-centeredness; and methodological – delivering m-learning content has dimensions not available to traditional face-to-face or e-learning environments (Miller, 2011). The theoretical framework for this study is informed by the tenets of constructivism having to do with how the learner builds knowledge through spatial context and positioned action rather than mere content.

Constructivism is an epistemological theory that describes the learning process as a series of learner-centered constructions of old and new information into meaningful knowledge. The key concept involves the learner as an active participant in learning rather than as a mere receiver of transmitted knowledge (Lowenthal & Muth, 2009). Constructivism is primarily concerned with understanding the creation of meaning in the learning experience. Since meaning is learner-focused and built by an integration of new information with existing knowledge, constructivism does not attempt to establish the ontological status of the learner's knowledge – beyond the extreme contention that there is no objective truth that a learner's knowledge corresponds to (Splitter, 2009).

Although constructivism has no definite beginning, early constructivism was shaped by the ideas of Jean Piaget and Lev Vygotsky (Lowenthal & Muth, 2009). Piaget's cognitive-stage theory describes functional invariants that persist throughout development and act to organize and adapt cognitive function to the external environment through assimilation and accommodation. During the process of assimilation, the interaction with objects and events causes a cognitive adjustment as the experience is incorporated and understood (Miller, 2011). Assimilation is the integration of new information into an existing cognitive structure that has been organized through a separate functional invariant. Accommodation is the changing and creation of new structures to understand information (Tsou, 2006) – an adjustment that is made to cognitive structure resulting from the demands of reality (Miller, 2011). The experience of using mobile technology influences these processes by positioning the student in novel contexts and giving control over the timing, placement, and manner of learning to the student (Hockly, 2013).

Von Glasersfeld (1991) pointed out that constructivism does not attempt to deny reality; only that one cannot claim to *know* reality in the sense that one can have knowledge that exactly corresponds to an objective, external reality (von Glasersfeld, 1991). This position is consistent with Kant’s notion that perception as a subjective sensibility cannot render an understanding of the “thing in itself” because of the spatio-temporal character of our senses (Kant, 1950). In this light, von Glasersfeld saw knowledge as conceptual structures underlied by Kant’s *unity of apperception* (Kant, 1950) that cannot be transferred to another through language without the recipient first unpacking and mentally constructing an understanding of the communicated knowledge (von Glasersfeld, 1991).

From this discussion, it is evident that acquiring knowledge is an active cognitive event, and an operative human process rather than a passive receiving of knowledge. Piaget characterized knowledge as a process rather than an end state (Tsou, 2006). Acquiring knowledge involves assimilating information in the external world through processes that transform that information into meaning. These functions are self-regulatory reactions to something new in the environment that the learner experiences as a “disequilibrium,” or disconnect with prior knowledge or the knowledge structure. The motivating force behind this reaction is to satisfy a need – an internal need to resolve a cognitive anomaly or an external need to solve a problem. The result of the interaction of assimilation and accommodation is equilibration – when the processes lead to a cognitive balance that satisfies a learning need. Although prominent in development, this process can proceed through time due to a universal tendency towards increasing equilibration (Tsou, 2006).

Vygotsky (1978) expanded on Piaget’s theory by examining the socio-cultural context of learning through the zone of proximal development. In a classic sense, an adult or more advanced person would interact with the child (or student) in order to cause an intramental (internal) change by an intermental (external) process (Vygotsky, 1978). This prompting and interaction are mediated by mobile technology in m-learning. Married to Information and

Communications Technology (ICT), the mediated interaction between mobile device, learner, instructor, and knowledge becomes a collaborative dialog (Rajasingham & Tiffin, 1995).

An interesting example of how construction of knowledge can go wrong through errant accommodation is the phenomenon illustrated by the video documentary “A Private Universe,” where twenty-three Harvard graduates were asked to describe the cause of the seasons. Twenty-one of the graduates did not give the correct answer (the angle of the sun’s rays due to the tilt of the earth on its axis while revolving around the sun), but instead explained that seasons were caused by the distance of the earth from the sun during the earth’s revolution. In this example, the students attempted to integrate the general idea that the closer to a heat source you are, the hotter it gets with the change of the seasons. And yet, most (if not all) of them – some were physicists – were presumably taught the correct answer at some point in their academic careers but could not reconcile the correct answer with other, already learned information (Schneps & Sadler, 1988).

Immersive, virtual learning environments can promote constructivist learning where learners take more control over learning experiences (Franklin, 2011). M-learning is nomadic; it engages students in learning activities in diverse environmental contexts (El-Hussein & Cronje, 2010). M-learning is characterized by a degree of unpredictability and insecurity as theoretical and educational practice involving m-learning are in the process of development. Improvements in mobile technology extend the structure of the wireless environment and reinforces constructivist learning. Mobile technology allows networks to deliver just-in-time, just-for-me access to tailored education that is different from previous implementations of PC-based platforms (Rajasingham, 2011).

Constructivist-oriented, self-directed students who are motivated to take more control over their learning (vs. students more reliant on instructor directions) can be more effective in the online environment, and in particular, m-learning. Control of the learning context (when, where, and how, along with motivation and self-management are critical factors for m-learning success (Richardson et al., 2013). The importance of an authentic context in the learning environment and student control over that context is a critical feature of m-learning from a constructivist point of view (Lowenthal & Muth, 2009). Mobile technology has converged with a constructivist, learner-centered pedagogy in several characteristic alignments: new learning is personalized, learner-centered, situated, collaborative, ubiquitous, and lifelong and new technology is personal, user-centered, mobile, networked, ubiquitous, and durable (Sharples, Taylor, & Vavoula, 2007).

There are still challenges ahead for complete constructivist support for m-learning. Collaboration in social constructivist learning that is a strong element of some uses of mobile technology can be problematic when it comes to assessment strategies. Scholtz (2007) found that group work mediated by mobile technology had the effect of homogenizing normative assessments to the disadvantage of the top tier of students and advantaging the bottom tier of students (Scholtz, 2007). These results are particularly relevant when it comes to high stakes assessment for individual achievement. Given the nature of m-learning's intersection with the advancement of mobile technology, it is necessary to define m-learning.

Related Literature

Defining M-learning

Identifying a consistent definition of m-learning is challenging since the technology involved is constantly changing (Rossing, Miller, Cecil, & Stamper, 2012). A common theme, however, is the flexibility and unique context of the m-learning experience – aptly characterized as “learning anytime, anywhere,” across many types of devices and a variety of physical and temporal settings (Hockly, 2013; Wong & Looi, 2011).

There are three common themes in the literature identified as integral to defining the m-learning experience: mobility of technology, mobility of learning, and the mobility of the learner (El-Hussein & Cronje, 2010). The mobility of technology and the learner are straightforward; the power of technology continues to allow for an increase in capability while enhancing mobility. The mobility of learning is where the essence of m-learning resides whether the device is a laptop, tablet or mobile phone. The type of device will dictate the degree of mobility and the possible contexts where learning can take place – tablet learning (t-learning) with a tablet will be somewhat more constrained with regard to portability than m-learning with a mobile phone (Little, 2013). Where and when learning takes place influences m-learning outcomes and constitutes a paradigm shift in higher education (El-Hussein & Cronje, 2010; Franklin, 2011; Rajasingham, 2011). An additional twist to the m-learning experience is ubiquitous learning or u-learning. This type of m-learning leverages context-aware sensor technology to interact with the user. For example, the mobile device might sense the location of the user and make images available showing the location’s history and evolution. Another application might make use of the camera and add informative data to the shops or businesses in the image. Context-aware technology can be used to supplement instruction in assessing responses to the sensed environment (Yu, 2012).

M-learning can be characterized as just learning when away from the usual learning environment or when using a mobile device. The e-Learning Guild’s definition provides more detail by stating that individuals can be more productive through m-learning exchanges using the mediation of a mobile device (Rajasingham, 2011). M-learning depends on the marriage of computer technology and telecommunications through digitalization. This infrastructure has made all forms of information available whether auditory, visual, graphical, etc. The m-learning environment provides appropriate access, adaptable choices, and enhancements to curriculum and instruction (Rajasingham, 2011).

One method of evaluating the m-learning environment is in terms of engagement, presence, and flexibility. Engagement is the active participation of the student in m-learning activities; presence is the awareness of self, fellow students, and instructor in space and time (mediated by technology); and flexibility encapsulates learning, teaching, and assessment activities. These characteristics can act as a lens to evaluate m-learning approaches to determining innovation (Danaher, Gururajan, & Hafeez-Baig, 2009).

Koole (2009) characterized m-learning as a process that combines mobile technologies (that will always be changing, improving, growing), the human ability to learn, and the social interaction aspects of the collaborative environment. Koole's Framework for Rational Analysis of Mobile Education (FRAME) model visualizes the interaction of the individual, the device, and learning as a series of intersections and interactions with the nexus being m-learning itself. The device aspect includes physical characteristics of the technology, input/output capabilities, file storage and retrieval, processor speed, and error rate. The learner aspect includes prior knowledge, memory, context and knowledge transfer, discovery learning, and emotions/motivation. The social aspect includes conversation/cooperation and social interaction. The device aspect intersects with the learner aspect through usability and with the social aspect through social technology. The learner aspect also intersects with the social aspect through interactive learning. These intersections converge at m-learning (device, learner, social) (Koole, 2009).

Kearney, Schuck, Burden, and Aubusson (2012) expanded on Koole's framework from a socio-cultural perspective to characterize m-learning in terms of authenticity, collaboration, and personalization. Authenticity includes the sub-scales contextualization and situatedness. For m-learning to be authentic, the context and situation should be relevant and meaningful to the learning activity. The closer to the real world the context and situation are, the more effective the learning. Collaboration includes the sub-scales conversation and data sharing. Conversation promotes productive connections with the involved dialog, and data sharing is the exchange and production of learning content. Personalization includes the sub-scales agency and customization. Agency is the degree of control the individual has over the time, place, and manner of learning activity, and customization is the learner-focused tailoring of tool and activity (Kearney et al., 2012).

The distinction between face-to-face, e-learning, and m-learning has evolved into a characterization of the learning environment as seamless across various learning and situated contexts. This construct overlaps and integrates well with the focus of the Wireless, Mobile and Ubiquitous Technology in Education (WMUTE) ongoing conferences since 2002 (Institute of Electrical and Electronics Engineers Inc., 2013). The relevant features of a WMUTE design that exhibit seamlessness include learning that is formal and informal, personalized, occurring across time and location, always accessible, and includes the physical and digital worlds (Wong & Looi, 2011).

Wong and Looi (2011) also recommended the merger of seamless learning with WMUTE into the characterization Mobile Seamless Learning (MSL). MSL dissolves the differentiation between contexts and integrates learning from the formal and informal environments. MSL allows for continuity of the learning experience and the ability of individuals to better control the learning environment (Wong & Looi, 2011). In fact, m-learning can support several learning practices and styles: individualized, situated, collaborative, and informal (Cheon, Lee, Crooks, & Song, 2012).

In the future, m-learning could provide more individualized, situated, and relevant learning opportunities to support any number of instructional techniques (Traxler, 2007). Although m-learning definitions are continually evolving, given the nature of technological and pedagogical adaptation to the learning environment, a useful definition includes not only the use of mobile technology to enhance learner outcomes but also efficient and effective use of mobile devices (Rossing et al., 2012).

Student Readiness for M-learning

Readiness for the m-learning experience can depend on various factors including: student perception of the ease and availability of mobile technology for learning, institutional policies regarding m-learning, the amount of effort (to operate the technology) expectancy, and facilitating conditions (Cheon et al., 2012; Nassuora, 2012). Students responded more favorably at some institutions when given more control and personalization to the m-learning experience (James, 2011). To make the best use of the m-learning environment, students need to understand information access, the hyperconnectivity of the web, and the resulting new sense of spatial context (Parry, 2011).

Student readiness for the m-learning environment involves several factors including perception of the ease and availability of mobile technology, the structure and policies of the institution, and the effort required to operate the technology (Cheon et al., 2012; Nassuora, 2012). Alrasheedi and Capretz (2013) conducted a meta-analysis of 19 studies to show that in addition to the learners’ perception of the ease of use of the technology, educational content, technical competence, and community maturity were also critical to the success of the m-learning experience. The analysis concluded that student perception was the fundamental factor, and other factors correlated with perception. The attitude of students toward mobile technology had a direct impact on intention for continued m-learning (Alrasheedi & Capretz, 2013). The 2013 ECAR study established that students across the United States are not only ready for the m-learning environment, but expect access to content using personal devices when and where they desire (Dahlstrom, 2013). Student readiness, however, is only one side of the issue regarding m-learning effectiveness.

Students' comfort level with computers and attitude toward using mobile technology to complete learning tasks can influence m-learning effectiveness. Student responses to an m-learning attitude survey and m-learning self-efficacy survey in a study at a technical university in central Taiwan showed most students were comfortable with m-learning technology, had a higher degree of motivation for learning, and engaged in more imaginative work as a product of the m-learning environment. In fact, the students found the experience so liberating, they expanded the formal learning from their coursework to informal learning in day-to-day experience (Yang, 2012). In an earlier study, Kim and Ong (2005) found that system, service, and content quality were all positive factors in m-learning success; however, they found user learning ability did not have a moderating effect on the degree of user satisfaction (Kim & Ong, 2005).

In a study with very similar research questions, Kim et al. (2013) assessed students according to the Technology Adopter Category Index (TACI), which is a scale of the degree of willingness to adopt new technology (including mobile technology). Students were assigned projects and completed a survey to determine the TACI score and collect reflections on their use of mobile technology. The study showed that students became more willing to adopt new technology after experiencing elements of m-learning. Students had positive views of m-learning, but the survey also showed that only half of the participants used a smartphone or other mobile device versus a laptop computer (Kim, Rueckert, Kim, & Seo, 2013). This finding is consistent with the overall trend in the ECAR study where laptops were still more prevalent than smartphones in m-learning (Dahlstrom, 2013). One reason for this result is the frustration students felt when the limits were reached on the effectiveness of mobile devices to satisfy learning tasks. When this limit was reached, students stopped using less capable devices (e.g. smartphones) and began using laptops (Kim et al., 2013).

A study of Malaysian students found a significant majority of respondents had mobile services and the ability to access video and audio files. Approximately 75% of the respondents had the necessary skills to take advantage of the m-learning environment and responded positively to questions designed to assess psychological readiness for m-learning. The one negative aspect was the prospect of paying more to engage in m-learning activities—the cost of phone services, Internet access, keeping up with technology, and others (Hussin, Manap, Amir, & Krish, 2012).

Chen and Huang (2010) studied user acceptance of a mobile knowledge management system in higher education in a Taiwan university. The study found larger screens perform better than smaller ones in learning activities and system quality. The group using the mobile knowledge management system had higher rates of acceptance of mobile technology than the group engaging in traditional classroom lectures. System acceptance assessed through survey found the ease of use of the mobile knowledge management system positively predicted user perception of the usefulness of the system. Additionally, ease of use and usefulness positively predicted whether users behaved positively regarding system acceptance (Chen & Huang, 2010).

Wang, Wu, and Wang (2009) found similar results concerning the ease of use of mobile devices and intention to use for students in higher education in Taiwan. Researchers used the Unified Theory of Acceptance and Use of Technology (UTAUT) to investigate the determinants of the acceptance of m-learning focusing on age and gender variables. The study found an older user's intention to use mobile technology was predicted by ease of use and social influence more often than younger users. Unexpectedly, social control was a greater influence on males than females, and the requirement for self-management was stronger for females than males (Wang et al., 2009).

Nassuora (2012) used the UTAUT model when studying the acceptance of m-learning in higher education students in Saudi Arabia. Even though greater than 50 percent of participants in the study were not m-learners, perception of ease of use and facilitating conditions showed a high level of acceptance. The study found social factors and facilitating conditions influenced attitude; performance and effort expectancy positively influenced intention to use (Nassuora, 2012). Shorfuzzaman and Alhussein (2016) also used UTAUT to assess learner readiness from the perspective of a Gulf Cooperation Council (GCC) higher education institution. The study found that students who expected high performance of their academic outcome viewed m-learning positively, whereas those who expected lower performance had a less positive view (Shorfuzzaman & Alhussein, 2016).

Tan, Ooi, Sim, and Phusavat (2012) found somewhat different results using the Technology Acceptance Model (TAM) identifying perceived usefulness, perceived ease of use, and subjective norms. Their study showed a positive association between these factors and the intention to use mobile technology but did not find a significant effect based on gender. Age had a significant impact on subjective norms and perceived ease of use but no significant relationship with perceived usefulness (Tan et al., 2012).

Alzaza and Yaakub (2011) developed a Student Mobile Information Prototype (SMIP) software framework to provide educational services for Malaysian higher education students. The SMIP provided course announcement, exam results, instructor information, registration, financial data, calendar, library services, and student profile information. The study evaluated student perceptions of the usability and usefulness of the SMIP. Results indicated the overwhelming majority rated the system as highly useful and usable. Additionally, students were aware of the benefits of m-learning and had the requisite skills for the environment. (Alzaza & Yaakub, 2011).

A qualitative study of higher education students in a Thailand university uncovered student perceptions of m-learning about the impact these perceptions would have on institutional management strategy and technology adoption. The major themes were that students want collaborative capability, flexibility, engagement, and efficient and rapid content delivery from their m-learning environments. Factors affecting acceptance and engagement included the speed of connection, costs of downloads, use and ownership issues, and the overall learning experience. The study also found interactiveness, mobile broadband, and adequate coverage were perceived to be advantageous to student learning effectiveness (James, 2011). Rapid and dependable content delivery and the novel and immediate nature of mobile access contributes to an enhanced ability to collaborate and capitalize on group activities in the classroom (Rossing et al., 2012).

Cochrane (2010) identified critical success factors as they related to the level of student engagement and satisfaction achieved, reflective feedback, and the level of mobile blogging achieved by the participants. Alrasheedi and Capretz (2013) conducted a meta-analysis of 19 studies with overlapping critical success factors. The study showed that educational content, ownership, learner's perceptions of the m-learning experience, learning community development, technical competence of the student, and user-friendly design of content were all significant factors in m-learning success. The emergent conclusion was that learner perception was the essential element in the studies, and all the other factors were correlated with learner perception. The highest correlations were for user-friendly design and educational content. Learner perception was a motivator for continued and future use of mobile technology for learning (Alrasheedi & Capretz, 2013). Alrasheedi, Capretz, and Raza (2015a), in a follow-up study of university student perspectives on critical factors for success of m-learning, found students were satisfied with m-learning implementation in their courses. The study found that students considered all 13 success factors as necessary to m-learning success with student perception of m-learning as the dominate factor (Alrasheedi, Capretz, & Raza, 2015b).

As shown by the proliferation of studies assessing m-learning effectiveness, the focus on student perception is pervasive. Shonola, Joy, Oyelere, and Suhonen (2016) used student perception of m-learning as the focus of a case study survey on the impact of mobile device use in higher education in Nigerian universities. Students overwhelmingly thought mobile devices enhanced the learning experience (88.2% of females and 83.3% of males). Students were again asked to evaluate their academic performance using mobile devices, and 92.6% believed their performance was improved (or could be improved) using mobile devices (Shonola et al., 2016).

Across the United States, the ECAR study (Dahlstrom, 2013) findings indicated students are ready for m-learning and are looking for (and expecting) opportunities to use mobile technology. Students expect anytime, anywhere access and would like to use their personal devices in and out of class. Undergraduates typically own two or three devices that can access the Internet with tablets and smartphones increasingly prevalent, although laptops are still considered the most useful for academics (Dahlstrom, 2013).

Demographic relationships do not necessarily correlate significantly with student attitudes towards the mobile technology used in learning activities. Richardson et al. (2013) found that students' perception of the utility and benefits of mobile technology was not confined to any demographic characteristic. Students identified benefits to planning, time efficiency, and content access. The primary practical benefit was perceived as flexibility, translated as portability of the learning context (Richardson et al., 2013). Al-Emran, Elsherif, and Shaalan (2015) studied student attitudes to m-learning and found no significant differences regarding age, gender, academic major, level of study, and academic rank. They did find, however, a significant difference in attitude toward m-learning favoring students who owned a tablet and smartphone versus just a smartphone (Al-Emran et al., 2015).

The ECAR study (Dahlstrom & Bichsel, 2014) found that demographic variables had little or no correlation to the inclination of students to use technology. The implication is the stereotypical assumption that younger students are more inclined (or are more prepared) to use technology is not supported by the data. Additionally, the study did not find significant evidence that students are more ready to use technology than in previous years (Dahlstrom & Bichsel, 2014).

Notably missing in the forgoing analyses is any objective achievement represented by outcomes such as grades. These studies primarily concentrated on learner perceptions, feedback, and constructive engagement which is consistent with the theoretical underpinning of m-learning as a student-centered activity. Koszalka and Ntloedibe-Kuswani (2010) noted that m-learning research was just beginning, and there had been very little replication of studies or investigation of particular aspects of mobile technology that might be effective in the m-learning environment. They also noted a lack of thoroughness in their review of the research literature (Koszalka & Ntloedibe-Kuswani, 2010). This situation has not substantially changed in the intervening years; Al Zahrani & Laxman (2015) and Ally and Prieto-Blázquez (2014) reiterated the observation as a recommendation for the future of m-learning in education (Ally & Prieto-Blazquez, 2014; Al Zahrani & Laxman, 2015).

M-learning Effectiveness

In a review of m-learning effectiveness based on theoretical underpinnings of 36 qualitative and quantitative studies from 2000 through 2013, Pimmer, Mateescu, and Gröhbiel (2016) found that instructionist m-learning applications could energize students across classrooms. A combination of constructivist, situated, and collaborative m-learning approaches could connect informal settings and contexts with formal instruction, resulting in greater educational gains and affordances (Pimmer et al., 2016).

An example of the referenced gap in assessment of m-learning effectiveness in an online environment is illustrated in a meta-analysis of mobile learning studies conducted by Wu et al. (2012). The meta-analysis reviewed 164 m-learning studies from 2003 to 2010 to uncover research purposes. The review showed most studies focused on m-learning effectiveness trailed by m-learning system design. The analysis listed the high citation studies for m-learning effectiveness, system design, and the influence of learner characteristics. An examination of these studies revealed that m-learning effectiveness assessments were mostly user perceptions as opposed to measured performance except for Chen, Chang, & Wang (2008) who assessed performance in a face-to-face environment. The authors found that all 21 citations referenced studies that did not assess performance. Citations for assessed performance were for survey and interview data. This shows the gap in studies with quantifiable assessments of mobile learning effectiveness (Wu et al., 2012).

Al Zahrani and Laxman (2015) conducted a meta-analysis of m-learning research from 2009 to 2013 and noted the lack of longitudinal m-learning studies because of the short history of m-learning and concluded a gap exists in research on learning outcomes using mobile technology. The authors recommended further research on m-learning outcomes and the impact on assessment. The authors also concluded that consideration must be given to pedagogical and theoretical issues if the true impact of m-learning to educational outcomes is to be understood (Al Zahrani & Laxman, 2015).

The effectiveness of m-learning in education has several relevant aspects. Figure 1 illustrates that availability, cost, time flexibility, co-student diversity, instructional capacity, student mobility, and the student spatial context are impacted by changes in mobile technology capability. The trend lines for these aspects point to increased capacity, availability, diversity, mobility, and spatial context, with a decrease in relative cost (Ally & Prieto-Blazquez, 2014; Dahlstrom, 2013; Hernandez & Perez, 2014; International Telecommunications Union, 2016; Lowenthal, 2010; Oller, 2012). As mobile technology gets smaller and more capable, the learner is increasingly untethered to the infrastructure in traditional distance learning and even e-learning.

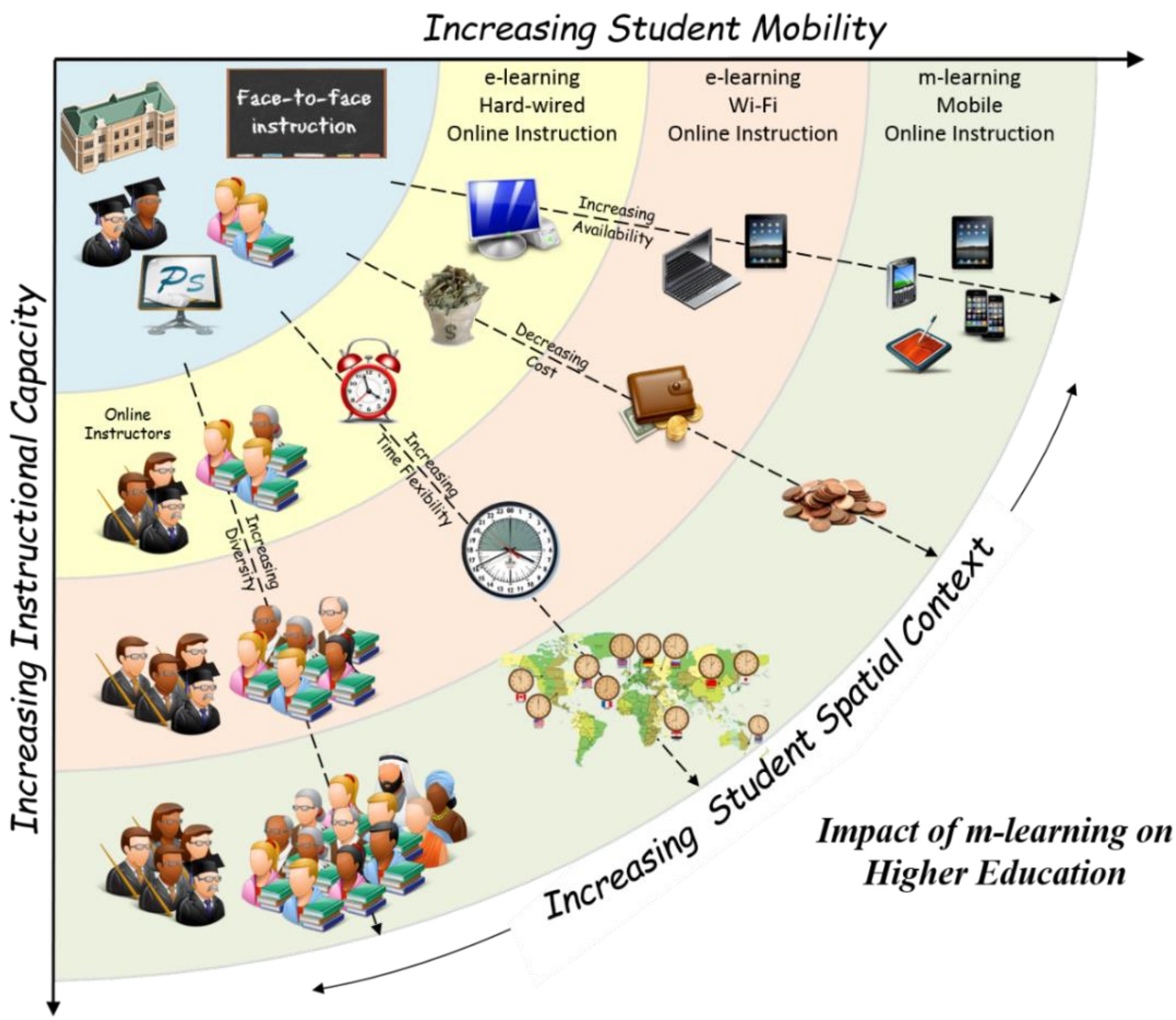


Figure 1. Aspects of the impact of m-learning on higher education. (Researcher original figure with data from International Telecommunications Union, 2016; Dahlstrom, 2013; Hernandez & Perez, 2014; Ally & Prieto-Blazquez, 2014; Lowenthal, 2010; Oller, 2012).

Mobile technology by itself has been shown to increase scores in the face-to-face environment. In an intervention for third-grade students at a Midwestern elementary school, researchers compared a classroom using the iPod Touch with a class using traditional flashcards to learn multiplication. The study controlled for prior achievement, home use of the technology, and previous teacher and found the intervention class outperformed the traditional class with a medium-sized performance advantage (b = .217) (Kiger, Herro, & Prunty, 2012). Hwang and

Chang (2011) also found a significant grade improvement ($F = 11.54$, $p < .01$) with a medium to large effect size ($d = 0.65$) in fifth-grade students using mobile devices with a formative-based assessment approach in a wireless environment (Hwang & Chang, 2011).

In a novel use of mobile technology in a Taiwan elementary school botany class, students used Personal Digital Assistants (PDA) to identify and research observed plant-life in a field environment. The quasi-experiment showed a significant improvement in post-test achievement, $t(30) = 3316$, $p < 0.05$ (Huang et al., 2010). In another quasi-experiment using mobile devices with elementary students in Taiwan, investigators used a concept-mapping approach to support learning by relating new to existing knowledge in an equilibration-like method. Post-test scores for the experimental groups had significantly better learning achievement, $F = 7.80$, $p < .01$, than the control group (Yang et al., 2013). Similar positive results for the use of mobile devices in elementary and secondary schools were observed in hard sciences, social science, language learning, and collaborative learning (Baloch et al., 2012; Huang, Liao, Huang, & Chen, 2014; Looi et al., 2011; Looi et al., 2014; Shih et al., 2010; Zhang et al., 2011).

Mobile technology use in higher and adult education has also shown positive results in the face-to-face environment. Jabbour (2013) showed student achievement in an educational technology course at the Modern University for Business and Science in Beirut was positively improved by using PDAs ($p = 0.017$) (Jabbour, 2013). Aker, Ksoll, and Lybbert (2012) conducted an intervention in Niger that involved distributing mobile phones to adult students and then tracking literary and math scores for several classroom cohorts. Compared to the group without the intervention, the group with mobile phones increased writing and math test scores by .19 to .25 standard deviations (Aker et al., 2012). Relevant to the present study, Mileva (2011) found students using a mobile device during an engineering course did not significantly out-perform the control group using a more standard e-learning approach (Mileva, 2011).

In a quantitative study of the effectiveness of m-learning on student achievement and conversational skills at Najran University in Saudi Arabia, Elfeky and Massadeh (2016) found positive results for the impact of m-learning versus traditional teaching methods. Student scores as Modified Gain Ratio (MGR) of means on the Conversational Rating Scale (CRS) showed the m-learning group mean as 16.16 versus the traditional face-to-face group mean of 12.92. The difference was significant [α=0.05] favoring the m-learning method of instruction (Elfeky & Masadeh, 2016).

Norouzi, Samet, Sharifuddin, Hjh and Hamid (2012) measured the effect of m-learning over critical thinking skills in students using the California Critical Thinking Disposition Inventory Scale (CCTDI) in a pre-test post-test analysis. The study found critical thinking skills and creativity improved with m-learning. The control group post-test obtained a mean of 48.30 and the experimental group mean equaled 62.85, t=2.57, p<.05 (Norouzi, Samet, Sharifuddin, Hjh, & Hamid, 2012).

M-learning offers new learning contexts not available to more traditional face-to-face or e-learning environments. Solvberg and Rismark (2012) noted that student interaction with educational material in m-learning environments has limitations. Students attending lectures, engaging in on-campus activities, or engaging in off-campus activities used mobile technology in different ways at varying depths and frequencies. The students in the study experienced physical contexts according to the learning space they were in at the time of the learning activity. Students moved through different spaces at different times and transitioned between mobile technologies in ways that enhanced learning. The implication is there needs to be a different approach to situated learning that considers the broad spatial contexts possible with mobile technology (Solvberg & Rismark, 2012).

Whether m-learning can satisfy the requirements of an authentic learning environment can be assessed by using a practical framework. Herrington and Oliver (2000) established characteristics of a situated learning environment where knowledge is best acquired if the environment provides an authentic context and activities, access to expert performances, multiple roles and perspectives, coaching and scaffolding, authentic assessment, and promotes refection, articulation, and collaboration (Herrington & Oliver, 2000).

The growth of mobile technology and its use as a delivery medium for education is still at the stage where it must be accepted as a norm in educational content delivery by students, teachers, and society in general in order to constitute a paradigm shift in the Kuhnian sense (Kuhn, 1996). It remains to be seen if m-learning is appropriate, sustainable, or adequate for real learning (Rajasingham, 2011). Franklin (2011) argued m-learning is at a tipping point – an epidemic of the use of mobile technology in many aspects of day-to-day living. The rapid nature of the change in mobile technology stands in contrast to the way educational practice tends to evolve, which is gradually. For the educational establishment to fully embrace the mobile revolution, it has to deal with the complexities of m-learning: pedagogy, communication, and infrastructure. Changes in pedagogy that result from m-learning revolve around the delivery of content by engaging, enabling, and empowering the learner. Learning experiences should be individualized with continuous content access, the freedom to make mistakes, and the ability to communicate, collaborate, and share documents. These are necessary steps because in many cases, m-learning is socially-based, without a teacher, and un-tethered to brick-and-mortar facilities. The successful m-learner will need to be able to manage the interaction with knowledge content and the context of the learning environment. The new choices of spatial context allow the m-learner to craft the physical learning environment to match, enhance, or facilitate the learning activity (Franklin, 2011).

For education to fully adopt m-learning as a new paradigm, Franklin (2011) further argued there are six elements of digital citizenship that apply to the effective use of digital technology: access, communication, rights, security, commerce, safety, and responsibility. Access is the equitable availability of internet services to all. Communication, however, needs some definition when it comes to the use of mobile technology in the classroom. Questions of how, when, where, and why are applicable to the use of cell phones (for instance) in the classroom; the manner of their use must be addressed and standardized. Digital citizens should expect and be afforded fundamental rights – free speech, property rights, and privacy. Digital security has become increasingly important as the use of mobile devices containing personal and financial information proliferates. Security concerns are of particular importance with regard to commerce in a mobile environment. Protecting identity and personal records become more difficult using the airwaves than face-to-face purchases. As much as it is a benefit to constructivist learning for users to leverage different spatial contexts, it is also a safety risk when driving or engaging in activities demanding attention. Digital responsibility is also an important factor when it becomes easier to post quick instant messages without a sense of ethical consequences (Franklin, 2011). Not a day goes by that some significant figure posts a Twitter comment that erupts in angry commentary and backlash.

M-learning moves the learning environment from a teacher-centric learning environment to a more learner-centric one where control over the interaction between learning content and student shifts to the student. This shift cannot become a new paradigm until higher education integrates the idea of the movement of control and learning activity from the teacher to the student. This is more than just the introduction of newer technologies to accomplish the same instructional strategies as more traditional environments. This does not eliminate the vital role of the instructor or the learning plan that provides the basis for the learning activity – it reflects the change in focus and has more profound implications for practice than just changing presentation modes (Rajasingham, 2011).

Gupta and Koo (2010) pointed out that with the constant bombardment of new information, the skills that come with mobile technology that are more suited to delivering knowledge content quickly and efficiently will become more central to learning activities. An added plus is the element of motivation on the part of the learner. This phenomenon is more indicative of the younger generation of learners who have grown up with computers and mobile technology and have a sense of ownership over the learning environment (Gupta & Koo, 2010). On the other hand, it should not be assumed all students have the same level of experience or expertise with mobile technology. Rossing et al. (2012) found the use of iPads in the classroom a distraction for some students who expressed frustration with the learning curve associated with using the technology (Rossing et al., 2012).

For m-learning to achieve the ubiquitous corollary to private mobile use, it must overcome the additional complexity of infrastructure and broadband Internet access. University budgets are impacted by the economy at large and the ever-changing need to keep up with technological advance to be relevant and authentic with the culture at large. The burden on staff and faculty is just as daunting, since there is a generational digital divide between many in higher education and the younger generation of learners. Keeping the connection to cultural change and refreshing faculty perspectives on new technology is a challenge to the full integration and exploitation of m-learning (Franklin, 2011). Gikas and Grant (2013) noted in a qualitative study that students were unhappy with "anti-technology" instructors who would not incorporate emerging technology into their courses (Gikas & Grant, 2013).

An additional challenge to a learner-centered, flexible environment is a requirement for students to exercise personal discipline. It is one thing to applaud the constructivist shift from teacher-centric control of the zone of proximal development to a student-centered control; it is also contingent upon the student's effectiveness in managing that control (Gupta & Koo, 2010). Students may be under the misapprehension that m-learning flexibility will mean an easier environment, or teachers believe m-learning will involve less labor-intensive preparation than the face-to-face learning environment. In fact, the team approach to online development is one of its strengths and is anything but simple to accomplish (Franklin, 2011). The critical issue is the learner's ability to decide when, where, and how to exercise or institute the learning context made available by m-learning. Along with the ability to control the learning context, the learner must also recognize (in a meta-cognitive way) that a learning opportunity has presented itself, and then he or she must be motivated to engage in learning (Sha, Looi, Chen, & Zhang, 2012).

Students who are proactive and motivated to be in charge of their learning can be more successful in the general online environment and in m-learning. Management of the learning environment (when, where and how), combined with motivation and self-discipline, are essential factors for m-learning success (Richardson et al., 2013). Providing an authentic context for learning while controlling that context is an essential feature of m-learning for the constructivist (Lowenthal & Muth, 2009).

Rajasingham (2011) pointed out the adoption of new and innovative technologies in e-learning and m-learning have had mixed success. The determinant of success or failure had less to do with the limitations of the new technology and more to do with the inability of institutions to develop an effective strategy to integrate the technology into the curriculum. In other words, higher education has not adjusted educational practice and curriculum development to accommodate the functionality and services provided by the new technologies. Whether m-learning can be implemented and supported across the variety of learning venues, learning styles, and cultural contexts is an open question. From a practical standpoint, it needs to be demonstrated that m-learning can be grafted into existing curriculum and the converse, the existing curriculum can be adjusted for m-learning, to achieve an effective learning environment (Rajasingham, 2011).

Alrasheedi et al. (2015a) pointed out that m-learning adoption by institutions relies upon more than teachers and students; university management is key to m-learning success. University upper management, deans, department leaders, and information technology system administrators are important participants and decision makers for new technology acceptance. Alrasheedi et al. modeled success factors for m-learning from the management perspective including organizational structure, culture, commitment, learning practices, and change/conflict management practices. The study found the critical factors were commitment to m-learning, learning practices, and change management practices. M-learning adoption is less successful without proper management of these factors (Alrasheedi et al., 2015a).

It may be too early to declare a paradigm shift in the absence of quantitative data to anchor the kind of commitment institutions will have to demonstrate to embrace the m-learning environment fully. The 2015 ECAR study shows that although mobile technology is imbedded in student lives, and their interest in using mobile technology remains high, their practical experience with campus networks and Wi-Fi are disappointing. Additionally, the study indicated technologies are not realizing the envisioned effectiveness for academic use, and mobile use continues to be low in spite of the dramatic increases in ownership among both students and faculty (Dahlstrom et al., 2016).

What remains to be determined is whether m-learning can provide a useful learning experience compared to traditional face-to-face or tethered distance and e-learning environments. The current study will examine the correlation of m-learning to summative assessment in an online environment.

The Future of M-learning

Sales of desktop computers have been declining compared to the exponential rate of mobile technology sales augmenting computers for individual needs. Over the last 10 years, laptops have outsold desktops in numerous world markets, and the universal appeal of smartphones has exceeded both. Mobile technology is evolving at a rapid pace. The next generation of m-learning will be more pervasive with smart systems being almost universally available. Cloud technology will make applications and capacity extensively accessible, widespread, and virtual. Learners will use multiple platforms to access content, with a variety of functionality (Ally & Prieto-Blazquez, 2014). Entner (2011) noted the replacement cycle for mobile handsets in the United States was consistently under two years for the period 2007 -2010. Regression analysis of the factors impacting this trend revealed that service provider price subsidies significantly reduced handset replacement cycles (Entner, 2011). This rapid market-based turnover caused diminishing smartphone innovation and even predictions that the smartphone will become obsolete as reliance on more customized, modular systems with cloud services increases (Doyle, 2014).

And yet, mobile computing is still in its early stages with the next generation of mobile technology forecasted to be ubiquitous, more portable, and personal with suites of sensors that can augment reality, track movement, heart rate, and general health. The mobile technology experience will likely be immersive and could include wearable computing capabilities. The downside is all this virtual communication could potentially overpower network capacity (Edmondson et al., 2014).

The availability and various functional capabilities of mobile technology has diffused through social, business, and educational realms to blur the distinction between traditional roles for information and where, when, and how information is accessed; in particular, the role of the library (Dempsey, 2008). Access to network resources has become more than a luxury to many governments; Finland became the first country to legislate a legal right for broadband access for all its citizens. Providers were required to offer access to all citizens by 2015 (BBC News, 2010).

Current educational practice is based on a paradigm established before the arrival of the information and communication technology revolution. The classroom face-to-face environment is narrowly focused on a limited sector of the population and is reliant on traditional infrastructure and a training model based on that paradigm. Teacher education needs reengineering to account for the change in the educational locus of control brought on by mobile technology. Changes to curriculum and teaching resources require redesign to align with new delivery methods and characteristics (Ally & Prieto-Blazquez, 2014).

The evolution and growth of the online environment has altered the perception of e-learning as a feasible substitute for some types of face-to-face learning. The value of e-learning has become well known for the qualities of flexibility, easy access, and advanced technology.

Moreover, the business world has brought innovation to a new level in the digital environment which is widely considered to be rich ground for new functionality, services, and devices (Johnson, Adams Becker, Estrada, & Freeman, 2014).

M-learning can advance the goals of higher education by appealing to a broader student demographic with flexible access to course materials without time and place constraint (Lowenthal, 2010). By making time zones irrelevant, m-learning enables equal opportunities to access educational content, and small, wireless devices provide anytime, anywhere ability to work together, share knowledge and skills, and communicate with others (Ally & Prieto-Blazquez, 2014). The flexibility enabled by m-learning has had the effect of increasing the likelihood of collaboration by integrating outside resources for discussion and project completion (Johnson et al., 2014).

The largest trend in m-learning and the use of mobile technology has been the impact of social media (collaborative projects, blogs/microblogs, content communities, social networking sites, virtual game worlds, and virtual social worlds). Social media facilitates the sharing of information about personal issues, subjects of interest, and the interchange of messages. This interaction breaks down barriers of distance and supplements already established connections between learners. Social media assists institutions to connect with a larger audience and is widespread in the learner population spanning all age groups and demographics (Johnson et al., 2014).

Because many mobile devices are provided with Global Positioning System (GPS) services, learners can share their location and be aware of other learner locations to facilitate interaction. Knowing the learner location allows geographically-pertinent information to be delivered as learners interact with natural and man-made points of interest. Another feature using location that is growing more refined every year is augmented reality. The real-world environment is sensed through a camera viewpoint and is combined with virtual content generated by computer application. The resultant image can be viewed by smartphone or special glasses (Cook & Sonnenberg, 2014; Oller, 2012).

Augmented reality has the potential to become a truly differentiated, constructivist tool as the capabilities of location-centered technology add another layer of perception to m-learning. Virtual avatars could be overlaid on actual locations to provide commentary, expertise, or narrative on the significance of the location in history, science, or culture. Information could be injected through geographical tagging into m-learning applications that would appear as the learner travelled through the location, either as part of the curriculum or learner-centered discovery. These overlays could even show the past or possible future for the learner's location, or peer into existing structures to reveal interior spaces and artifacts. Game interfaces could enhance the learner's environment and superimpose gaming objects for m-learning in a gaming mode (Cook & Sonnenberg, 2014; Oller, 2012).

The traditional face-to-face learning context creates a stable platform predominately controlled by the institution and the teacher. Traditional e-learning has rapidly grown away from a tethered environment, favoring more learner control over the learning context. As mobile technology continues to become ubiquitous, more control over context will flow to the learner, creating more immersive, constructivist, situated learning (Franklin, 2011; Sharples et al., 2007). Mobile technology permits delivery of timely, custom-made, differentiated education unlike prior implementations of tethered desktop-based platforms (Rajasingham, 2011). Students are beginning to expect access to course content free of the restrictions of time and place and prefer to use personal devices inside and outside the classroom (Dahlstrom, 2013).

Future m-learners' situational awareness will be heightened using sensors embedded in the learner's clothing or other wearable items. This capability will be able to sense learner surroundings and enhance cognizance of aural and optical data and could gather information beyond the ability of human senses to characterize the environment. An obvious benefit of this capability is the addition of positioned educational experiences for learners with disabilities. Portable to wearable computing naturally leads to even more personal technology that has benefited people with disabilities including learning implants (Oller, 2012).

The ultimate evolution of mobile and computing technology may be the realm of ambient intelligence. Ambient intelligence is computing integrated into the everyday environment to the point where only the interface with the user is experienced and the computing is embedded, adaptive, context aware, personalized, and anticipatory (Philips Inc., 2014). Ambient intelligence in the everyday world will make m-learning completely untethered from the infrastructure of traditional e-learning (Oller, 2012). Technological advances could eventually include evolutionary learning environments that would characterize students according to learning type to differentiate further and adapt by delivering educational content in a more appropriate way (Pereira & Rodrigues, 2013).

The future of m-learning will depend on the confluence of technological breakthrough with the ability of educational institutions to adapt and accommodate the capabilities of mobile computing. Higher education is quickly moving to adjust m-learning applications to make full use of technological capabilities that could, ironically, lead to the decline of those very same institutions as centers of learning. To keep current with the level of information communications technology that learners increasingly rely on, curriculum designers, institutional leaders, and instructors will need to try out new pedagogical approaches rather than trying to fit new capabilities into traditional educational practice (Oller, 2012). On all levels of the education spectrum, teachers, instructional technology experts, school administrators, and policy makers should expect to expend significant effort in time and resources to incorporate mobile devices into curriculums (Liu, Navarrete, & Wivagg, 2014).

Advancements in m-learning will hinge on the merging of progress in mobile technology and the willingness of educational institutions to redesign curricula and pedagogical practice (Oller, 2012). Rajasingham (2011) noted that adopting new mobile technologies to advance and innovate e-learning and m-learning has had varied success. The determining factor was the ability of the institution to accommodate mobile technologies and integrate capabilities into the institution's infrastructure and curriculum. Both sides of the issue need further analysis to demonstrate that curriculum and infrastructure can integrate mobile technologies and the m-learning experience is effective in supporting academic achievement (Rajasingham, 2011).

Although many institutions have embraced m-learning and have gone to great lengths to improve the technological base, faculty education to develop the necessary skills to make the best use of this technology is lacking (Johnson et al., 2014). Many instructors in higher education have less skill in digital media than their students and fail to meet learner expectations for integrated mobile technology in the e-learning and face-to-face classroom (Dahlstrom, 2013). In a two-year project at three institutions where mobile devices were introduced, there were several areas of success in integrating the technology, but one of the problems encountered was the resistance to change experienced at all three institutions. Teachers at one school, Information Technology support at another, and faculty at the third institution were all resistant to the proposed innovation in one way or another (Lacey et al., 2014). The ECAR longitudinal research has consistently identified the requirement for institutional leadership to prioritize and catalyze success for technology adoption and curriculum changes to leverage the m-learning environment (Dahlstrom et al., 2016).

Agreement that mastery of the digital frontier as a critical skill for teachers is universal in higher education. And yet, faculty preparation and teacher education are still lacking in teaching those skills for use in the classroom. Higher education faculty are not blind to the need for increased proficiency in digital skills and are obtaining training through unofficial means and forms of continuing education offered by their institutions. Ultimately, the skills in question are more meta-cognitive since m-learning is more a way of constructivist thinking than a set of practical skills (Johnson et al., 2014). Franklin (2011) argued m-learning is at a tipping point – the point where the use of mobile technology in education is exploding. The educational establishment is faced with the challenge of addressing the complexities of m-learning in terms of pedagogy, communication, and infrastructure. Rajasingham (2011) cautioned that the use of mobile technology must first be accepted as a norm by instructors, students, and society for a genuine paradigm shift to occur (Rajasingham, 2011). Dahlstrom (2013) noted in the ECAR findings that the banning of laptops, and other mobile devices in the classroom is common.

Summary

In 2016, approximately seven billion people had access to a cellular network and mobile broadband access reached 95% of the global population (International Telecommunications Union, 2016). Communication mobility increasingly affects every aspect of life, particularly education (Rajasingham, 2011). Mobile technology is pervasive on university campuses and has led to an evolving form of e-learning known as m-learning (Hernandez & Perez, 2014). M-learning can be defined as learning that takes place in environments that include the mobility of technology, learners, and learning. M-learning is constructivist and student-centered; it is extremely flexible and intersects with students in learning activities in diverse physical contexts (El-Hussein & Cronje, 2010). M-learning is changing conventional teaching and learning by introducing educational content into the everyday lives of students – even while the online environment is still catching up to the capabilities of mobile technology (Pereira & Rodrigues, 2013).

M-learning is becoming more common in online courses and is increasingly used for academic purposes. Students are convinced mobile technology is necessary for academic success and expect anytime, anywhere access to course content. The use of increasingly capable mobile technology among undergraduates has quickly ballooned to become ubiquitous. Students are ready to use mobile technology to achieve academic success (Dahlstrom, 2013). The Pearson Study (Harris Poll, 2015) shows students still prefer and learn best on laptops, but tablet and smartphone use continues to increase each year (Harris Poll, 2015).

Although many aspects of the m-learning environment have been examined, there is a lack of quantitative research in the successful use of mobile technology for achieving academic success (Koszalka & Ntloedibe-Kuswani, 2010; Rajasingham, 2011). Although there is much research related to user perceptions, more empirical evidence is needed to measure the effectiveness of mobile technologies in educational achievement in order to justify the necessary investment in time and funds to implement m-learning (Lacey et al., 2014; Richardson et al., 2013).

This study addresses the gap in m-learning research by examining the correlation of m-learning enabled by mobile technology to academic achievement expressed by final grades in a Community College System online learning environment.

CHAPTER THREE: METHODOLOGY

Overview

The strategy of inquiry for this study is a quantitative analysis since gaps in the literature point towards a lack of correlation between summative assessment and m-learning. The correlation design was chosen to relate the two variables to determine if they influence each other (Creswell, 2012). Therefore, the purpose of this study is to examine the relationship between m-learning using mobile technology and academic achievement in terms of final grades in an online environment. The literature on m-learning indicates the freedom and flexibility of the m-learner constitutes a new paradigm in education. The un-tethered nature of m-learning means students can access course content anywhere, anytime (Rajasingham, 2011). Studies have focused on the use of specific technologies in learning environments, but this study cuts across disciplines and measures the magnitude of mobile technology use as a function of degree of access to course materials while mobile. The study methodology includes design description, research questions and hypotheses, participant description and study setting, instrumentation, procedures, and data analysis.

Design

This study employed a bivariate correlation methodology to explore the strength and direction of the use of mobile technology on the dependent variable (GPA). A partial correlation approach removed the influence of demographic sub-groups (age, gender, and race) to examine the influence of mobile technology use. For the purposes of this study, the word *gender* is being used in the traditional sense to indicate male or female and is dependent upon the participant for gender identification. This non-experimental design was appropriate since the independent variables cannot be controlled, data must be collected after mobile technology use has occurred/not occurred, and grades are assigned. Cause and effect relationships in a correlational design cannot be completely established, but correlation coefficients can show the degree and direction of the relationship (Gall, Gall, & Borg, 2007).

This study correlated the use of mobile technology with student achievement through a survey instrument that elicits previous semester GPA, the degree of mobile technology use, and demographic data. The selection of the m-learning independent variable was based on the common characteristics of m-learning: the mobility of technology, learners, and learning (El-Hussein & Cronje, 2010). The essential nature of m-learning is succinctly described as learning anytime, anywhere (Wong & Looi, 2011).

The primary independent variable was the degree or frequency of mobile technology use by participants while accessing course material. The use of mobile technology when accessing course materials was captured by survey and measured on a Likert scale (always [100], often [75], sometimes [50], seldom [25], never [0]). The baseline condition was a student only using an at-home computer to access course material ("never" on the mobility frequency scale). With rapid technological innovation in mobile technologies, identifying specific devices for study is a moving target (Wu et al., 2012); mobile handset replacement has tended to be less than two years due to provider subsidies (Entner, 2011). The most relevant attribute of this variable is untethered mobility agnostic of the capability of the technology.

The selection of demographic sub-groups was based on the ECAR Study of Undergraduate Students and Information Technology (Dahlstrom, 2013) results showing students with the most mobile technology are male (34%) versus female (25%), older (41%) versus younger (23%), and white (32%) versus nonwhite (26%). The item regarding collegiate status (first or second year student) was not indicated in the research as a relevant variable, but is of interest to participating institutions. Therefore, the question was included but not covered by the research questions or null hypotheses. The dependent variable of GPA was anonymously self-reported through the survey instrument. The questionnaire was web-based through a link provided to the participants. Participants responded to the questionnaire items by selecting a consent button (Gall et al., 2007).

The variation in mobile technology functionality may contribute to positive or negative correlation. Although sample size does not have a direct impact on the correlation value, a small sample size can cause an inaccurate result. The sample size achieved for the current study (N = 506) contributes to a stable result (Hinkle, Wiersma, & Jurs, 2003).

Research Questions

RQ1: Is there a relationship between student use of mobile technology in an online environment and student achievement expressed by grade point average?

RQ2: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race?

RQ3: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender?

RQ4: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age?

Null Hypotheses

$H_0$1: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average.

$H_0$2: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race.

$H_0$3: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender.

$H_0$4: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age.

Participants and Setting

The target population for this study was students enrolled in online courses in a VCCS community college system (≥18 years old). The accessible population consists of the voluntary online subset of all students enrolled during the data collection period. The VCCS includes 23 community colleges with 40 campuses. Enrollment for the VCCS (annual unduplicated headcount) for 2013-14 school year was 273,026 students. The subset of students enrolled in distance learning courses only for the same period was 44,838 (VCCS Distance Learning Enrollment, 2013). This study included all distance learning students from participating colleges choosing to allow the questionnaire on a volunteer basis with a target response rate similar to the ECAR study (Dahlstrom, 2013) and the Pilot study (~10% of total participating distance learning students within the VCCS). To address sample heterogeneity, demographic data was formed into subgroups (age, gender, and race) during correlation analysis. The VCCS respondent profile for the ECAR 2012 study is shown in Table 1. This respondent profile is very similar to this study (Office of Institutional Research and Effectiveness, 2012).

Table 1

Respondent Profile

Demographic Category	Percentage
Age	
18-24	45%
25-39	33%
40 and above	22%
Gender	
Female	70%
Male	30%
Race	
White	61%
Minority	34%
Unknown	5%

Note. From "*Student success snapshot issue #23,*" Office of Institutional Research and Effectiveness, 2012.

The study setting was six community colleges in the VCCS and included online courses offered by accredited institutions taught by instructors trained and certified by the VCCS. Courses were delivered in 16-week formats in the Fall 2016 and Spring 2017 semesters using an LMS (e.g. Blackboard). Students used the LMS (or a mobile application) to access course content, syllabus information, grades, technical help, course tools, announcements, and a variety of site specific additional content.

Instrumentation

The data collection instrument for variables was a questionnaire (see Appendix C) with GPA, demographic, and mobile technology usage questions. The questionnaire measured the use of mobile technology to access course materials on a five-point, Likert-like scale. Likert scales are a psychometric measurement of attitude or perception regarding statements using bipolar-named categories (Willits, Theodori, & Luloff, 2016). This study instrument was not a measure of attitude or a perception about a statement; it was a measure of a behavior on a scale of 0% (never) to 100% (always) as a degree of mobile use.

Likert scales are considered ordinal and usually require a non-parametric statistical approach. Likert scales are rank ordered and the intervals between values cannot be considered equal (Norman, 2010). The instrument in this study was Likert-like in that there were five categorical responses: “never (0),” “seldom (25),” “sometimes (50),” “often (75),” and “always (100).” The instrument defined this scale as “percentage of time,” and each response item had a percentage in parenthesis after the response. The instrument is similar to a numerical scale, but with Likert-like categories. Assigning percentage values to each category allowed the intervals between values to be equal. Additionally, there is a true zero point in the scale, and so it can be considered a ratio scale. Analysis in this study included parametric and non-parametric approaches as mitigation for violations of normality and appropriateness of scale.

The dependent variable of GPA was anonymously self-reported by the participant through the instrument. The questionnaire was accessed through a web-based link from the institution or a direct email to the student by the researcher. Participants responded to survey items by selecting a button and checking the box for multiple answers (Gall et al., 2007). The questionnaire was hosted online at QuestionPro.com.

The construct for this study was the mobility of the student while accessing and interacting with course content. Construct validity was determined through the questionnaire by eliciting the degree of mobility experienced over the course of the study semesters. Individual items in the questionnaire were related through convergent or discriminant evidence that they measure the same mobility construct (Gall et al., 2007).

Instrument reliability was addressed using a pilot study administered to online students at Thomas Nelson Community College (TNCC) in Hampton, Virginia. The researcher received Liberty IRB and TNCC Director of Institutional Research and Effectiveness approval prior to distributing a link to the questionnaire. The questionnaire was offered to 1,450 online students with a response rate of 9.6%. One hundred and fifty students began the questionnaire; 86% of responses (N = 129) were valid with listwise deletion based on all variables in the procedure. The pilot study Cronbach's alpha coefficient was .956. The study showed most students used mobile devices to access course materials "Always," "Often," or "Sometimes" (see Figure 2). The pilot study summary item statistics are shown in Table 2 and pilot study total-item statistics are shown in Table 3 (Gliem & Gliem, 2003).

The questionnaire did not include demographic information and was anonymous with space for participants to provide criticisms and recommendations for improvement (Gall et al., 2007). Feedback on interpretation and meaning from participants in the pilot study was used to enhance the consistency of instrument scores (Radhakrishna, 2007).

Population validity was addressed through a stratified random sampling from the accessible population of the voluntary online subset of all students enrolled during the data collection period (Gall et al., 2007). The stratified random sample was drawn to proportionally match a profile of nationwide students based on National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS) data on age, gender, and ethnicity.

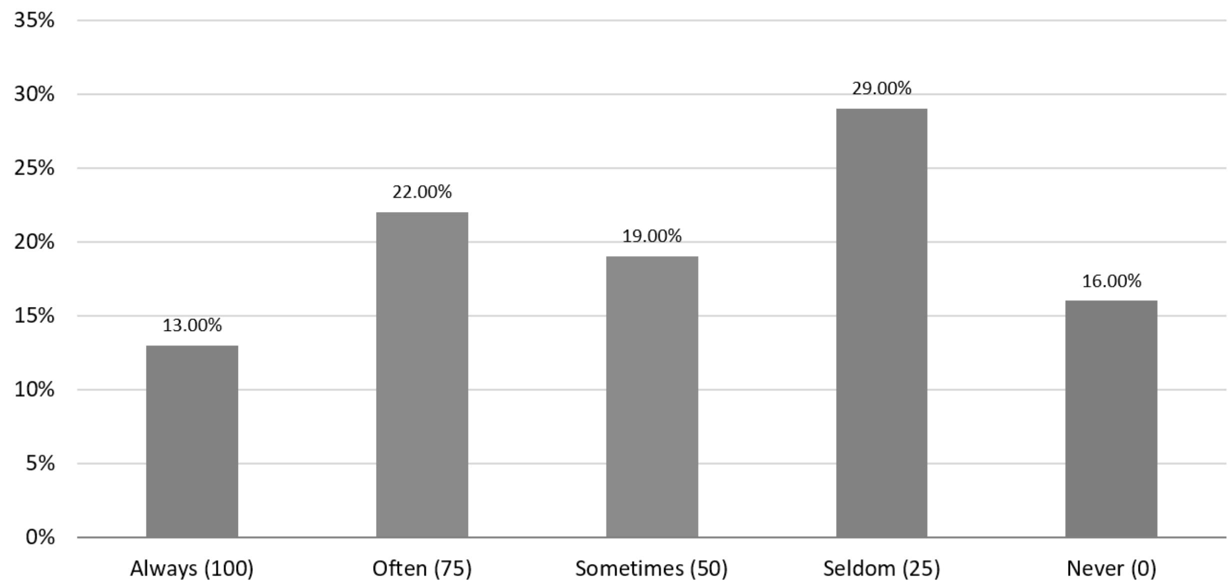


Figure 2. Pilot study question: "Generally, how often did you use a mobile device instead of a desktop device to access course materials?" Mode: Seldom, Mean: 46.7 (Sometimes), Standard Deviation: 32.5.

Table 2

Pilot Study Summary Item Statistics

	Mean	Minimum	Maximum	Range	Max/Min	Variance
Item Means	44.81	27.52	58.14	30.62	2.113	83.80
Item Variances	1194.65	1058.40	1454.70	396.30	1.374	19718.38
Inter-Item Correlations	.69	.50	.81	.31	1.62	.01

Note. *N* = 129.

Table 3

Pilot Study Item-Total Statistics

Item Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Item 2	411.56	72420.967	.673	.494	.957
Item 3	409.30	68936.228	.767	.686	.954
Item 4	399.61	68505.708	.858	.751	.950
Item 5	398.64	68870.216	.873	.804	.949
Item 6	389.92	70942.572	.791	.754	.952
Item 7	405.43	69091.418	.863	.767	.949
Item 8	405.04	69466.600	.863	.770	.950
Item 9	391.67	70628.255	.797	.759	.952
Item 10	420.54	68803.219	.788	.714	.953
Item 11	401.36	70344.825	.832	.721	.951
		Alpha	Standardized Item Alpha		
Reliability Coefficients		.956	.957		

Note. Item *N* = 10.

The face validity of the this study is supported by comparison to previous studies and literature designed to measure the degree of mobile usage in higher education (Dahlstrom, 2013; Dahlstrom & Bichsel, 2014; Harris Poll, 2014).

Procedures

The researcher applied for Liberty University Institutional Review Board (IRB) approval for the research project. Concurrently, the researcher contacted target institutions to request conditional approval to satisfy Liberty IRB requirements. After obtaining final Liberty IRB approval, the researcher submitted the research proposal to participating VCCS colleges for individual IRB and/or external requests for research approval processes. The study instrument was anonymous and GPA was self-reported; the researcher did not have access to student personal information (Liberty University, 2013).

The researcher provided a link to the questionnaire to all participating institutions or directly to online students during and after the target semesters and identified the researcher, described the purpose and significance of the study, requested cooperation and informed consent, and highlighted the importance of participation. The questionnaire included the purpose and significance of the study, reemphasized the importance of participant response, and explained how confidentiality would be maintained. The questionnaire also included an informed consent stipulation prior to questionnaire completion (Gall et al., 2007).

Participants were given access to the questionnaire either through LMS or direct e-mail from the institution or the researcher. The target semesters were Fall 2016 and Spring 2017. The survey was distributed during and after the Spring 2017 semester (participants reported on both semesters depending on when the survey was distributed and completed). All participant independent variable responses were matched to the GPA dependent variable through the Statistical Product and Service Solutions (SPSS) software analysis tool. Data resided on a password protected computer, and the survey at QuestionPro.com was closed after survey results were collected. After data were reduced and analyzed, it was securely stored and will be erased using deletion software at the appropriate time.

Data Analysis

The study used a bivariate correlation and removed the effect of age, gender, and race (two-tailed, $\alpha = .05$). The Pearson Product-Moment Correlation Coefficient (Pearson's *r*) and Spearman's rho were used between semester GPA (dependent variable) and mobile technology use (independent variable). Both parametric and non-parametric tests were used to address the distribution normality characteristics and appropriateness of scale.

Factors potentially affecting the size of the correlation included: the amount of variability in the data, differences in the shapes of the distributions, lack of linearity, the presence of one or more outliers, characteristics of the sample, and measurement error (Goodwin & Leech, 2006). The normality of variables is assumed and was checked by histogram with normal distribution overlay or by conducting Shapiro-Wilk and Kolmogorov-Smirnov tests (normality assumption tenable with significance level $p > .05$) (Howell, 2011). Linearity and homoscedasticity (assumption that variability of measures will be similar) between independent and dependent variables is assumed, and observations were independent (the measurements of variables do not influence each other). Linearity and homoscedasticity were checked using a scatterplot/heat map with best fit regression line (Gall et al., 2007).

The significance of correlation was assessed by comparing the zero-order correlation (correlation between two variables that does not include a control variable) with partial correlation (with control variables) to determine the influence of the demographic sub-groups on the significance of the correlation (Szapkiw, 2013; Rajrathnam, 2002). A significance level of $p \leq .05$ was used and the value for degrees of freedom and the magnitude of the accessible population helped to increase the power of the design.

Figure 3 shows the relationship interactions between the independent variable (mobility) and the dependent variable (grades) with age, gender, and race controlled. The subsequent coefficients of determination (strength of the relationship) r_p^2, could be reduced by the influence of the demographic variables (Creswell, 2012). For the purposes of this study, the word ‘gender’ is being used in the traditional sense to indicate male or female and is dependent upon the participant for gender identification.

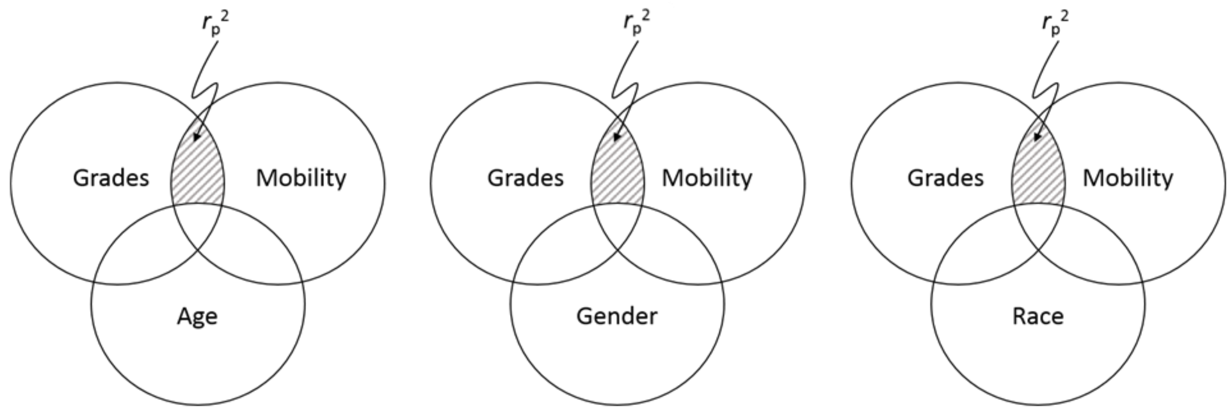


Figure 3. Shared variance for partial correlations.

Correlation results are displayed in correlation tables to include all variables in the study. Analysis included an examination of demographically heterogeneous subsamples as well as overall correlation (Howell, 2011). The strength and direction of the correlation coefficients indicate whether the increase in use of mobile technology correlates with increased achievement in the form of GPA.

CHAPTER FOUR: FINDINGS

Overview

This study surveyed online students in Virginia community colleges to examine the relationship between the use of mobile technology in the context of m-learning and achievement in the form of GPA. Appendix D shows the survey instrument data. Study findings include a review of research questions and null hypotheses, sample descriptive statistics (participant statistics, dependent variable, independent variables), and results (correlation inferential statistics).

Research Questions

RQ1: Is there a relationship between student use of mobile technology in an online environment and student achievement expressed by grade point average?

RQ2: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race?

RQ3: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender?

RQ4: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age?

Null Hypotheses

$H_0$1: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average.

$H_0$2: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race.

$H_0$3: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender.

$H_0$4: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age.

Descriptive Statistics

Participant Statistics

Survey participants were volunteer samples of convenience, and GPA was self-reported to satisfy Family Educational Rights and Privacy Act (FERPA) protections (Family Educational Rights and Privacy Act [FERPA] of 1974, 1974). The survey instrument was distributed to 11,078 online students from six Virginia community colleges during and after the Spring 2017 semester. The survey link was selected by 1,002 participants (approximately 9% of distribution), 560 participants began the survey by checking the consent button, 54 participants dropped out after selecting the consent button and before answering the first question (i.e., “What was your GPA last semester *for online courses only*”), and 506 participants completed the survey for a completion rate of 90.36% (completed/began). The average time to complete the survey was three minutes.

Laptops dominated mobile technology use followed by smartphone, then tablet/iPad. Figure 4 shows the cumulative uses of mobile technology and desktop computer. Over 50% of participants used at least two mobile devices (with or without desktop computer) during the target semesters. The most prevalent combinations were laptop and smartphone (*n* = 113), then laptop, smartphone, and desktop (*n* = 52).

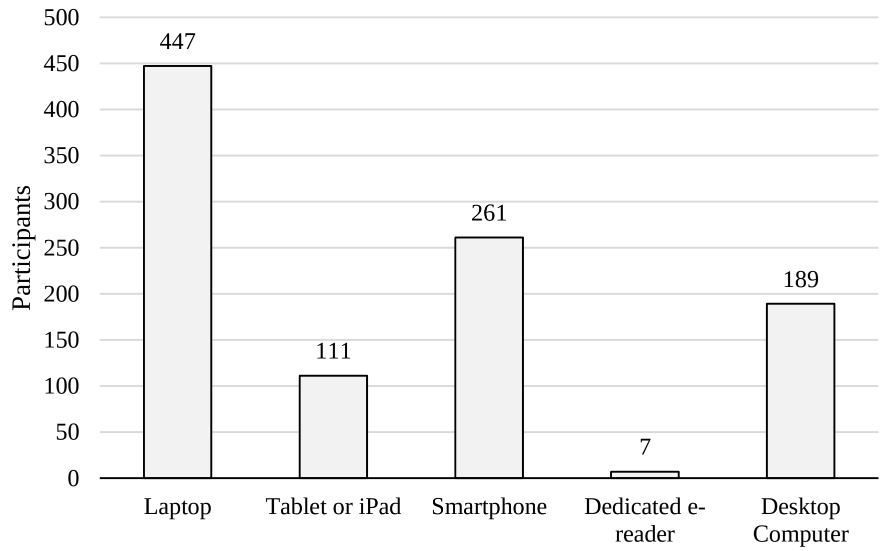


Figure 4. Cumulative mobile technology and desktop computer use.

Since laptops can be used like a desktop (even though technically a mobile device), it is useful to consider the mobile sub-group of smartphone, tablet, e-reader, and those who have both a desktop and laptop (assuming the laptop would constitute mobility). This sub-group (*n* = 203) was treated to the same statistical tests to accommodate the possibility that a laptop could be a desktop (for all intents and purposes) and is included in the results.

Participant gender was 76% female and 24% male. Participant age distribution is shown in Figure 5 with the mode between 18-24 and the mean between 25-34. Participant ethnicity distribution was predominately White and African American (87%) followed by Hispanic (5%). Ethnicity distribution is shown in Figure 6. Participant collegiate status was 34% first year (or approximately 0-30 credits) and 66% second year (or approximately 31-60 credits).

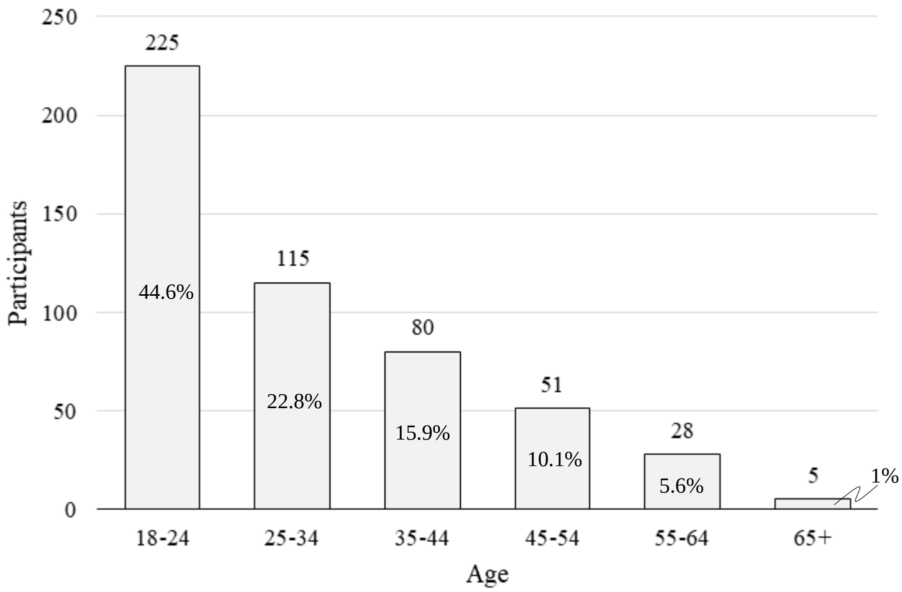


Figure 5. Participant age distribution. Age 18-24 (44.64%), 25-34 (22.82%), 35-44 (15.87%), 45-54 (10.12%), 55-64 (5.56%), 65+ (0.99%).

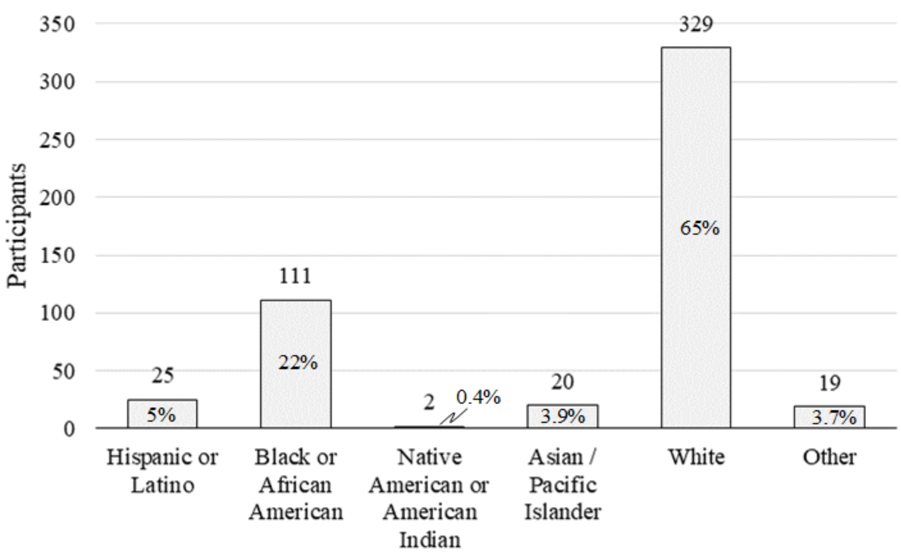


Figure 6. Participant ethnicity. Ethnicity percentages: Hispanic (4.94%), African American (21.94%), Native American (0.40%), Asian (3.95%), White (65.02%), Other (3.75%).

Dependent Variable

The study dependent variable is GPA. Figure 7 shows the frequency distribution (score density) of sample GPA scores with a non-normal, negatively-skewed distribution. GPA is a ratio scale (true zero point) with a range of 0.0 – 4.0 and intervals of 0.25. The interval was 0.125 around the midpoint with the exception of 1.0 and 4.0 responses; the 1.0 response included all scores from 0 to 1.125, and the 4.0 response included all scores from 3.875 to 4.0. The GPA variable was negatively skewed ($sk_p = -1.15$). A 5% trimmed mean of 3.44, taking into account outliers, still presents a negatively-skewed distribution. Table 4 shows the nonparametric Kolomogorov-Smirnov goodness-of-fit ($p = .000$) and the parametric Shapiro-Wilk test ($p = .000$), indicating there is sufficient evidence the GPA distribution violated the normality assumption.

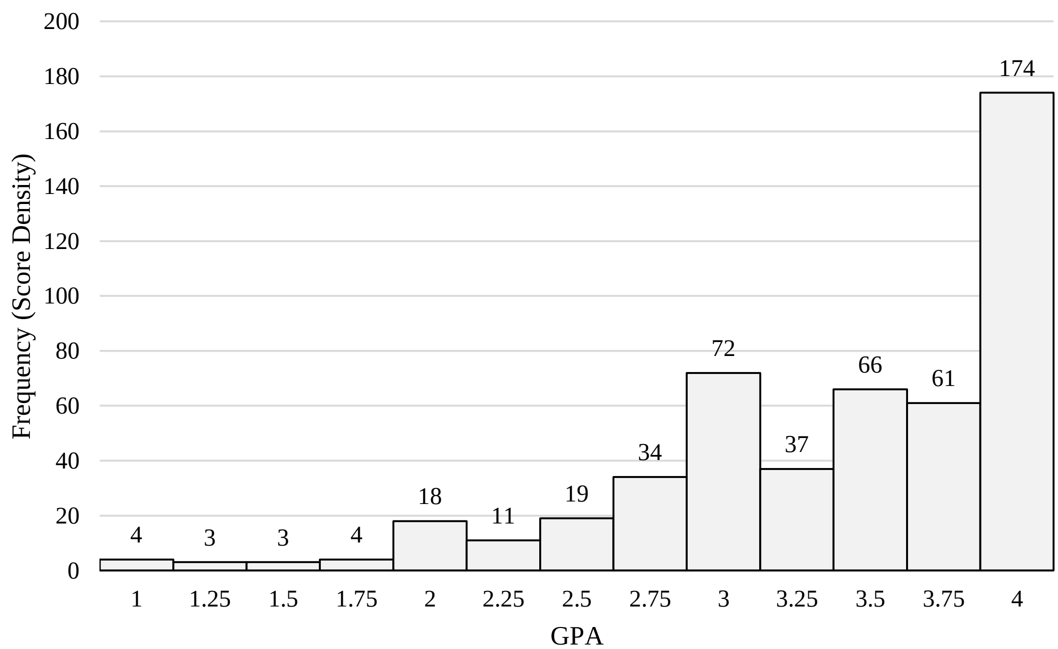


Figure 7. GPA frequency distribution. Sample $N = 506$, $\bar{x} = 3.39$, $s^2 = 0.44$, $s = 0.66$.

Table 4

Dependent variable normality tests

	Kolmogorov-Smirnov[a]		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
GPA	.177	.000	.850	.000

Note. *df* = 506
[a] Lilliefors Significance Correction

Independent Variable

The study independent variable was a series of questions designed to elicit the degree of mobile technology use for specific categories of online services (lecture recordings, practice quizzes/reviews, discussion forums, assignments, administration, study materials, links, announcements, and quizzes/tests). Questions were on a Likert-like scale (Never = 0%, Seldom = 25%, Sometimes = 50%, Often = 75%, Always = 100%), *N* = 506. Although Likert scales are usually considered ordinal scales and require a non-parametric statistical approach, the study instrument is more numeric than psychometric (designed to elicit a degree of behavior vs. a perception or attitude toward a given statement). Intervals between response categories are equal since each response is assigned a "percentage of time" as stated in the questionnaire. Additionally, there is evidence that parametric statistical tests can be robust when distributions are skewed or when applied to Likert scale results (Norman, 2010).

Table 5 shows the mean and standard deviation for the independent variable. Question responses show on average that participants used mobile technology "sometimes" or "often."

Table 5

Independent variable mean and standard deviation

Survey Instrument Question	$\bar{x}$	*s*
8. How often did you access online lecture recordings (video or audio) using a mobile device?	46.89	37.08
9. How often did you access online practice quizzes/reviews using a mobile device?	54.69	39.13
10. How often did you access online discussion forums using a mobile device?	58.15	36.95
11. How often did you access online course assignments using a mobile device?	63.59	35.59
12. How often did you access online course administration using a mobile device?	69.32	31.60
13. How often did you access online course study materials using a mobile device?	61.66	34.68
14. How often did you access links to other materials using a mobile device?	60.87	33.90
15. How often did you access online course announcements using a mobile device?	69.52	32.02
16. How often did you access and complete online quizzes/tests using a mobile device?	48.37	43.10
17. Generally, how often did you use a mobile device instead of a desktop device to access online course materials?	58.45	33.62

Table 6 shows the nonparametric Kolomogorov-Smirnov goodness-of-fit ($p = .000$) and the parametric Shapiro-Wilk test ($p = .000$), indicating there is sufficient evidence the independent variable distributions violated the normality assumption.

Table 6

Independent variables normality tests

	Kolmogorov-Smirnov[a]		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
8. How often did you access online lecture recordings (video or audio) using a mobile device?	.159	.000	.870	.000
9. How often did you access online practice quizzes/reviews using a mobile device?	.186	.000	.841	.000
10. How often did you access online discussion forums using a mobile device?	.184	.000	.857	.000
11. How often did you access online course assignments using a mobile device?	.215	.000	.841	.000
12. How often did you access online course administration using a mobile device (grades, tools, etc.)?	.233	.000	.834	.000
13. How often did you access online course study materials using a mobile device?	.207	.000	.863	.000

	Kolmogorov-Smirnov[a]		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
14. How often did you access links to other materials using a mobile device?	.195	.000	.875	.000
15. How often did you access online course announcements using a mobile device?	.240	.000	.827	.000
16. How often did you access and complete online quizzes/tests using a mobile device?	.233	.000	.786	.000
17. Generally, how often did you use a mobile device instead of a desktop device to access online course materials?	.167	.000	.884	.000

Note. *df* = 506
[a] Lilliefors Significance Correction

Figures 8-12 show the cumulative frequency of Survey Instrument Question responses (Q8-Q17) versus GPA. These figures sort the data according to independent variable responses (Always (100), Often (75), Sometimes (50), Seldom (25), Never (0)) across all mobile technology use questions. This view of the data across the independent variables showed a consistent negative skew similar to the overall dependent variable distribution.

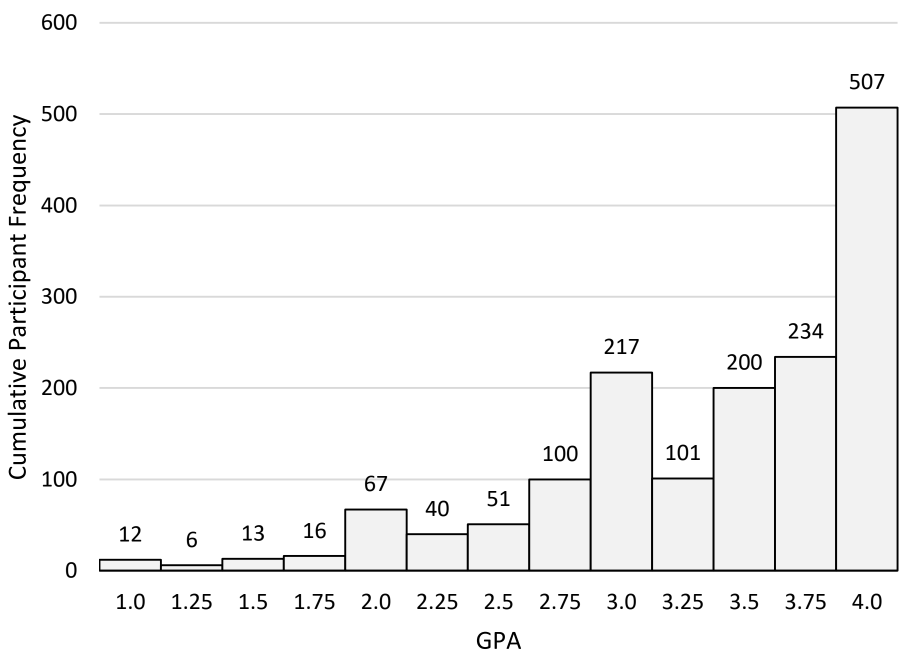


Figure 8. Cumulative frequency of “Always (100)” responses (Q8-Q17) versus GPA.

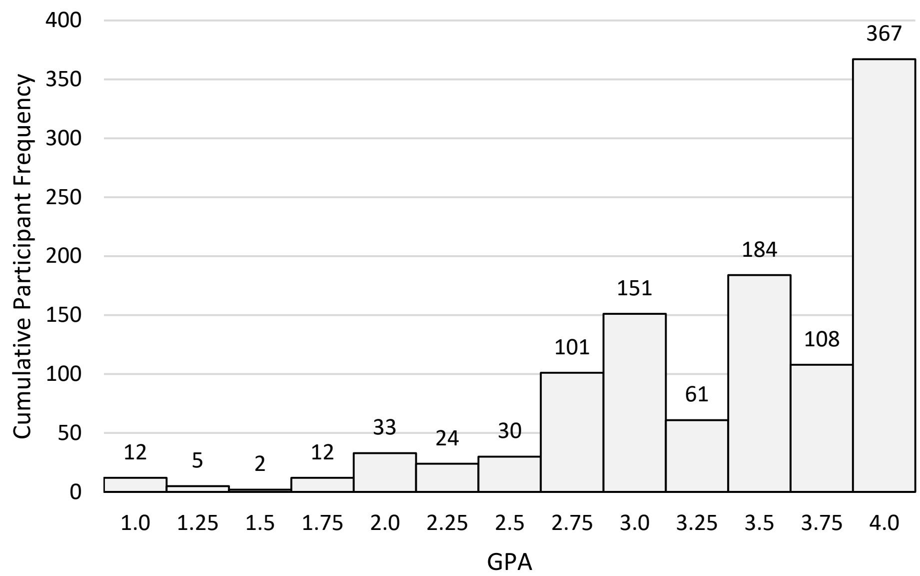


Figure 9. Cumulative frequency of "Often (75)" responses (Q8-Q17) versus GPA.

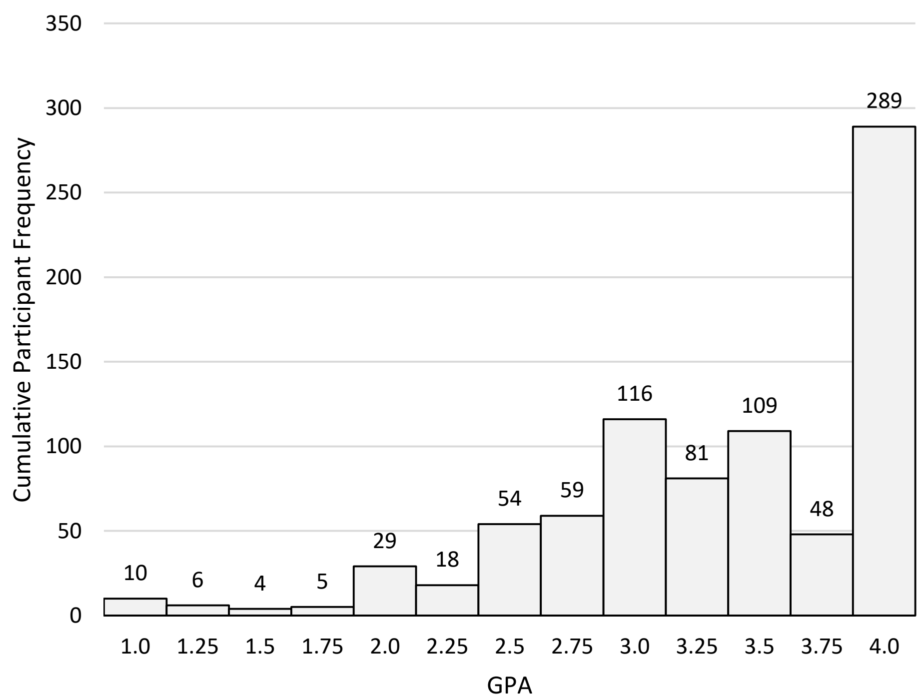


Figure 10. Cumulative frequency of "Sometimes (50)" responses (Q8-Q17) versus GPA.

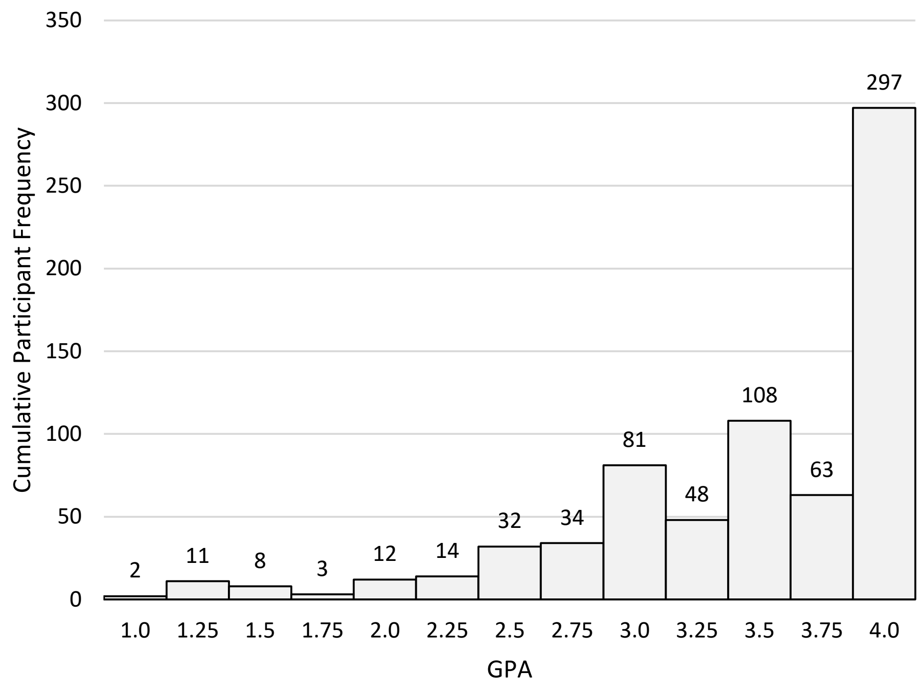


Figure 11. Cumulative frequency of "Seldom (25)" responses (Q8-Q17) versus GPA.

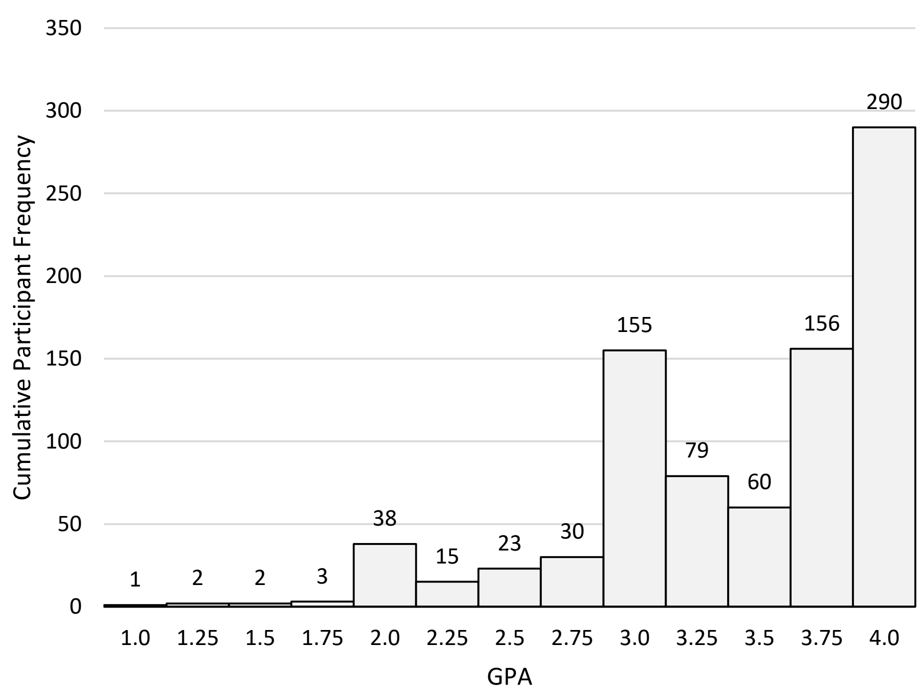


Figure 12. Cumulative frequency of "Never (0)" responses (Q8-Q17) versus GPA.

Results

Assumption Tests

Frequency distribution for GPA (DV) and mobility questions (IV) violated the assumption of normality. The nonparametric Kolomogorov-Smirnov goodness-of-fit and the parametric Shapiro-Wilk test both showed a significance of p = .000, indicating the GPA distribution violated the normality assumption. IV histograms also showed a consistent negative skew for mobility use responses. Kowalski (1972) reviewed the literature on the sensitivity of Pearson's r to non-normal distributions and concluded that in some cases Pearson's r will be sensitive to a non-normal distribution. This conclusion contrasts with his literature review that discovered an equal split of opinion on the robustness of Pearson's r in non-normal distributions – including Pearson himself who thought the test was insensitive to non-normal distributions (Kowalski, 1972). Norman (2010) agreed that parametric statistics can be used with unequal variances and non-normal distributions and still be robust (Norman, 2010). This study reports Pearson's r and non-parametric Spearman's rho (r_s) as a comparative analysis to address the skewed distributions.

Related m-learning literature considers laptops as mobile devices (Brooks & Pomerantz, 2017; Dahlstrom & Bichsel, 2014; Dahlstrom et al., 2016; Harris Poll, 2014; Harris Poll, 2015). The assumption that laptop use constitutes mobility was examined by creating a mobile sub-group (n = 203) of smartphone, tablet, dedicated e-reader, and laptop (when participant used desktop and laptop). The purpose of examining this sub-group was to address the possibility that laptop use in the role of a desktop would undermine the assumption of mobility with laptop use. The correlation results were compared to the larger sample that includes laptops (when not used along with desktops).

Mobile sub-group results were similar to subsequent total sample correlation results (Tables 5-8). Results showed no statistically significant correlation between the amount of student use of mobile technology defined by the sub-group of smartphone, tablet, dedicated e-reader, and laptop (when used with a desktop) in an online environment and student achievement expressed by grade point average for the sub-group sample (Pearson's $r = -.137$, $p = .051$).

Participant responses were independent observations. Participants were not surveyed repeatedly, and individual responses were unrelated to each other. Each participant Internet Protocol (IP) address was identified as a Response Identification (ID) through the QuestionPro application. SPSS software was used to filter Response ID data to identify duplicate cases. Results were 100% validity ($N = 506$) with no duplicate cases. There was no missing data listwise for all independent variables and the GPA dependent variable.

Figure 13 is a scatterplot/heat map representing the overarching IV question (Q17): "Generally, how often did you use a mobile device instead of a desktop device to access online course materials?" The plot is consistent with the skewed DV and IV distributions and shows a tenable linear relationship between variables. Although negatively skewed, the plot shows tenable homoscedasticity with a reasonably consistent variance from the linear fit line.

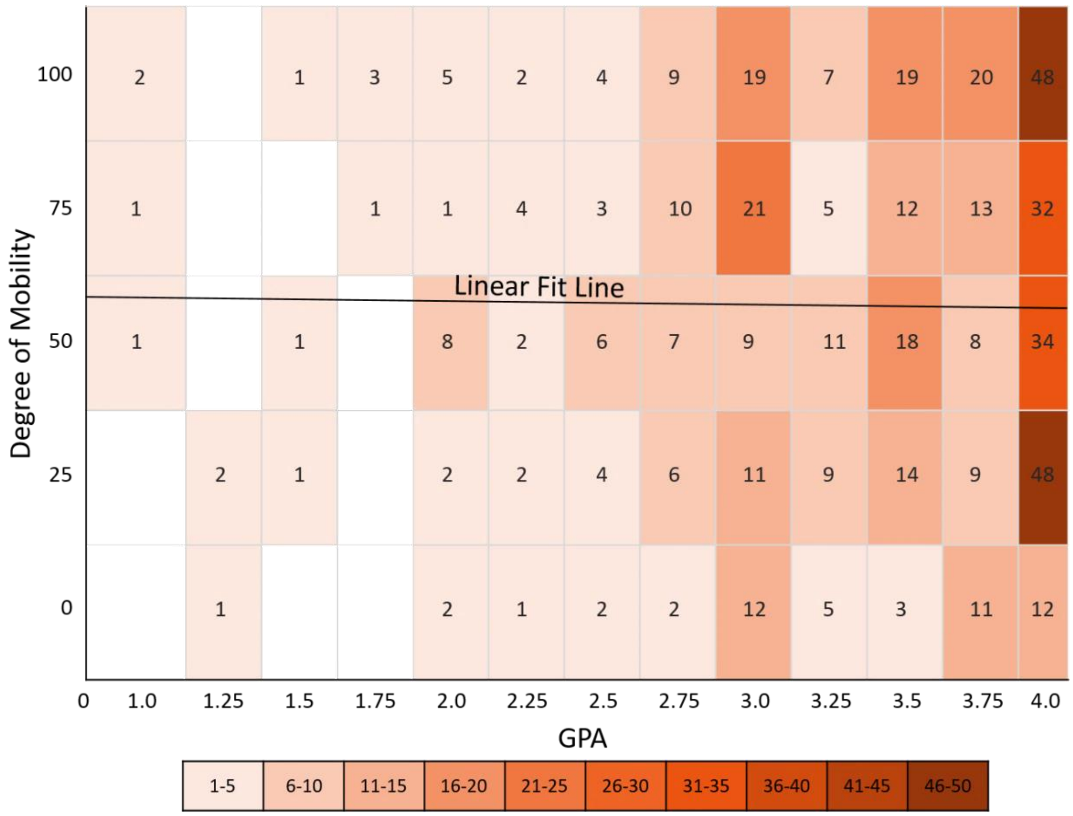


Figure 13. Q17 Scatterplot/heat map showing IV/DV linearity and homoscedasticity (N = 506).

Null Hypothesis One

The significance level for this study was α = .05. The $H_0 1$ hypothesis was addressed through parametric and non-parametric tests on the entire sample (N = 506). The demographic sub-group cases (race, gender, age) were sorted and also tested with parametric and non-parametric tests under $H_0 1$.

RQ1: Is there a relationship between student use of mobile technology in an online environment and student achievement expressed by grade point average?

$H_0 1$: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average.

Pearson's *r* and Spearman's rho correlation coefficients were applied to the combined question values (IV) and GPA (DV) ($N = 506$). Table 7 results indicate insufficient evidence to reject the null hypothesis that there is no statistically significant correlation between students using mobile technology in an online environment and student achievement expressed by grade point average.

Table 7

Parametric and non-parametric correlations between mobility (IV) and GPA (DV).

	Pearson's *r*	Spearman's rho
Correlation Coefficient	-.059	-.056
Significance (2-tailed)	.187	.206

Null Hypothesis Two

RQ2: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race?

$H_0$2: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race.

Table 8 shows a partial correlation removing the influence of race. The differences between Pearson's zero order *df*(504) and partial *df*(503) correlations was not significant, indicating race had little effect on the strength of the relationship between the degree of mobile technology use and GPA. Partial correlation results indicated insufficient evidence to reject the null hypothesis that there is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average removing the influence of race.

Table 8

Partial correlation between IV and GPA controlling for race

	Pearson's *r*	
	Zero order	Partial
Correlation Coefficient	-.059	-.036
Significance (2-tailed)	.187	.424
Degrees of Freedom	504	503

Null Hypothesis Three

RQ3: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender?

$H_0$3: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender.

Table 9 shows a partial correlation removing the influence of gender. The differences between Pearson's zero order *df*(503) and partial *df*(502) correlations was not significant, indicating gender had little effect on the strength of the relationship between the degree of mobile technology use and GPA. Partial correlation results indicated insufficient evidence to reject the null hypothesis that there is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average removing the influence of gender.

Table 9

Partial correlation between IV and GPA controlling for gender

	Pearson's *r*	
	Zero order	Partial
Correlation Coefficient	-.060	-.054
Significance (2-tailed)	.176	.224
Degrees of Freedom	503	502

Null Hypothesis Four

RQ4: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age?

$H_0$4: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age.

Table 10 shows a partial correlation removing the influence of age. The differences between zero order *df*(502) and partial *df*(501) correlations was not significant, indicating age had little effect on the strength of the relationship between the degree of mobile technology use and GPA. Partial correlation results indicated insufficient evidence to reject the null hypothesis that there is no statistically significant correlation between students amount of use of mobile technology in an online environment and student achievement expressed by grade point average removing the influence of age.

Table 10

Partial correlation between IV and GPA controlling for age

	Pearson's *r*	
	Zero order	Partial
Correlation Coefficient	-.063	-.062
Significance (2-tailed)	.159	.162
Degrees of Freedom	502	501

CHAPTER FIVE: CONCLUSIONS

Overview

This study surveyed online students in selected Virginia community colleges to investigate the relationship between the use of mobile technology in the online environment and achievement in the form of GPA. Study conclusions include a discussion of findings contrasted with previous research, implications of findings to the study of m-learning, limitations in terms of internal and external validity, and recommendations for future research.

Discussion

The purpose of this study is to examine the relationship between m-learning using mobile technology and academic achievement in terms of final grades in an online environment. Mobile technology use in the academic environment is widespread and on the rise (Dahlstrom et al., 2016; Harris Poll, 2015). Consistent with previous research, this study found over 50% of students used two or more devices in the online environment dominated by laptops and smartphones. Figure 14 shows the percentages for survey responses on mobility technology use. Study participants used mobile technology in the target semesters sometimes, often, or always 69% of the time across all mobile technology questions. This percentage coincides exactly with the response to question 17 in Figure 15: "Generally, how often did you use a mobile device instead of a desktop device to access online course materials?" Of total participants (N = 506), 347 participants answered sometimes, often, or always, equaling 69%. This study showed 83% of participants used mobile devices for learning puposes (at least seldom). This is similar to the study conducted by Lopez Hernandez and Silva Perez (2014) that showed 75% of surveyed students used mobile devices for learning purposes and the Harris Poll (2015) that showed 89% of students using a laptop and 64% using a smartphone two or three times per week for academic work (Harris Poll, 2015).

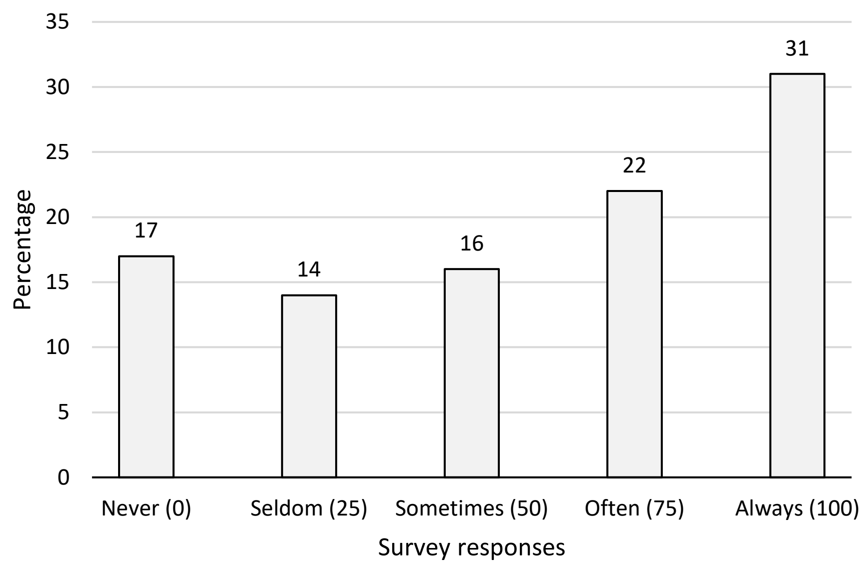


Figure 14. Mobility use survey responses across all mobility questions.

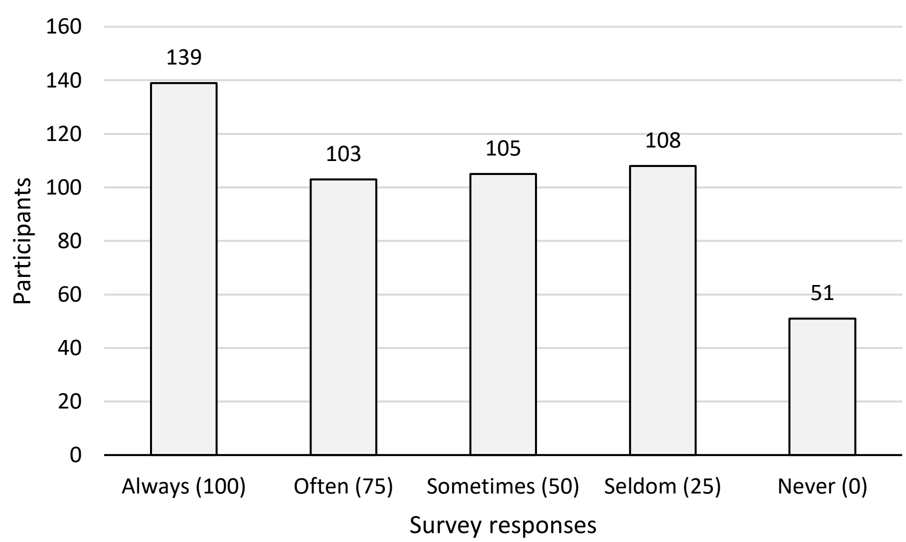


Figure 15. Question 17 responses: "Generally, how often did you use a mobile device instead of a desktop device to access online course materials?"

Laptop computers can take the place of desktop computers regarding capability (although tablets approach the same quality). M-learning related literature considers laptops to be mobile devices since portability is necessary for true m-learning. Relative capability of mobile devices aside, the central issue for m-learning is the untethered nature of the experience. Whether mobility is a few feet or a few miles from a desktop is not necessarily relevant. Anywhere, anytime access could be lounging by the pool, riding the bus to school, waiting in line, doing laundry at the laundromat, or simply in a different room in the house. The parametric results of the mobile sub-group are similar to overall sample results and showed no statistically significant correlation.

This study did not find a significant positive correlation in most cases for enhanced academic achievement with increasing use of mobile technology. Findings were consistently, slightly negative but not statistically significant when correlated to GPA.

Research Question One

RQ1: Is there a relationship between student use of mobile technology in an online environment and student achievement expressed by grade point average?

$H_0$1: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average.

There was insufficient evidence to reject the null hypothesis that there is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average.

Although the null hypotheses cannot be rejected, the research questions are meaningful when considering the impact of mobile technology use. Participants used mobile technology extensively without a significant correlation, either positive or negative, to GPA. The constructivist contention that m-learning will enhance achievement may not be evident in these findings, but the corollary that m-learning cannot be as effective as the tethered online experience was also not evidenced (Franklin, 2011).

Participant use of laptops over smartphones and other mobile devices in this study is consistent with previous research by Brooks and Pomerantz (2017), Dahlstrom, (2013), Dahlstrom and Bichsel (2014), Dahlstrom et al. (2016), Harris Poll (2014), and Kim et al. (2013). Kim et al. (2013) noted when smaller, more mobile devices reached a utility limit, students would revert to laptop use out of frustration (Kim et al., 2013). The 2017 ECAR undergraduate survey almanac responses revealed students rate handheld devices highest when communicating with other students (78%), communicating with instructors (75%), taking pictures of in-class resources and activities (74%), and checking grades (74%). Students rated handheld devices lowest when registering for courses (25%), producing content (23%), taking notes in class (22%), and recording lectures or in-class activities (22%) (Brooks & Pomerantz, 2017).

This points to the larger issue of m-learning effectiveness through institutional adaptation of the learning environment. Merely changing the external context by granting control to the student does not necessarily guarantee enhanced achievement. Franklin (2011) pointed out that infrastructure changes and refreshing faculty perspectives on mobile technology are part of the equation for m-learning success (Franklin, 2011). Services designed for websites without a mobile application will not be effective tools beyond a laptop. Mobile applications may or may not be able to deliver course content designed for desktop access.

Student readiness for m-learning identifies perception as the dominant factor predicting mobile technology use. Students perceive m-learning will enhance achievement (Alrasheedi et al., 2015b; Cheon et. al., 2012; Dahlstrom, 2013; Nassuora, 2012). Shonola et al. (2016) found

93% of students surveyed in Nigerian universities believed mobile devices improved their academic performance (Shonola et al., 2016). Willingness to adopt mobile technology for academic use and a positive perception are only part of the equation; the highest correlations to this perception is ease of use and educational content (Alrasheedi & Capretz, 2013). The fact that 69% of participants used mobile devices sometimes to always and 83% used mobile technology for academic purposes at least seldom indicates mobility is a fact regardless of effective content delivery.

Research Question Two

RQ2: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race?

$H_0$2: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of race.

Results show removing the influence of race had little effect on the correlation between degree of mobility and GPA. Zero order correlation was predominantly non-significant. Results indicated there is insufficient evidence to reject the null hypothesis that there is no statistically significant correlation between students using mobile technology in an online environment and student achievement expressed by grade point average after removing the influence of race. The lack of influence of race on the correlation of m-learning to GPA is consistent with studies showing student perception of the utility of mobile technology is independent of demographic characteristics (Al-Emran et al., 2015; Dahlstrom & Bichsel, 2014; Richardson et al., 2013). The

ECAR Study (Dahlstrom & Bichsel, 2014) found that ethnicity had no correlation to whether students chose to use mobile technology.

Research Question Three

RQ3: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender?

$H_0$3: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of gender.

Results showed removing the influence of gender had little effect on the correlation between the degree of mobility and GPA. Results indicated there is insufficient evidence to reject the null hypothesis that there is no significant correlation between students using mobile technology in an online environment and student achievement expressed by grade point average after removing the influence of gender. The lack of influence of gender on the correlation of m-learning to GPA is consistent with studies showing student perception of the utility of mobile technology is independent of demographic characteristics (Al-Emran et al., 2015; Dahlstrom & Bichsel, 2014; Richardson, et al., 2013). Wang et al. (2009) used the unified theory of acceptance and use of technology model to consider determinants for using mobile technology and found the social control determinant was a greater influence on males than females and the requirement for self-management was stronger for females than males. These differences do not imply a difference in effective use of mobile technology (Wang et al., 2009).

Research Question Four

RQ4: Is there a relationship between students using mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age?

$H_0$4: There is no statistically significant correlation between the amount of student use of mobile technology in an online environment and student achievement expressed by grade point average, removing the influence of age.

Results showed removing the influence of age had little effect on the correlation between the degree of mobility and GPA. Results indicated there was insufficient evidence to reject the null hypothesis that there is no statistically significant correlation between students using mobile technology in an online environment and student achievement expressed by grade point average removing the influence of age. The lack of influence of age on the correlation of m-learning to GPA is consistent with studies showing student perception of the usefulness of mobile technology is independent of demographic characteristics (Al-Emran et al., 2015; Dahlstrom & Bichsel, 2014; Richardson et al., 2013). Wang et al. (2009) found that ease of use and social influence were predictable determinants for older users more often than younger users (Wang et al., 2009).

Implications

M-learning is characterized by the mobility of technology, mobility of learners, and mobility of learning. The freedom to access and engage learning content and activities whenever, wherever, and however the student chooses is the core tenant of m-learning. This study did not show enhanced achievement from the use of mobile technology to access online content. The idea that a change in context by moving from a desktop or laptop computer at home in a focused environment to a smart phone or tablet in a variety of environments enhances student control and engagement, seems questionable. The positive element of “when” access is available is contrasted with the potential negative of “where” and “how” access is accomplished if the environment is not relevant to learning content. On the other hand, students are routinely accessing course content using mobile technology and expect (and demand) greater access and flexibility online (Dahlstrom et al., 2016).

For m-learning to reach its full potential, the constructivist migration of control from teacher to student must be accompanied by a change in pedagogy, educational content delivery adapted to mobile technology, investment in institutional infrastructure, and the merging of the unlimited and untethered spatial context with learning content. A change in geography is not necessarily an enhanced context – intentional situated learning should exploit the external environment (Solvberg & Rismark, 2012).

Limitations

The participant sample was composed of volunteer responses and therefore was not a random selection. Questions do not elicit opinions but ask about specific behavior regarding use of technology and the participant GPA, mitigating volunteer sample bias.

External validity was assessed by creating a stratified random sample (n = 250) from the total sample (N = 506) using study strata (age, gender, ethnicity) and data from the Institute of Education Sciences (IES), National Center for Education Statistics (NCES), and Integrated Postsecondary Education System (IPEDS). IPEDS data is from 1,556 Community Colleges across the United States for the 2015 fall semester (Integrated Postsecondary Education System, [IPEDS], 2015). The stratified random sample (SRS) was intended to match the IPEDS nationwide data for the chosen parameters. The SRS size was iteratively adjusted until the closest match was achieved with the nationwide data. The age and ethnicity strata could not be precisely matched with national data due to limitations of the overall sample. Table 11 shows the population parameters and stratified random sample (SRS) data.

Table 11

IPEDS population Characteristics and Stratified Random Sample Data

		IPEDS (*N* = 6,186,647)	SRS (*n* = 250)
Gender	Men	43%	43%
	Women	57%	57%
Age	18-24	54%	50%
	25-34	20%	21%
	35-65+	31%	28%
Ethnicity	White	48%	66%
	Black	14%	18%
	Hispanic	23%	6%

The SRS data was then correlated with GPA to compare with the overall sample. The small, negative trend continued in the stratified random sample seen throughout the total sample correlations. Table 12 shows Pearson's *r* and Spearman's rho for the zero-order overall sample and the stratified random sample designed to approximate the population parameters.

Table 12

Study Sample and SRS Parametric and Non-Parametric Correlations

	Study Sample		Stratified Random Sample	
	Pearson's *r*	Spearman's rho	Pearson's *r*	Spearman's rho
Correlation coefficient	-.059	-.056	-.057	-.042
Significance	.187	.206	.366	.512
N	506	506	250	250

Differences between the total study sample and stratified random sample were minimal, leading to the conclusion that study results are comparable to the larger population given the similar characteristics of age and gender with some differences in race.

The instrument Cronbach's alpha was .947 and .934 (based on standardized items). Construct validity was assessed through convergent and discriminant validity. Table 13 shows inter-item correlation values; convergent validity range is optimal from 0.15 to 0.50 (Clark & Watson, 1995). Values show a convergent validity with some indications of item redundancy. Discriminant validity is represented by GPA values correlated to mobility questions and show discrimination from the independent variables.

Table 13

Inter-item correlation matrix

	GPA	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17
GPA	1.000										
Q8	-.111	1.000									
Q9	-.102	.584	1.000								
Q10	-.038	.536	.765	1.000							
Q11	-.023	.491	.710	.769	1.000						
Q12	-.035	.432	.592	.677	.750	1.000					
Q13	-.022	.545	.733	.766	.808	.737	1.000				
Q14	-.045	.515	.684	.745	.776	.733	.852	1.000			
Q15	-.030	.461	.628	.724	.764	.800	.781	.785	1.000		
Q16	-.035	.489	.769	.761	.779	.649	.761	.729	.682	1.000	
Q17	-.013	.492	.727	.748	.792	.708	.779	.782	.765	.788	1.000

The body of research on m-learning is comprehensive and thorough regarding readiness for m-learning, perceived effectiveness of m-learning, and mobile technology. The purpose of this study was to address the quantitative gap in correlating achievement with the degree of mobility as a point-in-time correlation. The study did not assess online services regarding educational content adapted for mobile technology or all the possible variables that might contribute to academic achievement aside from m-learning. Canvasing available services across community colleges to accommodate different levels and quality of service would have added a significant number of variables and complexity to the analysis. Similarly, investigating all factors that might contribute to academic achievement would confound the focus of the extent of mobile technology use and greatly expand partial correlations.

Additionally, this study did not investigate the various physical contexts available through increased mobility and the potential applicability of situated learning. M-learning context could influence achievement in a number of ways, but the number of possible venues and contexts would again translate into a large increase in variables and exceed the planned scope of the study.

Recommendations for Future Research

Investigating m-learning achievement needs to be addressed at both ends of the continuum from content delivery to user device and spatial context. Although many studies investigated these m-learning aspects, the great majority were not anchored in quantifiable achievement that can be measured as a dependent variable. Determining mobile application usefulness and quality before assessing the degree of mobility versus achievement would allow these variables to be addressed in analysis.

Controlling factors such as quality of service, spatial context, and mobile application integration into learning management systems would allow a better assessment of the relationship between m-learning and achievement. This approach should also include differentiation between institutions, and instrumentation should elicit where and how students access online content along with the degree of mobility. Deeper insight into the entire m-learning spectrum will enlighten administrators as to the “center of gravity” that is at the heart of using mobile technology to enhance the online experience. Using an instrument that is a numerical scale (to allow more robust parametric analysis) and opening up the scope to include four-year institutions would also facilitate better external validity and applicability to a more expansive demographic.

As technology improves, mobile devices will supersede more traditional desktop hardware and constitute a new criteria for mobility. Approximately two thirds of participants did not have a desktop computer; the trend is toward more mobility that will require further studies to key on the physical context rather than the specific technology. The tethered nature of the traditional desktop environment is being replaced with increasingly cloud-based mobility. It will be important for future assessments of the impact of m-learning to understand the physical context regardless of the mobile technology.

REFERENCES

Adobe. (2017). *Touching the infinite: A report on the 2017 Adobe Mobile Maturity Survey.* Retrieved from https://adobe.ly/2n9X0Vk

Aker, J. C., Ksoll, C., & Lybbert, T. J. (2012). Can mobile phones improve learning? Evidence from a field experiment in Niger. *American Economic Journal: Applied Economics, 4*(4), 94-120. Retrieved from http://doi.org/10.1257/app.4.4.94

Al Zahrani, H., & Laxman, K. (2015). A critical meta-analysis of mobile learning research in higher education. *The Journal of Technology Studies, 41*(2), 74-89. Retrieved from http://doi.org/10.21061/jots.v41i2.a.1

Al-Emran, M., Elsherif, H. M., & Shaalan, K. (2015). Investigating attitudes towards the use of mobile learning in higher education. *Computers in Human Behavior, 56*(2016), 93-102. Retrieved from http://doi.org/10.1016/j.chb.2015.11.033

Ally, M., & Prieto-Blazquez, J. (2014). What if the future of mobile learning in education? Mobile learning in higher education [speical section]. *Revista de Universidad y Sociedad del Conocimiento, 11*(1), 142-151. Retrieved from http://doi.org/10.7238/rusc.v11i1.2033

Alrasheedi, M., & Capretz, L. F. (2013). A meta-analysis of critical success factors affecting mobile learning. *IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE)* (pp. 262-267). Kuta, Indonesia: IEEE. Retrieved from http://doi.org/10.1109/TALE2013.6654443

Alrasheedi, M., Capretz, L. F., & Raza, A. (2015a). A systematic review of the critical factors for success of mobile learning in higher education (university students' perspective). *Journal* *of Educational Computing, 52*(2), 257-276. Retrieved from http://doi.org/10.1177/0735633115571928

Alrasheedi, M., Capretz, L. F., & Raza, A. (2015b). Management's perspective on critical success factors affecting mobile learning in higher education institutions: An empirical study. *Journal of Educational Computing, 54*(2), 253-274. Retrieved from http://doi.org/10.1177/0735633115620387

Alzaza, N. S., & Yaakub, A. R. (2011). Students' awareness and requirements of mobile learning services in the higher education environment. *American Journal of Economics and Business Administration, 3*(1), 95-100. Retrieved from http://search.proquest.com/docview/1025014842?accountid=12085

Baloch, H. Z., Abdulrhaman, A., & Ihad, N. A. (2012). Mobile collaborative informal learning design: Study of collaborative effectiveness using activity theory. *International Journal of Interactive Mobile Technologies, 6*(3). Retrieved from http://doi.org/10.3991/ijim.v6i3.2090

BBC News. (2010, July 1). Finland makes broadband a 'legal right'. *BBC News Technology*. Retrieved from http://www.bbc.com/news/10461048

Beseda, J., Machat, Z., & Palecek, L. (2012). M-learning as a trend. *Technology Transfer and Innovation International Conference, 1*, pp. 32-38. Prague: PRADEC Interdisciplinary Conference Proceedings. Retrieved from http://www.academia.edu/3206575/M-learning_as_a_trend

Brooks, D. C., & Pomerantz, J. (2017). *The educause almanac for faculty and technology survey, 2017*. Retrieved from https://library.educause.edu/~/media/files/library/2017/8/studentalmanac17.pdf

Chang, J. M., Williams, J., & Hurlburt, G. (2014). Mobile commerce. *IT Pro, 16*(3), 4-5. Retrieved from http://doi.org/10.1109/MITP.2014.36

Chen, G. D., Chang, C. K., & Wang, C. Y. (2008). Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques. *Computers & Education, 50*(2008), 77-90. Retrieved from http://doi.org/10.1016/j.compedu.2006.03.004

Chen, H.-R., & Huang, H.-L. (2010). User acceptance of mobile knowledge management learning system: Design and analysis. *Educational Technology & Society, 13*(3), 70-77. Retrieved from http://bit.ly/1uCp0hT

Cheon, J., Lee, S., Crooks, S. M., & Song, J. (2012). An investigation of mobile learning readiness in higher education based on the theory of planned behavior. *Computers & Education, 59*(2012), 1054-1064. Retrieved from http://doi.org/10.1016/j.compedu.2012.04.015

Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment, 7*(3), 309-319. Retrieved from http://doi.org/10.1037/1040-3590.7.3.309

Cochrane, T. D. (2010). Exploring mobile learning success factors. *ALT-J, Research in Learning Technology, 18*(2), 133-148. Retrieved from http://doi.org/10.1080/09687769.2010.494718

Cook, C. W., & Sonnenberg, C. (2014). Technology and online education: Models for change. *ASBBS eJournal*, *10*(1), 43-59. Retrieved from http://bit.ly/1wZH0AU

Copley, J. (2007). Audio and video podcasts of lectures for campus-based students: Production and evaluation of student use. *Innovations in Education and Teaching International, 44*(4), 387-399. Retrieved from http://doi.org/10.1080/14703290701602805

Corlett, D., Sharples, M., Bull, S., & Chan, T. (2005). Evaluation of a mobile learning organiser for university students. *Journal of Computer Assisted Learning, 21*(2005), 162-170. Retrieved from http://doi.org/10.1111/j.1365-2729.2005.00124.x

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston: Pearson.

Dahlstrom, E. (2013). *ECAR study of undergraduate students and information technology.* Louisville: Educause Center for Applied Research. Retrieved from http://www.educause.edu/ecar

Dahlstrom, E., & Bichsel, J. (2014). *ECAR Study of undergraduate students and information technology.* Retrieved from http://www.educause.edu/library/resources/study-students-and-information-technology-2014

Dahlstrom, E., Brooks, D. C., Pomerantz, J., & Reeves, J. (2016). *2016 student and technology research study.* Retrieved from https://library.educause.edu/resources/2016/6/2016-student-and-technology-research-study

Danaher, P., Gururajan, R., & Hafeez-Baig, A. (2009). Transforming the practice of mobile learning: Promoting pedagogical innovation through educational principles and strategies that work. In H. Ryu, & D. Parsons (Eds.), *Innovative mobile learning: Techniques and technologies* (pp. 21-46). Hershey: IGI Global.

Dempsey, L. (2008). Always on: Libraries in a world of permanent connectivity. *First Monday, 14*(1), 1-16. Retrieved from http://doi.org/10.5210/fm.v14i1.2291

Doyle, K. (2014). *Will the smartphone become obsolete?* Retrieved from The Network: Cisco's Technology News Site: http://newsroom.cisco.com/feature/1436437/Will-The-Smartphone-Become-Obsolete-?utm_medium=rss

Edmondson, J., Anderson, W., Gray, J., Loyall, J. P., Schmid, K., & White, J. (2014). Next-generation mobile computing. *IEEE Software, 31*(2), 44-47. Retrieved from http://doi.org/10.1109/MS.2014.39

Elfeky, A. I., & Masadeh, T. S. (2016). The effect of mobile learning on students' achievement and conversational skills. *International Journal of Higher Education, 5*(3), 20-31. Retrieved from http://dx.org/10.5430/ijhe.v5n3p20

El-Hussein, M. M., & Cronje, J. C. (2010). Defining mobile learning in the higher education landscape. *Educational Technology & Society, 13*(3), 12-21. Retrieved from http://bit.ly/1uCpWD6

Entner, R. (2011). *International comparisons: The handset replacement cycle.* Retrieved from Mobile Future: http://mobilefuture.org/resources/international-comparisons-the-handset-replacement-cycle-2/

Evans, C. (2008). The effectiveness of m-learning in the form of podcast revision lectures in higher education. *Computers and Education, 50*(2), 491-498. Retrieved from http://doi.org/10.1016/j.compedu.2007.09.016

Family Educational Rights and Privacy Act of 1974, § 513 of P.L. 93-380 (The Education Amendments of 1974). (1974). Retrieved from U.S. Department of Education: https://www2.ed.gov/policy/gen/guid/fpco/ferpa/leg-history.html

Franklin, T. (2011). Mobile learning: At the tipping point. *The Turkish Online Journal of Educational Technology, 10*(4), 261-275. Retrieved from http://bit.ly/1E1CarH

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Boston: Pearson.

Garrett, B. M., & Jackson, C. (2006). A mobile clinical e-portfolio for nursing and medical students, using wireless personal digital assistants (PDAs). *Nurse Education in Practice, 6*(2006), 339-346. Retrieved from http://doi.org/10.1016/j.nepr.2006.07.015

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *Internet and Higher Education, 19*(2013), 18-26. Retrieved from http://doi.org/10.1016/j.iheduc.2013.06.002

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. *2003 Midwest Research to Practice Conference in Adult, Continuing, and Community Education* (pp. 82-88). Columbus: The Ohio State University. Retrieved from https://scholarworks.iupui.edu/bitstream/handle/1805/344/gliem+&+gliem.pdf?sequence=1

Goodwin, L. D., & Leech, N. L. (2006). Understanding correlation: Factors that affect the size of r. *The Journal of Experimental Education, 74*(3), 251-266. Retrieved from http://bit.ly/1oBfnck

Gupta, B., & Koo, Y. (2010). Applications of mobile learning in higher education: An empirical study. *International Journal of Information and Communication Technology Education, 6*(3), 75-87. Retrieved from http://doi.org/10.4018/jicte.2010070107

Harris Poll. (2014). *Pearson student mobile device survey 2014: College students.* Retrieved from http://bit.ly/1xjEatg

Harris Poll. (2015). *Pearson student mobile device survey 2015: College students.* Retrieved from http://www.pearsoned.com/wp-content/uploads/2015-Pearson-Student-Mobile-Device-Survey-College.pdf

Hernandez, F. A., & Perez, M. M. (2014). M-learning patterns in the virtual classroom. Mobile learning applications in higher education [special section]. *Revista de Universidad y Sociedad del Conocimiento, 11*(1), 208-221. Retrieved from http://doi.org/10.7238/rusc.v1i1.1902

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Edcuational Technology Reaearch and Development, 48*(3), 23-48. Retrieved from http://researchrepository.murdoch.edu.au/5251

Hinkle, D. E., Wiersma, W., & Jurs, S. G. (2003). *Applied statistics for the behavioral sciences.* Boston: Houghton Mifflin.

Hockly, N. (2013). Mobile learning. *Technology for the Language Teacher, 67*(1), 80-84. Retrieved from http://doi.org/10.1093/elt/ccs064

Howell, D. C. (2011). *Fundamental statistics for the behavioral sciences* (7th ed.). Belmont: Wadsworth.

Huang, Y.M., Liao, Y.W., Huang, S.H., & Chen, H.C. (2014). A jigsaw-based cooperative learning approach to improve learning outcomes for mobile situated learning. *Educational Technology & Society, 17*(1), 128-140. Retrieved from http://bit.ly/14NRNG5

Huang, Y.M., Lin, Y.T., & Cheng, S.C. (2010). Effectiveness of a mobile plant learning system in a science curriculum in Taiwanese elementary education. *Computers & Education, 54*, 47-58. Retrieved from http://doi.org/10.1016/j.compedu.2009.07.006

Hussin, S., Manap, M. R., Amir, Z., & Krish, P. (2012). Mobile learning readiness among Malaysian students at higher learning institutes. *Asian Social Science, 8*(12), 276-283. Retrieved from http://doi.org/10.5539/ass.v8n12p276

Hwang, G.J., & Chang, H.F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education, 56*, 1023-1031. Retrieved from http://doi.org/10.1016/j.compedu.2010.12.002

Institute of Electrical and Electronics Engineers Inc. (2013). *Wireless, mobile and ubiquitous technology in education.* IEEE Inc. Retrieved from http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?reload=true&punumber=6184369

Integrated Postsecondary Education Data System. (2015). *Summary data*. Retrieved 2017, from https://nces.ed.gov/ipeds/datacenter/InstitutionByName.aspx

International Telecommunications Union. (2014). *ICT Facts and figures 2014.* Retrieved from http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf

International Telecommunications Union. (2016). *ICT Facts and figures 2016.* Retrieved from http://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx

Jabbour, K. K. (2013). An analysis of the effect of mobile learning on Lebanese higher education. *Bulgarian Journal of Science and Education, 7*(2), 280-297. Retrieved from http://search.proquest.com/docview/1515644863?accountid=12085

James, P. T. (2011). Mobile-learning: Thai higher education student perceptions and potential technological impacts. *International Education Studies, 4*(2), 182-194. Retrieved from http://doi.org/10.5539/ies.v4n2p182

Jantjies, M., & Joy, M. (2014). *Mobile learning through indigenous languages: Learning through a constuctivist approach.* Retrieved from http://classroom-aid.com/2014/01/17/learning-through-a-constructivist-approach-with-mobile-device-mlearning/

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., & Ludgate, H. (2013). *NMC horizon report: 2013 higher education edition.* Austin: The New Media Consortium. Retrieved from http://www.nmc.org/publications/2013-horizon-report-higher-ed

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2014). *NMC horizon report: 2014 higher education edition.* Retrieved from http://www.nmc.org/publications/2014-horizon-report-higher-ed

Kant, I. (1950). *Prolegomena to any future metaphysics.* Indianapolis: Bobbs-Merrill Co.

Kearney, M., Schuck, S., Burden, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Research in Learning Technology, 20*(2012). Retrieved from http://doi.org/10.3402/rlt.v20i0/14406

Kiger, D., Herro, D., & Prunty, D. (2012). Examining the influence of a mobile learning intervention on third grade math achievement. *Journal of Research on Technology in Education, 45*(1), 61-82. Retrieved from http://search.proquest.com/docview/1448763675?accountid=12085

Kim, D., Rueckert, D., Kim, D.-J., & Seo, D. (2013). Students' perceptions and experiences of mobile learning. *Language Learning and Technology, 17*(3), 52-73. Retrieved from http://llt.msu.edu/issues/october2013/kimetal.pdf

Kim, G.-M., & Ong, S. M. (2005). An exploratory study of factors influencing m-learning success. *The Journal of Computer Information Systems, 46*(1), 92-97. Retrieved from http://search.proquest.com/docview/232578086?accountid=12085

Koole, M. L. (2009). A model for framing mobile learning. *Athabasca University Press*, 25-47. Retrieved from http://cguevara.commons.gc.cuny.edu/files/2009/09/A-Model-for-Framing-Mobile-Learning.pdf

Koszalka, T. A., & Ntloedibe-Kuswani, G. S. (2010). Literature on the safe and disruptive learning potential of mobile technologies. *Distance Education, 31*(2), 139-157. Retrieved from http://bit.ly/ZsLOUL

Kowalski, C. J. (1972). On the effects of non-normality on the distribution of the sample product-moment correlation coefficient. *Journal of the Royal Statistical Society, 21*(1), 1-12. Retrieved from http://www.jstor.org/stable/2346598

Kuhn, T. S. (1996). *The structure of scientific revolutions* (3rd ed.). Chicago: University of Chicago Press.

Lacey, C. H., Gunter, G. A., & Reeves, J. (2014). Mobile technology integration. *Distance Learning, 11*(1), 1-8. Retrieved from http://bit.ly/1prdM8W

Liberty University. (2013). *Institutional Review Board.* Retrieved from www.liberty.edu/media/9997/HandbookRevised.pdf

Little, B. (2013). Issues in mobile learning technology. *Human Resource Management International Digest*, *21*(3), 26-29. Retrieved from http://doi.org/10.1108/09670731311318361

Liu, M., Navarrete, C. C., & Wivagg, J. (2014). Potentials of mobile technology for K-12 education: An investigationof iPod touch use for english language learners in the United States. *Educational Technology & Society, 17*(2), 115-126. Retrieved from http://www.ifets.info/journals/17_2/10.pdf

Looi, C. K., Zhang, B., Chen, W., Seow, P., Chia, G., Norris, C., & Soloway, E. (2011). Mobile inquiry learning experience for primary science students: A study of learning effectiveness. *Journal of Computer Assisted Learning, 27*, 269-287. Retrieved from http://doi.org/10.1111/j.1365-2729.2010.00390.x

Looi, C.K., Sun, D., Wu, L., Seow, P., Chia, G., Wong, L.H., . . . Norris, C. (2014). Implementing mobile learning curricula in a grade level: Empirical study of learning effectiveness at scale. *Computers & Education, 77*, 101-115. Retrieved from http://doi.org/100116/j.compedu.2014.04.011

Lopez Hernandez, F. A., & Silva Perez, M. M. (2014). M-learning patterns in the virtual classroom. *Revista de Universidad y Sociedad del Conocimiento*, *11*(1), 208-221. Retrieved from http://doi.org/10.7238/rusc.v11i1.1902

Lowenthal, J. N. (2010). Using mobile learning: Determinates impacting behavioral intention. *American Journal of Distance Education, 24*(4), 195-206. doi:http://doi.org/10.1080/08923647

Lowenthal, P. R., & Muth, R. (2009). Constructivism. In E. F. Povenzo Jr. (Ed.), *Encyclopedia of the social and cultural foundations of education* (Vol. 1, pp. 177-179). Thousand Oaks, CA: SAGE Publications. Retrieved from http://bit.ly/1E1BrXo

McGraw-Hill Education. (2015). *McGraw-Hill Education*. Retrieved from http://www.mheducation.com/about/news-room/report-new-mcgraw-hill-education-research-finds-more-80-percent-students-use-mobile

Mell, P., & Grance, T. (2011). *The National Institute of Standards and Technology definition of cloud computing.* Retrieved from http://faculty.winthrop.edu/domanm/csci411/Handouts/NIST.pdf

Mileva, N. (2011). The effectiveness of mobile learning in the form of performance support system in higher education. *International Journal of Interactive Mobile Technologies, 5*(4). Retrieved from http://doi.org/10.3991/ijim.v5i4.1692

Miller, P. H. (2011). *Theories of developmental psychology* (5th ed.). New York: Worth Publishers.

Nassuora, A. B. (2012). Students acceptance of mobile learning for higher education in Saudi Arabia. *American Academic & Scholarly Research Journal, 4*(2), 1-6. Retrieved from http://www.aasrc.org/aasrj

Nicholson, P. (2007). A history of e-learning. In B. Ferandez-Manjon, J. M. Sanchez-Perez, J. A. Gomez-Pulido, M. A. Vega-Rodriguez, & J. Bravo-Rodriguez (Eds.), *Computers and education: E-learning, from theory to practice* (pp. 1-11). Dordrecht: Springer.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education, 15*(2010), 625-632. Retrieved from http://doi.org/10.1007/s10459-010-9222-y

Norouzi, M., Samet, A., Sharifuddin, R. S., Hjh, D., & Hamid, T. B. (2012). Investigate the effect of mobile learning over the critical thinking in higher education. *Advances in Natural and Applied Sciences, 6*(6), 909-915. Retrieved from http://www.aensi.org/anas.html

Office of Institutional Research and Effectiveness. (2012). *Student success snapshot issue #23.* Retrieved from http://www.vccs.edu/studentsuccess

Oller, R. (2012). *The future of mobile learning.* Retrieved from https://net.educause.edu/ir/library/pdf/ERB1204.pdf

Parry, D. (2011). Mobile perspectives on teaching: Mobile literacy. *Educause Review*(March/April), 14-18. Retrieved from https://net.educause.edu/ir/library/pdf/ERM1120.pdf

Pereira, O. R., & Rodrigues, J. J. (2013). Survey and analysis of current mobile learning applications and technologies. *ACM Computing Surveys*, *46*(2), 27:1-35. Retrieved from http://doi.org/10.1145/2543581.2543594

Pew Research Center. (2014). *PewResearch internet project: Mobile technology fact sheet.* Retrieved from http://www.pewinternet.org/fact-sheets/mobile-technology-fact-sheet/

Philips Inc. (2014). *What is ambient intelligence?* Retrieved from http://www.research.philips.com/technologies/projects/ami/

Pimmer, C., Mateescu, M., & Grohbiel, U. (2016). Mobile and ubiquitous learning in higher education settings: A systematic review of empirical studies. *Computers in Human Behavior, 63*(2016), 490-501. Retrieved from http://doi.org/10.1016/j.chb.2016.05.057

Poushter, J. (2017). *Smartphones are common in advanced economies, but digital divides remain.* Retrieved from http://pewrsr.ch/2otKxcD

Powell, C. B., & Mason, D. S. (2013). Effectiveness of podcasts delivered on mobile devices as a support for student learning during general chemistry laboratories. *Journal of Science Educational Technology,* 148-170. Retrieved from http://doi.org/10.1007/s10956-012-9383-y

Radhakrishna, R. B. (2007). *Tools of the trade*. Retrieved from http://www.joe.org/joe/2007february/tt2.php

Rajasingham, L. (2011). Will mobile learning bring a paradigm shift in higher education? *Education Research International, 2011*(528495), 1-10. Retrieved from http://doi.org/10.1155/2011/528495

Rajrathnam, V. P. (2002). *Sociology index*. Retrieved from http://sociologyindex.com/correlation_zero_order.htm

Richardson, B., Richardson, P., Dellaportas, S., & Perera, L. (2013). Students' perceptions on using iPods in accounting education: A mobile-learning experience. *Asian Review of Accounting, 21*(1), 4-26. Retrieved from http://doi.org/10.1108/13217341311316922

Rossing, J. P., Miller, W. M., Cecil, A. K., & Stamper, S. E. (2012). iLearning: The future of higher education? Student perceptions on learning with mobile tablets. *Journal of the Scholarship of Teaching and Learning*, *12*(2), 1-26. Retrieved from http://search.ebscohost.com.ezproxy.liberty.edu:2048/login.aspx?direct=true&db=ehh&AN=78115264&site=ehost-live&scope=site

Schneps, M. H., & Sadler, P. M. (Directors). (1988). *A private universe* [Motion picture]. Retrieved from http://www.learner.org/resources/series28.html

Scholtz, A. (2007). An analysis of the impact of an authentic assessment strategy on student performance in a technology-mediated constructivist classroom: A study revisited. *International Journal of Education and Development using Information and Communications Technology*, *3*(4), 42-53. Retrieved from http://ijedict.dec.uwi.edu

Sha, L., Looi, C. K., Chen, W., & Zhang, B. H. (2012). Understanding mobile learning from the perspective of self-regulated learning. *Journal of Computer Assisted Learning, 2012*(28), 366-378. Retrieved from http://doi.org/10.1111/j.1365-2729.2011.00461.x

Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews, & C. Haythornethwaite (Eds.), *The sage handbook of elearning research* (pp. 221-247). London: Sage. Retrieved from http://goo.gl/ejZSgp

Shih, J. L., Chuang, C. W., & Hwang, G. J. (2010). An inquiry-based mobile learning approach to enhancing social science learning effectiveness. *Educational Technology & Society, 13*(4), 50-62. Retrieved from http://search.proquest.com/docview/1287032142?accountid=12085

Shonola, S. A., Joy, M. S., Oyelere, S. S., & Suhonen, J. (2016). The impact of mobile devices for learning in higher education institutions: Nigerian universities case study. *International Journal of Modern Education and Computer Science, 8*(2016), 43-50. Retrieved from http://doi.org/10.5815/ijmecs.2016.08.06

Shorfuzzaman, M., & Alhussein, M. (2016). Modeling learners' readiness to adopt mobile learning: A perspectgive from a GCC higher education institution. *Mobile Information Systems, 2016*(6982824), 1-10. Retrieved from http://doi.org/10.1155/2016/6982824

Solvberg, A. M., & Rismark, M. (2012). Learning spaces in mobile learning environments. *Active Learning in Higher Education, 13*(1), 23-33. Retrieved from http://doi.org/10.1177/1469787411429189

Splitter, L. J. (2009). Authenticiy and constructivism in education. *Studies in the Philosophy of Education, 2009*(28), 135-151. Retrieved from http://doi.org/10.1007//s11217-008-9105-3

Szapkiw, A. (2013). *Statistics guide.* Retrieved from Liberty University Blackboard: http://bb7.liberty.edu/bbcswebdav/pid-20105597-dt-content-rid-138738193_1/xid-138738193_1

Tan, G. W. H., Ooi, K. B., Sim, J. J., & Phusavat, K. (2012). Determinants of mobile learning adoption: An empirical analysis. *The Journal of Computer Information Systems, 52*(3), 82-91. Retrieved from http://search.proquest.com/docview/1017541474?accountid=12085

Traxler, J. (2007). Defining, discussing, and evaluating mobile learning: The moving finger writes and having writ... *International Review of Research in Open and Distance Learning*, *8*(2), 1-12. Retrieved from http://bit.ly/1uejP6x

Traxler, J. (2010). Distance education and mobile learning: Catching up, taking stock. *Distance Education*, *31*(2), 129-138. Retrieved from http://search.proquest.com/docview/750315313?accountid=12085

Tsou, J. Y. (2006). Genetic epistemology and Piaget's philosophy of science : Piaget vs. Kuhn on scientific progress. *Theory & Psychology*, *16*(2), 203-224. Retrieved from http://philpapers.org/rec/TSOGEA

VCCS Distance Learning Enrollment. (2013). Retrieved from http://www.vccs.edu/about/where-we-are/impact/vccs-distance-learning-enrollment/

von Glasersfeld, E. (1991). A constructivist's view of learning and teaching. In R. Duit, F. Goldberg, & H. Niedderer (Eds.), *Research in physics learning: Theoretical issues and empirical studies* (pp. 29-39). Kiel, Germany: IPN. Retrieved from http://www.vonglasersfeld.com/135

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Wang, Y. S., Wu, M. C., & Wang, H. Y. (2009). Investigating the deterinants and age and gender differences in the acceptance of mobile learning. *British Journal of Educational*

Technology, *40*(1), 92-118. Retrieved from http://doi.org/10.111/j.1467-8535.2007.00809.x

Willits, F. K., Theodori, G. L., & Luloff, A. E. (2016). Another look at Likert scales. *Journal of Rural Social Sciences*, *31*(3), 126-139. Retrieved from http://ezproxy.liberty.edu/login?url=https://search-proquest-com.ezproxy.liberty.edu/docview/1872116904?accountid=12085

Wong, L. H., & Looi, C. K. (2011). What seams do we remove in mobile-assisted seamless learning? A ciritical review of the literature. *Computers & Education, 57*(2011), 2364-2381. Retrieved from http://doi.org/10.1016/j.compedu.2011.06.007

Wu, W. H., Wu, Y. C., Chen, C. Y., Kao, H. Y., Lin, C. H., & Huang, S. H. (2012). Review of trends from mobile learning studies: A meta-analysis. *Computers & Education, 59*(2012), 817-827. Retrieved from http://doi.org/10.1016/j.compedu.2012.03.016

Yang, Guangbing, Nian-Shing Chen, Kinshuk, Erkki Sutinen, and Terry Anderson. 2013. "The effectiveness of automatic text summarization in mobile learning contexts." *Computers & Education* 68 (2013): 233-243. Retrieved from http://dx.doi.org/10.1016/j.compedu.2013.05.012

Yang, C. C., Hwang, G. J., Hung, C. M., & Tseng, S. S. (2013). An evaluation of the learning effectiveness of concept map-based science book reading via mobile devices. *Educational Technology & Society, 16*(3), 167-178. Retrieved from http://search.proquest.com/docview/1462203910?accountid=12085

Yang, S. H. (2012). Exploring college students' attitudes and self-efficacy of mobile learning. *The Turkish Online Journal of Educational Technology*, *11*(4), 148-154. Retrieved from http://files.eric.ed.gov/fulltext/EJ989264.pdf

Yu, F. (2012). *Mobile/smart phone use in higher education.* Retrieved from http://bit.ly/W8FNuq

Zhang, H., Song, W., & Burston, J. (2011). Reexamining the effectiveness of vocabulary learning via mobile phones. *The Turkiish Online Journal of Educational Technology, 10*(3), 203-214. Retrieved from http://search.proquest.com/docview/1288349971?accountid=12085

APPENDIX A: CONSENT FORM

The Liberty University Institutional
Review Board has approved
this document for use from
4/19/2017 to --
Protocol # 2832.041917

CONSENT FORM

THE RELATIONSHIP BETWEEN MOBILE LEARNING AND ACADEMIC ACHIEVEMENT IN A COMMUNITY COLLEGE SYSTEM ONLINE ENVIRONMENT

Daniel P. Grenier
Liberty University
School of Education

You are invited to be in a research study on mobile learning. You were selected as a possible participant because you are an online student in the Virginia Community College System. Please read this form and ask any questions you may have before agreeing to be in the study.

Daniel P. Grenier, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to understand the relationship between the use of mobile technology and student achievement expressed by GPA in an online environment. In this anonymous questionnaire, you will be asked to answer questions about your previous semester GPA and use of mobile technology to access course material.

Procedures: If you agree to be in this study, please select the link and complete the survey (it will take approximately 5 minutes).

Risk and Benefits: Your participation is completely voluntary and anonymous. There are no foreseeable risks involved in this study. Participants should not expect to receive a direct benefit from taking part in this study. This study will benefit online teachers and students by improving course delivery using mobile technology.

Compensation: Participants will not be compensated for participating in this study.

Confidentiality: Your participation will be anonymous and the records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records.

Voluntary Nature of the Study: Your participation in this study is voluntary, your decision whether or not to participate will not affect your current or future relations with your community college or Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time prior to submitting the survey without affecting those relationships.

Contacts and Questions: The researcher conducting this study is Daniel P. Grenier. If you have questions, **you are encouraged** to contact him at . You may also contact the researcher's faculty advisor, Dr. Daniel Baer, at

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Green Hall Suite 1887, Lynchburg, VA 24515 or email at irb@liberty.edu.

Thank you very much for your time and support. By selecting the consent box below, you agree that you have read and understood the above information, have received answers to any questions you may have, and consent to participate in the study.

APPENDIX B: LIBERTY IRB EXEMPTION

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

April 19, 2017

Daniel P. Grenier
IRB Exemption 2832.041917: The Relationship between Mobile Learning and Academic Achievement in a Community College System Online Environment

Dear Daniel P. Grenier,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under exemption category 46.101(b)(2), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

> (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
> (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

Administrative Chair of Institutional Research
The Graduate School

LIBERTY
UNIVERSITY
Liberty University | Training Champions for Christ since 1971

APPENDIX C: SURVEY INSTRUMENT

1. What was your GPA last semester *for online courses only* (select the closest value)?

    a) 1.0

    b) 1.25

    c) 1.5

    d) 1.75

    e) 2.0

    f) 2.25

    g) 2.5

    h) 2.75

    i) 3.0

    j) 3.25

    k) 3.5

    l) 3.75

    m) 4.0

2. What is your age?

    a) 18-24

    b) 25-34

    c) 35-44

    d) 45-54

    e) 55-64

    f) 65+

3. What is your gender?

    a) Male

b) Female

4. What is your ethnicity?

a) Hispanic or Latino

b) Black or African American

c) Native American or American Indian

d) Asian / Pacific Islander

e) White

f) Other

5. What college do you attend?

a)

b)

c)

d)

e)

f)

6. What is your collegiate status?

a) Freshman or first-year student (or approximately 0-30 credits)

b) Sophomore or second-year student (or approximately 31-60 credits)

For the purposes of this survey, a mobile device is one that you can travel with outside the home or classroom (e.g. smartphone, laptop, tablet or iPad, e-reader). The number is percentage of time.

7. Which of the following electronic devices do you use to study? (Select all that apply.)

a) Laptop

b) Tablet or iPad

c) Smartphone

d) Dedicated e-reader

e) Desktop computer

The following questions apply to last semester's online courses only (not including hybrid):

8. How often did you access online lecture recordings (video or audio) using a mobile device?

a) Always (100)

b) Often (75)

c) Sometimes (50)

d) Seldom (25)

e) Never (0)

9. How often did you access online practice quizzes/reviews using a mobile device?

a) Always (100)

b) Often (75)

c) Sometimes (50)

d) Seldom (25)

e) Never (0)

10. How often did you access online discussion forums using a mobile device?

a) Always (100)

b) Often (75)

c) Sometimes (50)

d) Seldom (25)

e) Never (0)

11. How often did you access online course assignments using a mobile device?

a) Always (100)
b) Often (75)
c) Sometimes (50)
d) Seldom (25)
e) Never (0)

12. How often did you access online course administration using a mobile device (grades, tools, etc.)?

a) Always (100)
b) Often (75)
c) Sometimes (50)
d) Seldom (25)
e) Never (0)

13. How often did you access online course study materials using a mobile device?

a) Always (100)
b) Often (75)
c) Sometimes (50)
d) Seldom (25)
e) Never (0)

14. How often did you access links to other materials using a mobile device?

a) Always (100)
b) Often (75)
c) Sometimes (50)

d) Seldom (25)

e) Never (0)

15. How often did you access online course announcements using a mobile device?

a) Always (100)

b) Often (75)

c) Sometimes (50)

d) Seldom (25)

e) Never (0)

16. How often did you access and complete online quizzes/tests using a mobile device?

a) Always (100)

b) Often (75)

c) Sometimes (50)

d) Seldom (25)

e) Never (0)

17. Generally, how often did you use a mobile device instead of a desktop device to access online course materials?

a) Always (100)

b) Often (75)

c) Sometimes (50)

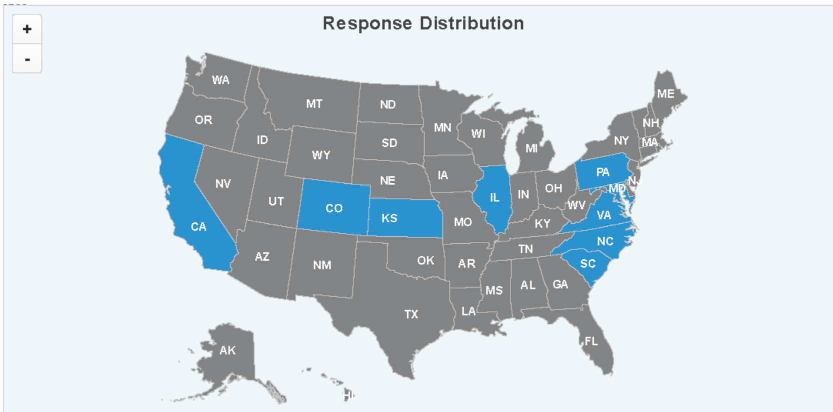
d) Seldom (25)

e) Never (0)

APPENDIX D: SURVEY INSTRUMENT DATA

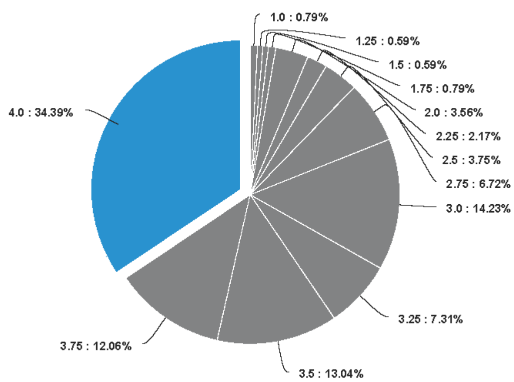
M-learning Survey

VIEWED	STARTED	COMPLETED	COMPLETION RATE	DROP OUTS	TIME TO COMPLETE
1002	560	506	90.36%	54	3 mins



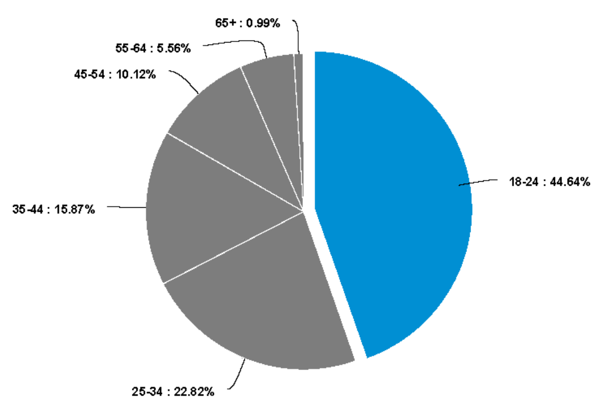
States	Responses
VA	85.36%
Unknown (US)	4.64%
MD	1.79%
PA	1.79%
IL	1.43%
KS	0.89%
DC	0.54%
CA	0.36%
CO	0.36%

What was your GPA last semester for online courses only (select the closest value)?



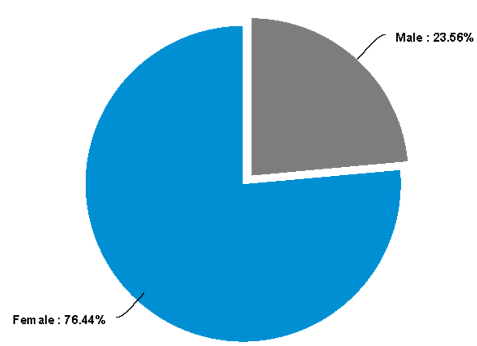
Answer	Count	Percent
1.0	4	0.79%
1.25	3	0.59%
1.5	3	0.59%
1.75	4	0.79%
2.0	18	3.56%
2.25	11	2.17%
2.5	19	3.75%
2.75	34	6.72%
3.0	72	14.23%
3.25	37	7.31%
3.5	66	13.04%
3.75	61	12.06%
4.0	174	34.39%
Total	506	100 %

What is your age?



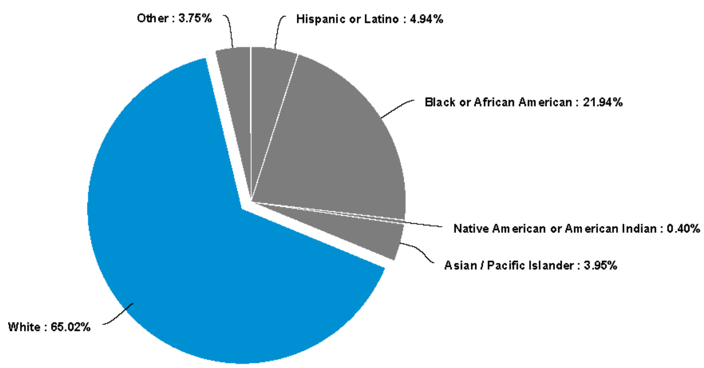
Answer	Count	Percent
18-24	225	44.64%
25-34	115	22.82%
35-44	80	15.87%
45-54	51	10.12%
55-64	28	5.56%
65+	5	0.99%
Total	504	100 %

What is your gender?



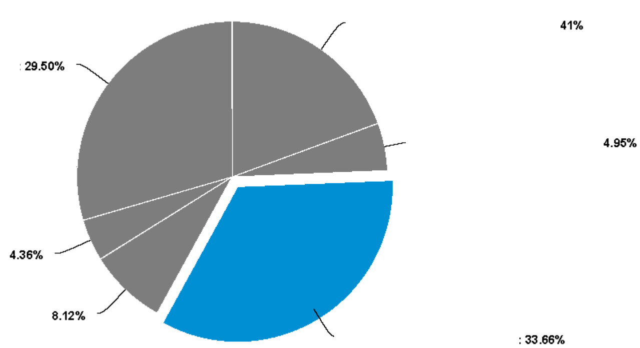
Answer	Count	Percent
Male	119	23.56%
Female	386	76.44%
Total	505	100 %

What is your ethnicity?



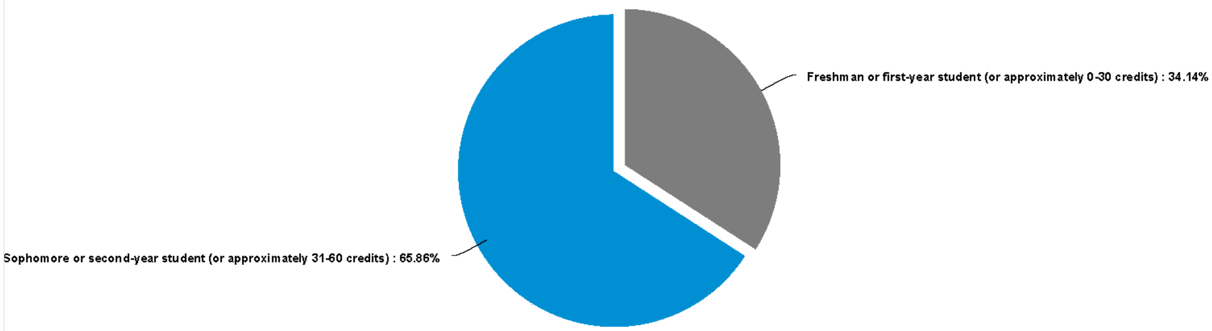
Answer	Count	Percent
Hispanic or Latino	25	4.94%
Black or African American	111	21.94%
Native American or American Indian	2	0.4%
Asian / Pacific Islander	20	3.95%
White	329	65.02%
Other	19	3.75%
Total	506	100 %

What college do you attend?



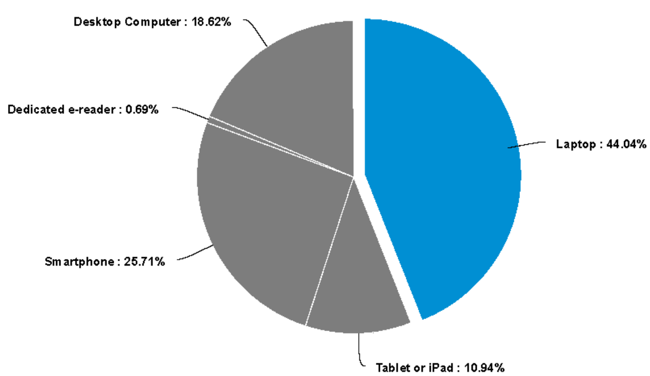
Answer	Count	Percent
	98	19.41%
	25	4.95%
	170	33.66%
	41	8.12%
	22	4.36%
	149	29.5%
Total	505	100 %

What is your collegiate status?



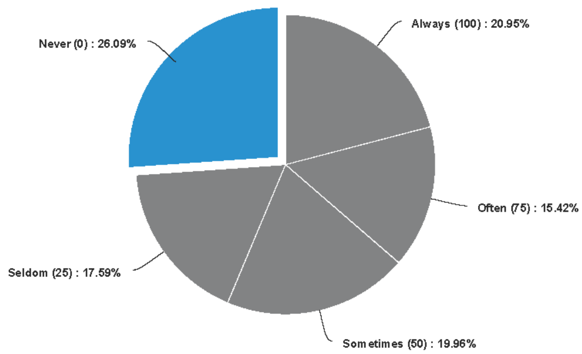
Answer	Count	Percent	20% 40% 60% 80% 100%
Freshman or first-year student (or approximately 0-30 credits)	170	34.14%	
Sophomore or second-year student (or approximately 31-60 credits)	328	65.86%	
Total	498	100 %	

For the purposes of this survey, a mobile device is one that you can travel with outside the home or classroom (e.g. smartphone, laptop, tablet or iPad, e-reader). The number is percentage of time. Which of the following electronic devices do you use to study? (Select all that apply)



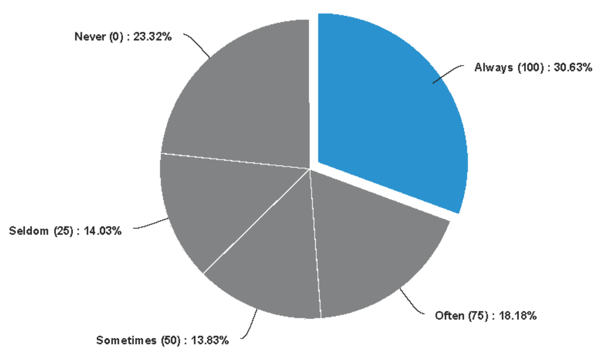
Answer	Count	Percent	20% 40% 60% 80% 100%
Laptop	447	44.04%	
Tablet or iPad	111	10.94%	
Smartphone	261	25.71%	
Dedicated e-reader	7	0.69%	
Desktop Computer	189	18.62%	
Total	1015	100 %	

The following questions apply to last semester's online courses only (not including hybrid): How often did you access online lecture recordings (video or audio) using a mobile device?



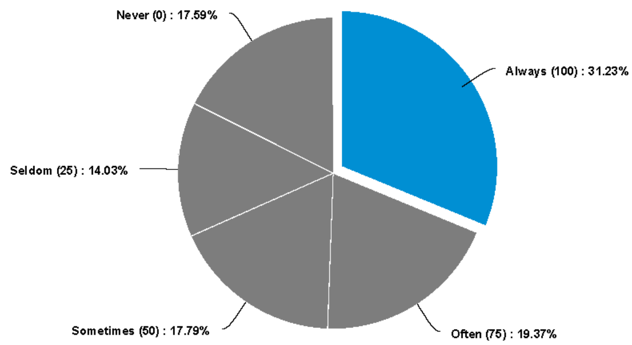
Answer	Count	Percent
Always (100)	106	20.95%
Often (75)	78	15.42%
Sometimes (50)	101	19.96%
Seldom (25)	89	17.59%
Never (0)	132	26.09%
Total	506	100 %

How often did you access online practice quizzes/reviews using a mobile device?



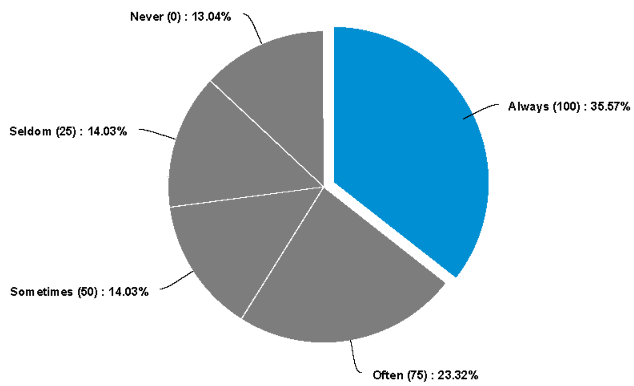
Answer	Count	Percent
Always (100)	155	30.63%
Often (75)	92	18.18%
Sometimes (50)	70	13.83%
Seldom (25)	71	14.03%
Never (0)	118	23.32%
Total	506	100 %

How often did you access online discussion forums using a mobile device?



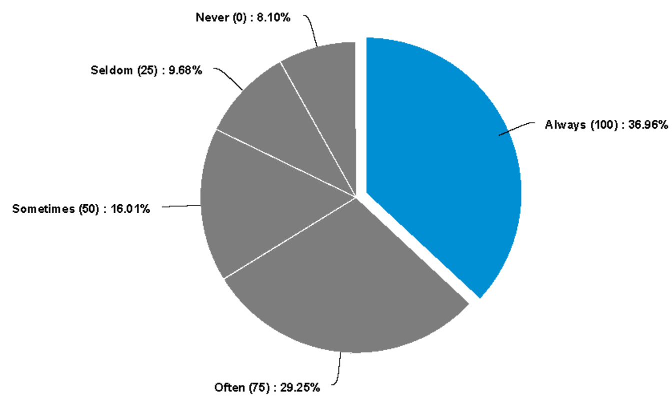
Answer	Count	Percent
Always (100)	158	31.23%
Often (75)	98	19.37%
Sometimes (50)	90	17.79%
Seldom (25)	71	14.03%
Never (0)	89	17.59%
Total	506	100 %

How often did you access online course assignments using a mobile device?



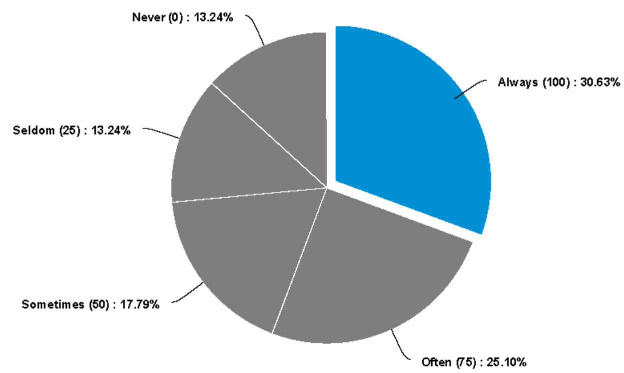
Answer	Count	Percent
Always (100)	180	35.57%
Often (75)	118	23.32%
Sometimes (50)	71	14.03%
Seldom (25)	71	14.03%
Never (0)	66	13.04%
Total	506	100 %

How often did you access online course administration using a mobile device (grades, tools, etc.)?



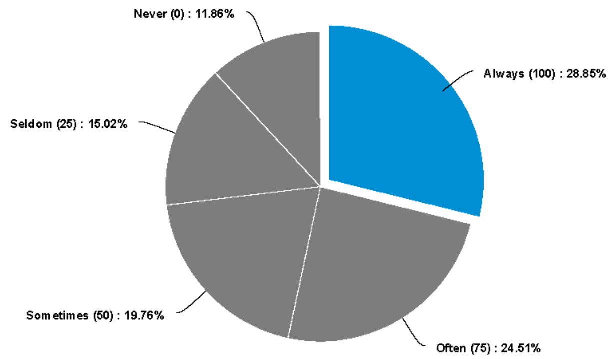
Answer	Count	Percent
Always (100)	187	36.96%
Often (75)	148	29.25%
Sometimes (50)	81	16.01%
Seldom (25)	49	9.68%
Never (0)	41	8.1%
Total	506	100 %

How often did you access online course study materials using a mobile device?



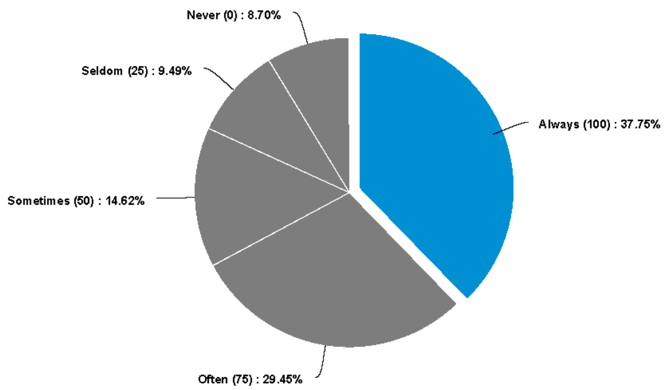
Answer	Count	Percent
Always (100)	155	30.63%
Often (75)	127	25.1%
Sometimes (50)	90	17.79%
Seldom (25)	67	13.24%
Never (0)	67	13.24%
Total	506	100 %

How often did you access links to other materials using a mobile device?



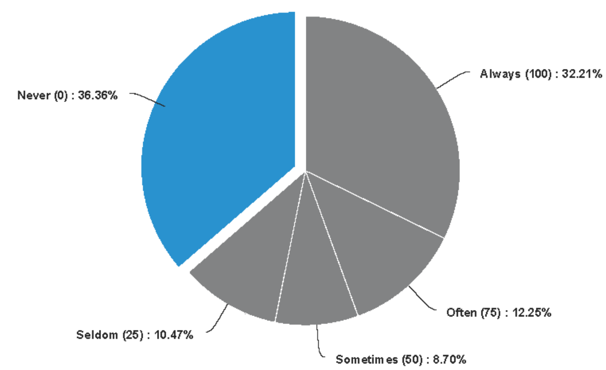
Answer	Count	Percent	20% 40% 60% 80% 100%
Always (100)	146	28.85%	
Often (75)	124	24.51%	
Sometimes (50)	100	19.76%	
Seldom (25)	76	15.02%	
Never (0)	60	11.86%	
Total	506	100 %	

How often did you access online course announcements using a mobile device?



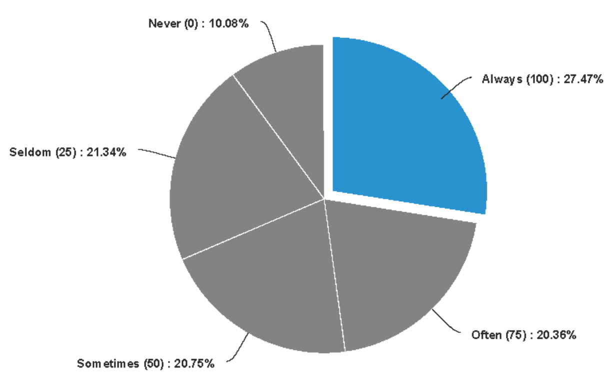
Answer	Count	Percent	20% 40% 60% 80% 100%
Always (100)	191	37.75%	
Often (75)	149	29.45%	
Sometimes (50)	74	14.62%	
Seldom (25)	48	9.49%	
Never (0)	44	8.7%	
Total	506	100 %	

How often did you access and complete online quizzes/tests using a mobile device?



Answer	Count	Percent
Always (100)	163	32.21%
Often (75)	62	12.25%
Sometimes (50)	44	8.7%
Seldom (25)	53	10.47%
Never (0)	184	36.36%
Total	506	100 %

Generally, how often did you use a mobile device instead of a desktop device to access online course materials?



Answer	Count	Percent
Always (100)	139	27.47%
Often (75)	103	20.36%
Sometimes (50)	105	20.75%
Seldom (25)	108	21.34%
Never (0)	51	10.08%
Total	506	100 %

APPENDIX E: INDEPENDENT VARIABLE DATA

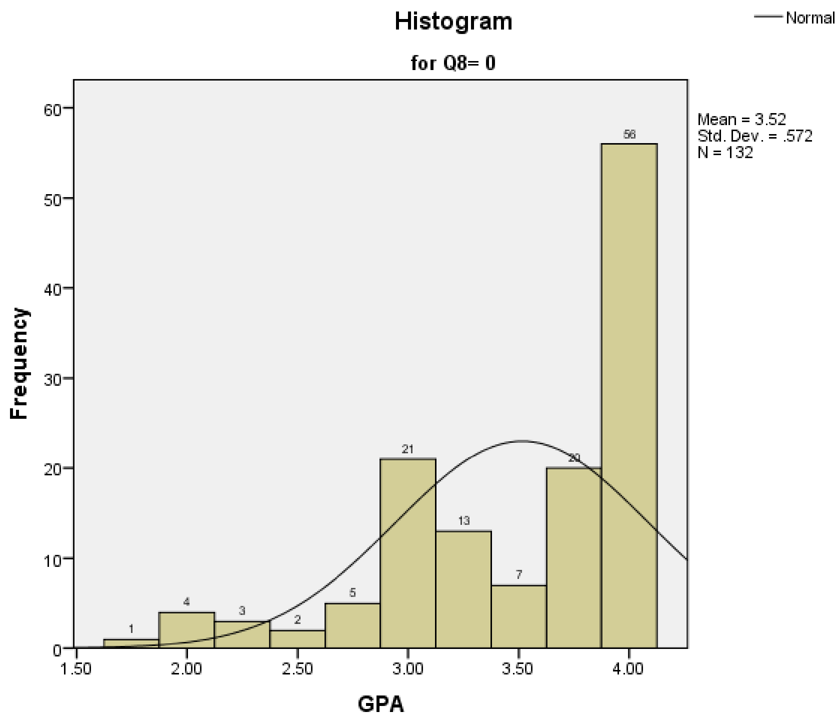


Figure 16. Q8 "Never" response distribution vs. GPA.

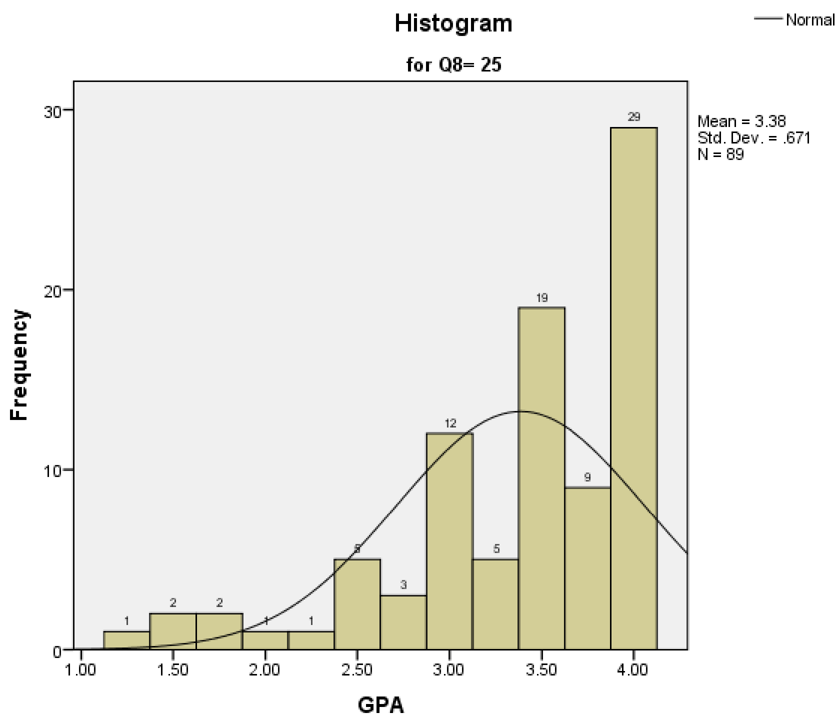


Figure 17. Q8 "Seldom" response distribution vs. GPA.

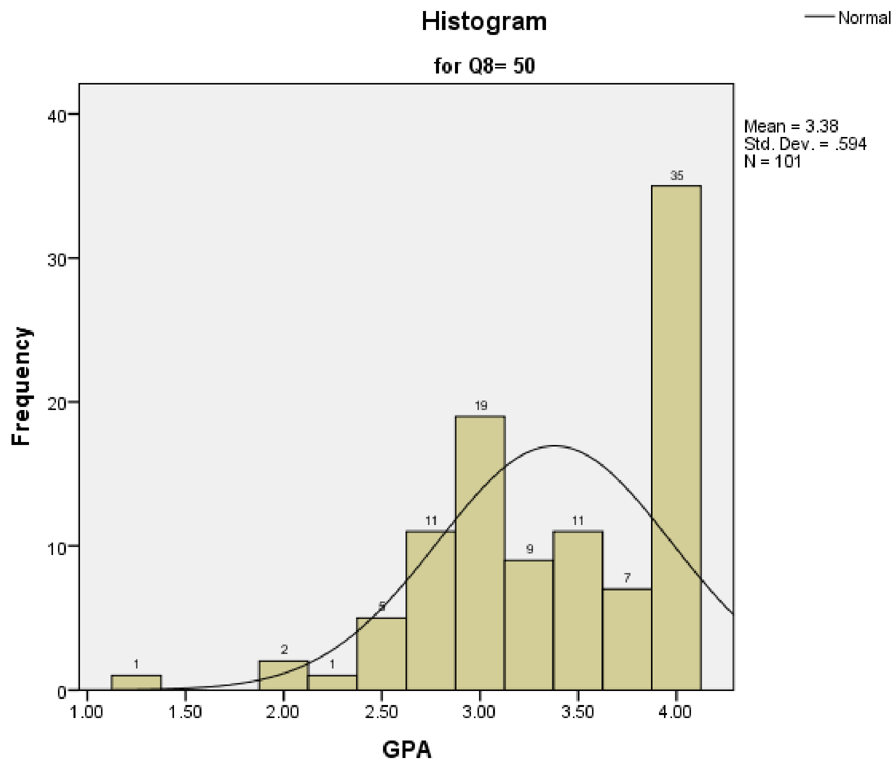


Figure 18. Q8 "Sometimes" response distribution vs. GPA.

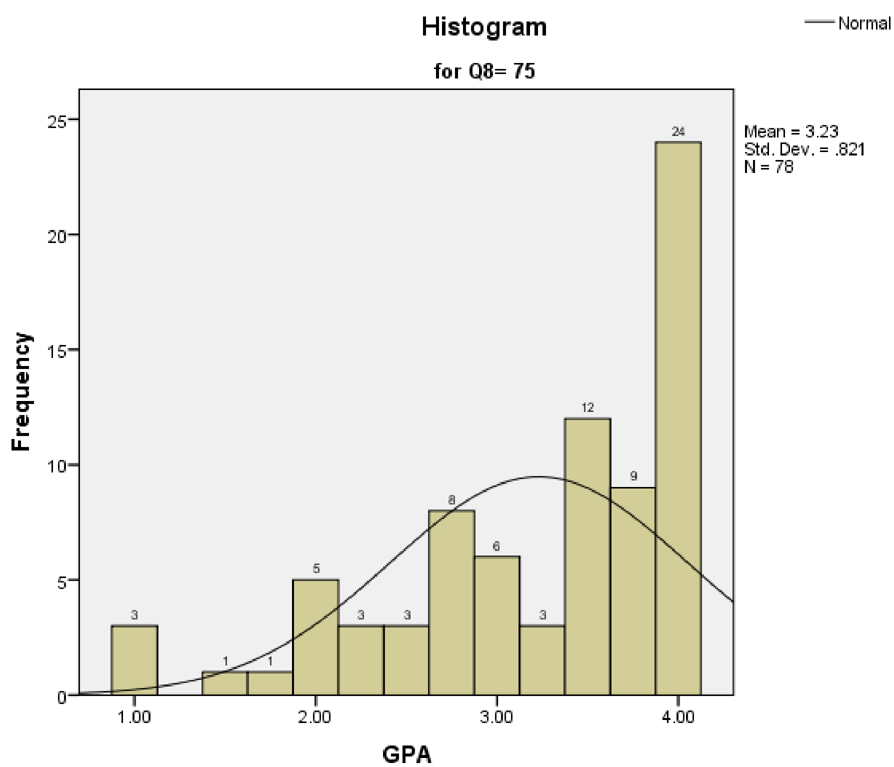


Figure 19. Q8 "Often" response distribution vs. GPA.

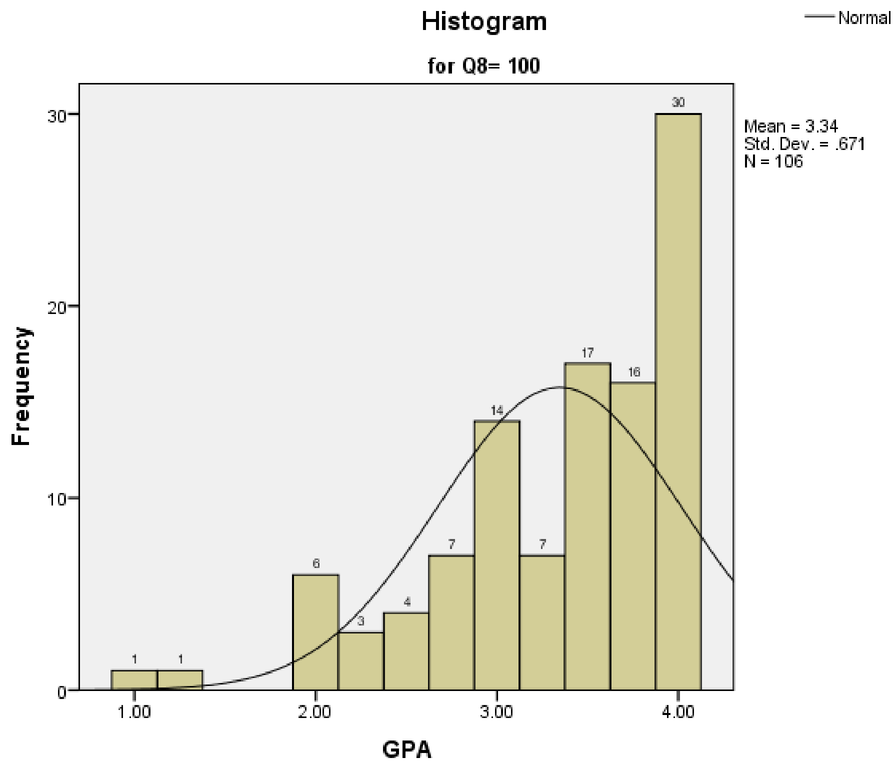


Figure 20. Q8 "Always" response distribution vs. GPA.

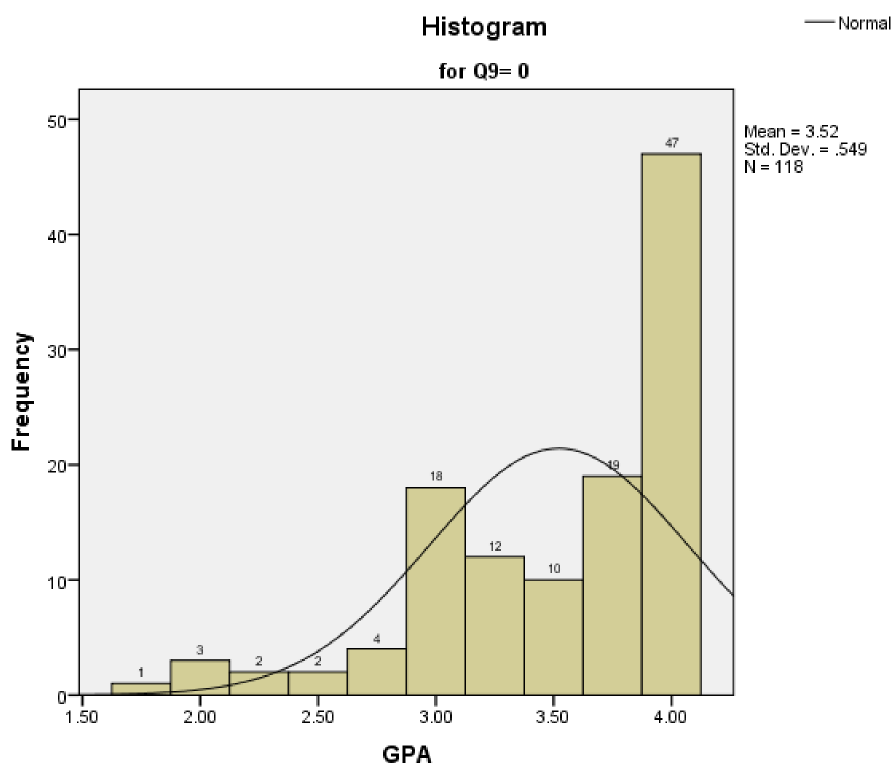


Figure 21. Q9 "Never" response distribution vs. GPA.

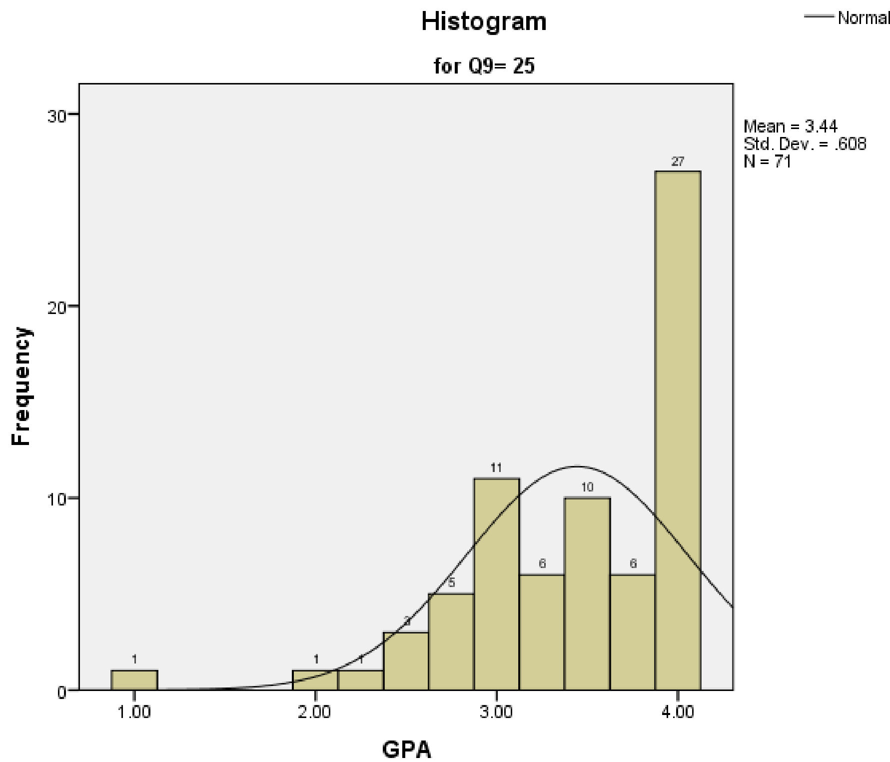


Figure 22. Q9 "Seldom" response distribution vs. GPA.

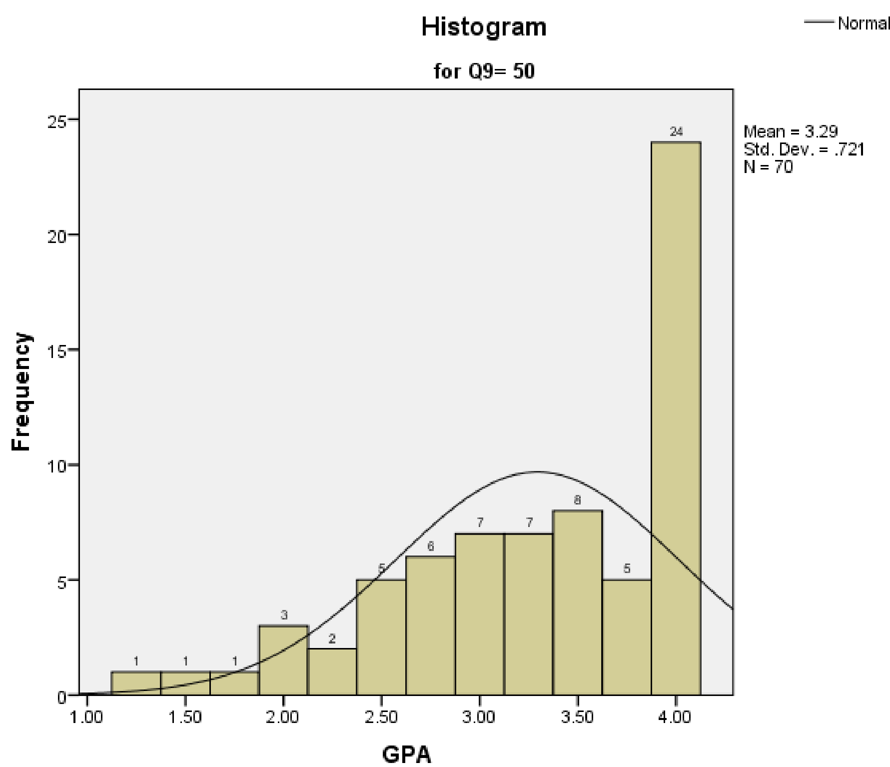


Figure 23. Q9 "Sometimes" response distribution vs. GPA.

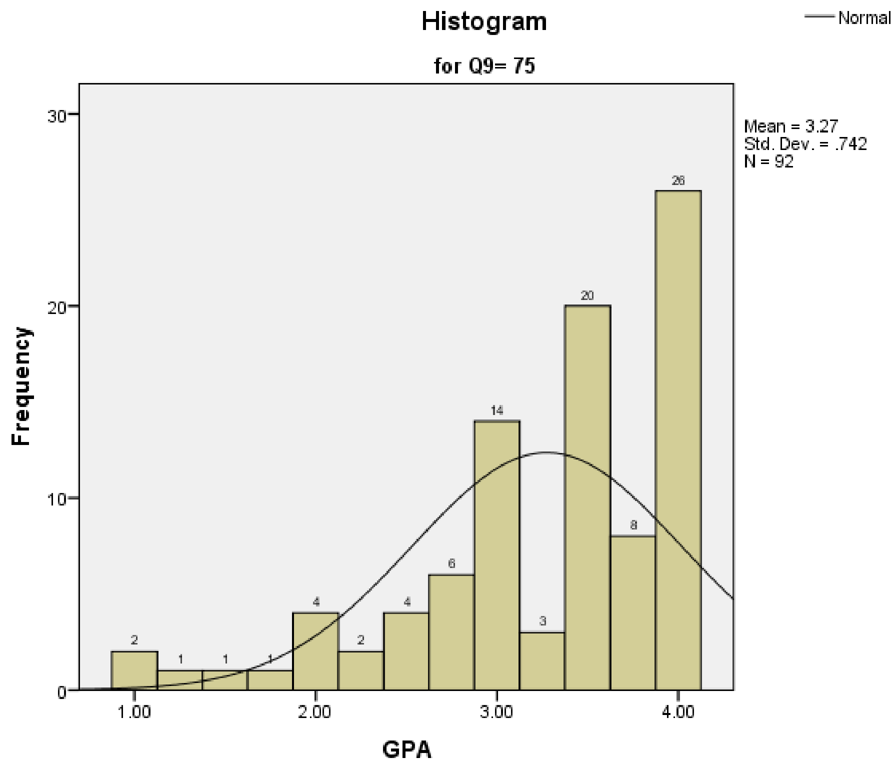


Figure 24. Q9 "Often" response distribution vs. GPA.

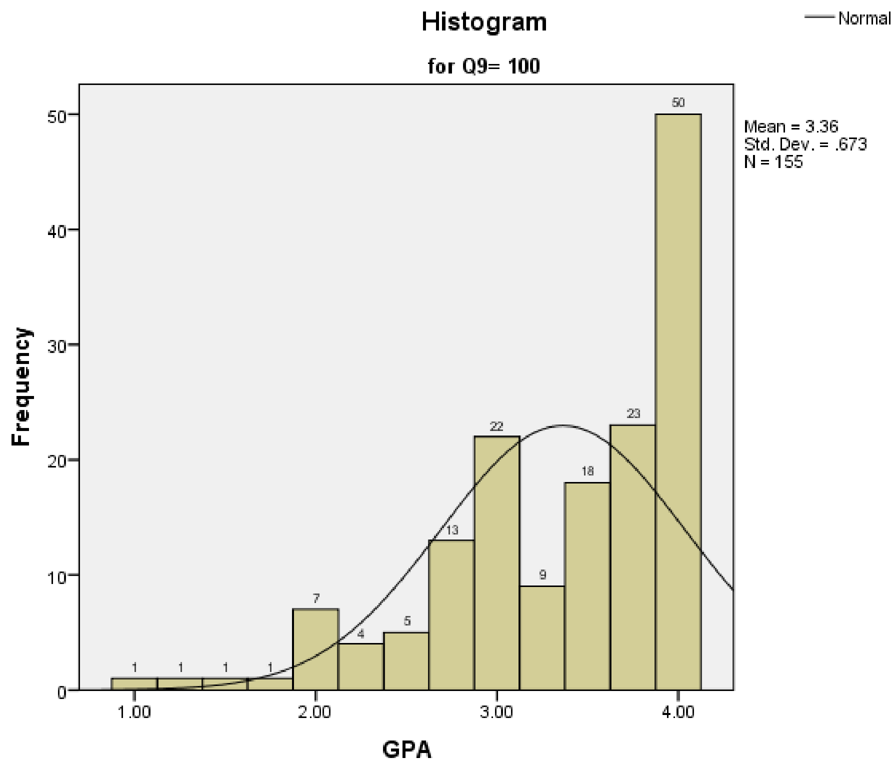


Figure 25. Q9 "Always" response distribution vs. GPA.

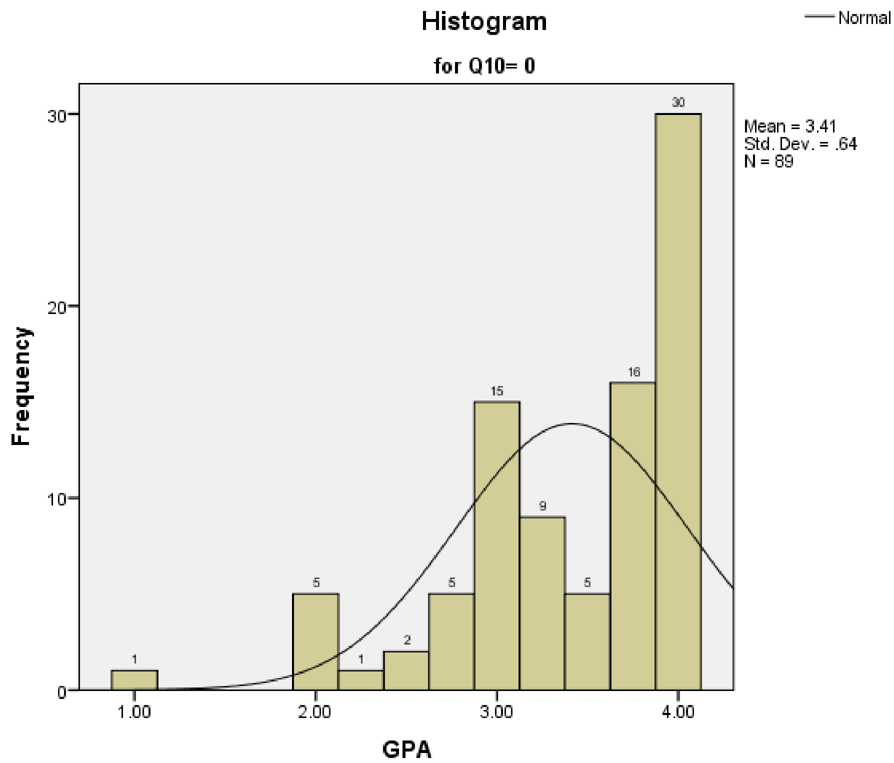


Figure 26. Q10 "Never" response distribution vs. GPA.

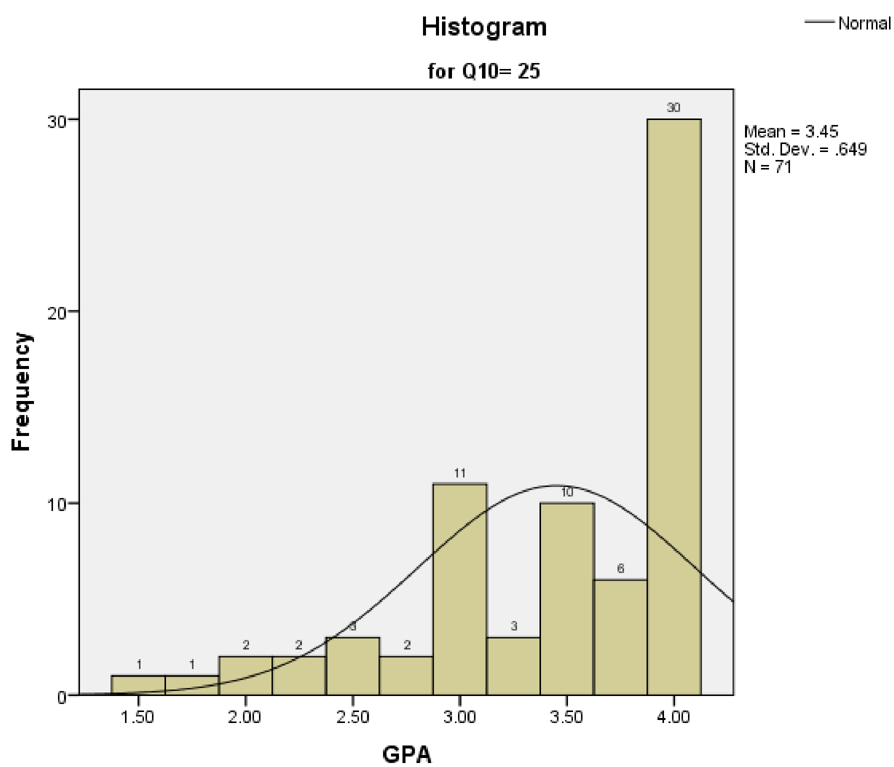


Figure 27. Q10 "Seldom" response distribution vs. GPA.

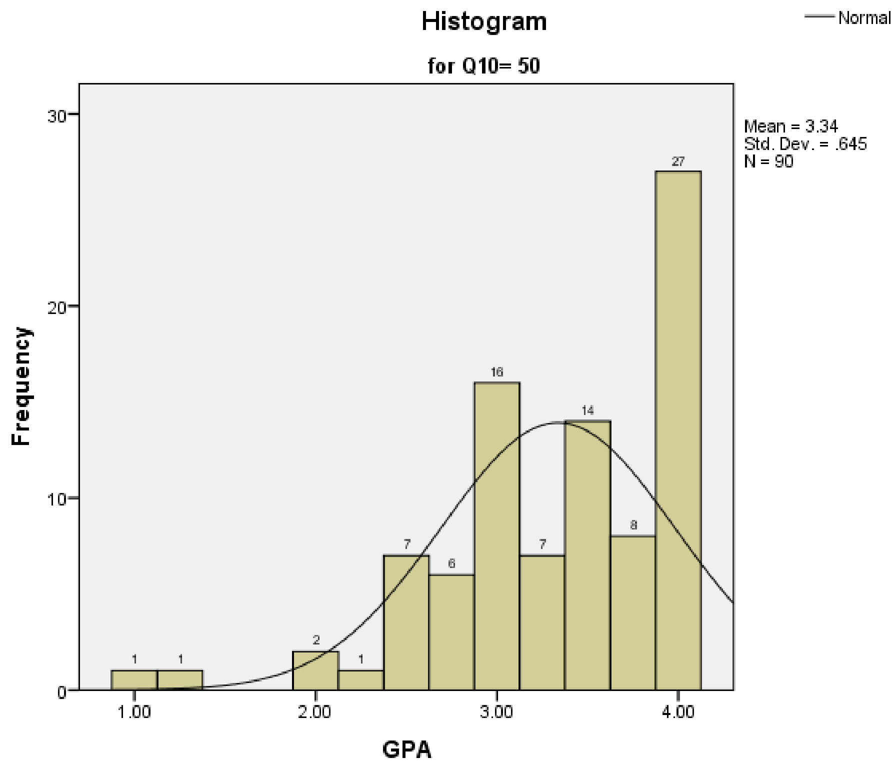


Figure 28. Q10 "Sometimes" response distribution vs. GPA.

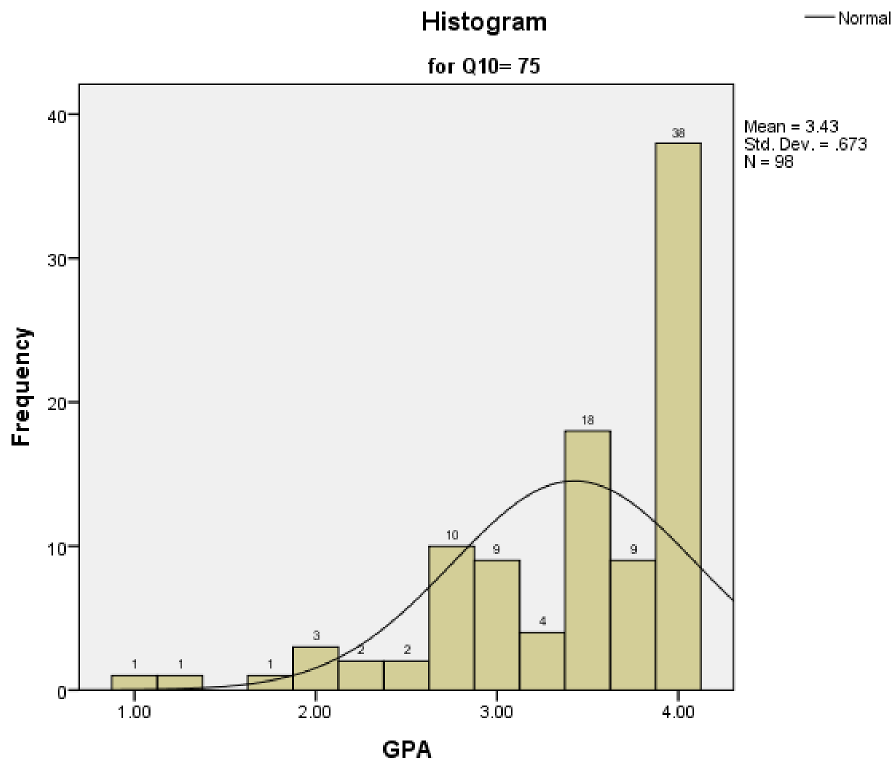


Figure 29. Q10 "Often" response distribution vs. GPA.

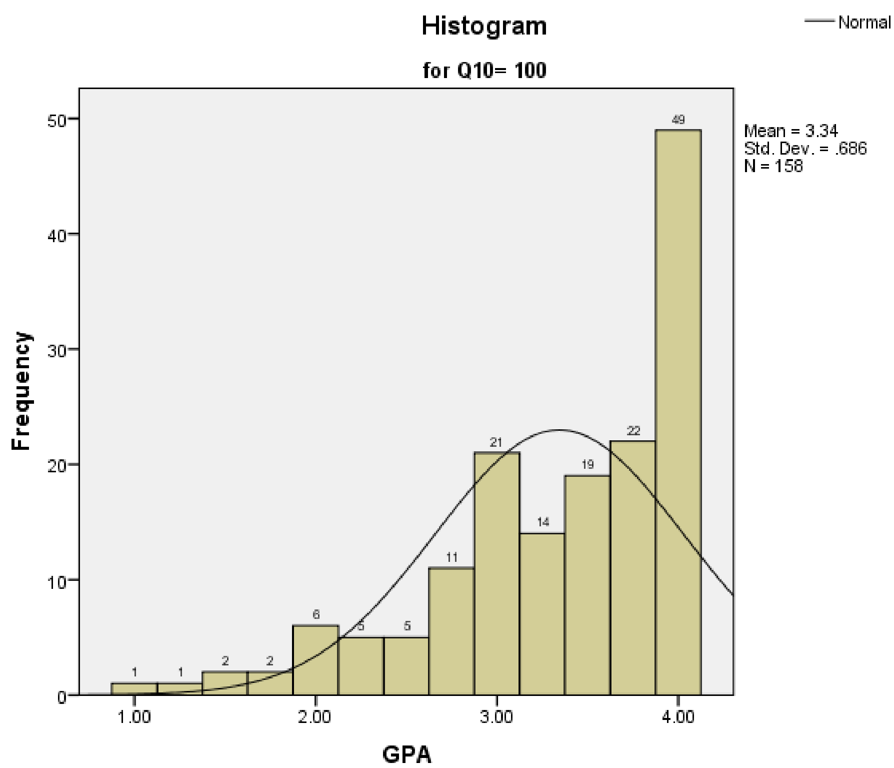


Figure 30. Q10 "Always" response distribution vs. GPA.

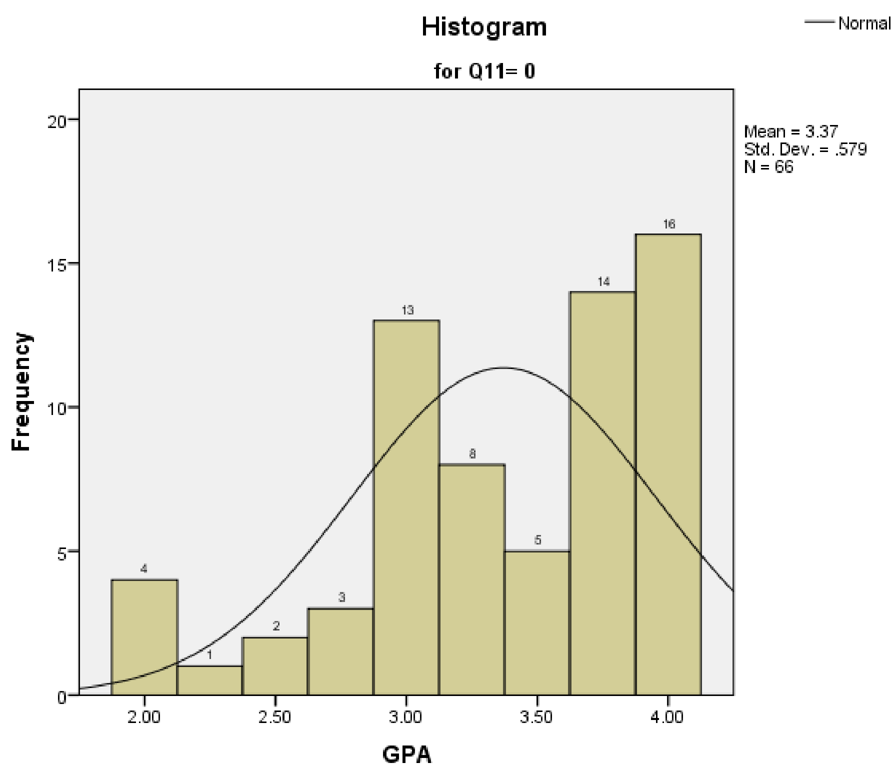


Figure 31. Q11 "Never" response distribution vs. GPA.

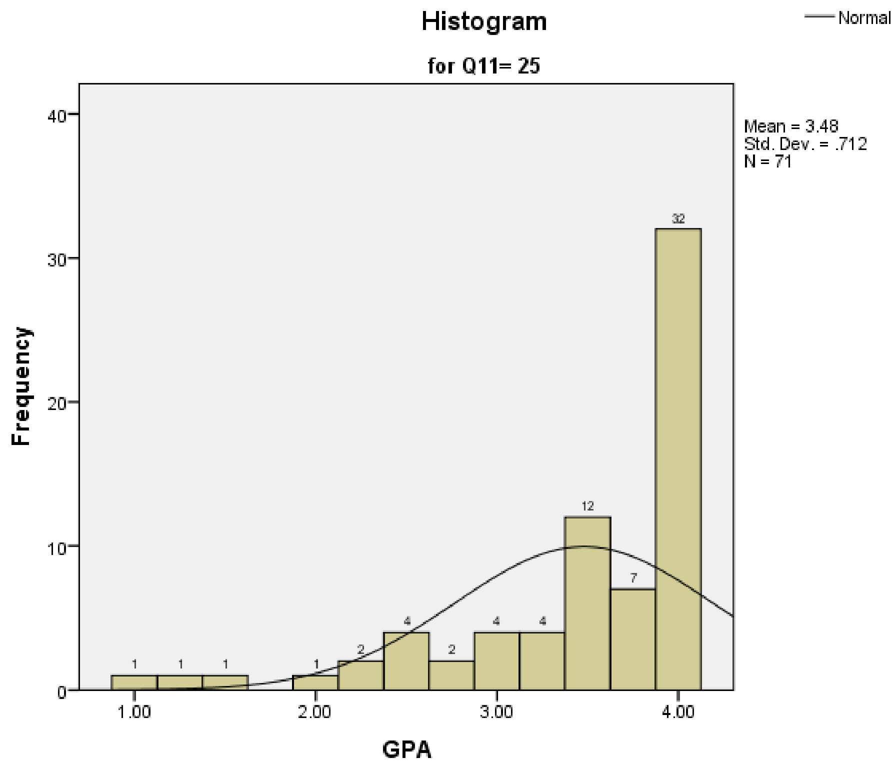


Figure 32. Q11 "Seldom" response distribution vs. GPA.

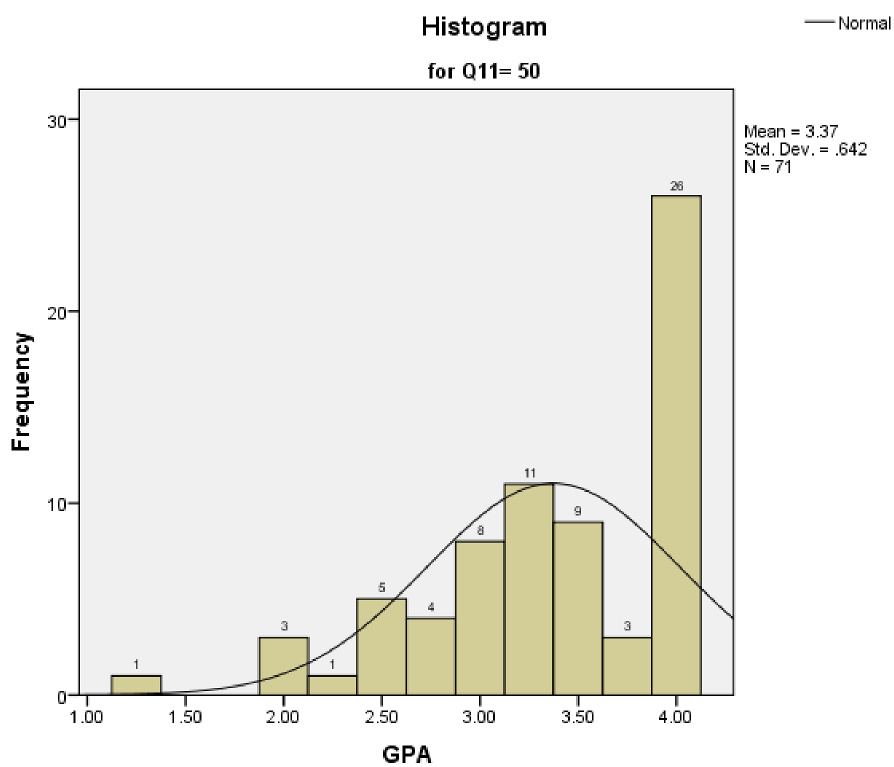


Figure 33. Q11 "Sometimes" response distribution vs. GPA.

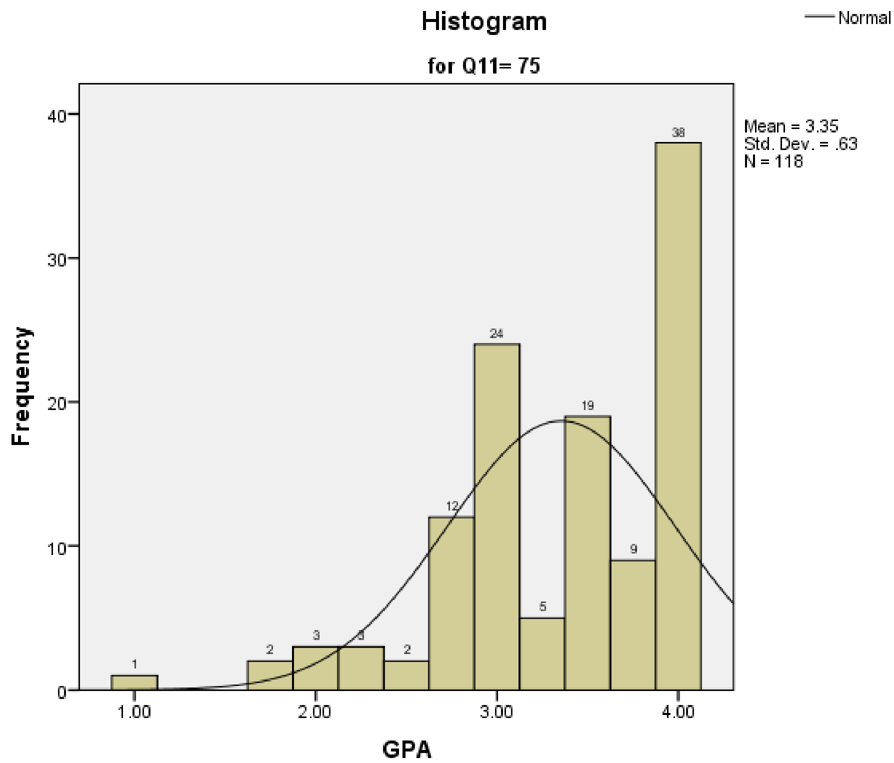


Figure 34. Q11 "Often" response distribution vs. GPA.

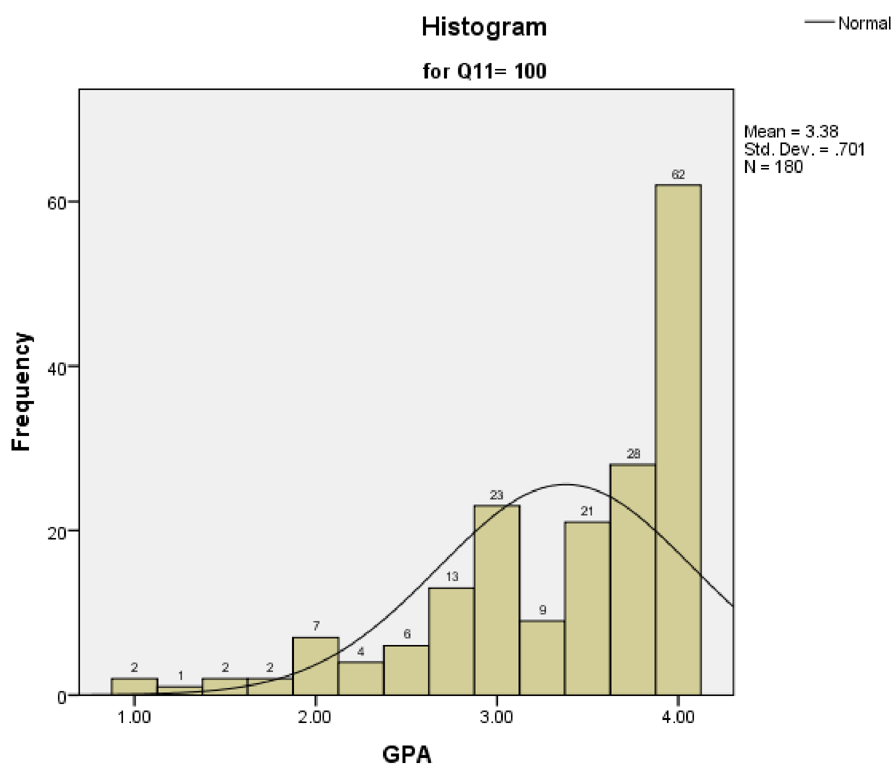


Figure 35. Q11 "Always" response distribution vs. GPA.

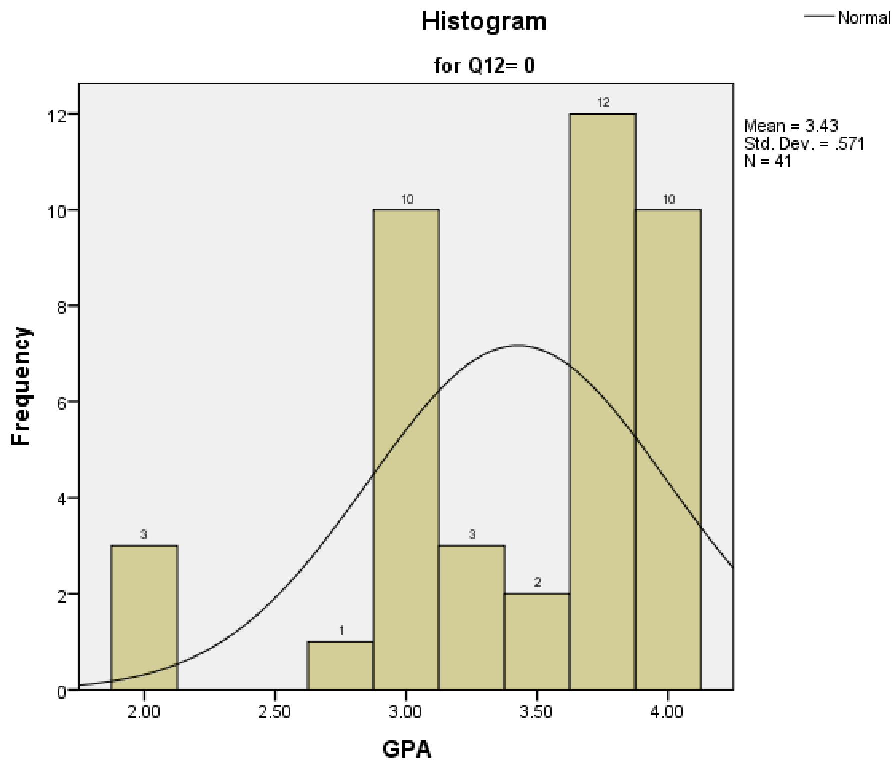


Figure 36. Q12 "Never" response distribution vs. GPA.

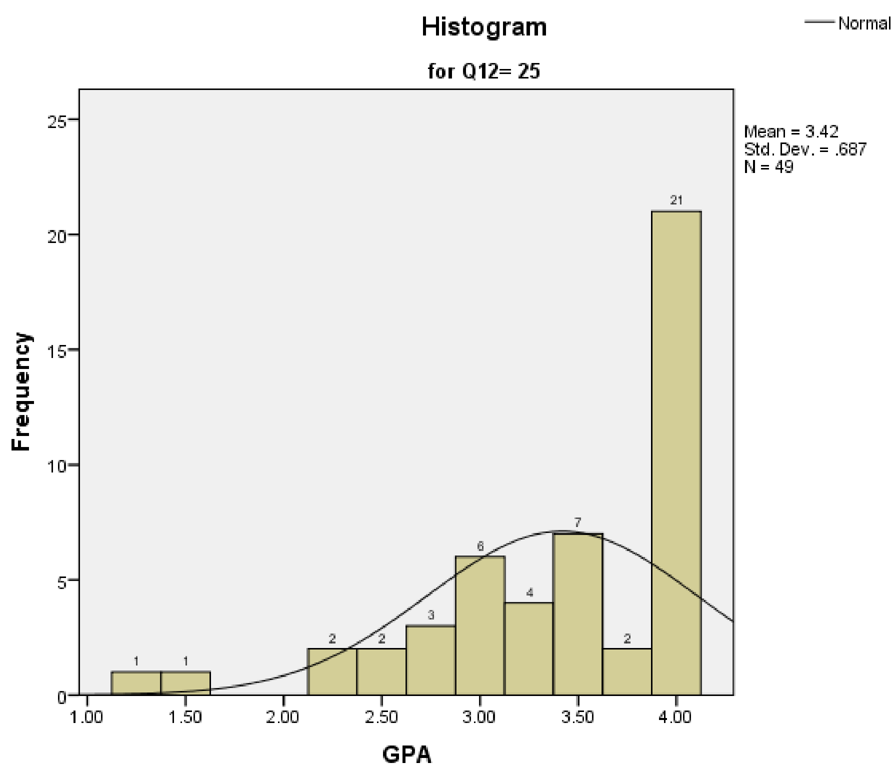


Figure 37. Q12 "Seldom" response distribution vs. GPA.

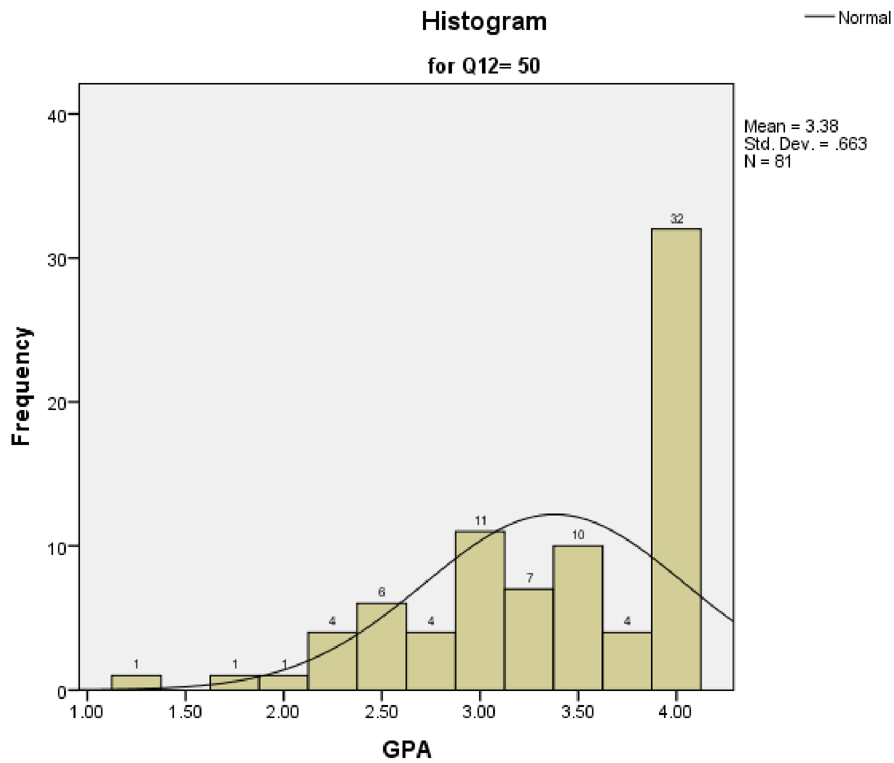


Figure 38. Q12 "Sometimes" response distribution vs. GPA.

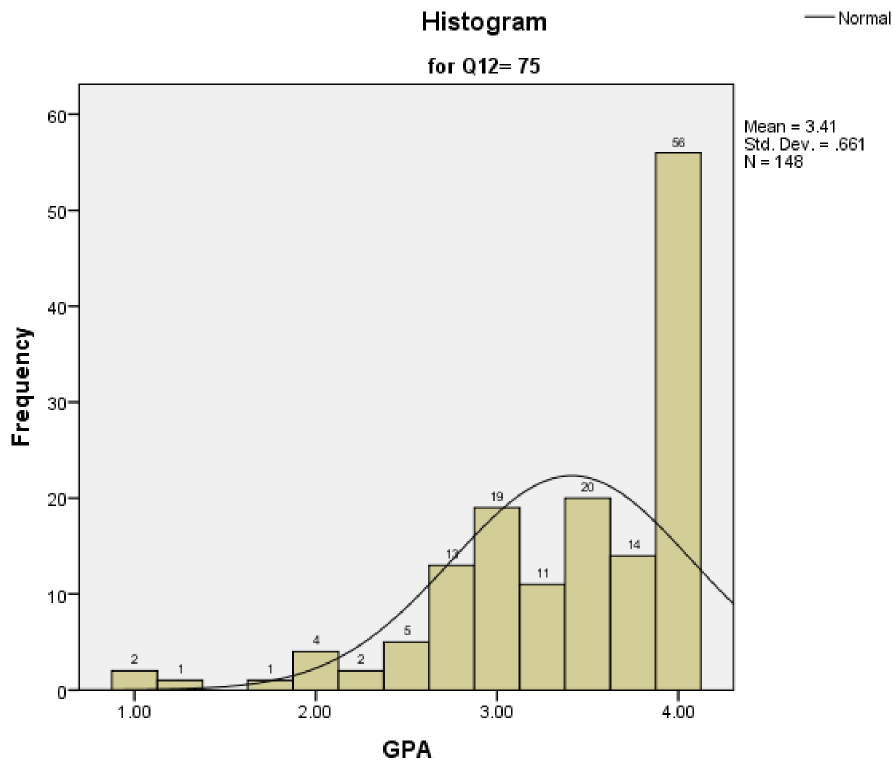


Figure 39. Q12 "Often" response distribution vs. GPA.

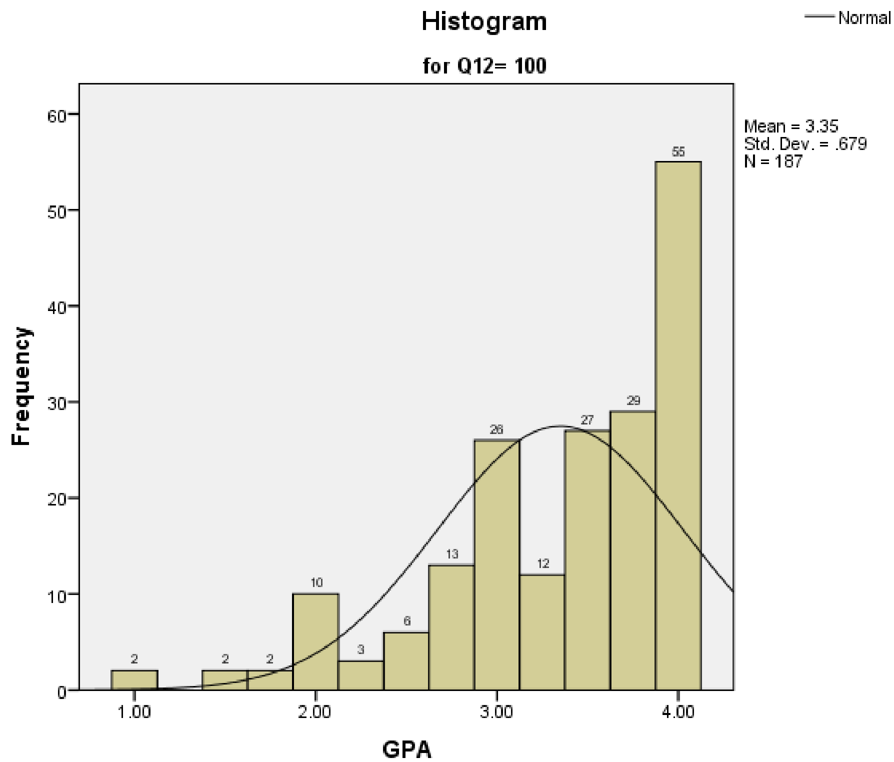


Figure 40. Q12 "Always" response distribution vs. GPA.

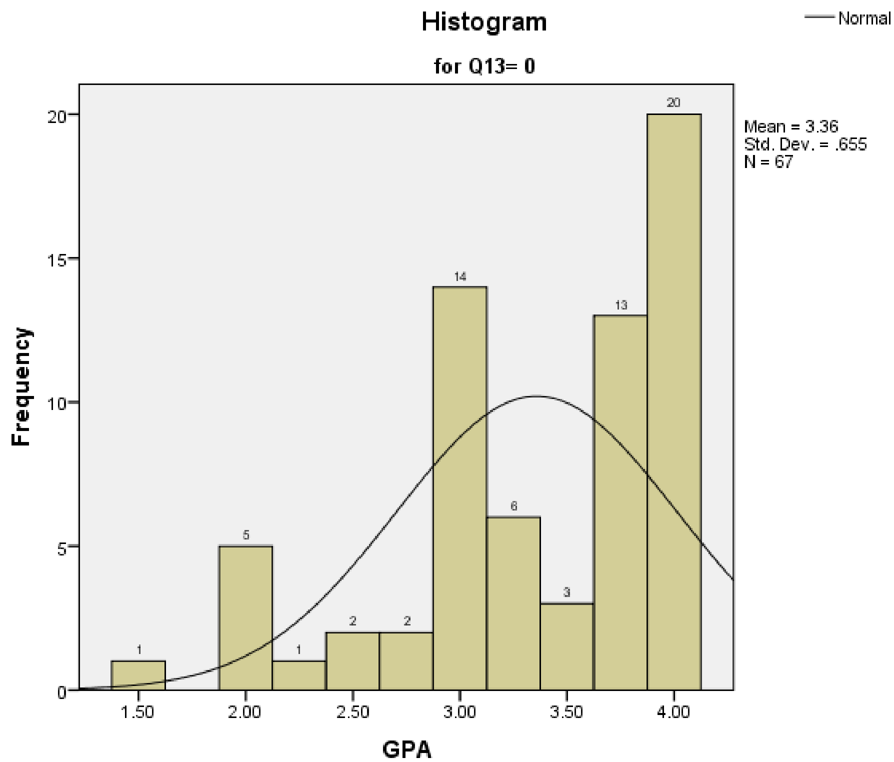


Figure 41. Q13 "Never" response distribution vs. GPA.

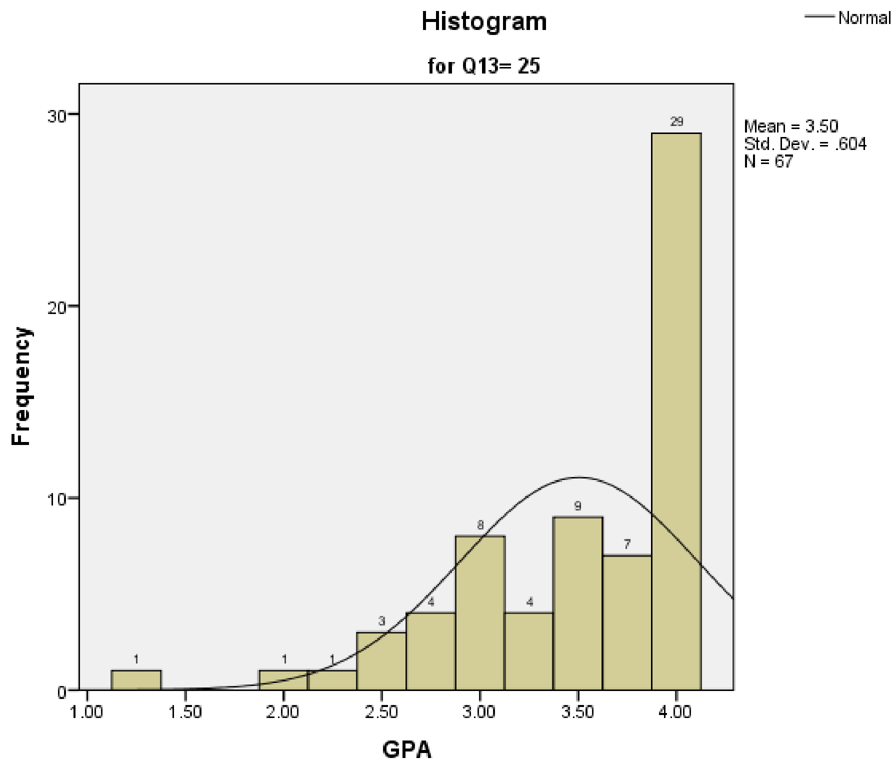


Figure 42. Q13 "Seldom" response distribution vs. GPA.

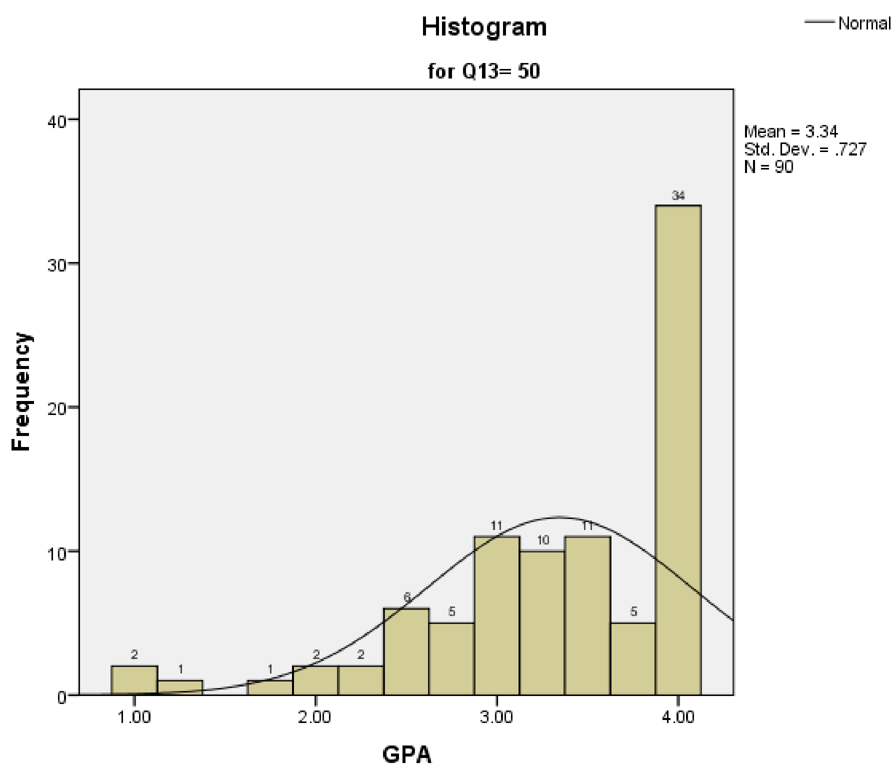


Figure 43. Q13 "Sometimes" response distribution vs. GPA.

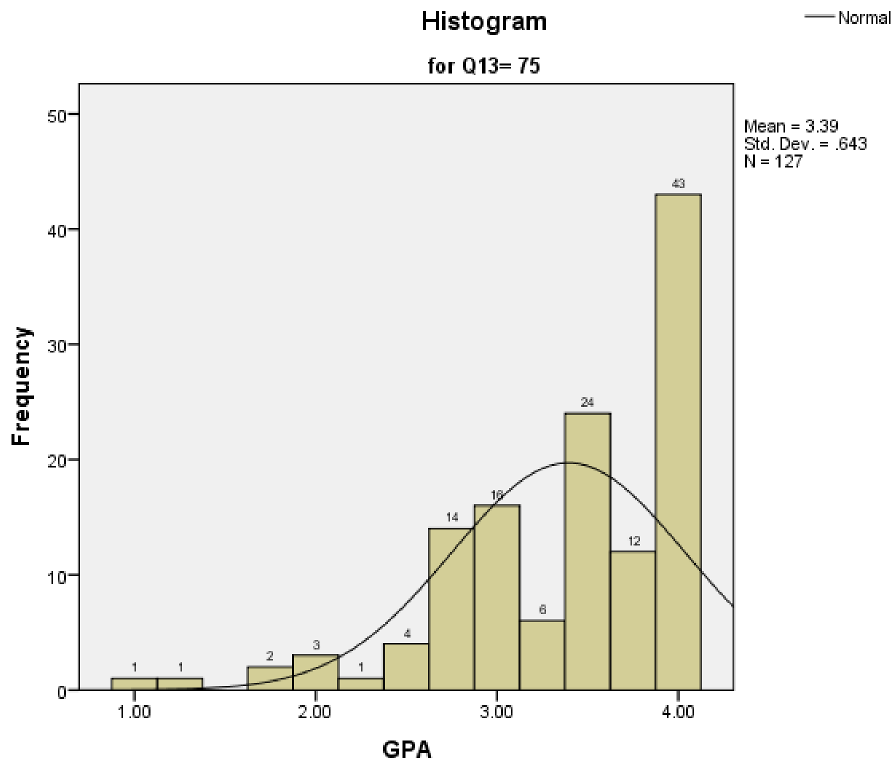


Figure 44. Q13 "Often" response distribution vs. GPA.

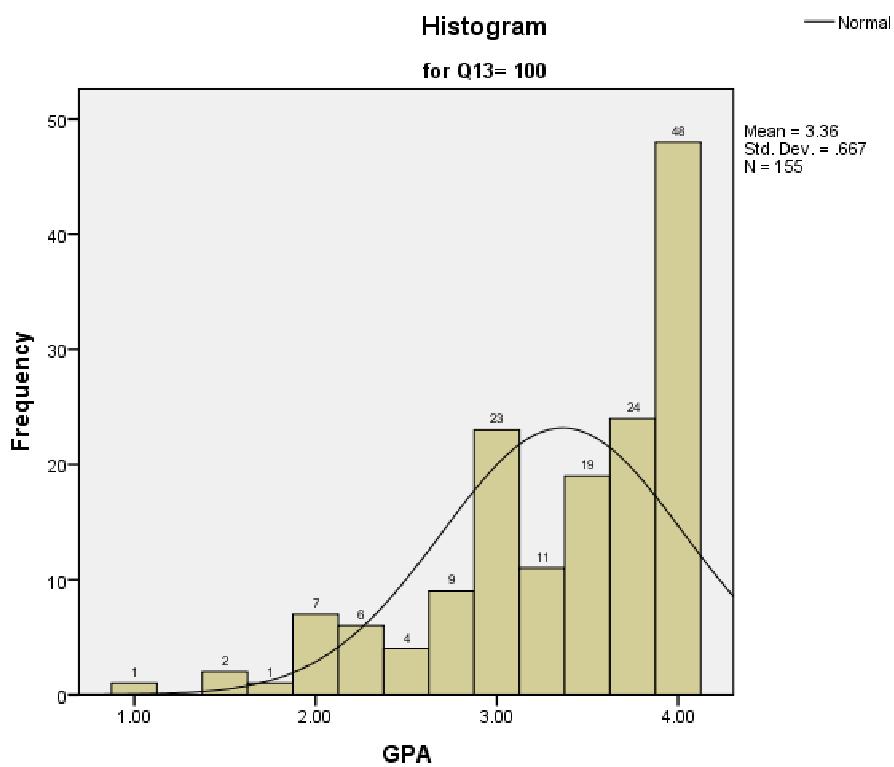


Figure 45. Q13 "Always" response distribution vs. GPA.

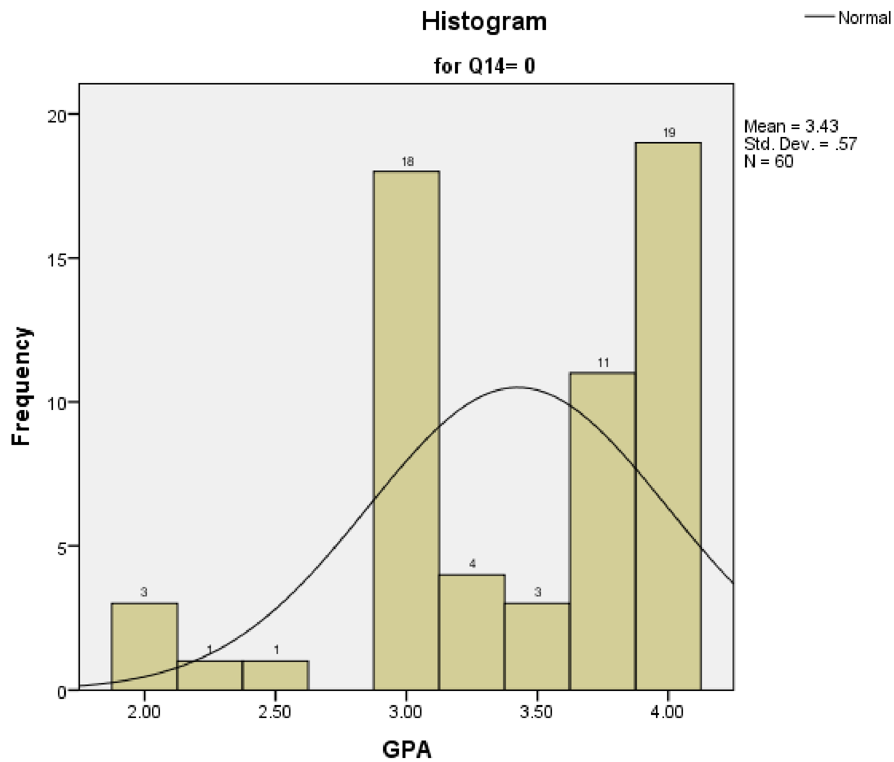


Figure 46. Q14 "Never" response distribution vs. GPA.

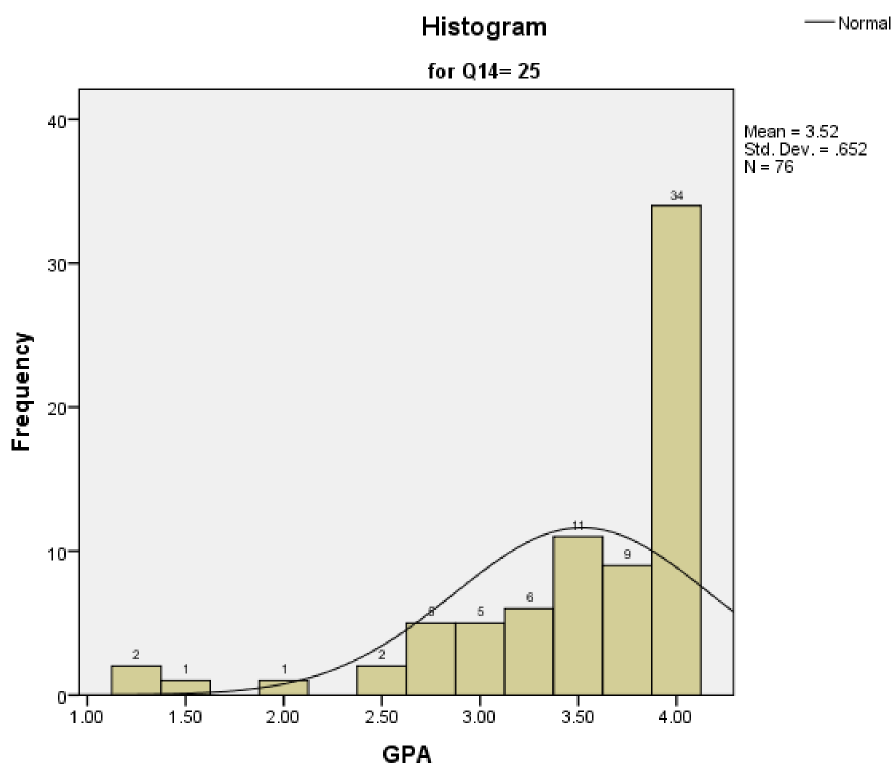


Figure 47. Q14 "Seldom" response distribution vs. GPA.

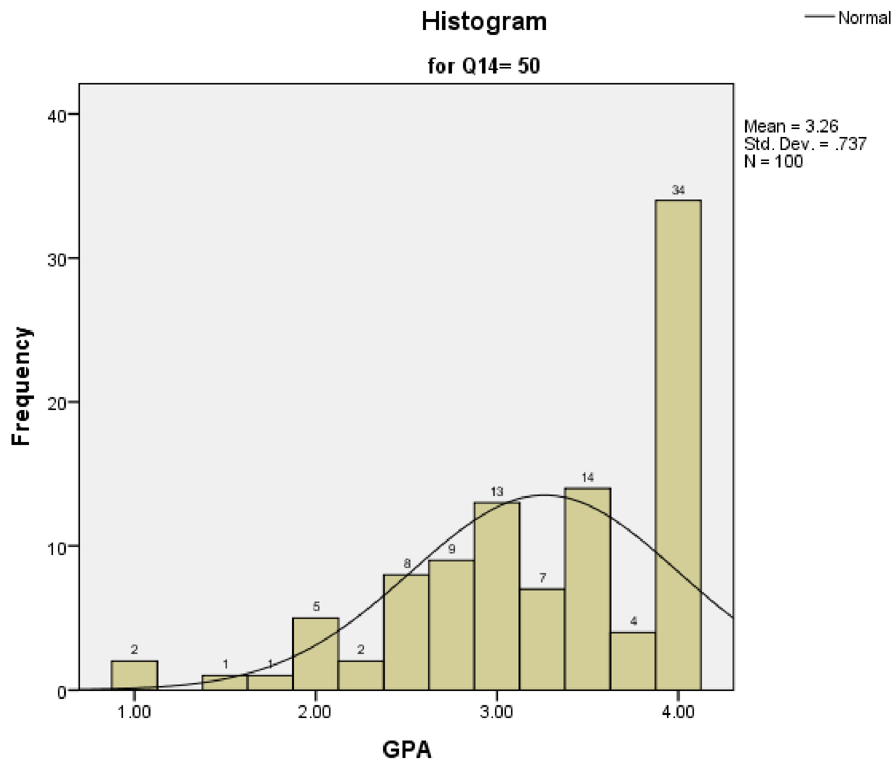


Figure 48. Q14 "Sometimes" response distribution vs. GPA.

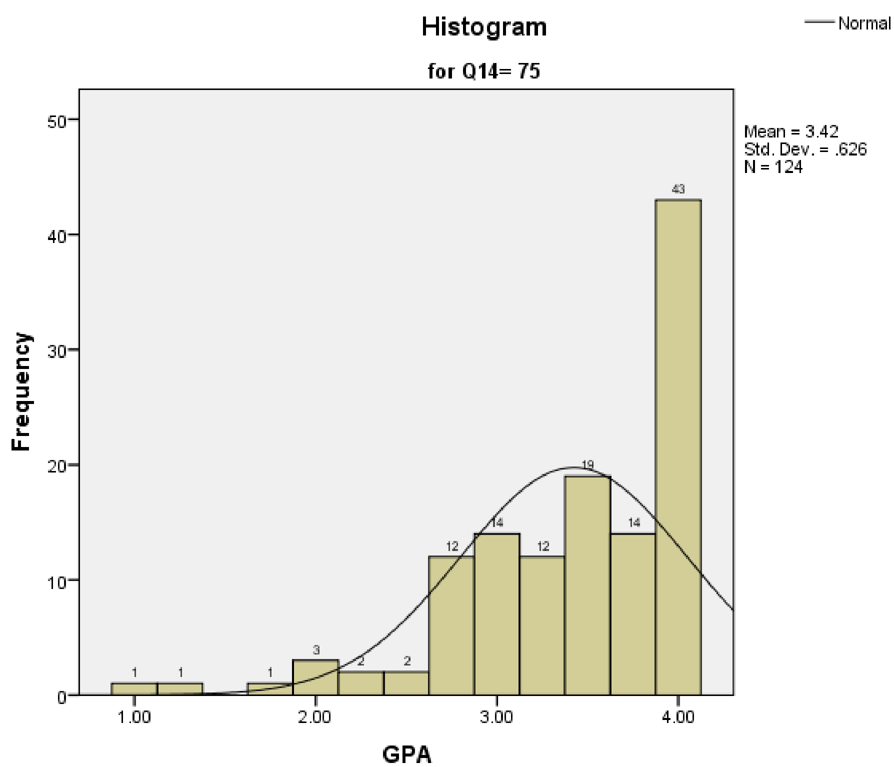


Figure 49. Q14 "Often" response distribution vs. GPA.

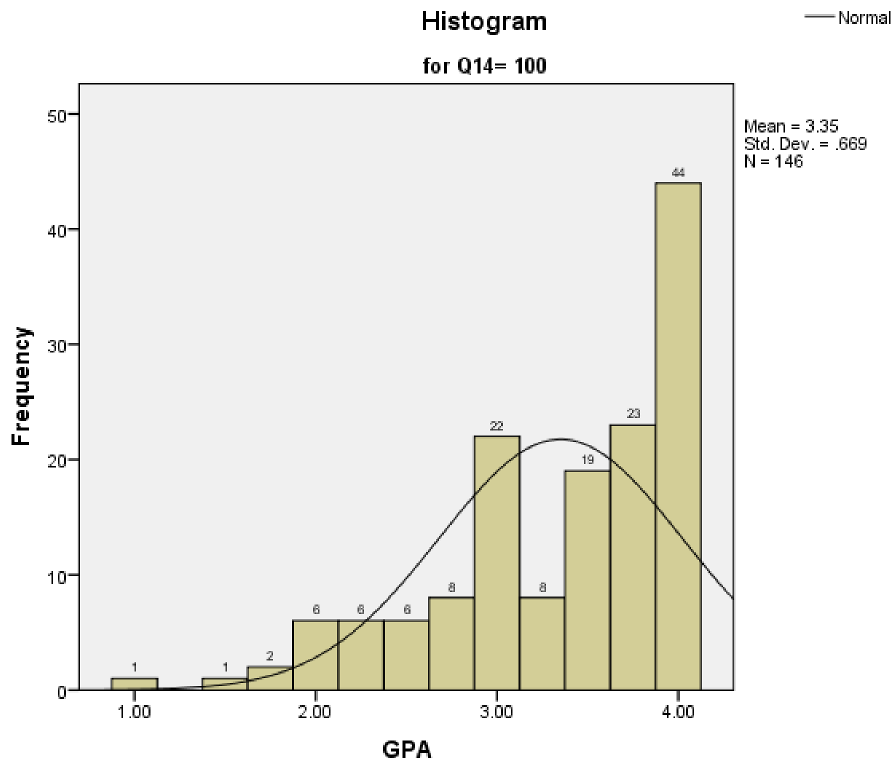


Figure 50. Q14 "Always" response distribution vs. GPA.

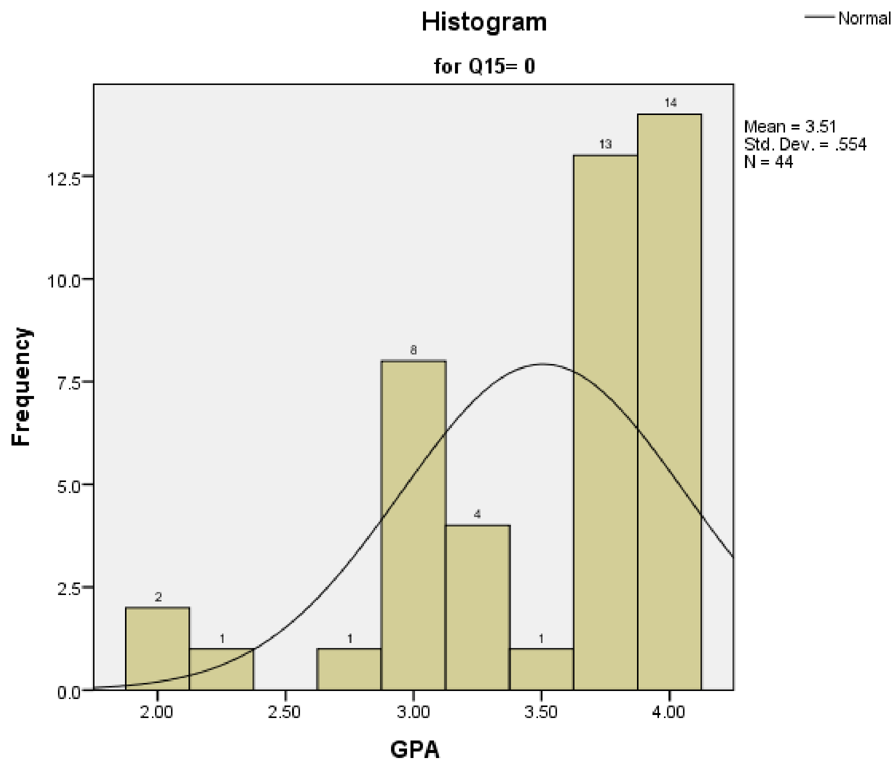


Figure 51. Q15 "Never" response distribution vs. GPA.

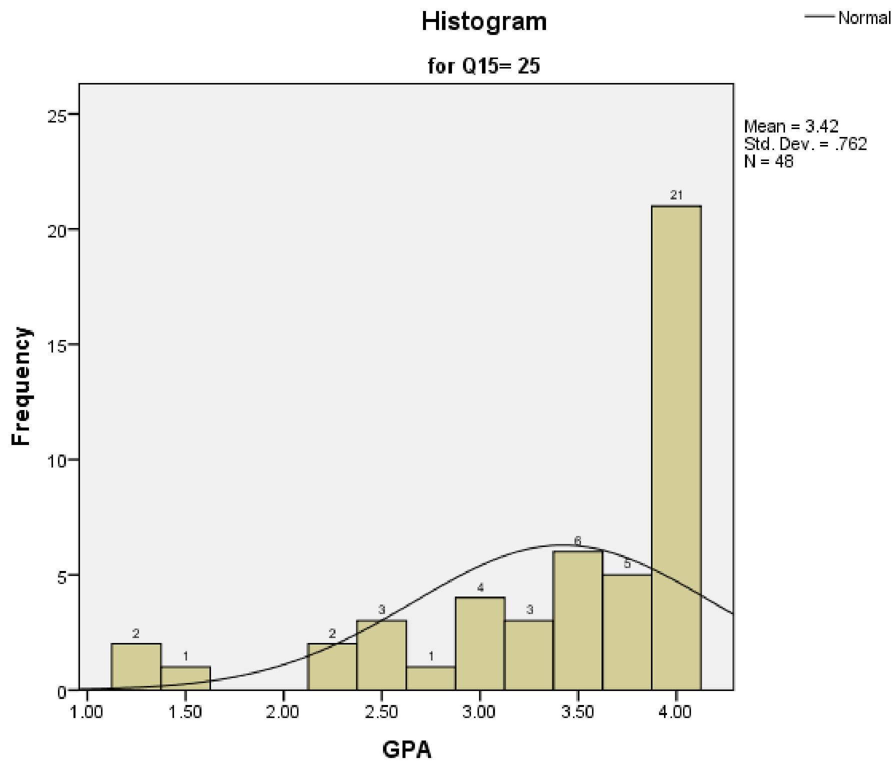


Figure 52. Q15 "Seldom" response distribution vs. GPA.

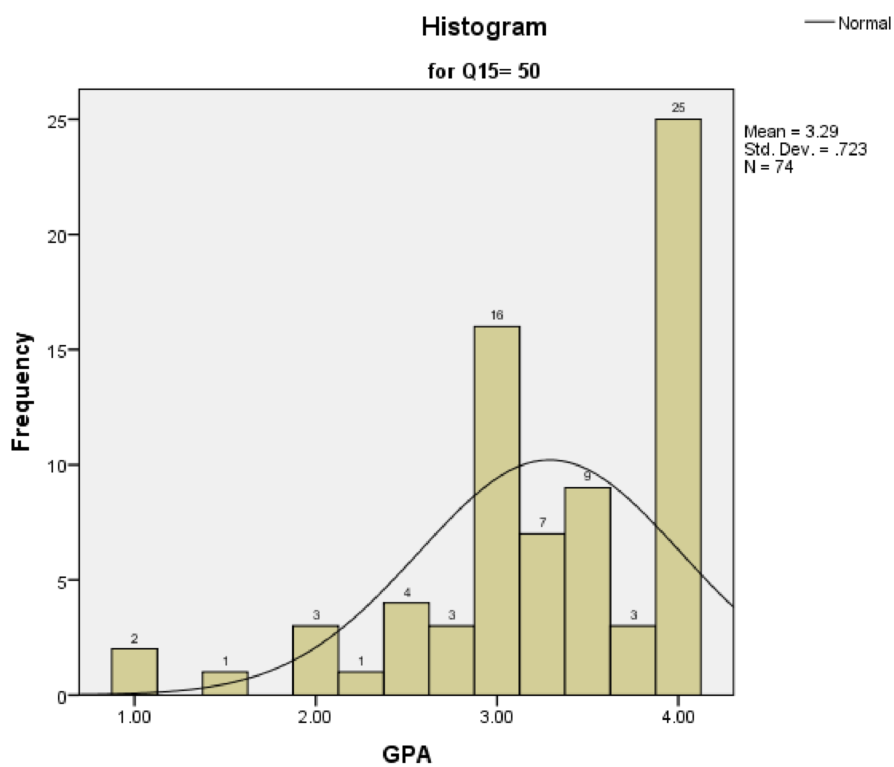


Figure 53. Q15 "Sometimes" response distribution vs. GPA.

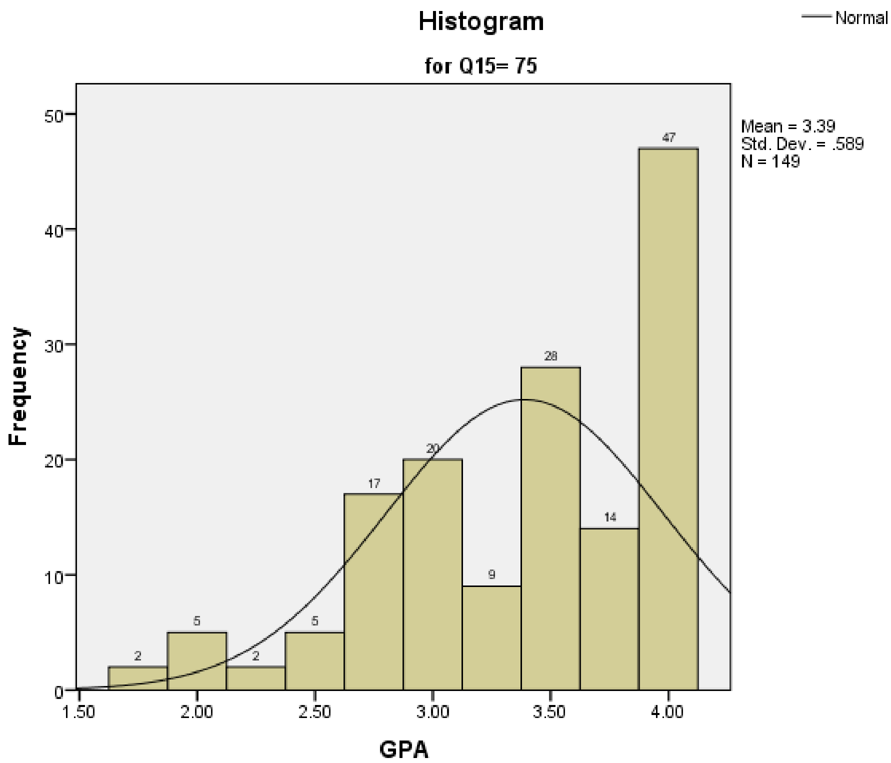


Figure 54. Q15 "Often" response distribution vs. GPA.

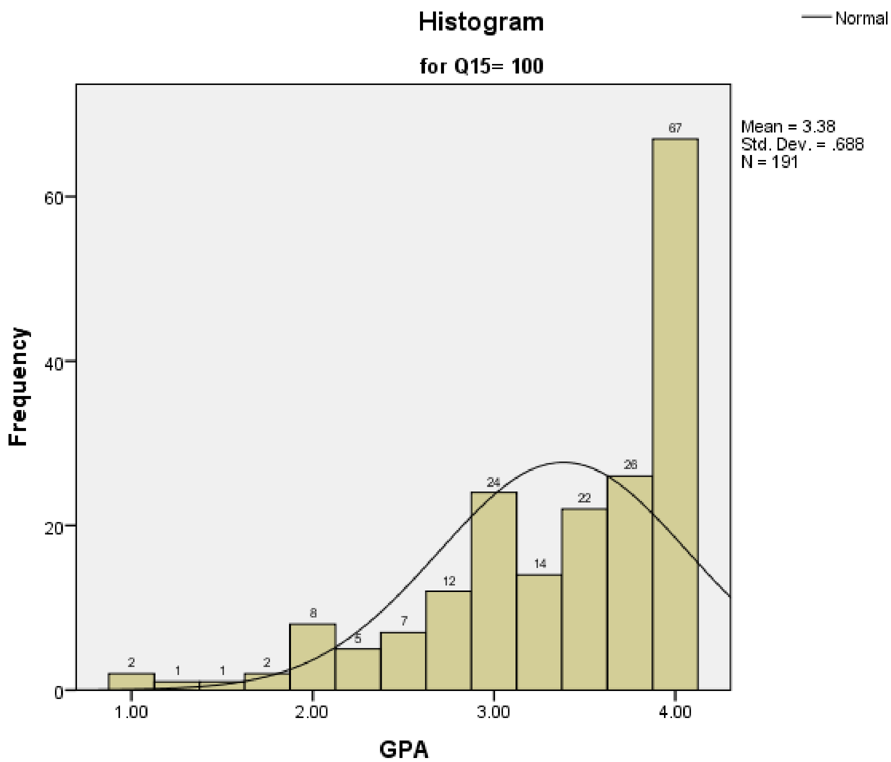


Figure 55. Q15 "Always" response distribution vs. GPA.

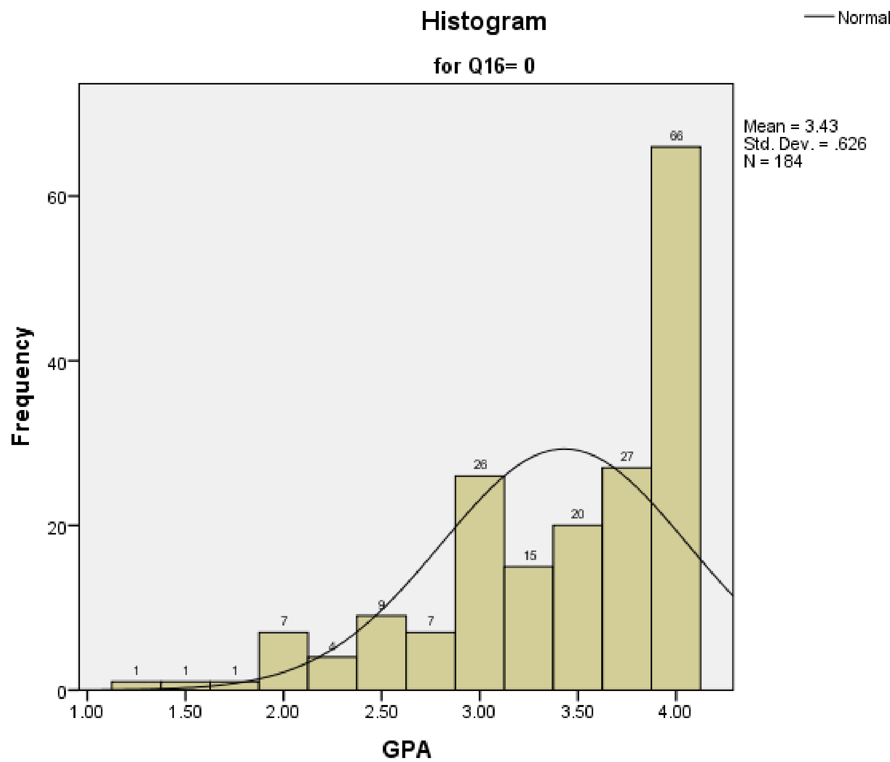


Figure 56. Q16 "Never" response distribution vs. GPA.

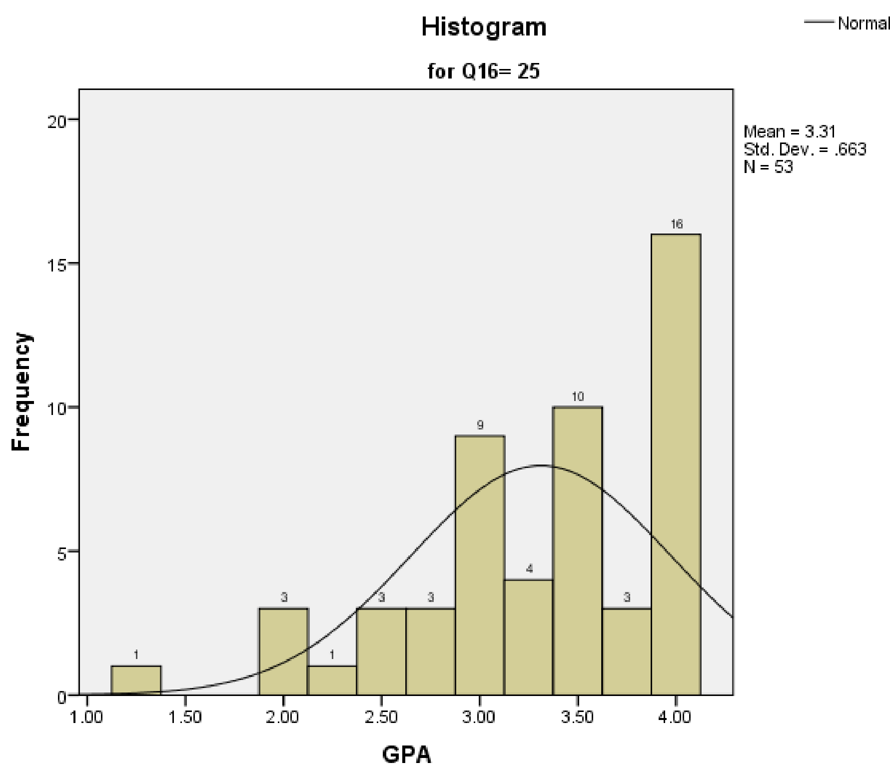


Figure 57. Q16 "Seldom" response distribution vs. GPA.

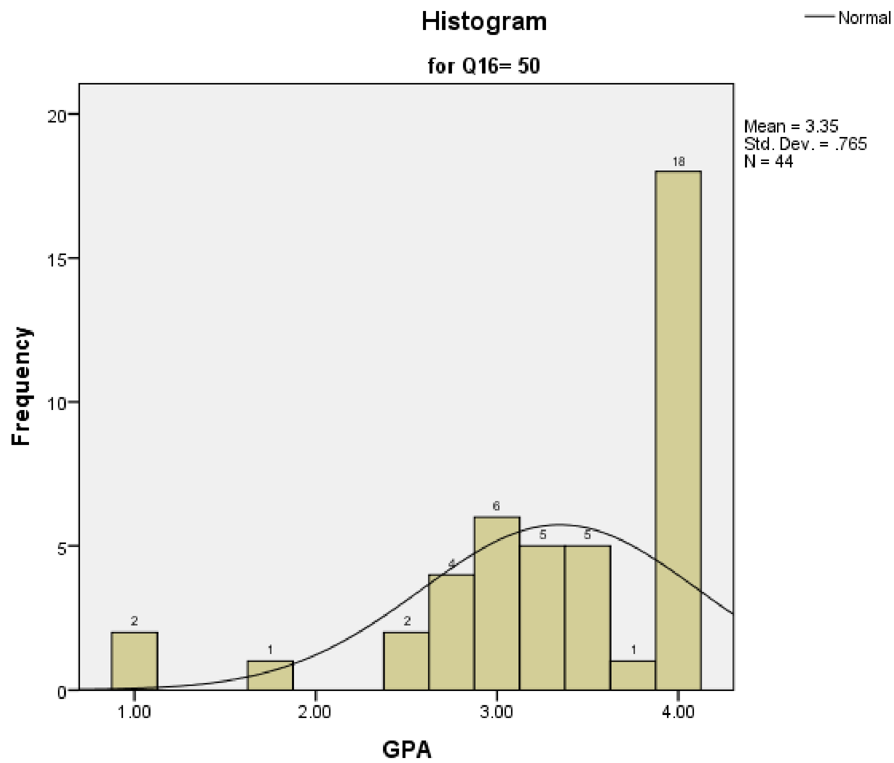


Figure 58. Q16 "Sometimes" response distribution vs. GPA.

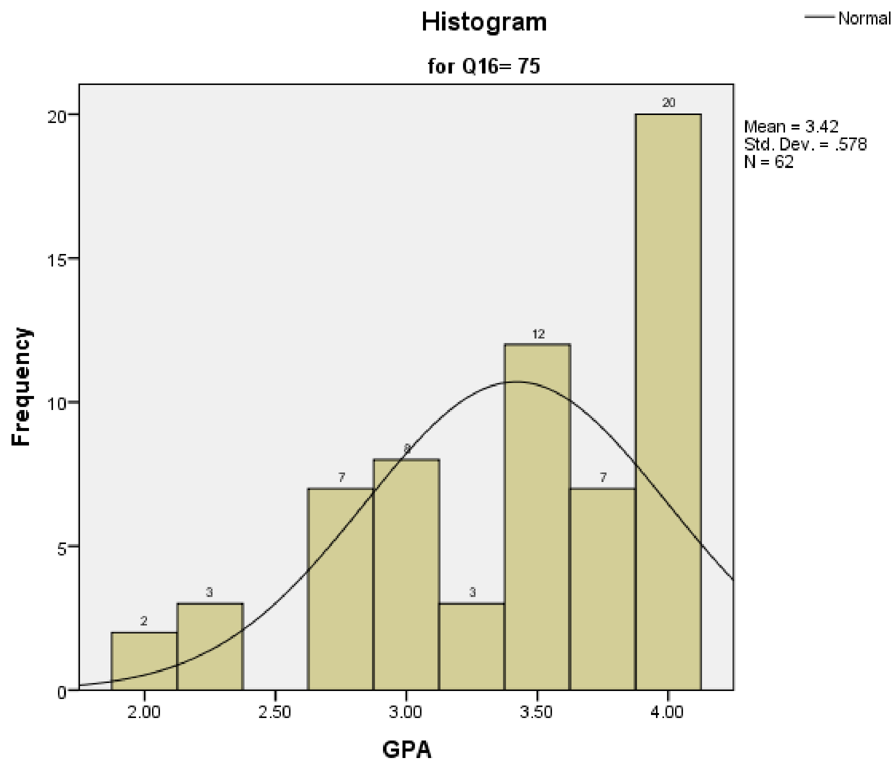


Figure 59. Q16 "Often" response distribution vs. GPA.

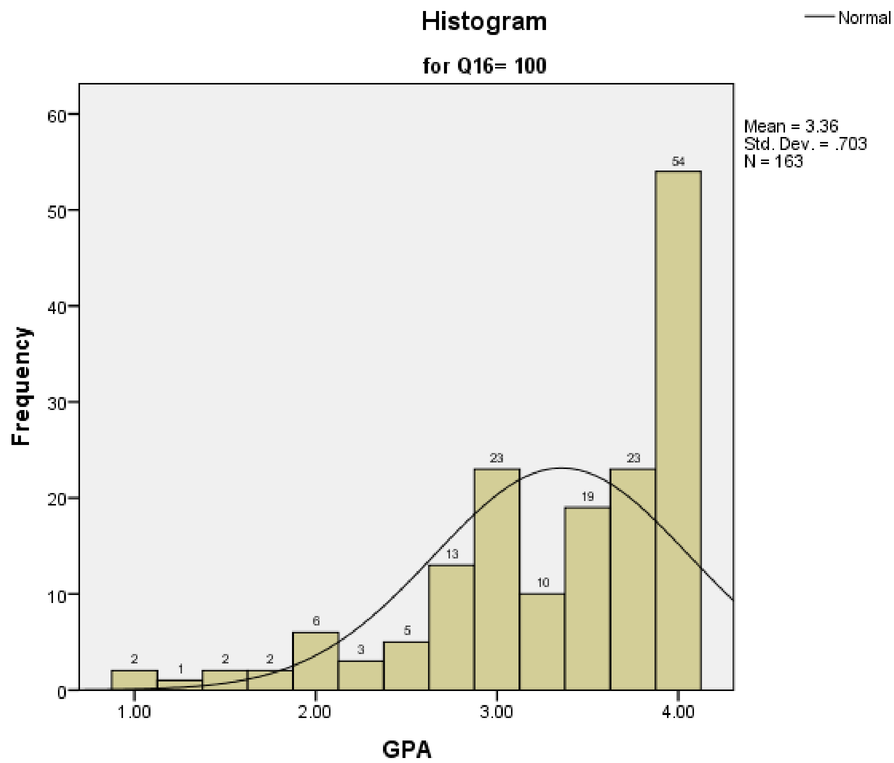


Figure 60. Q16 "Always" response distribution vs. GPA.

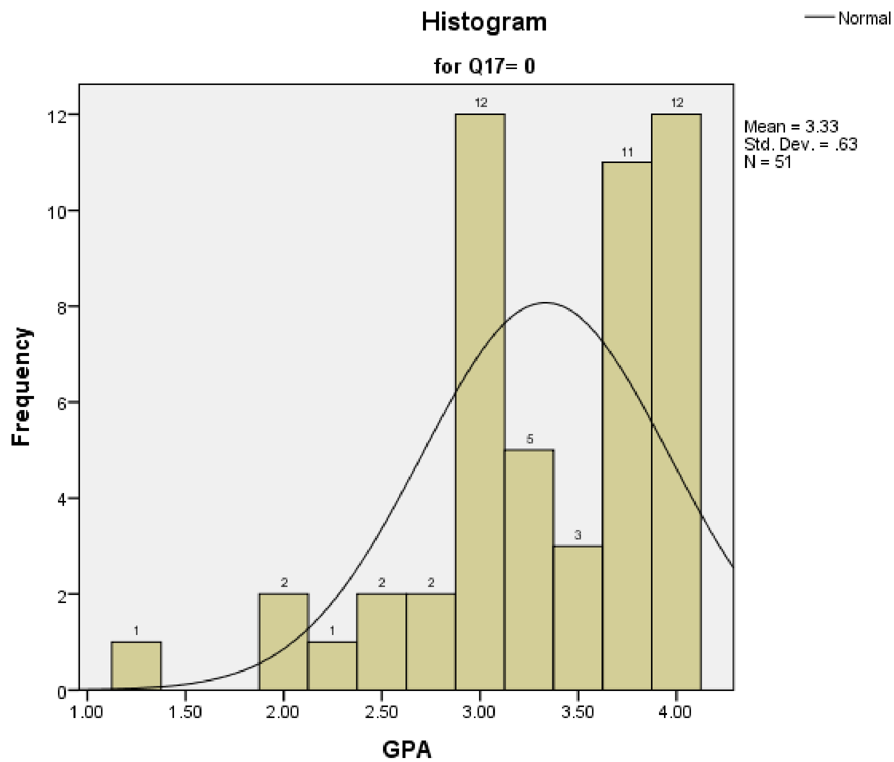


Figure 61. Q17 "Never" response distribution vs. GPA.

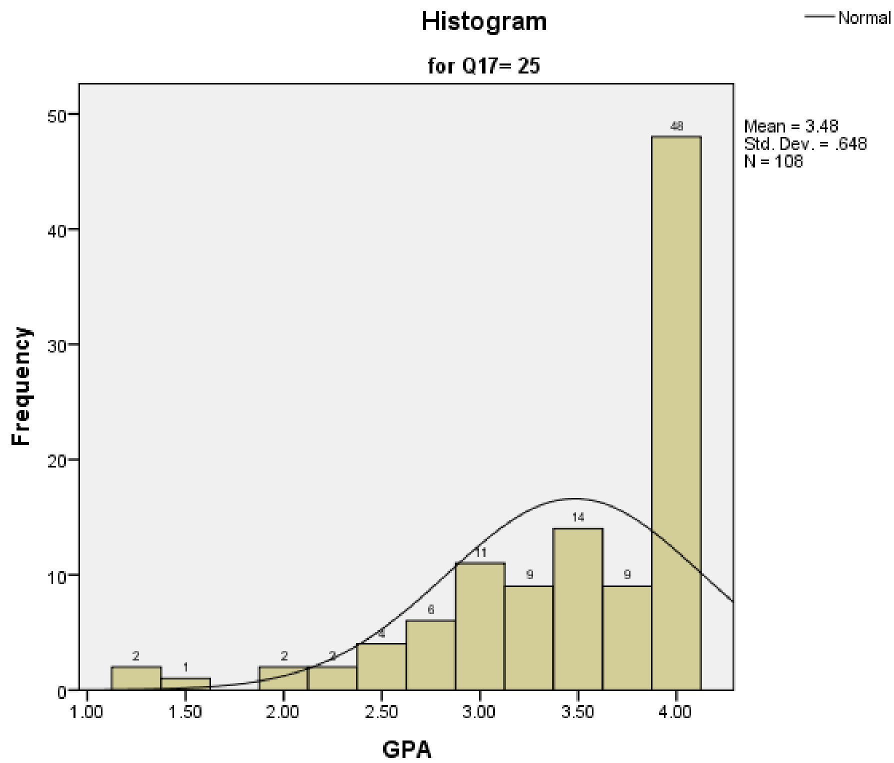


Figure 62. Q17 "Seldom" response distribution vs. GPA.

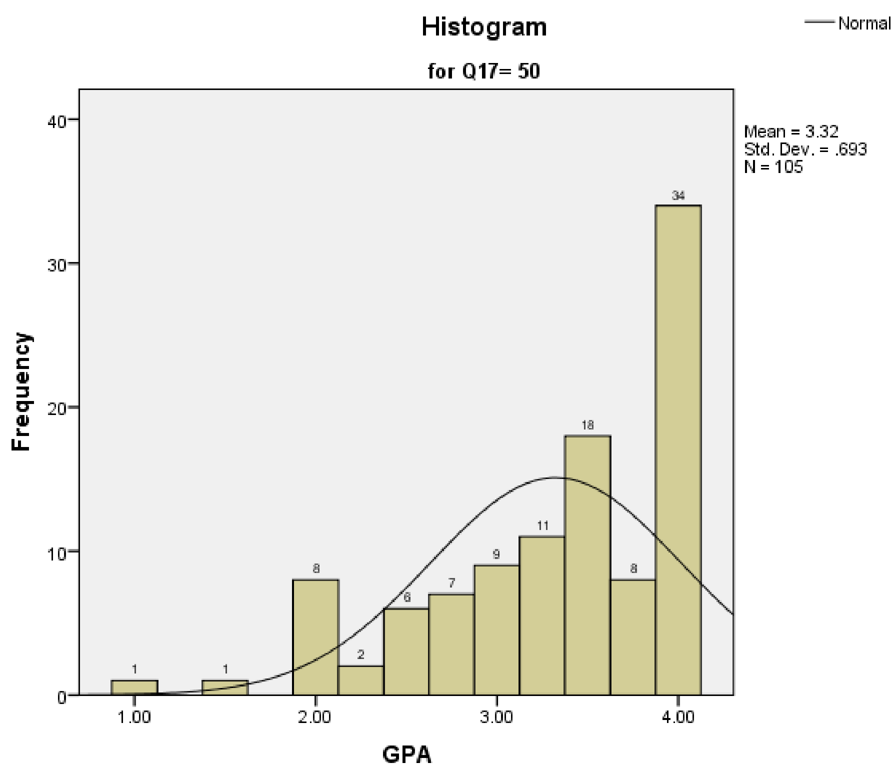


Figure 63. Q17 "Sometimes" response distribution vs. GPA.

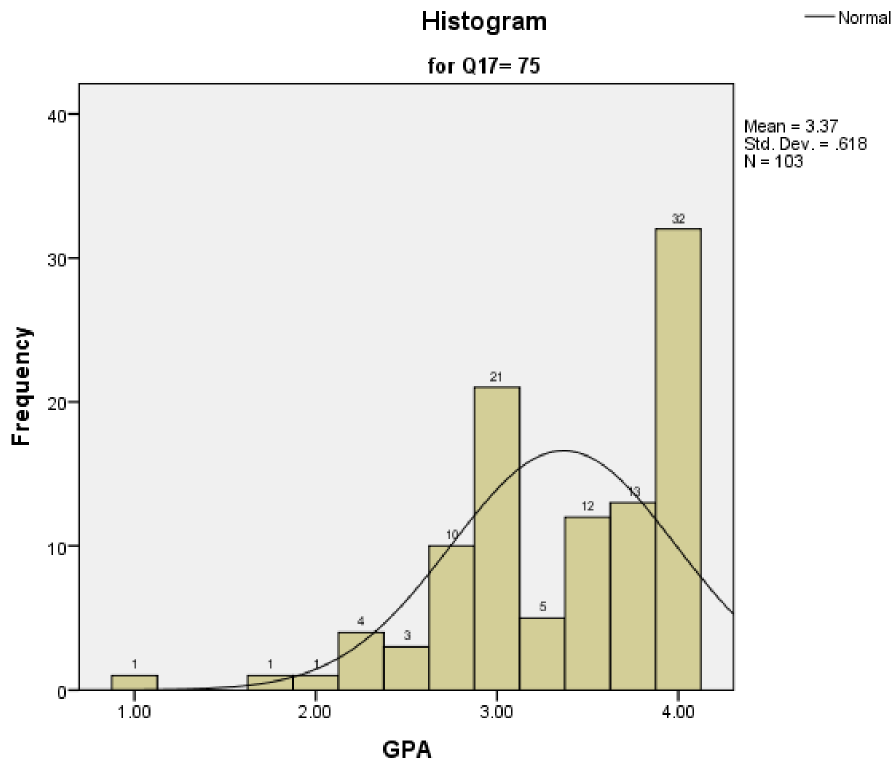


Figure 64. Q17 "Often" response distribution vs. GPA.

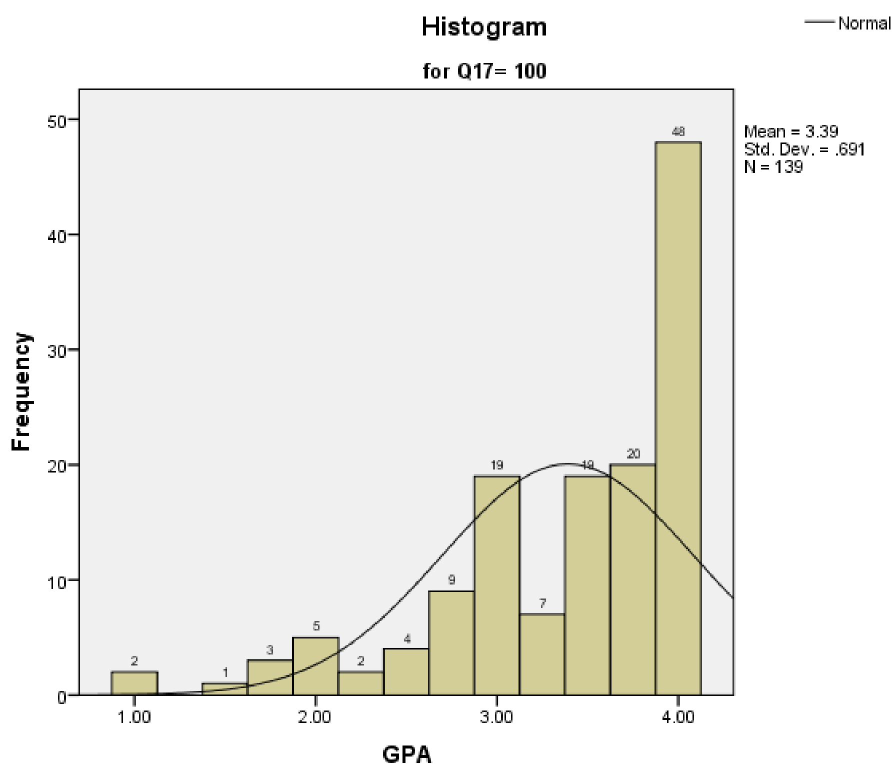


Figure 65. Q17 "Always" response distribution vs. GPA.