DEVELOPMENT OF A BRING YOUR OWN DEVICE (BYOD) ELEARNING CONCEPTUAL FRAMEWORK FOR PRIVATE SECONDARY SCHOOLS IN DUBAI, UNITED ARAB EMIRATES

By

MANOJ MECHANKARA VARGHESE, M. Ed.

A Dissertation

Submitted in Partial Fulfilment of the Requirements for

the Degree of Doctor of Philosophy

in eLearning Methodology

April 2018

Assumption University of Thailand

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Doctor of Philosophy

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DEVELOPMENT OF A BRING YOUR OWN DEVICE (BYOD) ELEARNING CONCEPTUAL FRAMEWORK FOR PRIVATE SECONDARY SCHOOLS IN DUBAI, UNITED ARAB EMIRATES.

Researcher: Manoj Mechankara Varghese; **Advisor**: Dr. Poonsri Vate-U-Lan; **Co-Advisor**: Assoc. Prof. Dr. Varughese K. John; **Degree**: Doctor of Philosophy in eLearning Methodology; Graduate School of eLearning, Assumption University of Thailand, 2018.

ABSTRACT

The objectives of this dissertation were (1) to study the impact of grade 9 students' achievement in Science and Mathematics in BYOD schools and Non-BYOD schools, (2) to examine the variation in grade 9 students' achievement in Science and Mathematics based on gender in BYOD schools and Non-BYOD schools, and (3) to develop a BYOD eLearning Conceptual Framework for private secondary schools in Dubai, UAE based on documentary research and confirm it with an empirical research.

The population of this quantitative non-experimental design included 21,127 students and 1,241 teachers. The sample size was 1,800 students and 120 teachers. Probability sampling method was used in this research study. The data collecting instruments were self-administered questionnaires. The data were analysed using both descriptive and inferential statistical methods such as percentile, mean, independent t-test, Chi-Square test and discriminant analysis.

Major Findings : 1) The student's achievement in Mathematics and Science in BYOD Schools vs Non-BYOD shows there was a significant difference in both subjects score with BYOD schools students score are higher (Mean score, Mathematics – BYOD School – 78.01, Non-BYOD School – 74.50, Science – BYOD School – 77.84, Non-BYOD School – 74.01) ; 2) On comparison of students' achievement in Mathematics and Science with their genders in BYOD Schools show there were significant difference whereas the Non-BYOD Schools shows the differences were not significant and ; 3) the BYOD critical factors such as Teaching Methods (TM), Learning Methods (LM), Technology Usage (TU), and Evaluation Methods (EM) of BYOD Schools have a positive impact on student achievement, and hence the BYOD eLearning Conceptual Framework found to be effective.

The "new knowledge" found in the field of eLearning Methodology was the detailed finding of the influence of TM, LM, TU and EM on student's Science and Mathematics achievements of BYOD schools. "Academic Progression" which is used as proof of the expertise of a researcher in the field of eLearning Methodology was the body of knowledge that the researcher acquired with regard to BYOD eLearning factors which can impact student achievement in Science and Mathematics with this empirical research.

Keywords: Bring Your Own Device (BYOD), Digital Content, eLearning, Technology Integration, Technology Usage, Virtual Learning Environments

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MANOJ MECHANKARA VARGHESE

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TABLE OF ABBREVIATIONS

Acronym	Explanation
BYOD	Bring Your Own Device
CMS	Course Management System
DCC	Digital Curriculum Content
EM	Evaluation Methods
F2F	Face to Face
ICT	Information Communication Technology
KHDA	Knowledge and Human Development Authority
LM	Learning Methods
LoTi	Levels of Teaching Innovation
PDST	Professional Development Service for Teachers
SESS	Special Education Support Services
SPOC	Single Point of Contact
STEM	Science Technology Engineering & Mathematics
TM	Teaching Methods
TU	Technology Usage
UAE	United Arab Emirates
VLE	Virtual Learning Environment

CHAPTER I

INTRODUCTION

1.1 Background of the Study

An innovative technology movement that can carry on to build an important presence in school education is Bring Your Own Device (BYOD) (Cisco Systems, 2012). In a BYOD environment, administrators, staff, students and teachers can bring various types of mobile devices, such as laptops, clickers, tablets, smartphones, portable media players etc. into a learning or working environment (Cisco Systems, 2012). The BYOD movement was a major challenge to education institutions. By making use of the existing devices that students have, BYOD makes one to one teaching easier. A large shift is seen in schools with the coming of internet revolution and evolution of computer usage in K-12 and post-secondary educational institutes. This resulted in the integration of newer technologies in schools. Consequently, the internet turned to be one of the most important channels for effective collaboration and communication, and therefore BYOD becomes a noteworthy tool for support to teachers and learning experience of learners.

1.1.1 New Knowledge in eLearning Methodology

BYOD was a concept which was quickly getting popular in many forward-thinking schools globally. The term BYOD with respect to a school environment mainly comprised student's bringing their own mobile devices like tablets, laptops, smartphones as practice, or any other similar device to classrooms for learning. The term BYOD implementation with respect to office staff bringing their own

mobile devices is in vogue, like tablets, laptops smartphones, or any other similar device to the office for work. The main idea of introducing BYOD in schools was to enrich the teaching and learning experience and to capitalise on younger generation students' high degree of exposure to the digital devices and inclination to use it that can lead to improved learning outcomes. Adequate teacher training, a proper conceptual framework and availability of relevant pedagogy based digital content may ensure this program is a success.

The BYOD concept permits students to bring personally owned devices such as tablets, smartphones, laptops etc. to the school for learning rather than schools providing desktop PCs or laptops or digital devices for leaning inside schools to the students. The advantage of BYOD at first may look like a way to cut costs for the schools, which may be one good side effect as funding for education continues to feel the squeeze. Finance concern was not the main goal of BYOD initiative. The focus of BYOD was personalization and student centred method to learning (Alberta Education, 2012; Argueta, Huff, Tingen, & Corn, 2011). It was about flexible, mobile and personalized learning practices.

Letting students bring their personal technology and mobile devices to schools has given them more learning power and easiness of use of technology. Giving students more freedom to choose the way they like to learn was indeed the best approach. Teachers and instructors can now stay more focused on managing the learning process rather than the source of information (Clifford, 2012).

A full switch to complete BYOD in all schools might be a plan for the future. The objective of BYOD implementation in schools was to enhance the teaching

and learning experience which includes improving students' achievement, improving student-teacher engagements, improving students access to course materials on campus wirelessly through their own device, giving instructors the ability to send class announcements with a few clicks, allowing learners to review notes, allowing learners to even watch a live webcast of a lecture and overall increase in access to school resources on mobile devices and e-books that are now used instead of textbooks.

According to Alberta Education, "mobile devices in the hands of students provide affordable and seamless learning opportunities to bridge the formal learning in schools with the informal learning happening outside of classrooms an schools" (Alberta Education, 2012). Students using mobile devices can bring these seamless learning opportunities into schools, and it can now create a bridge between the formal learning in schools and the informal learning also happening outside of classrooms and schools (Alberta Education, 2012).

1.1.2 Academic Progression in eLearning Methodology

Students' use of personally owned devices leads to increase motivation level and increase in engagement. Students may prefer this model rather than having separate school and "home" devices. Students could simplify their technology by consolidating personal and school computing onto the same device. Based on authorization from school administration, K-12 school classrooms allowed mobile devices as part of a BYOD program. As observed, schools require more support to prepare their students for the current applications of global society (Cisco Systems, 2012).

A survey exploring the impact of BYOD by Bradford Networks (2013) revealed the current status of BYOD being used in education. The population included IT professionals from colleges/universities and K-12 schools located in the United States of America and United Kingdom. There were 500 institutions that participated in this survey. Majority or about three fifths (62%) of the respondents of the Bradford Networks (2013) survey were in higher education and approximately one quarter (26%) were in K-12 while about one-tenth (12%) or all the rest were in other levels of education. The survey result reflected that the majority of students and staff could use BYOD on the network of institutions (75.5, 72 and 57.5% respectively) which can help us make the implication that BYOD was adopted across all educational institutions. The finding also confirmed that less than 15 percent of the staff, faculty and students were required to use school-issued devices through their school's network. Acceptance of BYOD was most widespread in colleges and universities rather than schools where the BYOD movement first took off with over 89 percent of the institutions letting students bring their personal devices on campus. Figures of BYOD are lower for K-12 districts with less than half of the institutions (44% of schools) letting their students bring their personal devices. This was still a large number and reveals a changing mindset for many K-12 schools that have long been wary about letting personal devices on their school network (Bradford Networks, 2013).

BYOD was a crucial strategy since students should be able to connect through the Internet not at home alone while doing homework, even during the school day and during lessons (Scrivano, 2013). The educational institutions of today have changed their thinking of prohibiting mobile phones or similar devices in school

premises after realizing the benefits of BYOD. Many schools allow the use of mobile devices as part of adopting BYOD in the teaching and learning process. Studies have proved that implementing BYOD improves student learning and development skills along with student engagement activities, as well as collaboration and communication skills. The schools have also improved substantially by upgrading the existing infrastructure, staff productivity and operational efficiency by embracing BYOD.

For teachers, who favour technology integration, BYOD was the right solution. The fact is that in the 21st Century, children grew-up playing on mobile devices and learning through gaming and hence such devices are familiar to the students from K-12 or Higher Secondary student, and they prefer to use them inside and outside the classroom. Similarly, administrators, staff and teachers are also familiar with these smart mobile devices in their daily life hence working smarter within the school campus will be more encouraging for them.

Early research findings stated that the learner using these devices has demonstrated increased efficiency and engagement through the action of a school student using their own device for the purpose of learning (Larry, 2012). Larry stated that speed of BYOD implementation and usage has enhanced with the handheld devices, especially in higher education. The small size, low-cost mobile devices are seen as a better option in comparison to traditional laptops (Larry, 2012). With their increasing power, tablets which now include an expanding set of choices, such as the Nexus, Surface, Galaxy, iPad and Nexus are well placed for the right environments for BYOD (Larry, 2012).

According to Jeffries, new generation students, also called digital natives, have frequent access to a wide variety of mobile devices like laptops, smartphones and tablets owned by them (Jeffries, 2013). These devices along with various social networking sites and mobile applications have a big influence on a student's daily life, and they are losing aptitude in the traditional way of teaching and learning provided by schools, and it is affecting their learning outcomes. Students are finding it difficult to concentrate because of the increasing number of digital devices and internet access available to them (Jeffries, 2013).

A recent survey conducted among 2,500 teachers in America by the Pew Research Centre noted that nearly four-fifths (77%) teachers believed that the internet had a generally encouraging influence on students' study work, while about nine-tenths (87%) sensed new technologies were making an effortlessly unfocussed group with small responsiveness times as reported on the Guardian's Teacher Network (Jeffries, 2013). To address this issue schools initiated the BYOD programme.

"Flash Traffic" was a new era that schools had entered where a variety of mobile devices with various applications are trying to connect anywhere and at any time on campus. In this digital era, the latest release of any new device can immediately create spikes in demand and traffic congestion on the school data network. With students, faculty, and staff all using their own devices, IT and school administrators required assistance with policies, capacity, integration, and device access. This will help to deliver a superior user experience in a manageable, secure, and cost-effective way (Cisco Systems, 2012). These challenges can be overcome

by embracing BYOD as an opportunity to enhance productivity and engage learners on latest trends in technology.

1.2 Statement of the Problem

Schools started exploring BYOD based eLearning methodology with the expectation that included improving teaching & learning experience, student achievements, learning outcome and student-teacher engagement. The main problem related to BYOD based teaching and learning was that it did not practice uniformly in schools, students were informally used these devices with or without the formal assent of the teachers in some schools. The reason was that there was no BYOD eLearning Conceptual Framework for schools to practice it effectively. Therefore the problem identified was whether BYOD practice in teaching and learning process was more effective when used with the traditional method of teaching and learning process. If it was effective how to develop a Conceptual Framework for schools to adapt it uniformly among various schools under the purview of the study. Most of the BYOD initiatives in schools are driven by few teachers who have a personal interest in it rather than a collective organisational initiative, Oncu et al. (2008). It was also observed that teachers in different age groups behave differently to this self-initiative (Russell et al., 2003). Younger teacher shows more interest than senior teachers in taking any technology-based initiatives, Metzler et al. (2008). These teachers adopt a methodology convenient for allowing students own device to bring to schools and used as a complementary tool for learning. There may not be any uniform approach in the same grade of students in two different divisions. Use of eLearning tools in such environment was primitive and ineffective. Success factor measurement of this type of

initiatives was highly difficult. If this study enables to develop a BYOD eLearning Conceptual Framework, school authorities would be able to rollout it out as an organisational initiative and which would have better and positive impact on teaching as well as student achievement.

1.3 Research Objectives

BYOD eLearning Conceptual Framework development based on the impact of BYOD implementation on student achievement in private secondary schools in Dubai, UAE was the main objective of this research.

The specific research objectives were:

1. To study the impact of grade 9 student's achievement in Science and Mathematics in BYOD schools and Non-BYOD schools.
2. To examine the variation in grade 9 student's achievement in Science and Mathematics based on gender in BYOD schools and Non-BYOD schools.
3. To develop a BYOD eLearning Conceptual Framework for private secondary schools in Dubai, UAE based on documentary research and confirm it with empirical research.

1.4 Research Questions

This study was conducted to seek answers to the following questions.

1. What was the difference between grade 9 student's achievement in Science and Mathematics in BYOD schools and Non-BYOD schools?
2. Did the gender difference cause any variation in student achievement in Science and Mathematics in BYOD schools and Non-BYOD schools?

3. How can an effective BYOD Conceptual Framework be developed for the practice of schools in UAE?

1.5 The significance of the Research

Resource material used for developing BYOD eLearning Conceptual Framework was used from this empirical study, and it also can be used for other schools that have yet to deploy BYOD in their schools. The countries that have not started implementing a BYOD programme may use the findings from this study as an example to start such a programme. Outcomes of this study provided information on what was appropriate for BYOD implementation in secondary schools in terms of Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods for better student achievements.

This researcher emphasizes the strategy to enrich the educational experience with Mobile Learning solutions and involve new generation students on the devices they have, know and prefer, and use them any time, any place as a learning platform and get access to all aspects of a digital learning experience. The knowledge base of the effectiveness of BYOD implementation can be enriched based on the findings from this research. Research findings of this work were used to develop a BYOD eLearning Conceptual Framework for private secondary schools in Dubai, UAE. The new BYOD eLearning Conceptual Framework based on this empirical research study can help schools to increase their consciousness level of possible impact on student academic achievement and level of critical factors of BYOD initiatives.

1.6 Definitions of Terms

21st Century Learning: The Center for 21st Century Skills (2009) defined student outcomes as the skills, knowledge, and expertise that students should master to succeed in work and life in the 21st century including core subjects (the three R's) and 21st century themes, learning and innovation skills, creativity and innovation, critical thinking and problem solving, communication and collaboration, information, media and technology skills, information literacy, media literacy and Information and Communication Technology (ICT) literacy, life, and career skills.

App: It is application software that is exclusively designed to work on a mobile device like tablet and smartphone.

BYOD (in school): Bring Your Own Device is the consumerization of IT, to individuals (students) who bring their personal computing devices – such as smartphones, laptops and tablets – in the academic environments for learning or use and connectivity on the secure organization's network.

BYOD eLearning Conceptual Framework: It is a framework for effectively implement BYOD using eLearning methodology to improve teaching and learning and hence the student achievements.

Digital Curriculum Content (DCC): It is a collection of electronic resources as opposed to textbooks collected of Twitter, blogs, wikis, video/audio, journalism artifacts and real-time digital teamwork that are used for engaging, instructing, and assessing students and staff. The students and staff connected to these

resources experience personalised learning in every aspect of the learning process including that can happen through the use of technology.

eLearning: Method by which utilizing electronic technologies or electronic media outside of a traditional classroom for learning by accessing the educational curriculum. In most of the cases is an online delivered degree, program or course.

Mobile Learning: In mLearning or mobile learning, learning happens using personal electronic devices and through social and content interactions across multiple contexts.

Pedagogy: An academic subject or theoretical concept (etymology and pronunciation) practice or method of teaching.

Student resources on mobile devices: Extending all educational or curriculum resources through useful applications or as smart apps designed or tailor-made to meet various needs of teaching and learning that can be downloaded on the mobile gadgets - cell phones, tablets, and smartphones.

Social Networking: Web-based services that allow individuals to connect and socialize are defined as social network sites, and it is (1) build a public or semi-public profile within a confined system (2) eloquent a list of users with they have shared a connection and (3) view and navigated their list of networks within the system.

Virtual Learning Environment (VLE): VLE is a web-based platform of an education system that models conventional real-world education through digital aspects by providing equivalent virtual access to classes, class content, tests, homework, grades, assessments, other class tools and even museums and other

external academic resources. These kinds of systems also include collaboration and communication tools, student tracking and assessment.

Technology Integration: It is defined as the enhancement and support provided for learning by using technology in an educational environment. In the classroom, technology integration helps for more advanced learning among broad topics by creating opportunities for students to explore more. Use of technology in curriculum integration involves technology as a digital tool to enhance learning in a multidisciplinary setting or content area.

Traditional Classrooms: It is a classroom which uses the traditional way of teaching through the chalk and board.

1.7 Limitation of the Research

1. The target population was restricted to 32 schools of private secondary international Indian based curriculum located in Dubai, UAE.
2. The samples were limited to students and teachers of grade 9 with respect to their performance in subjects of Science and Mathematics from the selected eight private secondary international Indian based curriculum schools located in Dubai, UAE.
3. The study was limited to 1,800 students from grade 9 from eight selected schools in Dubai, UAE.
4. The participating teachers were limited to 120 Science and Mathematics teachers from the eight selected schools in Dubai, UAE.

1.8 The scope of the Research and Population

The research was conducted in grade 9 of selected private secondary schools in Dubai, UAE, where BYOD based instructional method has been implemented and has not been implemented. The selected schools follow similar curriculum and students, parents and teachers were from the similar social, economic background. Grade 9 student's Science and Mathematics achievement data were collected from BYOD and Non-BYOD schools. The population of this study included 21,127 students and 1,241 teachers.

Data with respect to student gender, internet connectivity at home, ICT infrastructure of their school, Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods was collected using a self-administered questionnaire instrument. The data was collected from schools in Dubai during the academic year 2016-17.

1.9 Conceptual Framework of the Research

The preliminary framework design suggested for the development of BYOD eLearning Conceptual Framework based on the findings of the literature review was given in the figure below 1-1. The researcher provided more details on the BYOD eLearning Conceptual Framework in Chapter IV where its details are articulated.

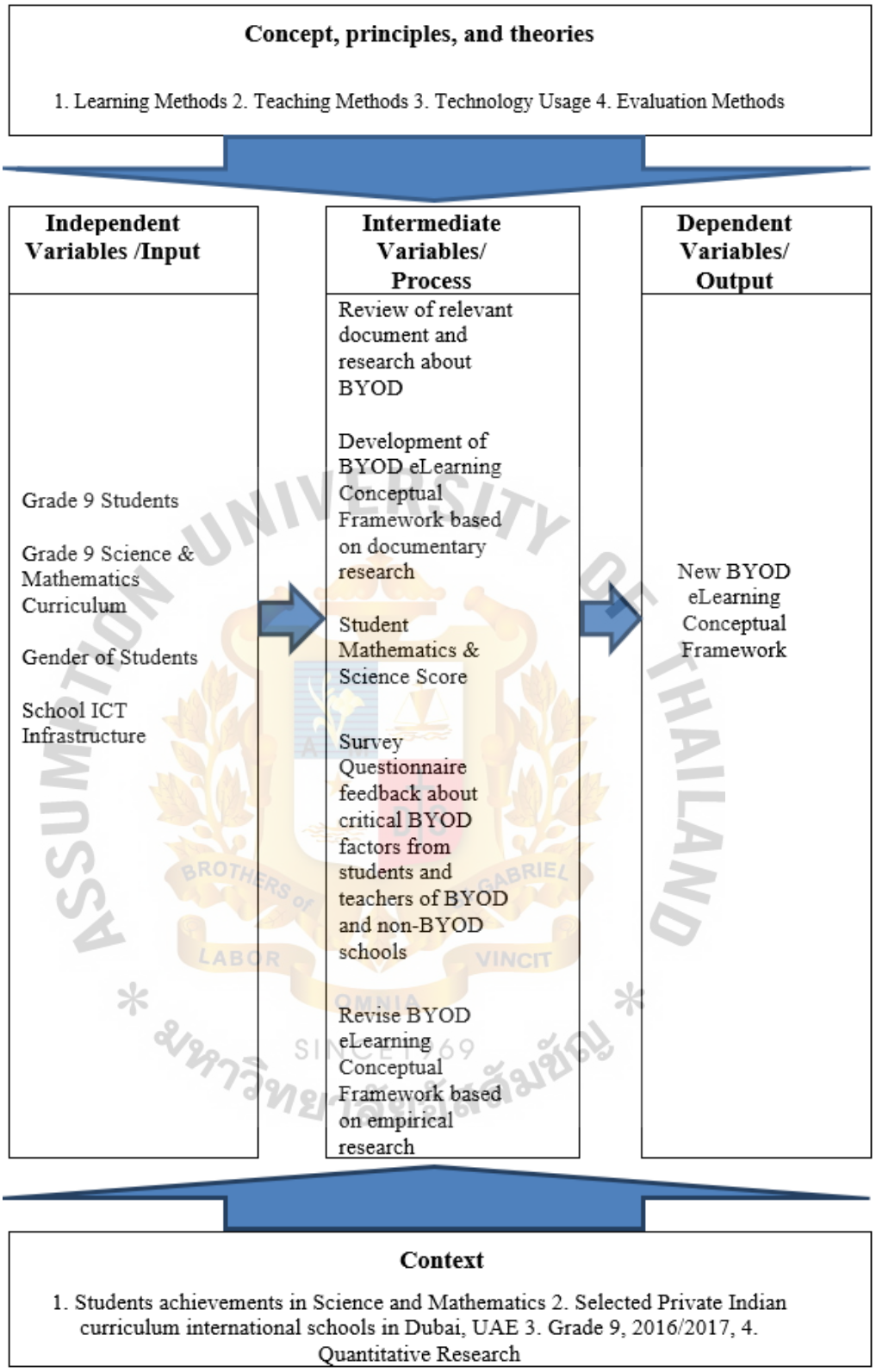

Figure 1-1: The Research Conceptual Framework

CHAPTER II

LITERATURE REVIEW

This chapter constitutes a scholarly review of earlier work relevant to BYOD and related topics giving relevant history and also recognizing the priority and importance of the work of others that are relevant to this study. The review process involved collecting data from both primary and secondary sources. Only digital resources were used that included journals, articles, e-books, websites, conference and seminar proceedings and any other materials which enlighten the research on the subject of BYOD. The literature review included peer-reviewed and scholarly articles published as part of the scope of this literature review. However, further to support some of the points related to the study a few articles older than this were also used. For keeping track of the vast number of articles and papers identified, the researcher used Zotero, a free online referencing system manager and academic, social network that allows authors and researchers to easily import, store, access, references and citations as academic work was developed.

This research assessed and evaluated the level and nature of BYOD use in K-12 private secondary schools in Dubai, UAE. This literature review chapter provides an overview of the changing technology environment in teaching and learning, some theories of eLearning & mobile-learning (mLearning), learning modalities, articles and research based on which learning theories agree and disagree with BYOD, the trends of BYOD in teaching and learning, concerns of using BYOD in an educational setting. This chapter also reviewed the literature related to the use of technology in education and use of eLearning tools.

2.1 Use of Technology in Teaching and Learning

Information and Communication Technologies (ICTs) usage are changing the organization's environment and the offerings in education. The educational institutions especially, learning institutions adopted and integrated ICTs in teaching and learning through pedagogical and socio-economic forces that have been driven by factors that include better information access, better communication, synchronous and asynchronous learning, improved cooperation and collaboration, cost-effectiveness and pedagogical development. ICTs have not encompassed to an excessive extent in many learning institutions in most of the developing countries due to their socio-economic and technological circumstances.

If educators or teachers can make sure that mobile devices have a viable and quantifiable impact on studies with quality that takes place both inside and outside of educational institutions, then the significance of digital technologies in learning can raise its importance (Rogers & Cox, 2005). Mobile technologies with new touchscreen and with internet access within a school system have created a great shift from the Professional Learning Community to various types of socio-technical innovations for learning practices. Technology-enhanced learning (TEL) (Goodyear & Retalis, 2010), for educational purposes combined with social media (Davis, 2010), will be an important factor for today's students to enhance creativity, knowledge, innovation and collaboration in the classroom and outside the classroom (Friesen & Lowe, 2011).

The digital culture in which digital natives (today's students) have grown up has influenced their learning skills and preferences in education (Oblinger, 2003).

Digital natives live in a multimedia world, fully connected and they collaborate constantly, and through their mobile devices, they constantly access information (Prensky, 2001). 21st-century learning was mobile, connected and on-demand. Teachers or the educators recognize the power of technology tools and the need to adapt new pedagogical models of technology integration to support 21st-century learning. The main focus thus on creating an environment with the "Four Cs" of 21st-century education such as communication, collaboration, critical thinking and creativity (Oblinger, 2003; Prensky, 2001).

ICT in school census report by the New Media Consortium (NMC) ("NMC New Horizon Report-k12," 2013) on Themes and Subthemes identified in the year 2013 was shown in Figure 2-1 below. The four themes are including; 1. Teaching Learning and Assessment Using ICT, 2. Teachers Professional Learning, 3. Leadership, Research and Policy, and 4. ICT Infrastructure which forms the backbone of digital strategy in learning, teaching and assessments ("NMC New Horizon Report-k12," 2013).

Broad Theme	Subtheme
Theme 1 ***Teaching, Learning and Assessment Using ICT***	Use of ICT in Teaching and Learning. Developing 21st Century Skills Using ICT. Assessment and ICT. Internet Safety (including critical and ethical use of the internet). Digital Content for Schools. Inclusion.
Theme 2 ***Teachers' Professional Learning***	Specifying Teacher Professional Knowledge. Supporting Teacher Professional Learning.
Theme 3 ***Leadership, Research and Policy***	National and School Leadership, Planning and Research as a Driver of Policy.
Theme 4 ***ICT Infrastructure***	Internet Connectivity. Access to Computing Devices and Other Technologies. Technical Support and Maintenance. Purchasing and Procurement.

Figure 2-1: Digital Strategy for Schools

Source: NMC Horizon Report-2015 -2020 ("NMC Horizon Report K12," 2013)

A study conducted in Irish primary and post-primary schools in the period 2015-2020, by the Department of Education and Skills to embed ICT in teaching, learning and assessment shows there was rising sign that digital technologies make changes to way school students learn, the way school teachers teach and the location where learning takes place and its time (Amos, Copeland, Fidow, & Langford, 2014). ICT can connect educational policy with economic and social development, and ICT has the potential to support transformation in learning, assessment practices and teaching in schools (Butler, Leahy, Shiel, & Cosgrove, 2013). Establishing ICT in education processes like learning, teaching or assessment was a complex task and simply making the presence of ICT in schools will not relate to its effective use (OECD, 2015).

In Irish primary and post-primary schools a study was conducted to understand the differences and the difficulty in integrating ICT in teaching from traditional school practices with that of teachers' views of teaching. The report showed constructivist views of teaching in the majority of Irish teachers, whereas learners' involvement in ascertaining meaning, knowledge and self-learning was active and expressed a positive attitude. Traditional pedagogical orientation and teacher-practices were found to be dominant in most schools. A decision taken towards this strategy recommends that the UNESCO ICT Competency Framework (Figure 5) for Teachers (ICT CFT) (2008, 2008a and 2011) be used by the school to guide them for the implementation and review of the strategy at school level over the next five years. The Figure 5 gives a lens view on how to monitor and support the transformation of ICT implementation in schools and indicates the importance of how an education policy connects with the economic and social development through implementation of ICT. The three methodologies described by UNESCO are:

• *Technology Literacy approach* - Describes on incorporating new and improved technology skills into school curriculum thereby increasing the use of new technology by students, teachers, workforce and citizens.

• *Knowledge Deepening approach* - To use the knowledge gained by the students, the workforce and citizens in solving complex, real-world problems and to bring more value-add to the society and the economy

• *Knowledge Creation approach* - This approach states that the students, citizens and the workforce should have the ability to benefit from their new

knowledge gained in creativity, innovation and to develop learning capabilities to further produce new knowledge (Vosloo, 2012).

	TECHNOLOGY LITERACY	KNOWLEDGE DEEPENING	KNOWLEDGE CREATION
UNDERSTANDING ICT IN EDUCATION	Policy awareness	Policy understanding	Policy innovation
CURRICULUM AND ASSESSMENT	Basic knowledge	Knowledge application	Knowledge society skills
PEDAGOGY	Integrate technology	Complex problem solving	Self management
ICT	Basic tools	Complex tools	Pervasive tools
ORGANISATION AND ADMINISTRATION	Standard classroom	Collaborative groups	Learning organisations
TEACHER PROFESSIONAL LEARNING	Digital literacy	Manage and guide	Teacher as model learner

Figure 2-2: UNESCO ICT Competency Framework for Teachers

Source: UNESCO Competency Framework (UNESCO, 2011)

The study revealed that ICT integration at primary and post-primary level could transform all aspects of education. This competency framework will also set a clear standard on how teachers can enhance the connection between effective learning and teaching methodology with that of innovative information, communication and technology practices.

Embracing latest technology allows a better implementation strategy with the quicker development of learning tools. Technology integration in education and its application allows new and improved ways of learning which in turn motivates the students and results in more focus on subject areas and improved attendance. Technology adoption in education not only benefits teachers and students but also makes their parents/guardians more actively involved in their children's learning.

This could be done by engaging the parents in conversation with respective teachers and through accessing and commenting on students' work. There are several organizations that promote and support the integration of the use of technology in teaching and learning in schools like; Special Education Support Services (SESS), Professional Development Service for Teachers (PDST) etc. One such organization responsible for the growth of private education was the "*Knowledge and Human Development Authority"* (*KHDA*) in Dubai, UAE where this research will be done. These support providers are enablers who drive this implementation program in schools to integrate ICT effectively into teaching, learning and assessment and with the engagement of community provide necessary advice on teaching and learning and its impact of using technology.

2.2 Learning Conceptual Framework

A Learning Conceptual Framework can create an effective and efficient learning environment; one that allows the learner to go outside the boundaries that the educator defines. The Conceptual Framework provides ontology or a specification of the concepts (Gregor, 2006; Gregor & Jones, 2007). Learning Framework acts as a guide for education practitioners, system developers, policymakers and researchers. It provides a summary and in-depth view of learning implementation.

2.3 BYOD in Education

Bring Your Own Device (BYOD), and mLearning initiatives connect the power of the devices that students own and increase student engagement and provide to the student anytime, anywhere access of information (Peng, Su, Chou, & Tsai, 2009). While the interaction between students and their teachers will

always be a key to the educational experience, the shift to digitally-driven learning models that have proved considerable impact on the expectations and on the culture in academic learning, giving birth to next revolution in school teaching. BYOD already has some traction in schools in the U.S.; this concept has yet to infiltrate in the educational institutes within the developing and developed countries. According to Sheninger, devices adopted by students are a huge part of their lives, and therefore, schools should teach students about the powerful tool they own, but they also take benefit of this resource since budgets are tight (Sheninger, 2011).

In the United Kingdom, George Spencer Academy located at Nottinghamshire was one of the early adopters of BYOD in the U.K. According to Morrison, while the finances are stacking up at the school before it could introduce BYOD, they still had a number of issues to address (Morrison, 2014). One was whether all students had access to a device and whether the disparity of devices could be a cause of friction. It will soon become very clear that having access to devices was not a problem. Many students had at least one suitable mobile device, and many students had more than one devices. According to Morrison in most of the cases, the introduction of BYOD has gone easily. Although BYOD does not mean that the entire school would use student devices in subjects across the curriculum. BYOD used for activities from peer assessment to basic research. Morrison stated that BYOD use had become the norm so quickly that there may be a new trend for bringing your phone into school (Morrison, 2014).

Based on a most recent study conducted in the United States, one among four teenagers are internet users and they mostly go online using their phone and not desktop or laptop computer (Madden et al., 2013).

The researchers mentioned above establish that 78% of teens now have a cell phone, and almost half (47%) of those own smartphones. This illustrates that, from 23 percent in 2011, there was a rise to 37 percent of all teens who have smartphones.

Ever growing possession of smart devices means that many students, but not all, own devices or have access to such devices for learning purposes. This indicates that the use of tablet devices and computers has greater than before, as 23 per cent teens have a tablet computer and about 93 per cent teens have a computer or have access to one at home. (Madden et al., 2013).

The landscape of learning has changed by the web-based tools and resources. Unlimited access to resources, communities of interest, digital content, databases, and experts are available for students at their fingertips. According to Alberta Education study (2012), school authorities can develop citizenship fluency and digital literacy in students that will make them ready for the technology-rich world in which they will learn, work and live. They can create an opportunity to deepen student learning by efficiently utilising such resources (Alberta Education, 2012).

The study conducted “Mobile Math: Math Educators and Students Engage in Mobile Learning” by Franklin and Peng was in order get the most out of technology and to address the difficulty in math education to improve the teaching and learning experiences (Franklin & Peng, 2008). The study showed, “how a set of

third-grade math students achieved on a test after using technology in the classroom; their scores were compared to other third grade students who were not exposed to the technology.

Studies showed that over the last year there had been an intense increase in the dominance of students bringing personal mobiles devices such as laptops, tablets and smartphones with better or more custom-made features competences than the ones issued by the schools into the classroom for BYOD in Australia and New Zealand schools (Sweeney, 2012). Many stakeholders feel BYOD was unavoidable and for classroom activities, they started utilising consumer devices – especially tablet devices with great interest (Sweeney, 2012).

2.4 Trends in Use of BYOD in Teaching

Today's expert teachers have accepted the advancements in technology, and it's integration in education, and they use mobile devices, gadgets and social media as a means to stay connected with their students, families, and other classrooms. A study on "BYOD in K-12 classroom", by Elena Dickerson, Teacher Education Dept., University Of Texas, has stated findings from various researchers that "the common mentality of the "I teach" curriculum may be another challenge in the development and implementation of the BYOD program in K-12 classrooms" (Norris & Soloway, 2011). Neubert stated that the conventional classroom ideology could be maintained even with the BYOD implementation program which would act as another medium to disseminate information (Neubert, 2010).

According to Neubert (2010), the teachers get engaged and lead various types of teaching and learning activities. This helps student's practise new learning based

on same methodologies and theoretical practices. Examples are group discussions, lectures and teachers-led instructions (Neubert, 2010).

Schools should initially make necessary changes in the curriculum for students to make them more creative and think "out-of-the-box" by using new learning initiatives with the help of mobile application technologies. This includes, (a) development of relevant and significant goals and objectives in implementing BYOD program to support teaching and student learning, (b) adaptation of constructivism in redesigning curriculum and content delivery and (c) creation of opportunities for students and teachers to exhibit increased student achievement through open dissertation and critical thinking (Neubert, 2010). With the focus on making teachers as change agents, by shifting them from an inadequate and not so user-friendly technological access environment to incorporating technology in teaching and learning through BYOD implementation programs. In such scenario, the right teacher training and support will be required in order for effective technology integration in the classroom and to become a seamless component of the curriculum (Trombley, 2000).

Researcher Shapley found that "preliminary Professional Development (PD) for teachers in 1:1 device schools was critical for successful implementation of technology in practice" (Shapley, 2009). For a successful integration of technology in teaching and learning, a properly planned and repeated set of training sessions were provided to teachers (Lowther, Strahl, Inan, & Bates, 2007). A variety of learning patterns like workshops, mentoring, group discussions, observations and

lesson designing were incorporated in formal Professional Development (PD) did not examine learning outside of the formal context (Vrasidas & Glass, 2005).

2.5 Trends in Use of BYOD in Learning

The reasons for more popularity of BYOD was cited as student centred and personalized learning (Alberta Education, 2012; Argueta et al., 2011). The important role played by mobiles devices in shaping the learning trends was explored by Mobile Learning Trends Infographic in 2015. These trends with mobile devices prove that the current generation is on the brim of a new era of learning. The advancement in technology made education more interesting and meaningful to students, despite few, who were not willing to adopt this change. Learning through digital devices makes coordination & communication among each other easier and encourages student interaction and builds interest in learning. This kind of learning was faster as the students get immediate feedback which helps in developing and managing their thinking and actions as well as providing quick feedback which always helps the students learn faster (Brown, 2005).

BYOD places students in a place of power over their learning. Giving students the authority over their own learning was the best way of learning anything according to many educational researchers. They further argue that rather than a direct source of information the teacher becomes a manager of learning (Clifford, 2012). According to the New Horizon Report, students should be allowed to access the same devices at school and at home as part of BYOD. This Programmes can extend learning opportunities to times and places outside of the classroom. BYOD

allows students to work with comfortable and familiar technology ("NMC New Horizon Report-k12," 2013).

Mobile devices provide seamless learning opportunities to students that bridge the formal learning in schools with the informal learning inside schools and outside of classrooms (Alberta Education, 2012). Student owned mobile devices are a very important part of students' lives according to many studies (Clifford, 2012; Sheninger, 2011; Sweeney, 2012). Mobile devices have turned to be an integral part of this 21st-century student's lives and learning patterns.

According to DeWitt, many workplaces and schools ban the devices since it makes it uncomfortable for them. Rather than banning these devices, we should teach students how to use it properly. The banning of mobile devices in schools can only make the school system seem further complicated and make it behind the modern society (DeWitt, 2012). As more and more classrooms integrate digital technology tools, the desire to utilise mobile technology to enhance teaching and learning will also increase consequently.

According to Clifford, there are many reasons why mobile learning has become so appealing and most important was the convenience of being portable. School classroom that does not hold technology was becoming progressively out of reach with the way the youngest generation interacting and learning at home and outside of school hours. Students can integrate the mobile devices into their daily lives and make learning easier to achieve and more collaborative (Clifford, 2012).

2.6 Technology, BYOD, Science and Mathematics Achievement

Many researchers reported technology could help as a catalyst to improve student achievements in Science and Mathematics. Though researchers have reported mixed findings, evidence that support student achievement was more significant than the evidence not supporting it. This point was also previously stressed in Schacter's (1999) review of research in CAI, integrated learning systems technology, simulations and software that teaches critical thinking, collaborative networked technologies, and design and programming technologies. His analysis showed the implementation of these technologies increased student achievement, but that there needs to be a clear intention in how the technology will be used in the classroom; specifically the technology needs to have a connection to an educational goal, and not be used for the sake of being used (Disney et al., 2013).

A study by Li's (2008) found that students gained new perspectives on the application of personal interest and career options connected to the math and science fields when technology was integrated into a classroom in a dynamic way, as opposed to just drill.

Song (2014) found that BYOD was not only a feasible instructional practice for elementary science students it leads to increased levels of understanding and positive attitudes. Song (2014) studied the effect of BYOD policy in one primary science classroom while studying the "Anatomy of a Fish" and presented its effect upon student content knowledge and student perceptions regarding their learning experiences. Song (2014) indicated that students' understandings are more

advanced when using BYOD than that available from a text-based instruction, and they exhibit a more positive attitude towards learning.

The findings of a meta-analysis by Cheung & Slavin (2013) investigating prior evaluations of technology applications in the K-12 mathematics setting were that they produced a "positive but small effect." They also found that computer-assisted instruction (CAI) had the largest effect on mathematics achievement.

Patricia (2017) conducted a mixed methods BYOD impact study in two middle schools in South Texas. The State of Texas Assessment of Academic Readiness (STAAR) scores were analyzed to test the hypothesis that 7th graders who used the BYOD program (n = 297) would score higher on standardized mathematics achievement than the students who had not used the BYOD program (n = 297).

In a study of mobile device use, using an open source mathematics program to reinforce mathematics topics and skills for primary school students in Malaysia, Mahamad, Ibrahim, Foad, and Taib (2008) demonstrated that a mLearning environment allowed for the improvement of tracking and monitoring of student performance, and clear evidence of student satisfaction. Other scholars provided further evidence of mobile device classroom use facilitating a building of mathematical knowledge across European borders (Granic, Cukusic, & Walker, 2009).

Hwang and Chang (2011) conducted a study on formative assessment-based approach to mobile learning in elementary school in Taiwan. Hwang and Chang's findings revealed the possibility that many computer-assisted learning strategies

with the use of mobile technologies have the potential for enhancing the learning achievements of students.

2.7 BYOD and 4Cs

Four Cs (Collaboration, Creativity, Critical Thinking and Communication) was a concept developed in the U.S for 21st-century learning, and it was also called P21 (Partnership for 21st-century skills) (National Education Association, 2017). BYOD supports the 4 Cs of 21st Century Learning and other key capability areas. By using BYOD, students get a cross-capability learning opportunity. The collaboration was increasingly mentioned as an important educational outcome, and most models of 21st-century education include collaboration as a key skill. Creativity was widely acknowledged to be a key 21st-century skill and included in many countries' desired college and career ready outcomes for students. Although many aspects of human cognition are still a mystery, psychologists have begun to flesh out critical thinking, or the strategies that people use to think in organized ways to analyze and solve problems. Communication was one of the key components of 21st-century learning, yet it has not attracted the same level of research or attention as creativity, collaboration, or critical thinking.

Argueta et al. (2011) conducted a study analyzing major one-to-one initiatives in over 300 school districts in six different states including, Florida, North Carolina, Michigan, Pennsylvania, Texas, and Virginia. The results of this study indicated findings related to student outcomes including an increase in attendance, motivation, engagement, and an overall decrease in the discipline (Argueta et al., 2011). The results also supported the use of technology in classrooms to help

students prepare for the future. “Researchers also report that laptops have facilitated the development of 21 st -century skills, digital literacy, creativity and innovation skills, critical thinking and problem-solving skills, communication and collaboration, and self- directed learning) among students” (Argueta et al., 2011)

2.8 BYOD and Gender

Researchers, Keller et al. (2007) have reported mixed and neutral findings evidence that support student achievement with regards to gender. However, findings that support females are significant rather than not supporting, Jung (2012).

To explore the gender differences influencing technology-based learning, Jung (2012) found a relationship between gender differences in the perceptions of dimensional impact on the quality of technology usage. The researcher indicated that females had perceived all quality domains and dimensions as being more important in evaluating the quality of technology-based learning than males. Keller et al. (2007) also found gender to influence acceptance and in line with Jung’s study (2012), females experienced more performance expectancy than males did.

Pascual (Pascual, 2016) and his colleagues at the University of Melbourne found that girls are less likely to choose one of the STEM (Science, Technology, Engineering & Mathematics) subjects than boys do, despite many testing better in these areas. A summary of their findings follows. Female students tend to have better grades in core classes such as mathematics, science, history, and reading than do males.

2.9 Digital Tools in Implementation of BYOD

Two main digital tools highlighted in this study are Digital Curriculum Content (DCC) and Virtual Learning Environment (VLE). Many researchers drive us through various learning and teaching concepts to give an insight into these digital tools apt for the millennial.

Digital curriculum thus deployed on all these digital media as mentioned above and supported by many researchers' benefits each student in their learning process and makes them more successful. Learning through digital media opened diverse opportunities to student's learning process like visualize and explore into more learning aids, concepts, apply and practice and thus enhance learning. Such learning approach to Digital Curriculum Content develops critical thinking skills for the educators /teachers. Virtual Learning Environment provides a deep understanding that prepares them for success. By using resources, digital content and tools in various learning environments, teachers can empower innovation and prepare their students for success.

Researcher in this study emphasizes that personalized learning method empower students to a committed learning process. This study comprehends on the implementation of BYOD and its impact on student engagement and achievement through the learning approach (tools) Digital Content Curriculum and Teachers acceptance and encouragement to enrich BYOD implementation in learning and development through Virtual Learning Environment. The curriculum needs to be rigorous and challenging but not to the point which causes students to lose interest in order to keep the student engaged and hence the curriculum's entertainment

element was very vital to make learning fun and not a burden. Schools now look for a way to incorporate social media into the formal learning process.

2.9.1 Digital Curriculum Content (DCC)

According to Ray Eernisse, CIO, Francis Howell School District, MO, Digital Curriculum Content was defined "as a collection of electronic resources as opposed to textbooks that is composed of blogs, wikis, twitter, journalism, video/ audio, real-time digital collaboration and projects and personal learning networks that are used for engaging, instructing, and assessing students and teachers". Ray says that these digital resources should be connected with students and the teachers every day through the use of technology by personalizing their learning process (Thiele, 2013).

In a CIO Summit, Andrade, CIO, Bridgeport Public Schools said, "Digital Curriculum was any digital media that teachers and students use for learning." According to Hogan (2013), school teachers and students will be able to use Digital Curriculum along with other applications like Google Apps for Education to share and access learning materials and student-related works (Hogan, 2013).

There are great advantages with digital learning resources as it gives way to easy access to content and can be easily transferred into desired formats as required by the learner. Researchers' say students want support to access both content and meaning to build content area knowledge and expertise (Rose, Meyer, Anne, & David, 2002). Some findings of research studies point out that, for students to develop specific skills like study skills, time management or organizational skills to complete their projects effectively they require adequate support (Leu, 2000).

Governments in developed and developing nations are promoting various "National reference point for schools for high standard of high-quality digital content," with adequate support provided in all areas /subjects (Science, Maths, Arts, Language etc.,) in education. Such a kind was the "Scoilnet" - Ireland's official education portal, Arts in Education Portal" at a website of arts in education.ie, an important national digital resource of arts in education practice in Ireland ("Scoilnet Website," 2017).

2.9.2 Virtual Learning Environment (VLE)

Virtual Learning Environment (VLE) is a learning system for delivering learning materials to students via the web such as student tracking, assessment, and collaboration and communication tools. VLEs are also known as Course Management Systems (CMS) or Learning Management Systems (LMS) (Oxford University Press, 2016).

The VLE provides teachers and students with the opportunity to assess online assignments, access available course material or curriculum that could be mapped easily, makes communication between teachers and students or among students simpler through e-mail or electronic communication tools, chats etc. The above-stated tools or means to gather or share information of knowledge in teaching and learning forms core components of VLE package. Here teachers and students are provided with an ID so that the teacher can view what a student was accessing and only teachers are given special rights to modify and/or create the contents of the curriculum. Most commonly used VLEs are Blackboard, WebCT, Moodle when

compared to many other commercial VLE software (Lotus Learning Space, COSE).

Most of the schools have, as an important component of eLearning and teaching programmes, a Virtual Learning Environment something for learners and teachers alike as quoted from BBC ACTIVE (BBC Active, 2010). A virtual and infinite online storage space can be created by teachers to store their worksheets, documents or presentations which can be shared later with the students. VLE opens up infinite communication channels, links to outside sources, embedded content and many more to the advantages to list. In VLE, a small drawback was that because the school's security policy students and teachers may have to physically log-in to their accounts. As the students are all Digital Natives, teachers who are not Tech-savvy, tend to lack IT skills as compared to the students and hence teachers need to learn and update their skillset for which they may require extra effort and time. It was noted from the above literature that is going forward with high usage of the internet; all educational establishments will adapt to Virtual Learning Environments.

2.10 Learning Theories and BYOD

One learning theory was not sufficient to define BYOD. There are several theories supported the idea of BYOD and could have possibly been part of the foundation of the idea of BYOD. According to Mobi21.com, currently, there was no widely accepted learning theory that can be suitable for mobile technologies based on effective learning, pedagogy, assessment and design of new applications

(mobl21.com, 2012). As the foundation of BYOD, the below-listed theories are worth noting.

The BYOD initiative in "Social learning theory" or "*Social Constructivism"* states that "students carry their own understandings to the classroom and further through interactions and experiences in the class, develop new knowledge" (Clark, 2011). Social interactions that emphasize "critical thinking", "collaboration", "communication", and "learning by doing" and the "Constructivism", "Connectivism" theories and also "We All Learn" (WAL) framework model assists and encourages learning process through technology integration thus making education more interesting and meaningful to students.

According to Siemens, *Constructivism* was a broad and well-known theory in education, which was developed during a time when technology was not impacting learning process (Siemens, 2005).

Siemens also denotes that, "the *Connectivism* theory combines many learning theories with technology and the diminishing half-life of knowledge" (Siemens, 2005). Connectivism believes that "we learn when we make connections". The main principles of connectivism as stated by Siemens are (Siemens, 2005):

"(1) Learning rests in a variety of opinions, (2) It was a process of connecting information, (3) It may reside in non-human appliances, (4) The intent was up-to-date knowledge and (5) Decision making was a learning process".

Mobile devices connect us with the latest information in many different sectors in a novel and interesting manner. Bonk's 21st-century learning developments known as

"**WE-ALL-LEARN"** as cited in (Jimison, Norris, Waskey, & Jarvis, 2012) :

"Web searching through e-books."

"E-learning"

"Availability of open source."

"Leveraged resources and open courseware."

"Learning object repositories."

"Learner participation."

"Electronic collaboration."

"Alternate reality learning."

"Real-time mobility" and

"Networks of personalized learning".

The above defined "WE-ALL-LEARN" framework brings a change in the traditional teaching pattern of teacher-centric to a more professional and learner-centric personalized learning environment (Bonk, 2010). Bonk in 2009 wrote a book "The World is Open", on adoption of BYOD and the motivation for the same, based on "WE-ALL-LEARN" framework, which describes on the aspects of learning anywhere, anytime by anyone. Potentiality of technology integration and also on the benefits of adoption of the right resources available in technology in the right means was highlighted by this framework.

Eugenie Kat's Pinterest.com page has a 21st Century Learning compared with the Traditional Learning given below in Table 2-1 (Eugenie, 2016).

Table 2-1: Traditional Learning vs 21st Century Learning

Traditional Learning	21st Century Learning
Schooling	Lifelong Learning
Knowing (factual knowledge based learning)	Understanding
Broadcast/ Teacher centred / Transmission model/passive learning	Constructivist / student centred L/ information exchange/ active learning
Single sense stimulation / single media	Multi-sensory stimulation / multimedia
Traditional Content / isolated, artificial context	Contemporary Content/ real world, authentic context
Learning Tech Skills / individual work/	Developing 21st Century Skills / collaborative work / critical thinking

Source : www.pinterest.com (Eugenie, 2016)

The above Table 2-1 shown a simple and self-explanatory comparison. However, all theories in learning describe the accuracy of adopting of right information that is processed, utilized or absorbed during learning.

2.11 Benefits of BYOD:

The researcher highlights in this study, on several benefits of BYOD in secondary schools, referred by various scholars. Allow to use student's personal devices was a cost-effective benefit. "The Tech-Savvy Triangle" author, Donavan Walling, wrote about a "Generation M" study published in 2005, which showed that 39 % of students (ages 8-18) owned a personal cell phone whereas high-schoolers were 56 %" (Walling, 2012). In the following Generation M study in 2010, there showed a greater percentage of users than the previous study (39% changed to 66%, whereas 56% to 85%), (Walling, 2012). Among millennials, there will be very little, or no students without access to cell phones as the availability

of cell phones will most likely rise with the low cost and many options and plan now available, making the devices easily accessible to today's students. A positive aspect of BYOD program was that it provides students with the access from home to study materials which thus makes learning simpler and quicker and reduces the burden of carrying too many books daily to school. For teachers, BYOD offers a paperless classroom making it more cost-effective.

In addition to highlighting the benefits of BYOD, the drawbacks with regard to BYOD noted by few researchers also are considered in this study like; An article was written by, Flanigan named, "BYOD Boundaries, a school in Fairfax County, VA" briefed that, beginning of the school year in 2011 to 2012, when BYOD was implemented, he observed that during school hours, the number of discipline referrals on cell phone usage was significantly decreased (Flanigan, 2013). According to the article, "the number of digital-related infractions, dropped from 474 in 2010-2011 to 366 in 2012-2013," (Flanigan, 2013). This noticeable decrease was basically due to the implementation of BYOD in the school. Instructions were given on proper usage, when and where or at what time the students can use cell phones or their personal devices at school. The school set clear policies and boundaries to use their own devices while providing students with an opportunity to use it.

The researcher also probes on various situations to understand the drawbacks of BYOD implementation along with its benefits. There may be initially a direct impact on parents, teachers or the students upon BYOD implementation in schools. A variety of expensive devices are available in the market and parents may hesitate

to allow students to carry such expensive devices to the school. Schools may have to define policies on the usage and safety measures of devices within the premises of the school by students. Schools also need to communicate this policy to parents to avoid further risks or in case of any unfavourable circumstances. Previous research studies also show that the student's in lower elementary classrooms need more assistance in operating these devices which will be time-consuming for teachers leaving behind their priority duties.

There could be chances of having apps or pictures inappropriate for the school learning and in classroom while learning on personal devices it will be difficult to monitor the student activity or what the students are looking at during learning time as a major challenge when students bring their personal mobile devices from their home to school for learning purpose. However, having stated the demerits of BYOD, many researchers support the BYOD movement in schools and this study highlights on various findings on student achievement in learning as well as teaching methodologies to enhance student learning and development through BYOD implementation. As published in the article by Walling, a middle school in Hudson Valley implemented BYOD through teaching poetry on cell phones and assigning a task to students, to identify meanings of several stanzas of poetry (Walling, 2012). This study revealed that "among the students who used their cell phones for the assignment scored an average of 80 % of questions about the poem on the test correctly. The students who were not involved in using a cell phone to find answers scored only 40 % on the same test" (Walling, 2012). BYOD program was an initiative as part of progression in technology integration in teaching and learning, and there are not many types of research or studies on this movement in

schools. Even though the studies were primitive with regard to BYOD, the feedback on using personal devices in classrooms are welcoming and positive on student's learning and development process.

Thus, considering all the above literature reviews and studies by various authors, the implementation of BYOD movement in education provides a technology-rich content, more secure and latest education plan for complete successful student engagement and enrichment utilizing digital technology in learning.

2.12 LoTi Framework and Survey Instrument

There are several frameworks that have been developed to measure technology integration in the classroom. Survey instrument of this research was developed based on the LoTi Framework. Moersch of Learning Quest has developed LoTi Framework survey instrument in 1994 (LoTi Connection, 2011). According to Moersch, the LoTi questionnaire was designed to determine the level of teacher's technology implementation by generating a profile for the teacher across three specific domains such as level of technology implementation (LoTi), personal computer use (PCU) and current instructional practices (CIP) (Moersch, 1999). Moersch developed LoTi framework based on the concerns and also based on adoption model. This framework emphasises that people experience a change in the process of learning and there need be sufficient support throughout the change process to ensure that the learning process was deeply rooted (Loucks & Hall, 1979).

Effective use of technology by teachers will be the major determinant of the success of technology interventions provided for schools. A consistent outcome on student learning potential and achievement can be measured through teachers' level of technology implementation. Since its inception in 1994 it has experienced several reviews, the LoTi Framework has been used as a state-wide survey to measure technology use, school improvement model at the district level, and also as a tool impacting thousands of schools nationally for a classroom walkthrough (LoTi Connection, 2011).

Jones and Spotswood examined teacher levels of technology implementation self-ratings and student Texas Assessment of Knowledge and Skills (TAKS) scores. The finding was that there was no difference between teachers' LoTi scores and student mean scores on ELA and math TAKS (Jones & Spotswood, 2012). Alfaro established a relationship between teacher LoTi scores and student scores in language arts but found no difference in math and social studies (Alfaro, 2008).

2.13 Usage of BYOD and BYOD Initiatives in UAE

Many authors cite 21st-century skills as a justification for the BYOD. 21st-century skills was no longer an advanced phase to latch onto but an actuality that we need to install into our school systems (DeWitt, 2012).

Learning becomes easier to achieve, as it was more collaborative. Students can integrate their personal device into their daily lives (Clifford, 2012). These authors believe that mobile devices are a vital part of 21st-century living and learning skills. BYOD, as studied by Horizon Project, students, access to the same devices at home and at school and it can be used to extend learning opportunities to times

and places outside of the school classrooms, and allow students to work with technology they are comfortable and familiar ("NMC New Horizon Report-k12," 2013). Further for such reasons and to bring control to the usage of devices within and outside the classroom, schools need to frame proper BYOD policy and students should be taught on the proper use of devices (DeWitt, 2012).

Sweeney stated that BYOD usage models included the highly locked down models where the device to be used was dictated by the school, and the other was to bring your own device whatever connects to the internet (Sweeney, 2012). Researchers like Dixon, Tierney and the Alberta Guide have studied and explained on various kinds of models of BYOD implementation (Dixon & Tierney, 2012) (Alberta Education, 2012). The Alberta guide for schools (Alberta Education, 2012) has stated five models as follows:

1. Limiting personally owned devices to a specific brand/model of the device.
2. Limiting personally owned devices to those that meet specific technical specifications .
3. Limiting personally owned devices to those with specific functionality.
4. Accepting all personal mobile devices provided they are Internet ready.
5. Mixtures or blends of the four models listed above.

Further studies on various controlled models were the student has no control over her/his device and teachers know what are the specific models and technical specifications on the mobile devices (Dixon & Tierney, 2012). Another type of controlled model was that of students using smartphones and accepting such

personally owned device that is internet enabled which can be of greater compliance (Lee, 2012). According to Williams, IT Department will have less workload on BYOD Implemented schools since students themselves will troubleshoot and manage their personal device being brought to schools (Williams, 2012).

Parents have hopes as well as doubts about students using the personally owned device, home network and home internet for accessing information. Parents need training, support and relevant information on this usage to support students (Alberta Education, 2012). DeWitt advises that children using costly devices as they bring it to school should be with parents knowledge (DeWitt, 2012).

Guidelines covered in NSW Department of Education and Communities Legal Issues Bulletins states that: (i) Damage or loss will not accepted by schools (ii) Students bring their own property to the school at their own risk, (iii) School may be liable to compensate the student if their personal device confiscated from a student and was lost or destroyed thereafter (iv) Students and parents should be constantly reminded of this (Stavert, 2013).

The BYOD information to parents and students emphasizes on the role of parents in this initiative and safety of students as well as on code of conduct according to Swan Christian College, Western Australia (Stavert, 2013). Based on the BYOD model chosen, the policies are outlined and are also made available on school websites. The Cheshire Public Schools, United States website, for example, contains digital citizenship and safety information and links along with a BYOD resource centre with sections for parents and students (Stavert, 2013).

GEMS Education was the first education group to adopt a BYOD programme in Dubai, UAE, where this study will be conducted. GEMS has announced a 'Bring Your Own Device' (BYOD) initiative in all GEMS schools in the UAE along with setting up a secure Wi-Fi facility to access the school's internet and the network and permitting students and teachers from GEMS Schools to use their own devices (laptops, tablets etc.) and use them for educational purposes within the classrooms. The BYOD specifications on hardware and software are outlined and made available in GEMS schools' website (Figure 2-3) for parents and students to adhere to while purchasing the device for their wards.

Windows	Apple MacBook Pro	Apple MacBook Air
Processor: Intel Core TMi3 (2330M) or better Operating System: Windows 8 **(Not Starter, Basic or Home)** or Windows 10 • Microsoft Surface Pro has capabilities of a PC, but the portability of a tablet. It must have a detachable keyboard if used as a primary device. **Memory:** Minimum 2GB DDR3 SDRAM at 1333MHz, preferably **4GB** **Hard Drive:** Up to 500GB (5400RPM) **Connectivity:** 10 / 100. 1000 Gigabit Ethernet **Wireless LAN:** Bluetooth optional **Ports, slots & chassis:** 2 or more USB 2.0 / 3.0 slots. **Dimensions:** 11-15 inch screen **Power:** 6-cell (60W) Lithium Ion Battery or 3-4 hours of battery life with Wi-Fi on.	13 inch, 2.4 GHz dual core Intel Core i5 with 4GB 1333MHz 500GB 5400-rpm Intel HD Graphics 3000 HDMI Note: This laptop automatically meets power requirements	11.6 Inch, 1.6 GHz dual core Intel Core i5 with 3MB shared L3 cache 2GB 1333MHz (additional 2GB RAM available - 4GB is preferable) Intel HD Graphics 3000 HDMI Note: This laptop automatically meets power requirements

Figure 2-3: BYOD Specification Sample

Source: www.gemsinternationalschool-alkhail.com (Hopcroft, Nabi, & Moores, 2016)

Many research studies conclude that "the diverse combinations of mobile hardware and software can result in novel trouble tickets that take extra time to

resolve and for this reason, many organizations are limiting what hardware and software combinations are allowed to participate in BYOD initiatives" (Caldwell, Zeltmann, & Griffin, 2012). This eases IT support.

2.14 Dubai and UAE

The researcher is a resident of Dubai, UAE and this study was conducted in Dubai, one among the seven Emirates of United Arab Emirates. The UAE is in the Middle East region of Asia, lying at the tip of the Arabian Peninsula, borders with Saudi Arabia and Oman. UAE is one of the GCC (Gulf Co-operation Council) States. Abu Dhabi is the capital of United Arab Emirates (UAE), and its seven emirates are Abu Dhabi, Dubai, Sharjah, Ajman, Umm Al Quwain, Ras Al Khaimah and Fujairah.

Figure 2-4: UAE MAP

Source : (United Nations, 2011)

The UAE is one of the wealthiest countries in the Middle East and world's fastest growing and highly developed Nation (Forbes.com, 2015). The seventh-largest in the world is UAE's oil reserves, while the world's seventeenth-largest is its natural gas reserves (Ministry of Environment and Water, 2014), and the country has steered up in healthcare and education. Dubai, UAE's most populous city, is an international aviation hub and a global city too. The petroleum and natural gas are country's export products.

UAE's highest priorities along with human resource development are Education. As President, His Highness Sheikh Zayed Bin Sultan Al Nahyan, founder of the UAE, stated that creating generations of educated and trained people is the greatest wealth of the nation. A key area of focus of UAE has been to transform schools to make sure students in the country are fully prepared and equipped to attend universities for higher studies around the world and compete with the growing global marketplace (UAE Embassy website-Education, 2016)

The Knowledge and Human Development Authority (KHDA) is the Educational Quality Assurance and Regulatory Authority of the Government of Dubai, United Arab Emirates. KHDA manages the private education sectors in Dubai, as well as childhood education centres, schools, higher education providers, and training institutes. In 2006, KHDA was established, under the directive of HH Sheikh Mohammed bin Rashid Al Maktoum (Vice President and Prime Minister of the UAE, and the Ruler of Dubai), with the aim of developing the education and human resource sectors in the Dubai to the level of international standards and best practice. Director-General of the Knowledge and Human Development Authority (KHDA), Karam revealed that over 15 to 20 new private schools were opened in

Dubai during the 2016-17 academic year, which will be highest in number in a year, in the history of Dubai (GulfNews, 2016).

2.15 Growth in Dubai Private Schools

The education system of the UAE is developing and expanding. The number of schools during the academic year 2015-16 has totalled to 173 and which are home to 265,299 students from 183 countries. This number shows a 5.6 percent of the growth of student enrolment for schools, which was an increase from the previous academic year when the number of schools was 169, and the number of students was 255,208 (KHDA, 2015). Out of the total 173 private schools in Dubai stated earlier, 65 schools offer the UK curriculum, 32 of them offer the Indian curriculum and 31 offer the U.S curriculum. The International Bachelorette, Minister of Education, Iranian, French, Sabis, Philippines and Pakistani curriculums are also followed respectively (KHDA, 2015). A pictorial representation of figures and facts by KHDA report for the year 2014 – 2015 was given (see Figure below 2-5).

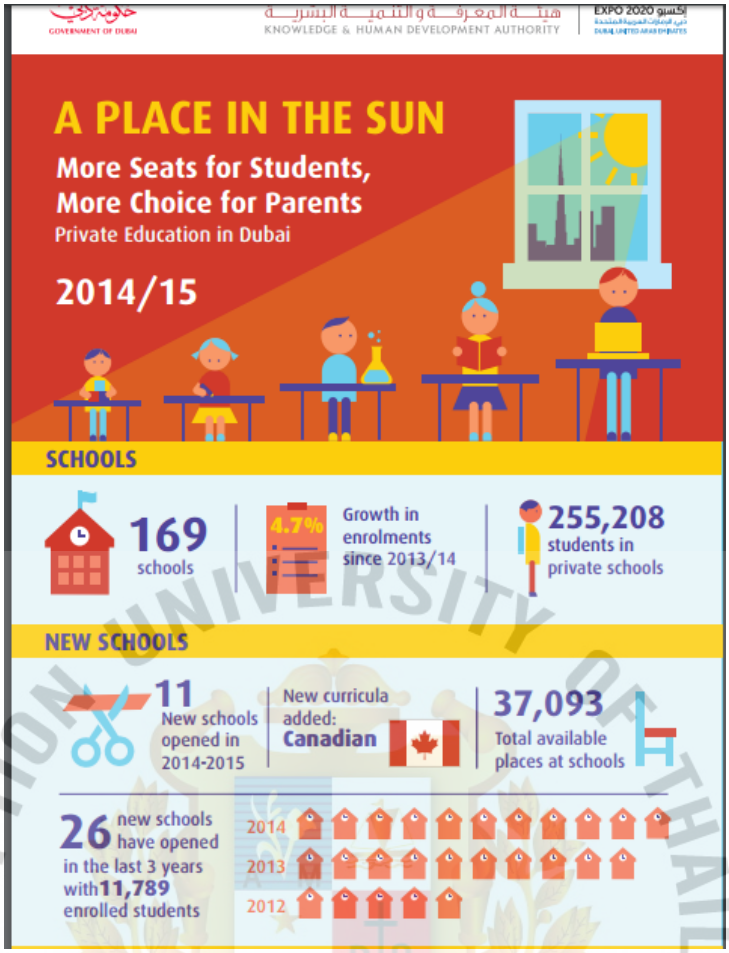

Figure 2-5: KHDA report for the year 2014 – 2015

Source : www.khda.gov.ae (KHDA, 2015)

Reformation in educational systems focuses on higher standards, greater preparations and accountability. Technology interactions in Science, Mathematics or other subjects are some of the other changes. The Ministry of Education (MOE), frames the strategy and was the education council that implements government policy. Other education councils of emirates engaged in reforming education program in UAE are The Abu Dhabi Education Council (ADEC), the Dubai Education Council (DEC), the Sharjah Education Council and the UAE Ministry of Education (UNESCO, 2010).

UAE's vision 2021 focuses to reform education and to establish a diversified knowledge-based economy within the country. To accomplish this vision, education has become one of the government's top priorities followed by human capital development.

"Education 2020", a five-year plan designed by the government to bring significant qualitative improvement in the education system in the country, especially in the way teachers teach and students learn was introduced by MOE. MOE was also bringing advanced education techniques with best practices, self-learning abilities, innovative skills etc. in student learning processes. The new strategy includes, "Smart learning programmes, new teachers' codes and evaluations systems, as well as curriculum revisions".

"The Dh1 billion programme", is part of a 5-year plan for government schools, with an objective to provide a smart tablet to every student and access to high-speed 4 G networks. By 2017 the teachers will also be given special training, and new syllabuses will be developed. The plan was to execute this project in association with Etisalat, around 400 campuses with the latest 4G networks, and e-boards, smart tablets with e-content including textbooks on iPhones, iPads and Android platforms.

A UAE Society for Education supported by UAE National Media Council states that to reduce the need for costly private tuition, the ministry along with the cooperation of Etisalat and Google developing a dedicated Arabic language tutorial YouTube channel for grade 11 and 12 students. The 600 tutorials on

the Duroosi (my studies) channel plan to cover a variety of subjects. Students can use this channel and learn at their own pace (UAEINTERACT, 2016).

During the inauguration of the International Council for Open and Distance Education Standing Conference of Presidents 2012 (ICDE SCOP 2012) at the Hamdan Bin Mohammad e- University (HBMeU), the first eLearning platform in the UAE was announced through a global campaign and I was invited to promote eLearning in Dubai (GulfNews, 2012).

As part of KHDA's mission to improve education in Dubai, every year inspection was carried out in all private schools by Dubai Schools Inspection Bureau (DSIB) reference to a special education authority (KHDA-DSIB, 2007). The report stated a positive acceptance of ICT in most of the schools in Dubai as a tool for learning and also an important part of teacher training. A KHDA report on ICT use in schools (KHDA, 2015). Few examples of schools reported who readily embraced technological changes are American School of Dubai, Dubai National School, Jumeirah English speaking school are examples of institutions where significant steps have been taken to integrate ICT into the life of the school. ICT learning resources are utilized creatively by both teachers and the students to support and challenge teaching and learning at all stages. Students from KG onwards are confident about finding information as their carefully designed curriculum programmes with access to digital devices ensure applying ICT in a responsive and discerning manner (KHDA, 2015).

Other BYOD Initiatives in Dubai, was the iThink Conference on Digital technologies in learning. On February 3, 2016, the first iThink Conference took

place at Freemake School, Al Barsha, Dubai. The scope of the iThink conference was to create a consultation place for everyone who was inspired by the goal of maximizing the learner's experience in schools (as shown in the below figure 2-6). Educators, technologists and leaders joined the conference to find an approach to digital technology to effectively enhance and also to support teaching and student learning.

Figure 2-6: e-Brochure of iThink Conference

Source: www.ithinkconference.com (iThink Conference, 2016)

2.16 Research Hypothesis

According to the trend appearing from the literature review and based on the research questions defined in Chapter I the researcher makes the following alternative hypothesis:

Ha1: The students' achievement was significantly improved by the use BYOD against the traditional teaching methods.

Ha2: The students' achievement was varying significantly in relation to gender as far as BYOD implemented and practised.

2.17 Summary of Literature Review

It becomes evident from the literature review that BYOD implementation in schools was getting popular day by day and the stakeholders believe that BYOD implementation has an impact on student achievement.

Learners of this generation are called "Millennials", "Generation Next", or the "Net Generation" for a good reason. This new generation of people was almost and always digitally connected and are already used to inter-communication and collaboration using the digi-tech resources. It was understood that millennials were updated with the current information and happenings, view the world from side to side the prism of their personal interests and wired for the next moment's activities. Ancient or previous generations worldview was different from that of 21st-century digital generation and so the digital conversion of secondary school classrooms from the chalkboard to tablets or digital devices.

BYOD benefits the students by the use of technology that they have personalized or they are already familiar with. Hence, the acceptance of BYOD in

classrooms by students were more welcoming when compared to some negative feedback or criticism by staff or the administrators. With the evolution of mobile devices, a new trend has risen with more opportunities available in learning and developing skills than when compared to traditional classrooms. This has started a trend to focus curriculum on learning through interaction, communication and collaboration with less effort in teaching and more to probe into learning. The students show great interest in learning as they have more reach and availability of learning resources and can access information from anywhere or anytime. Moreover, students also maintain positive interaction with teachers -who turn to be a good facilitator. The results of many studies prove that there was a positive impact on teaching by integrating technology and students were successful in technology-enabled classrooms and showed a positive impact on their learning and development skills.

BYOD program motivates the students to interact with each other, improves learning and communication skills, develop collaborative and constructive skills. BYOD also involves training, exchange of ideas and point of views and delivery of knowledge. Despite some challenges highlighted in this study, the literature seeks to explain the importance and the impact of eLearning and mLearning in particular in teaching and learning. Acceptance and adoption of eLearning and mLearning have proved to be productive for learners and provided rich environments for collaboration as well as improved academic standards.

CHAPTER III

RESEARCH METHODOLOGY

The previous chapters have established and presented the theoretical framework on which this research study was based. This chapter has explained the research methodology that was used to conduct the research. This chapter contains separate sections discussing for Research Design, Target Population and Sample, Research Instruments, Data Collection, Data Analysis, Reliability and Validity and Summary. This study was conducted in Dubai, UAE where stakeholder represents various nationalities of students and teachers from eight private secondary schools.

3.1 Type of Research

This research's main objective was to develop a BYOD eLearning Conceptual Framework for private secondary schools in Dubai, UAE based on BYOD factors that impact student achievement in Science and Mathematics subjects in private secondary schools in Dubai, UAE. This research has incorporated the usage of Levels of Technology Implementation (LoTi) based survey instruments to collect relevant data to assess how student and teacher factors impact BYOD.

This research study has helped to understand the connection between BYOD factors and achievement of grade 9 students' Science and Mathematics.

The study examined the correlation, if any, between gender, BYOD factors and their impact on achievement.

Knowledge base of the effectiveness of BYOD factors on student achievement was included as the new finding of this study. The study had enhanced the knowledge base of teacher's BYOD factors its effect on student's achievements.

The result of this research can give awareness to the usefulness of BYOD and a better understanding of its use. It can also pave a path for its implementation in schools across Dubai, UAE. It can also shed some light on teachers' level of usage of technology and impact on students' level of achievements as a result of BYOD Implementation.

This study can also aid as resource material for schools that have yet to deploy BYOD and can be an example for schools in countries that have not shown any interest in BYOD initiatives. The outcome of this research work can be used for a new eLearning Conceptual Framework to promote the use of BYOD. Solid evidence derived from this empirical research may help promote BYOD in Dubai schools and in other regions of UAE.

3.2 Research Design

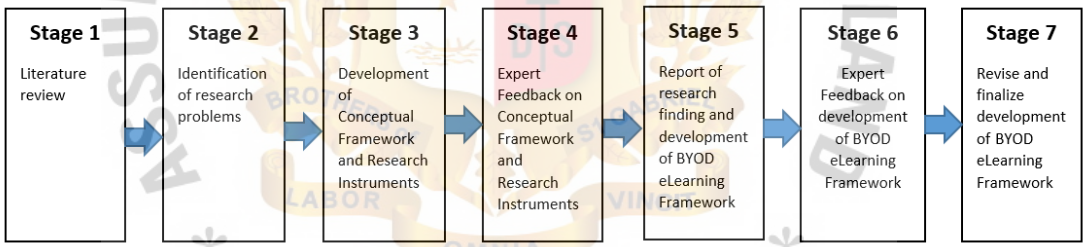

Figure 3-1: Seven Stages Research Methodology

The plan of this study consisted of seven distinct but interconnected stages where the output of each stage was suitably used to inform the initiation and effective completion of the next stage (Brahmawong & Vate-U-Lan, 2009).

This study was based on the principles of quantitative nonexperimental design. This causal-comparative study was based on independent and dependent variables. In causal-comparative research, the study emphases on the connection between one

or more categorical independent variables and one or more quantitative variables (Johnson & Christensen, 2008).

In cross-sectional research, data collection from participants was accomplished at a single point in time or in a relatively short period (Johnson, 2001). Causal-comparative studies were used to define the presence of relations between independent and dependent variables after the occurrence of the events ("Encyclopaedia of Research Design," 2010).

This researcher has chosen a non-experimental comparative method to examine various types of correlations between dependent and one or more independent variables with each other. Since the focus of this study was to assess the impact of BYOD on student academic achievement, other types of experimental research designs were found inappropriate.

Several studies have used causal-comparative design because of its advantage in terms of access to the large volume of data, large sample size and data collected from a larger population in a cost-effective manner and thereby adding it to the knowledge base of the design ("Encyclopaedia of Research Design," 2010).

3.3 Target Population and Sample

3.3.1 Target Population of the Study

The target population of this study involved teachers from private schools in Dubai, UAE. According to the official KHDA report (KHDA, 2015), the number of schools in Dubai during the 2015-16 academic year totalled to 173, and these schools were home to 265,299 students from 183 nationalities. Out of the total, 5.6% growth in student enrolment was recorded in Dubai, and this growth was an

escalation from the previous year when the number of schools was 169, and the student population was 255,208. Dubai private schools have about 17,000 teachers.

Figure 3-2: Map of UAE

Source: ThingLink.Com (Emiliano, 2015)

Out of the 173 Dubai private schools, 65 schools offer the UK based curriculum, 32 schools offer the Indian curriculum, and 31 schools offer the U.S curriculum. The other curriculum followed was from Iran, France, Sabis, Philippines and Pakistani (KHDA, 2015).

The schools chosen for this study were eight international private secondary schools following a similar Indian curriculum. The researcher had a clear understanding of the type of schools in Dubai and curriculum they follow since the researcher had worked in this domain for nearly 20 years in Dubai. Other rationales for choosing international schools following Indian curriculum for this study was

because all the 32 such schools in Dubai follow a similar type of Indian curriculum, they have similar academic grading pattern, similar academic school terms, and the students, parents and teachers come from a similar social, economic background. These schools also provided similar Technology Infrastructure for teaching and learning. U.S or UK curriculum schools did not have the above type of similarity in its characteristics and hence using those schools for this study and its result to develop a common framework would not have been appropriate.

The total population of the students in the selected sample of eight schools during the current year was 21,127 which was about 6% of the total student population of Dubai private secondary schools and 1,241 teachers which was about 7% of total teacher population of Dubai private secondary schools. 1,800 students were part of this study while the Science and Mathematics teachers' sample size was 120.

The sample size of eight schools had chosen for this study from 32 international schools following Indian curriculum in Dubai, which was about 20% of such 32 schools and was a standard industry acceptable sampling percentage for a finite population.

The researcher also used infinite population-based sampling size method to validate the sample size of participating students. Sample student number size had arrived using that sample size formula, Sample Size = $(\text{Z-score})^2 * \text{StdDev}*(1-\text{StdDev}) / (\text{margin of error})^2$, where Z-score was a constant value corresponds to the confidence level. Standard survey confidence level was 95%, and for a confidence level of 95%, the Z score was 1.96 (Smith, 2013). The standard margin

error (confidence interval) was less than 2.5 %, and 2.4% has taken margin error here. Applying the above formula here was result to $((1.96)^2 \times .5(.5)) / (.024)^2 =$ 1,667, which was less than the actual students, 1,800, participated in the study. A sample size of teachers, 120, has chosen to match student sample size representation. In other words, about 120 teachers were teaching Science and Mathematics subject for 1,800 students in grade 9.

3.3.2 Sampling and Sampling Procedure

Probability sampling method was used as sampling strategy for this research. Barreiro and Albandoz of the University of Seville recommend usage of probability sampling because this case of choosing the appropriate technique will assure us that the sample will be the representative and could estimate the errors for the sampling (Barreiro & Albandoz, 2001).

There were various types of probability sampling, random sampling with and without replacement, stratified sampling, cluster sampling systematic sampling, other types of sampling techniques (Barreiro & Albandoz, 2001) .

Participated eight schools were grouped as BYOD schools and Non-BYOD schools. This researcher found probability sampling as most appropriate because examination scores of grade 9 students and teachers involved were the target population. This method was the one in which each sample has the same probability of being chosen.

The researcher had proper permission from the school authorities to obtain the archived examination score data for Science and Mathematics for all grade 9 students. As mentioned earlier, 1,800 students of grade 9 from the eight selected

schools were included in this study and their scores collected from respective schools.

The teachers for this study were selected from the teachers involved with teaching Science and Mathematics in the grade 9 of the participating students. The teachers' selection was also on purposeful sampling method. Formal consent was obtained before their participation in this study. 120 teachers from eight selected schools participated in the study.

3.4 Data Collection

Official permission was obtained from the school authorities to start a collection of data. This researcher met with school principals and explained to them the objectives of this research. The principal then assigned one SPOC (Single point of contact) to help researcher based on his request to manage survey instruments in respective school and to organise student examination scores. Upon receipt of permission from the school authority, this researcher explained objectives of the research to SPOC. SPOC helped in arranging a meeting with section head to provide student examination scores and identified teachers in the sample to provide valuable input to the researcher.

Students' examination scores were collected from each of the schools through principal the SPOC. Students ID number and teacher ID number from participating schools were coded to maintain confidentiality. Other than gender and exam scores, all other personal details were excluded. SPOC also helped to explain the objective of the study to supervisors and they have cascaded it to the teachers who had participated.

3.5 Research Instruments

As mentioned earlier, data were put into two groups. One group consisted schools that did BYOD implementation, and the other were schools were BYOD where it was not implemented. BYOD schools had access to technology, and their students were bringing their own devices to classes for learning and had been previously exposed to using eLearning tools. On the other hand, BYOD not implemented schools did not have access to the above. They were using the conventional Face-2-Face (F2F) teaching methods. However, teachers of those schools were using Laptops for teaching.

3.5.1 Examination Scores

Quantitative data required for this study was collected as examination scores of the participated grade 9 with a focus on Science and Mathematics and subjects. Teddlie and Tashakkori stated that to assess learners' knowledge, ability and intelligence examinations were systems designed (Teddlie & Tashakkori, 2009)

Science and Mathematics subjects were offered at all grades in the participating schools. Student's examination scores (terms end scores) comprised of three-term scores. Each term scores were cumulative, and it was based on three continuous term assessments of the students and its average. Regular test, project, or other assignments given to the students as part of the continuous assessment on every term and represents a percent of the total obtainable score of that term.

In UAE, the participating schools were affiliated to different educational boards, and each board's assessment and grading policy differ from one another.

The scores used in this study was graded as a common standard and scale irrespective the board.

3.5.2 Implementation Questionnaire Based on LoTi Framework and 4Cs.

The questionnaire based on LoTi Framework and 4Cs were used to collect BYOD factors data from the students and teachers' BYOD schools and Non-BYOD schools. This survey was conducted after informing them the purpose of this study.

The survey questions were concentrated on Teaching Methods, Learning Methods, Technology Usage and Evaluation Method. This researcher did not contact LoTi Connection to seek any approval since the questionnaire was only based on LoTi Framework, not the Framework directly.

3.5.3 Construction of Research Instrument

The process used to construct the questionnaire consists of the following steps:

1. The first draft of the student questionnaire and teacher questionnaire which have been developed based on the research objectives were presented for advice from the two advisors.
2. The second draft of the questionnaire was revised based on the feedback and recommendation from the two advisors. Then, they were analysed and reported in the operational definition and questionnaire items analysis (Appendix 1).
3. The third draft of the questionnaire was made in consultation with experts after obtaining their feedback. Six experts, PhD holders, were

consulted for reviewing the drafted student and teacher survey instruments and their feedback was incorporated into the instruments

4. The fourth draft of the questionnaire was used to check usability by "Thinking aloud techniques" for both students and teachers. Three students: above average, average and under average was randomly selected. Two teachers: one female and one male were randomly selected. This was to find out any difficulty while answering the student survey; time consumes to complete the form and the comprehensive level of language of the survey. All feedback was brought to revise the survey.
5. The fifth draft of the questionnaire was to test for validity and reliability by Cronbach's Alpha Co-efficiency test using IBM SPSS. The student questionnaire was tested with 50 students, and the teacher questionnaire was tested with 10 teachers who have represented the population of the study.
6. The questionnaire was modified according to the pilot result. The acceptable reliability score then was higher than 0.7. (Appendix 2)

3.6 Data Analysis

IBM SPSS Software and Microsoft Excel were used for the detailed analysis of the data collected from students and teachers.

Analysis of Critical Factors of BYOD related to students' characteristics such as Internet connection at home, School ICT Infrastructure, Teaching Methods by teachers, Learning Methods by students, Technology Usage factors and Evaluation

Methods were ranked and analysed using descriptive statistics methods (frequencies, mean & standard deviation).

Analysis of Critical Factors of BYOD related to Teachers' Characteristics such as Internet connection at home, School ICT Infrastructure, Teaching Methods by teachers, Learning Methods by students, Technology Usage factors and Evaluation Methods were ranked and analysed using descriptive statistics methods (frequencies, mean & standard deviation).

Analysis of Student's Mathematics & Science Scores were conducted using Independent Sample t-test by splitting schools into BYOD Schools and Non-BYOD schools using IBM SPSS.

In order to determine the difference between teachers' and students' perceptions of factors Mean, SD & Independent Sample t-test was used. Mean, SD & t-test and a one-way ANOVA test were used to analyse Students' Perceptions of BYOD Factors and Teachers' Perceptions of BYOD Factors. Discriminant Analysis method was used to analyse the data to examine the effectiveness of BYOD critical factor and students achievements.

The validity test result was the indication of the extent to which the inferences made based on the students' scores in both learning environments. The assumption was that there might be linear relationships among the dependent variables, Science and Mathematics achievements.

Levene Howard's test of similarity of the variance will be used to test equality of variance as it tolerates violations of normality and this will also scrutinize whether the amount of variance was respectively represented within the

independent variable (BYOD Implementation) groups. The similarity of variance was that the variance of the scores in one type of school that would be equal to the inconsistency of scores in the second type school (Gastwirth, Gel, & Miao, 2009).

Findings specifying the different levels together with the student achievement was analysed using IBM SPSS Software to establish the connection between teachers' BYOD factors and student achievements.

3.7 Reliability, Validity and Ethical Procedures

3.7.1 Reliability & Validity

Validity was the degree to which an instrument measures what it was purported to measure (Lunenburg & Irby, 2008). The degree to which an instrument consistently measures whatever it was measuring was its reliability (Lunenburg & Irby, 2008).

LoTi was widely used to create data in various schools in the United States of America and in many countries to measure teachers' level of technology implementation since its reliability and validity were high (Fields, 2005; Malcolm-Bell, 2010; M. Semih Summak & Mustafa Samancıoğlu, 2011; Stubbs, 2008).

It was expedient to utilize procedures to ensure the validity of the data and findings (Creswel & Clark, 2007). Validity serves the purpose of checking on data quality and determining if what was being measured was what was planned to be measured (Frankfort-Nachmias & Leon-Guerrero, 2010).

There was a prerequisite as a researcher to design studies to reduce the threats to internal validity and external validity. Creswell and Plano Clark stated that internal validity was the extent to which a researcher can accomplish the existence

of cause-and-effect relations among variables (Creswel & Clark, 2007). External validity was the extent to which a decision can be derived that the results apply to a large population. In this research study, the threats to external validity will be comprised using the location of private secondary schools selected for this research.

The findings cannot be generalized based on the area of the schools and might be less applicable to another area. In order to reduce these threats, the specificity of variables was based on similar technology implemented in these learning environments.

As proven during the pilot study, threats to internal validity of this study were minimal, since the testing involved a large sample of student examination scores. Teaching or instructional methods in various participating schools were not different.

3.7.2 Ethical Procedures

The data collecting from schools was be kept confidential to protect the rights of participating sample, students and teachers. Separate codes were used for student data and teacher to protect confidentiality.

To avoid any form of data leakage, all research data was stored in the laptop of the researcher with password protection. After successful completion of this study, all research data related to samples would be deleted.

3.8 Summary of Research Methodology

The causal-comparative research design allowed gathering of a large amount of data proportionate for this research study. The student examination scores were

used to determine the level of student academic achievement, and the LoTi and 4Cs based survey gave information on students and teachers' level of BYOD factors.

The descriptive statistical analysis was used to detect the differences in the mean, the equality of variance, and a relationship between the independent variables and dependent variables. The result of this analysis was helped to establish the specified hypotheses. Suitable consideration was given to ethical processes by protecting the rights of participants, specifically in the examination data of student scores.

The researcher modified the BYOD eLearning Conceptual Framework based on the outcome of this study for schools to increase the level of awareness of the potential impact and benefits of BYOD on student academic achievement and significance of the teachers' BYOD factors.

CHAPTER IV

DEVELOPMENT OF THE "BRING YOUR OWN DEVICE" ELEARNING CONCEPTUAL FRAMEWORK

This research proposes a BYOD eLearning Conceptual Framework that can create an effective and efficient BYOD learning environment. This research intended to investigate developing a BYOD eLearning Conceptual Framework that integrates BYOD factors which impact students' achievements and demographical variables to test its validity in private secondary schools in Dubai. The Conceptual Framework provides ontology or a specification of the concepts (Gregor, 2006; Gregor & Jones, 2007).

Research clearly shows that chances of success of an eLearning project are highly unlikely without an eLearning Framework.

Previous examples-based attributes of successful eLearning projects were grouped into a framework, and such framework has reported in their study by researchers like Sun et al. (2008), Ozkan and Koseler (2009).

4.1 Existing BYOD Frameworks

It was noted during the documentary research that the existing BYOD Frameworks were developed around technology infrastructure, policy, administration of BYOD programme and they were not focused on eLearning factors of BYOD which can impact student achievements (Ryan, 2016). It was noted that some schools released documents by name BYOD Framework

mentioning about BYOD programme of their school (liverpool-h.schools.nsw.edu.au, 2016).

During the documentary research, the researcher noted few eLearning related frameworks which had a connection with the BYOD principles. Few such frameworks are reported by Madina, a researcher from Bahrain, in his study (Madina, 2014): 1. A Framework focused on factors and dimensions of eLearning environment, 2. A framework aimed at the important success of eLearning, 3. An assessment framework aimed at important attributes of eLearning, 4. A framework which aimed at attributes that impact student acceptance of eLearning. The available frameworks focus on aspects that include factors of eLearning environment and eLearner satisfaction.

4.2 Conceptual Framework of Factors that Impact Student Achievements

This study highlighted the connection between teachers' and students' insight of BYOD based eLearning. A significant role of this framework was to report the necessity to recognise and authenticate the attributes measured as the main components which can enhance and improve BYOD based eLearning, its development and expansion.

This framework focused on exploring the attributes that have an influence towards student's achievements related to BYOD based learning. The framework emphases on the connection between the student and teacher attributes of BYOD which can improve the students' accomplishments.

Critical factors impacting BYOD such as Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods were identified based on literature review of LoTi Framework and 4Cs.

The eLearning Frameworks cited in the literature were not directly addressing the need of BYOD eLearning Conceptual Framework, and consequently, there was a requirement to advance a Conceptual Framework that highlighted on eLearning aspects of BYOD and student achievements especially in Science and Mathematics subjects. This research can be measured as valuable yardsticks to recognise the main aspects that impact BYOD based eLearning implementation and student achievement in the secondary schools in Dubai, UAE.

4.3 Building BYOD eLearning Conceptual Framework

4.3.1 Proposed Conceptual Framework

Based on the findings of the literature review, a Conceptual Framework for the BYOD eLearning was developed and the same given below in figure 4-1.

The identified students and teachers' factors of BYOD eLearning Conceptual Frameworks that had a significant impact on student achievement were Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods.

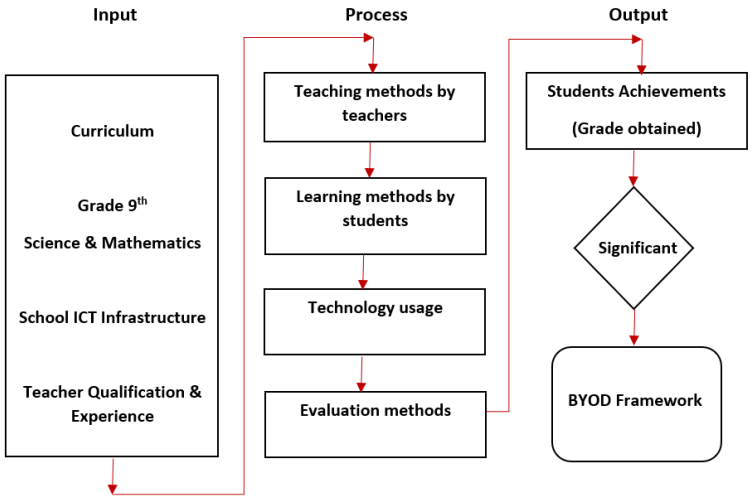

Figure 4-1: Proposed BYOD eLearning Conceptual Framework

This study investigated the students and teachers' factors influencing BYOD eLearning Conceptual Framework and student achievements using a survey designed based on Level of Technology Implementation ("loticonnection | LoTi® Framework," 2015) and 21st Century skills (Communication, Collaboration, Creativity and Critical thinking).

The LoTi Framework was grounded in the work of Dwyer, Ringstaff, and Haymore in Apple Classrooms of Tomorrow (ACOT) (Haymore, Ringstaff, & Dwyer, 1994). The LoTi® Framework has shown a considerable increase in student achievement using technology in the classrooms together with innovative ways to design instruction, assessment and curriculum. This has been used for more than a decade. The reflection level of progress in the competency of teaching with technology was measured with LoTi Framework (Moersch, 2001).

Moersch stated in "Computer Efficiency: Measuring the instructional use of technology" guide that the survey items were laid open to an exhaustive developmental and evaluation process (Moersch, 1997). The framework uses a

scale based on six levels, comprised of No use (Level 0); Awareness (Level 1); Exploration (Level 2); Infusion (Level 3); Mechanical (Level 4a) and Routine Integration (Level 4b); Expansion (Level 5); and Refinement (Level 6).

The framework for 21st-century learning was developed by Partnership of 21st Century Skills to address essential skills a learner must demonstrate in order to be an effective citizen of the world (National Education Association, 2017). The skills such as 4Cs: Critical Thinking, Communication, Collaboration, and Creativity along with literacy skills such as information literacy, media literacy, and technology literacy were aligned with Common Core State Standards (CCSS) and were available to teachers who wish to integrate such skills in lessons (Magner, T., Soulé, H., & Wesolowski, K. 2011).

Today's students want to compete in this global society, and they must also be proficient communicators, creators, critical thinkers, and collaborators (the "Four Cs") (National Education Association, 2017). It was clear that the "Four Cs" need to be fully integrated into classrooms, schools, and districts around the country to produce citizens and employees adequately prepared for the 21st century (National Education Association, 2017).

4.3.2 Stakeholders in the Implementation of BYOD

The key stakeholders of BYOD eLearning are mainly the teachers and students. It is vital to clearly inform these key stakeholders about their roles and responsibilities to implement BYOD eLearning successfully. Earlier studies on eLearning stakeholders have also reported the same (Wagner et al., 2009).

The success of any project, including learning projects, has an influence on well-defined roles and responsibilities of its key stakeholders (Kituyi and Tusubira 2013). Teachers and students taking their responsibility are very important for achieving success for a BYOD eLearning project since they are the key stakeholders.

In an eLearning environment, the teachers take up the role of an individual who facilitates the learning process. In the same eLearning environment, the student is expected to direct their own learning and acquire new knowledge, and this was reported in earlier studies (Chang and Fisher, 2003).

4.3.3 Factors Impacting Effective Implementation of BYOD

4.3.3.1 Student's Characteristics

Implementation of learning projects has the key contribution to Students' characteristics, and students' characteristics do affect the level of their interaction in learning activities (Selim, 2007). The identified student factors of BYOD eLearning Conceptual Frameworks that had a significant impact on the student achievements were Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods related to students.

4.3.3.2 Teacher's Characteristics

The teachers' characteristics also influenced the BYOD eLearning Conceptual Framework. It helps us understand what makes every teacher unique in the teaching and learning process (Babic, 2012). The recognised teacher factors of BYOD eLearning Conceptual Frameworks that impacted the student achievements

were Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods related to teachers. The successful implementation of BYOD was heavily depended on the teacher's characteristics.

4.3.4 Demographic Variables

Student demographic variables such as gender and teacher demographic variables such as gender, years of experience and qualifications have been included in this empirical research to understand its impact on student achievements and therefore in BYOD eLearning Conceptual Framework.

As discussed in Chapter 2, there are a significant difference gender perceptions of technology-based learning factors such as BYOD. Research shows that there is a clear difference between the male population and the female population in their acceptance and use of technology in learning (Zhou and Xu, 2007). Okazaki and Santos (2012) observed a connection between gender differences in eLearning implementation.

Mahdizadeh et al., (2008) have noted that increased experience in the eLearning environment correlates with positive intent towards the perception of eLearning environment. They found that the more ability to use technology and the more involvement teachers have in using eLearning, the greater their intention to use an eLearning environment.

Earlier studies reported that there were notable differences between less experienced teachers and more experienced teachers in using technology for teaching (Russell et al., 2003). Findings of Oncu et al. (2008) were also supporting it. Their study found that acceptance level for more experienced teachers was high

since they feel jobs can be easy with the use of technology. However, new teachers view was different, and their rationale was more time required for preparation.

There were study findings which reported new teachers more willing to accept technology-based teaching than experienced teachers, Metzler et al. (2008). Studied conducted by Williams, Foulger, and Wetzel (2009) observed that found that new teachers have confidence issue in using technology in teaching. Another interesting finding was level of technology integration into instruction. Researchers Russell et al. (2003) found experience teachers are good in it.

Lankford, Loeb, and Wyckoff (2002) showed that teacher qualifications were substantially worse in low-performing schools that have large populations of poor and minority students.

4.4 Summary

This chapter has developed a proposed Conceptual Framework for the research that includes: documentary research, defining the stakeholders of BYOD eLearning in schools, listing out the BYOD eLearning factors which impact student achievement and defining demographical variables based on LoTi Framework and 4Cs.

This Conceptual Framework offers the reference and investigation for the analysis and survey that was carried out in this research to explore the factors impacting BYOD in schools. The proposed conceptual framework also combines the stakeholders and BYOD factors impacting student achievements that were identified in earlier studies with the demographical details.

The researcher could not find any previous studies with similar objectives as stated above. The proposed Conceptual Framework could be used by governments and educational institutions that seek to implement and develop BYOD. This Conceptual Framework can also be used by researchers and scholars.

CHAPTER V
DATA ANALYSIS AND RESULTS

This chapter presents the findings of the analysis of the research surveys, as well as answers to the research questions concerning the factors influencing BYOD.

This Chapter is divided into seven sections; Section 5.1 describes the demographic profiles of the respondents. Section 5.2 provides a ranking of critical factors influencing the BYOD. Section 5.3 provides data analysis with respect to research question 1 and research question 2. Section 5.4 shows the analysis of data with respect to research question 3 and Section 5.5 provides a summary of the chapter. 129 teacher sample units and 2,454 student sample units were originally collected, and after data cleaning process (removed the unengaged, outliers, and missing) the final sample size was reduced to 120 cases of teachers and 1,800 cases of students.

Analysis of Levene's test (Appendix No 2) of homogeneity was conducted, and the result was .00 which is lesser than .05, and it is statically significant, and hence BYOD Schools sample data and Non-BYOD Schools are not homogenous, and therefore the sample data are comparable.

5.1 Respondents' Profiles:

5.1.1 Students

Table 5-1 and Figure 5-1 below shows the students' demographic features who participated in the survey. Table 5-1 below shows in terms of gender, 846 (47%) of the students were females, and 954 (53%) were males. With regard to the type

of school 900 (50%), students were from BYOD schools and 900 (50%) students from Non-BYOD Schools. 408 (45.30%) of students in BYOD schools were females, and 492 (54.70%) of students were males. 438 (48.70%) of students in Non-BYOD schools were females, and 462 (51.30%) of students were males.

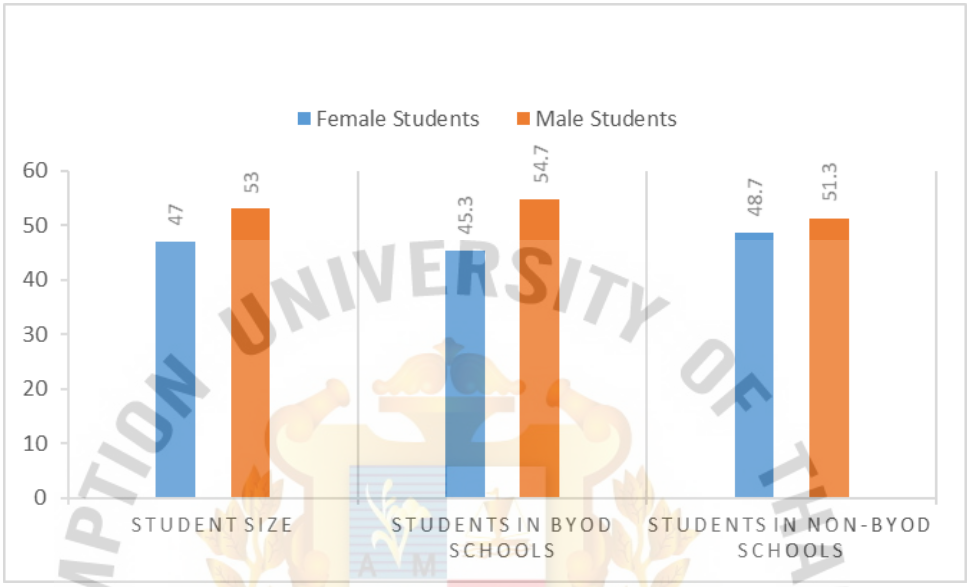

Figure 5-1: Demographic Profile of Students in Percentage

Table 5-1: Demographics of the Students

Item	n	Percentage
Students		
Female	846	47.00
Male	954	53.00
Total	**1,800**	**100**
Students - Schools Type Wise		
BYOD School Students	900	50.00
Non - BYOD School Students	900	50.00
Total	**1,800**	**100**
Students - BYOD Schools		
Female	408	45.30

Male	492	54.70
Total	**900**	**100**
Students - Non-BYOD Schools		
Female	438	48.70
Male	462	51.30
Total	**900**	**100**

5.1.2 Teachers

The teachers' demographic features are shown in Table 5-2 and in Figure 5-2, including their gender, area of specialization, BYOD practice, teaching experience, and highest qualifications. Table 5-2 shows that in terms of gender, there were 97 (80.83%) female teachers and 23 (19.17%) male teachers. This large number of representation of female teachers is due to the large population of female teachers in the schools of Dubai. In terms of the areas of specialization, 41 (34.17%) of the participants were Mathematics teachers, and 79 (65.83%) were Science teachers.

Moreover, with regard to teaching experience, 45 (37.50%) of teachers had 20 years or more experience, 21 (22.50%) had 15-19 years, 33 (27.50%) had 10-14 years, 9 (7.50%) had 5-9 years and 6 (5.00%) had less than 5 years of experience. In addition, based on the teachers' responses, it was found that 46 (38.3%) of the sampled teachers had BYOD practice.

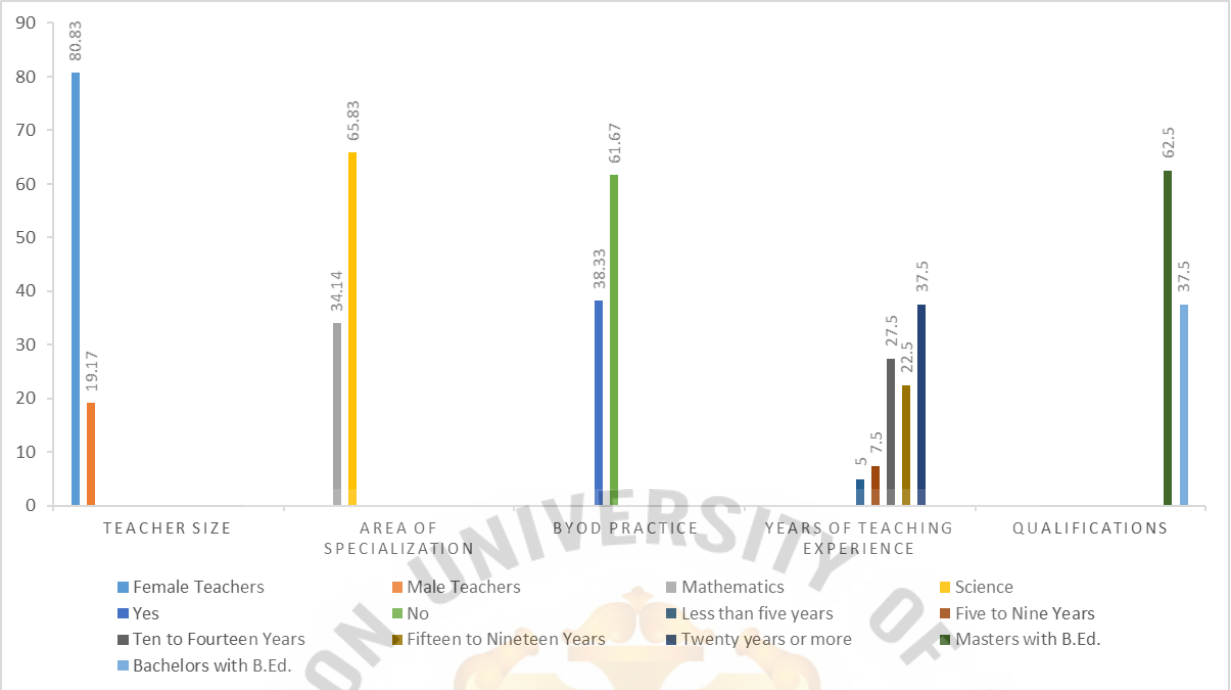

Figure 5-2: Demographic Profile of Teachers in Percentage

Table 5-2: Demographics of the Teachers

Item	n	Percentage
Gender		
Female	97	80.83
Male	23	19.17
Total	**120**	**100**
Area of Specialization		
Mathematics	41	34.17
Science	79	65.83
Total	**120**	**100**
BYOD Practice		
Yes	46	38.33
No	74	61.67
Total	**120**	**100**
Years of Teaching Experience		

Less than five years	6	5.00
Five to Nine Years	9	7.50
Ten to Fourteen Years	33	27.50
Fifteen to Nineteen Years	21	22.50
Twenty years or more	45	37.50
Total	**120**	**100**
Qualifications		
Masters with B.Ed.	75	62.50
Bachelors with B.Ed.	45	37.50
Total	**120**	**100**

5.2 Analysis of Critical Factors of BYOD

In order to answer the research questions and in order to identify which of the indicated factors are perceived to be crucial for BYOD, the level of agreement and the mean were used. In the following sections, the researcher discusses and determines the ranking for each factor.

The variables used in this study are Teaching Methods (TM), Learning Methods (LM), Technology Usage (TU), and Evaluation Method (EM). The items used to measure these variables and listed in Table 5-3 and Table 5-4

Table 5-3: Questionnaire Items (Students)

Variable	Item No	Item Statement	Type of Item
	3.5	I believe teaching methods by conventional chalk and talk is effective in learning Mathematics.	Negative
	3.6	I believe teaching with the support of Technology (Computer/ Laptop/ Tablet/	Negative

Teaching Methods		Projector/ Interactive Board/ Interactive LED) will enhance my learning experience in Mathematics.	
	3.7	I believe teaching methods by conventional chalk and talk is effective in learning Science.	Positive
	3.8	I believe teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance my learning experience in Science.	Positive
Learning Methods	4.5	I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to think creatively about Science.	Positive
	4.6	I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to think critically about Science.	Positive
	4.7	I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to collaborate effectively with other students in Science.	Positive
	4.8	I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to communicate effectively with teachers and student groups on Science.	Positive
	4.9	I believe learning with the help of using my own technology device (Computer / Laptop / Tablet)	Positive

		during the school hours can enhance my ability to think creatively about Mathematics.	
	4.10	I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to think critically about Mathematics.	Positive
	4.11	I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to collaborate effectively with other students in Mathematics.	Positive
	4.12	I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to communicate effectively with teachers and student groups on Mathematics.	Positive
Technology Usage	5.5	I believe that I am aware of how technology can be used for my learning.	Positive
	5.6	I believe that I am aware of how Technology can be explored and integrated into my learning.	Positive
Evaluation Methods	6.1	I believe BYOD is a suitable tool for doing self-assessment for my Mathematics learning.	Positive
	6.2	I believe BYOD is a suitable tool for doing self-assessment for my Science learning.	Positive
	6.3	I believe using BYOD for the study is more convenient and time-saving in assessing my learning than the traditional methods.	Positive

	6.4	I believe that assessment through BYOD can be used more frequently than that of traditional methods.	Positive

Table 5-4: Questionnaire Items (Teachers)

Variable	Item No	Item Statement	Type of Item
Teaching Methods	4.3	I believe teaching methods by conventional chalk and talk is effective in teaching Science and Mathematics.	Negative
	4.4	I believe teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance teaching experience in Science and Mathematics.	Positive
	4.5	I believe teaching with the support of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance self-directed learning.	Positive
	4.6	I believe teaching with the support of technology device (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance innovative teaching practices.	Positive
Learning Methods	5.3	I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students' ability to think creatively in Science and Mathematics.	Positive

	5.4	I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students' ability to think critically in Science and Mathematics.	Positive
	5.5	I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students ability to collaborate effectively with other students in Science and Mathematics.	Positive
	5.6	I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students ability to communicate effectively with teachers and student groups in Science and Mathematics.	Positive
Technology Usage	6.5	I believe that I am aware of how technology can be used for my teaching.	Positive
	6.6	I believe that I am aware of how Technology can be explored and integrated into my teaching.	Positive
Evaluation Methods	7.1	I believe BYOD (Bring Your Own Device) is a suitable tool for self-assessment of student learning.	Positive
	7.2	I believe students using BYOD (Bring Your Own Device) for the study is more convenient and time-saving in assessing students learning than the traditional methods	Positive

7.3	I believe that assessment through BYOD (Bring Your Own Device) can be used more frequently than that of traditional methods	Positive

The respondents (teachers and students) were asked to indicate their opinions or perceptions on using BYOD. The items are measured on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The results of the respondents' ratings for each of the items are reported in the following section.

Interpretation of 5-point Likert scale data in the following ranking sections is based on table 5-5 below.

Table 5-5: Interpretation Table - 5-point Likert Scale Data

Mean Range	Interpretation
1.00 – 1.80	Strongly Disagree
1.81 – 2.60	Disagree
2.61 – 3.40	Neutral
3.41 – 4.20	Agree
4.21 – 5.00	Strongly Agree

5.2.1 Data Analysis – Students

5.2.1.1 Ranking Based on Internet Connection at Home

The results of the student respondents' ratings for Internet connections at home are shown in below Table 5-6. The mean score of BYOD school students was 4.59, and Non-BYOD schools' students were 4.57. The results reveal that students surveyed from both types of schools strongly agreed that they have a good internet connection at home.

Table 5-6: Descriptive Statistics- Students' Internet Connection at Home

1. Personal Information	School	N	Mean	S.D.	Interpretation
1.6 - I have a good internet connection at my house.	BYOD	900	4.59	.532	Strongly Agree
	Non-BYOD	900	4.57	.656	Strongly Agree

5.2.1.2 Ranking Based on School ICT Infrastructure

The results of the student respondents' ratings for School ICT Infrastructure factors are reported in Table 5-7. The mean score of BYOD school students was 4.18, and Non-BYOD schools' students were 3.76. The results reveal that students surveyed from BYOD type schools agreed that their school provides them with good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for student learning and the students surveyed from Non-BYOD type schools also agree on this characteristic.

Table 5-7: Descriptive Statistics- School ICT Infrastructure (student respondents)

2. School ICT Infrastructure	School	N	Mean	S.D.	Interpretation
2.1 - I believe that my school provides me good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for my learning.	BYOD	900	4.18	.676	Agree
	Non-BYOD	900	3.76	.900	Agree

5.2.1.3 Ranking Based on Teaching Methods by Teachers

The results of the student respondents' ratings for Teaching Methods by Teachers factors are reported below.

The results reveal that students surveyed from BYOD type schools and Non-BYOD Type schools reported that all their teachers use some kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching them Mathematics and Science.

The results revealed that 3 percent students surveyed from BYOD type schools reported that teachers using some kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching them Mathematics for Less than three months, 7.20 percent students reported Less than six months, 12.20 percent students reported Less than nine months and 77.60 percent students reported more than nine months.

Results also revealed that 25.60 percent students surveyed from Non-BYOD type schools reported that teachers using some kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching them Mathematics for Less than three months, 16.30 percent students reported Less than six months, 23.40 percent students reported less than nine months and 34.70 percent students reported more than nine months.

The results revealed that 2.90 percent students surveyed from BYOD type schools reported that teachers using some kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching them Science for less than three months, 5.40 percent students reported less than six months, 18.40 percent students reported less than nine months and 73.20 percent students reported more than nine months.

Results also revealed that 12.30 percent students surveyed from Non-BYOD type schools reported that teachers using some kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching them Science for Less than three months, 30.30 percent students reported Less than six months, 19.60 percent students reported Less than nine months and 34.80 percent students reported more than nine months.

The results of the student respondents' ratings for more Teaching Methods by Teachers factors are reported below in table 5-8.

As shown in table 5-8 below, the mean score of BYOD school students on their belief on Teaching Methods by conventional chalk and the talk was effective in learning Mathematics was 2.61 and Non-BYOD schools' students were 2.42. The results reveal that students surveyed from BYOD type schools are Neutral whereas the students surveyed from Non-BYOD type schools Disagree on this characteristic.

As shown table 5-8 below, the mean score of BYOD school students on their belief on Teaching Methods by conventional chalk and the talk was effective in learning Science 2.88, and Non-BYOD schools' students were 2.67. The results reveal that students surveyed from BYOD type schools are Neutral and the students surveyed from Non-BYOD type schools are also Neutral on this characteristic.

As shown in table 5-8 below, the mean score of BYOD school students on their belief on teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance their learning experience in Mathematics was 4.24 and Non-BYOD schools' students was 3.85.

The results reveal that students surveyed from BYOD type schools are Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools just Agree on this characteristic.

As shown table 5-8 below, the mean score of BYOD school students on their belief on teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance their learning experience in Science was 4.41 and Non-BYOD schools' students were 4.30. The results reveal that students surveyed from BYOD type schools and Non-BYOD type schools are Strongly Agree on this characteristic.

Table 5-8: Descriptive Statistics - Teaching Methods by Teachers (student respondents)

3. Teaching Methods by Teachers	**School**	**N**	**Mean**	**S.D.**	**Interpretation**
3.5 - I believe teaching methods by conventional chalk and talk is effective in learning Mathematics.	BYOD	900	2.61	1.130	Neutral
	Non-BYOD	900	2.42	1.065	Disagree
3.6 - I believe teaching methods by conventional chalk and talk is effective in learning Science.	BYOD	900	2.88	1.160	Neutral
	Non-BYOD	900	2.67	1.099	Neutral
3.7 - I believe teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance my learning experience in Mathematics.	BYOD	900	4.24	.828	Strongly Agree
	Non-BYOD	900	3.85	.947	Agree
3.8 - I believe teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance my learning experience in Science.	BYOD	900	4.41	.675	Strongly Agree
	Non-BYOD	900	4.30	.795	Strongly Agree

5.2.1.4 Ranking Based on Learning Methods by Student's Factors

The results of the student respondents' ratings for Learning Methods by Student factors are reported below.

The results reveal that students surveyed from BYOD type schools and Non-BYOD Type schools reported that they are all using their own technology device (Computer/Laptop/ Tablet) for learning Mathematics and Science.

Results revealed that 13.90 percent students surveyed from BYOD type schools reported that they have been using their own technology device (Computer/Laptop/ Tablet) for learning Mathematics for less than three months, 9.70 percent students reported less than six months, 9.00 percent students reported less than nine months and 67.40 percent students reported more than nine months.

The results also revealed that 33.30 percent students surveyed from Non-BYOD type schools reported that they have been using their own technology device (Computer/Laptop/ Tablet) for learning Mathematics for less than three months, 11.90 percent students reported less than six months, 22.80 percent students reported Less than nine months and 32.00 percent students reported more than nine months.

Results revealed that 18.20 percent students surveyed from BYOD type schools reported that they have been using their own technology device (Computer/Laptop/ Tablet) for learning Science for less than three months, 8.20 percent students reported less than six months, 19.90 percent students reported less than nine months and 53.70 percent students reported more than nine months.

The results also revealed that 29.20 percent students surveyed from Non-BYOD type schools reported that they have been using their own technology device (Computer/Laptop/ Tablet) for learning Science for less than three months, 20.80 percent students reported less than six months, 16.70 percent students reported less than nine months and 33.30 percent students reported more than nine months.

The results of the student respondents' ratings for more Learning Methods by Students factors focusing on Science are reported in below table 5-9.

As shown table 5-9 below, the mean score of BYOD school students on their belief on learning with the help of using student own technology device (Computer / Laptop / Tablet) during the school hours can enhance their ability to think creatively on Science was 4.29 and Non-BYOD schools' students were 4.13. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools are only Agree on this characteristic.

As shown table 5-9 below, the mean score of BYOD school students on their belief on learning with the help of using the student's own technology device (Computer / Laptop / Tablet) during the school hours can enhance their ability to think critically on Science was 4.30 and Non-BYOD schools' students were 4.05. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools only Agree on this characteristic.

As shown in table 5-9 below, the mean score of BYOD school students on their belief on learning with the help of using their own technology device (Computer / Laptop / Tablet) during the school hours can enhance their ability to collaborate effectively with other students on Science was 4.34 and Non-BYOD schools' students were 4.07. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools only Agree on this characteristic.

As shown in table 5-9 below, the mean score of BYOD school students on their belief on learning with the help of using their own technology device (Computer / Laptop / Tablet) during the school hours can enhance their ability to communicate effectively with teachers and student groups on Science was 4.28 and Non-BYOD schools' students was 4.04. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools only Agree on this characteristic.

Table 5-9: Descriptive Statistics - Learning Methods by Students in Science (student respondents)

4. Learning Methods by Students	**School**	**N**	**Mean**	**S.D.**	**Interpretation**
4.5 -I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to think creatively about Science.	BYOD	900	4.29	.741	Strongly Agree
	Non-BYOD	900	4.13	.780	Agree
4.6 - I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to think critically about Science.	BYOD	900	4.30	.669	Strongly Agree
	Non-BYOD	900	4.05	.798	Agree

4.7 - I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to collaborate effectively with other students in Science.	BYOD	900	4.34	.694	Strongly Agree
	Non-BYOD	900	4.07	.829	Agree
4.8 - I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to communicate effectively with teachers and student groups on Science.	BYOD	900	4.28	.706	Strongly Agree
	Non-BYOD	900	4.04	.795	Agree

The results of the student respondents' ratings for more Learning Methods by Students factors focusing on Mathematics are reported in Table 5-10.

As shown in table 5-10 below, the mean score of BYOD school students on their belief on learning with the help of using their own technology device (Computer / Laptop / Tablet) during the school hours can enhance their ability to think creatively on Mathematics was 4.07 and Non-BYOD schools' students were 3.66. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Agree on this characteristic.

As shown in table 5-10 below, the mean score of BYOD school students on their belief on learning with the help of using student own technology device (Computer / Laptop / Tablet) during the school hours can enhance their ability to think critically on Mathematics was 4.11 and Non-BYOD schools' students were 3.68. The results reveal that students surveyed from BYOD type schools Strongly

Agree on this characteristic and the students surveyed from Non-BYOD type schools also Agree on this characteristic.

As shown in table 5-10 below, the mean score of BYOD school students on their belief on learning with the help of their own technology device (Computer / Laptop / Tablet) during the school hours can enhance their ability to collaborate effectively with other students on Mathematics was 4.21 and Non-BYOD schools' students was 3.84. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools only Agree on this characteristic.

As shown in table 5-10 below, the mean score of BYOD school students on their belief on learning with help of using student own technology device (Computer / Laptop / Tablet) during the school hours can enhance their ability to communicate effectively with teachers and student groups on Mathematics was 4.19 and Non-BYOD schools' students was 3.90. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic and the students surveyed from Non-BYOD type schools also Agree on this characteristic.

Table 5-10: Descriptive Statistics - Learning Methods by Students in Mathematics (student respondents)

4. Learning Methods by Students	School	N	Mean	S.D.	Interpretation
4.9 -I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to think creatively about Mathematics.	BYOD	900	4.07	.892	Agree
	Non-BYOD	900	3.66	.952	Agree

4.10 - I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to think critically about Mathematics.	BYOD	900	4.11	.893	Agree
	Non-BYOD	900	3.68	.996	Agree
4.11 - I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to collaborate effectively with other students in Mathematics.	BYOD	900	4.21	.804	Strongly Agree
	Non-BYOD	900	3.84	.924	Agree
4.12 - I believe learning with the help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance my ability to communicate effectively with teachers and student groups on Mathematics.	BYOD	900	4.19	.817	Agree
	Non-BYOD	900	3.90	.922	Agree

5.2.1.5 Ranking Based on Technology Usage Factors

The results of the student respondents' ratings for Technology Usage factors are reported below.

The results revealed that 3.00 percent students surveyed from BYOD type schools reported that type of technology devices used to learn was Desktop Computer, 61.40 percent students reported Laptop and 37.10 percent students reported using Mobile devices (Tablet/Phone). The results also revealed that 4.60 percent students surveyed from Non-BYOD type schools reported that type of technology devices used to learn was Desktop Computer, 70.40 percent students

reported using Laptops and 38.60 percent students reported using Mobile devices (Tablet/Phone).

The results revealed that 4.10 percent students surveyed from BYOD type schools reported that their 1st choice of type of technology devices they believe could help with better learning in the classroom was Desktop Computer, 65.90 percent students reported Laptop and 30.80 percent students reported Mobile devices (Tablet/Phone). The results also revealed that 5.70 percent students surveyed from Non-BYOD type schools reported that type of technology devices they think could help with better learning in the classroom was Desktop Computer, 60.80 percent students reported Laptop and 33.60 percent students reported Mobile devices (Tablet/Phone).

Results revealed that 4.20 percent students surveyed from BYOD type schools reported that their 2nd choice of type of technology devices they think could help with better learning in the classroom was Desktop Computer, 31.90 percent students reported Laptop and 63.90 percent students reported Mobile devices (Tablet/Phone). The results also revealed that 6.00 percent students surveyed from Non-BYOD type schools reported that type of technology devices they think could help with better learning in the classroom was Desktop Computer, 35.20 percent students reported Laptop and 58.80 percent students reported Mobile devices (Tablet/Phone).

The results revealed that 91.70 percent students surveyed from BYOD type schools reported that their 3rd choice of type of technology devices they think could help with better learning in the classroom was the Desktop Computer, 2.20 percent

students reported Laptop and 6.10 percent students reported Mobile Devices (Tablet/Phone). The results also revealed that 88.30 percent students surveyed from Non-BYOD type schools reported that type of technology devices they think could help with better learning in the classroom was Desktop Computer, 4.00 percent students reported Laptop and 7.70 percent students reported Mobile device (Tablet/Phone).

The results revealed that 44.40 percent students surveyed from BYOD type schools reported that type of Operating System they are using to learn was iOS, 34.40 percent students reported Android and 64.10 percent students reported Windows. The results also revealed that 39.60 percent students surveyed from Non-BYOD type schools reported that type of Operating System they are using to learn was iOS, 36.90 percent students reported Android and 70.90 percent students reported Windows.

Results revealed that 21.00 percent students surveyed from BYOD type schools reported that their 1st choice of type of Operating System they think could help with better learning in the classroom was iOS, 16.80 percent students reported Android and 62.20 percent students reported Windows. The results also revealed that 19.80 percent students surveyed from Non-BYOD type schools reported that type of Operating System they think could help with better learning in the classroom was iOS, 18.40 percent students reported Android and 61.80 percent students reported Windows.

The results revealed that 52.60 percent students surveyed from BYOD type schools reported that their 2nd choice of type of Operating System they think could

help with better learning in the classroom was iOS, 13.80 percent students reported Android and 33.70 percent students reported Windows. The results also revealed that 54.10 percent students surveyed from Non-BYOD type schools reported that type of Operating System they think could help with better learning in the classroom was iOS, 11.90 percent students reported Android and 34.00 percent students reported Windows.

The results revealed that 26.40 percent students surveyed from BYOD type schools reported that their 3rd choice of type of Operating System they think could help with better learning in the classroom was iOS, 69.40 percent students reported Android and 4.10 percent students reported Windows. The results also revealed that 26.10 percent students surveyed from Non-BYOD type schools reported that type of Operating System they think could help with better learning in the classroom was iOS, 69.70 percent students reported Android and 4.20 percent students reported Windows.

The results of the student respondents' ratings for more Technology Usage by Students factors are reported in below table 5-11.

As shown table 5-11 below, the mean score of BYOD school students on their belief that they are aware of how technology can be used for student learning was 4.56, and Non-BYOD schools' students were 4.46. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

As shown table 5-11 below, the mean score of BYOD school students on their belief that they are aware of how Technology can be explored and integrated for

student learning was 4.54, and Non-BYOD schools' students were 4.43. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

Table 5-11: Descriptive Statistics - Technology Usage (student respondents)

5. Technology Usage	School	N	Mean	S.D.	Interpretation
5.5- I believe that I am aware of how technology can be used for my learning.	BYOD	900	4.56	.579	Strongly Agree
	Non-BYOD	900	4.46	.660	Strongly Agree
5.6 – I believe that I am aware of how Technology can be explored and integrated into my learning.	BYOD	900	4.54	.616	Strongly Agree
	Non-BYOD	900	4.43	.678	Strongly Agree

5.2.1.6 Ranking Based on Evaluation Methods Factors

The results of the student respondents' ratings for Evaluation Methods by Students factors are reported in Table 5-12.

The mean score of BYOD school students on their belief that BYOD (Bring Your Own Device) was a suitable tool for doing self-assessment for students' Mathematics learning was 4.28, and Non-BYOD schools' students were 3.94. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools Agree on this characteristic.

The mean score of BYOD school students on their belief that BYOD (Bring Your Own Device) was a suitable tool for doing self-assessment for students' Science learning was 4.38, and Non-BYOD schools' students were 4.29. The

results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools Strongly Agree on this characteristic.

The mean score of BYOD school students on their belief that BYOD (Bring Your Own Device) for the study was more convenient and time-saving in assessing students' learning than the traditional methods was 4.36, and Non-BYOD schools' students were 4.13. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools only Agree on this characteristic.

The mean score of BYOD school students on their belief that assessment through BYOD can be used more frequently than that of traditional methods was 4.39, and Non-BYOD schools' students were 4.15. The results reveal that students surveyed from BYOD type schools Strongly Agree on this characteristic whereas the students surveyed from Non-BYOD type schools only Agree on this characteristic.

Table 5-12: Descriptive Statistics - Evaluation Methods (student respondents)

6. Evaluation Methods	School	N	Mean	S.D.	Interpretation
6.1-I believe BYOD is a suitable tool for doing self-assessment for my Mathematics learning.	BYOD	900	4.28	.938	Strongly Agree
	Non-BYOD	900	3.94	1.012	Agree
6.2 - I believe BYOD is a suitable tool for doing self-assessment for my Science learning.	BYOD	900	4.38	.845	Strongly Agree
	Non-BYOD	900	4.29	.836	Strongly Agree

6.3-I believe using BYOD for the study is more convenient and time-saving in assessing my learning than the traditional methods.	BYOD	900	4.36	.915	Strongly Agree
	Non-BYOD	900	4.13	.990	Agree
6.4 - I believe that assessment through BYOD can be used more frequently than that of traditional methods.	BYOD	900	4.39	.937	Strongly Agree
	Non-BYOD	900	4.15	.982	Agree

5.2.2 Data Analysis – Teachers

5.2.2.1 Ranking Based on Internet Connection at Home

The results of the teacher respondents' ratings for Internet connections at home are reported in Table 5-13. The mean score of BYOD school teachers' was 4.78 and Non-BYOD school teachers' was 4.66. The results reveal that teachers surveyed from both types of schools strongly agreed that they have a good internet connection at home.

Table 5-13: Descriptive Statistics – Teachers Internet Connection at Home

1. Personal Information	**School**	**N**	**Mean**	**S.D.**	**Interpretation**
1.5 - I have a good internet connection at my house.	BYOD	46	4.78	.417	Strongly Agree
	Non-BYOD	74	4.66	.476	Strongly Agree

5.2.2.2 Ranking Based on School ICT Infrastructure Factors

The results of the teacher respondents' ratings for School ICT Infrastructure factors are reported in Table 5-14. The mean score of BYOD school teachers' was 4.83 and Non-BYOD school teachers' was 4.73. The results reveal that teachers surveyed from BYOD type schools strongly agreed that their school provides them good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for teaching and the teachers surveyed from Non-BYOD type schools also strongly agreed on this characteristic.

Table 5-14: Descriptive Statistics - School ICT Infrastructure (teacher respondents)

3. School ICT Infrastructure	**School**	**N**	**Mean**	**S.D.**	**Interpretation**
3.1 - I believe that my school provides me good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for teaching.	BYOD	46	4.83	.383	Strongly Agree
	Non-BYOD	74	4.73	.447	Strongly Agree

5.2.2.3 Ranking Based on Teaching Methods by Teacher's Factors

The results of the teacher respondents' ratings for Teaching Methods by Teachers factors are reported below.

The results reveal that teachers surveyed from BYOD type schools and Non-BYOD Type schools reported that all the teachers use some kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching Mathematics and Science.

The results revealed that 100.00 percent teachers surveyed from BYOD type schools reported that teachers are using some kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching Mathematics and Science for more than nine months.

The results revealed that 100.00 percent teachers surveyed from Non-BYOD type schools also reported that teachers are using some kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching Mathematics and Science for more than nine months.

The results of the Teacher respondents' ratings for more Teaching Methods by Teachers factors are reported in Table 5-15.

The mean score of BYOD school teachers on their belief on teaching methods by conventional chalk and the talk was effective in teaching Mathematics was 1.67, and Non-BYOD schools' was 1.57. The results reveal that teachers surveyed from BYOD type schools and Non-BYOD type schools Strongly Disagree on this characteristic.

The mean score of BYOD school teacher on their belief on teaching methods by conventional chalk and the talk was effective in teaching Science was 4.18, and Non-BYOD schools' students were 3.96. The results reveal that teachers surveyed from BYOD type schools and Non-BYOD type schools Agree on this characteristic.

The mean score of BYOD school teachers on their belief on teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance teaching experience in Mathematics was 4.72, and

Non-BYOD schools' students were 4.91. The results reveal that teachers surveyed from BYOD type schools and Non-BYOD type schools Strongly Agree on this characteristic.

The mean score of BYOD school teachers on their belief that teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance teaching experience in Science was 4.64, and Non-BYOD schools' students were 4.65. The results reveal that teachers surveyed from BYOD type schools and Non-BYOD type schools Strongly Agree on this characteristic.

The mean score of BYOD school teachers on their belief that teaching with the support of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance self-directed learning was 4.48, and Non-BYOD schools' students were 4.58. The results reveal that teachers surveyed from BYOD type schools and Non-BYOD type schools Strongly Agree on this characteristic.

The mean score of BYOD school teachers that their belief on teaching with the support of technology device (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance innovative teaching practices was 4.48, and Non-BYOD schools' students were 4.57. The results reveal that teachers surveyed from BYOD type schools and Non-BYOD type schools are Strongly Agree on this characteristic.

Table 5-15: Descriptive Statistics- Teaching Methods by Teachers (teacher respondents)

4. Teaching Methods by Teachers	School	N	Mean	S.D.	Interpretation

4.3 - I believe teaching methods by conventional chalk and talk is effective in teaching Mathematics.	BYOD	18	1.67	.485	Strongly Disagree
	Non-BYOD	23	1.57	.507	Strongly Disagree
4.3 - I believe teaching methods by conventional chalk and talk is effective in teaching Science.	BYOD	28	4.18	.548	Agree
	Non-BYOD	51	3.96	.564	Agree
4.4 - I believe teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance teaching experience in Mathematics.	BYOD	18	4.72	.461	Strongly Agree
	Non-BYOD	23	4.91	.288	Strongly Agree
4.4 - I believe teaching with the support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance teaching experience in Science.	BYOD	28	4.64	.488	Strongly Agree
	Non-BYOD	51	4.65	.483	Strongly Agree
4.5 - I believe teaching with the support of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance self-directed learning.	BYOD	46	4.48	.505	Strongly Agree
	Non-BYOD	74	4.58	.497	Strongly Agree
4.6 - I believe teaching with the support of technology device (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance innovative teaching practices.	BYOD	46	4.48	.505	Strongly Agree
	Non-BYOD	74	4.57	.499	Strongly Agree

5.2.2.4 Ranking Based on Learning Methods by Student's Factors

The results of the teacher respondents' ratings for Learning Methods by Student factors are reported below.

The results reveal that teachers surveyed from BYOD type schools reported that their students are using their own technology device (Computer/Laptop/ Tablet) for learning Mathematics and Science. Teachers surveyed from Non-BYOD Type schools reported that their students are not using own technology device (Computer/Laptop/ Tablet) for learning Mathematics and Science.

The results revealed that teachers surveyed from BYOD type schools reported that their 100.00 percent students have been using own technology device (Computer/Laptop/ Tablet) for learning Mathematics and Science for more than nine months.

The results revealed that teachers surveyed from Non-BYOD type schools reported that their 00.00 percent students have been using own technology device (Computer/Laptop/ Tablet) for learning Mathematics and Science.

The results of the teacher respondents' ratings for more Learning Methods by Students factors focusing on Science are reported in Table 5-16.

The mean score of BYOD school teachers on their belief on learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance Students' ability to think creatively in Science was 4.18 and Non-BYOD schools' students were 4.12. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Agree on this characteristic.

The mean score of BYOD school teachers on their belief on learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance Students' ability to think critically in Science was

4.18, and Non-BYOD schools' students were 4.12. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Agree on this characteristic.

The mean score of BYOD school teachers on their belief on learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance Students ability to collaborate effectively with other students in Science was 4.39, and Non-BYOD school students were 4.37. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Strongly agree on this characteristic.

The mean score of BYOD school teachers on their belief on learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance Students ability to communicate effectively with teachers and student groups in Science was 4.50, and Non-BYOD schools' students were 4.53. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

Table 5-16: Descriptive Statistics - Learning Methods by Students in Science (teacher respondents)

5. Learning Methods by Students	School	N	Mean	S.D.	Interpretation
5.3 - I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students' ability to think creatively about Science.	BYOD	28	4.18	.390	Agree
	Non-BYOD	51	4.12	.325	Agree

5.4 - I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students' ability to think critically about Science.	BYOD	28	4.18	.390	Agree
	Non-BYOD	51	4.12	.325	Agree
5.5 - I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students ability to collaborate effectively with other students in Science.	BYOD	28	4.39	.497	Strongly Agree
	Non-BYOD	51	4.37	.488	Strongly Agree
5.6 - I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students ability to communicate effectively with teachers and student groups in Science.	BYOD	28	4.50	.509	Strongly Agree
	Non-BYOD	51	4.53	.504	Strongly Agree

The results of the teacher respondents' ratings for more Learning Methods by Students factors focusing on Mathematics are reported in Table 5-17.

The mean score of BYOD school teachers on their belief on learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students' ability to think creatively in Mathematics was 4.11 and Non-BYOD school students were 4.09. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools are also Agree on this characteristic.

The mean score of BYOD school teachers on their belief on learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during

the school hours can enhance students' ability to think critically in Mathematics was 4.11 and Non-BYOD school students' was 4.09. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

The mean score of BYOD school teachers on their belief on learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance Students ability to collaborate effectively with other students in Mathematics was 4.67, and Non-BYOD schools' students were 4.61. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Strongly agree on this characteristic.

The mean score of BYOD school teachers on their belief on learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance Students ability to communicate effectively with teachers and student groups in Mathematics was 4.67 and Non-BYOD schools' students was 4.61. The results reveal that students surveyed from BYOD type schools and the students surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

Table 5-17: Descriptive Statistics - Learning Methods by Students in Mathematics (teacher respondents)

5. Learning Methods by Students	School	N	Mean	S.D.	Interpretation
5.3 - I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students' ability to think creatively about Mathematics.	BYOD	18	4.11	.323	Agree
	Non-BYOD	23	4.09	.288	Agree

5.4 - I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance students' ability to think critically in Mathematics.	BYOD	18	4.11	.323	Agree
	Non-BYOD	23	4.09	.288	Agree
5.5 - I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance student's ability to collaborate effectively with other students in Mathematics.	BYOD	18	4.67	.485	Strongly Agree
	Non-BYOD	23	4.61	.499	Strongly Agree
5.6 - I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance student's ability to communicate effectively with teachers and student groups in Mathematics.	BYOD	18	4.67	.485	Strongly Agree
	Non-BYOD	23	4.61	.491	Strongly Agree

5.2.2.5 Ranking Based on Technology Usage Factors

The results of the teacher respondents' ratings for Technology Usage factors are reported below.

The results revealed that 100.00 percent of the teachers surveyed from BYOD type schools and Non-BYOD schools reported that type of technology devices are using to teach was learn was Laptop.

The results revealed that 100.00 percent teachers surveyed from BYOD type schools and Non-BYOD type schools reported that their 1st choice of type of technology devices they think could help with better teaching in the classroom was Laptop.

The results revealed that 100.00 percent of the teachers surveyed from BYOD type schools and Non-BYOD type schools reported that their 2nd choice of type of technology devices they think could help with better teaching in the classroom was a Mobile device (Tablet/Phone).

The results revealed that 100.00 percent teachers surveyed from BYOD type schools and Non-BYOD type schools reported that their 3rd choice of type of technology devices they think could help with better teaching in the classroom was Desktop.

The results revealed that 100.00 percent teacher surveyed from BYOD type schools and Non-BYOD schools reported that type of Operating System used to teach and learn was Windows.

The results revealed that 100.00 percent teachers surveyed from BYOD type schools and Non-BYOD type schools reported that their 1st choice of type of Operating System they think could help with better teaching in the classroom was Windows.

The results revealed that 100.00 percent teachers surveyed from BYOD type schools and Non-BYOD type schools reported that their 2nd choice of type of Operating System they think could help with better teaching in the classroom was iOS.

The results revealed that 100.00 percent teachers surveyed from BYOD type schools and Non-BYOD type schools reported that their 3rd choice of type of Operating System they think could help with better teaching in the classroom was Android.

As shown table 5-18 below, the mean score of BYOD school teachers on their belief that they are aware of how technology can be used for their teaching was 4.48, and Non-BYOD schools' teachers were 4.31. The results reveal that teachers surveyed from BYOD type schools and the teachers surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

As shown in table 5-18 below, the mean score of BYOD school teachers on their belief that they are aware of how technology can be can be explored and integrated for teaching was 4.46 and Non-BYOD school teachers were 4.32. The results reveal that teachers surveyed from BYOD type schools and the teachers surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

Table 5-18: Descriptive Statistics - Technology Usage (teacher respondents)

6. Technology Usage	School	N	Mean	S.D.	Interpretation
6.5- I believe that I am aware of how technology can be used for my teaching.	BYOD	46	4.48	.505	Strongly Agree
	Non-BYOD	74	4.31	.466	Strongly Agree
6.6 - I believe that I am aware of how Technology can be explored and integrated into my teaching.	BYOD	46	4.46	.504	Strongly Agree
	Non-BYOD	74	4.32	.471	Strongly Agree

5.2.2.6 Ranking Based on Evaluation Methods Factors

The results of the teacher respondents' ratings for Evaluation Methods by Students factors are reported in Table 5-19.

The mean score of BYOD school teachers on their belief on BYOD (Bring Your Own Device) was a suitable tool for self-assessment of student learning was 4.57, and Non-BYOD schools teachers were 4.54. The results reveal that teachers

surveyed from BYOD type schools and the teachers surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

The mean score of BYOD school teachers on their belief on using BYOD (Bring Your Own Device) for the study was more convenient and time-saving in assessing students learning than the traditional methods were 4.26, and Non-BYOD schools' teachers were 4.16. The results reveal that teachers surveyed from BYOD type schools Strongly Agree on this characteristic whereas the teachers surveyed from Non-BYOD type schools only Agree on this characteristic.

The mean score of BYOD school teachers on their belief that assessment through BYOD (Bring Your Own Device) can be used more frequently than that of traditional methods was 4.33, and Non-BYOD schools' teachers were 4.35. The results reveal that teachers surveyed from BYOD type schools and the teachers surveyed from Non-BYOD type schools also Strongly Agree on this characteristic.

Table 5-19: Descriptive Statistics - Evaluation Methods (teacher respondents)

7. Evaluation Methods	School	N	Mean	S.D.	Interpretation
7.1 I believe BYOD (Bring Your Own Device) is a suitable tool for self-assessment of student learning.	BYOD	46	4.57	.501	Strongly Agree
	Non-BYOD	74	4.54	.502	Strongly Agree
7.2 I believe students using BYOD (Bring Your Own Device) for the study is more convenient and time-saving in assessing students learning than the traditional methods	BYOD	46	4.26	.444	Strongly Agree
	Non-BYOD	74	4.16	.371	Agree

7.3 I believe that assessment through BYOD (Bring Your Own Device) can be used more frequently than that of traditional methods	BYOD	46	4.33	.474	Strongly Agree
	Non-BYOD	74	4.35	.481	Strongly Agree

5.3 Data Analysis – Inferential Statistics: Students

5.3.1 Independent t-test on Students' Achievement

Table 5-20 shows the Independent Samples t-test results (research question 1) of the difference of grade 9 student's achievement in Mathematics and Science of the students studying in BYOD schools versus Non-BYOD schools.

Table 5-20: Results of Independent sample t-test: Student's Achievement in Science and Mathematics in BYOD Schools and Non-BYOD Schools

Subject	School	N	Mean	SD	T	Df	Sig.
Mathematics	BYOD	900	78.01	13.37	5.475	1796	.000*
	Non-BYOD	900	74.50	13.79			
Science	BYOD	900	77.84	12.34	6.348	1790	.000*
	Non-BYOD	900	74.01	13.20			

* The mean difference is significant at the 0.05 level.

Results of Independent Samples t-test of grade 9 students' achievement in Mathematics and Science in BYOD Schools and Non-BYOD shows the mean difference in achievement is statistically significant in both subjects at less than 1 percent level.

Table 5-21 and 5-22 show the Independent Samples t-test results (research question 2) of interaction between student's gender in BYOD Schools and Non-BYOD Schools, and its interaction with achievement in Mathematics and Science.

Table 5-21: Comparison of Grade 9 Student's Achievement in Science and Mathematics in BYOD Schools Based on Gender

Subject	Gender	N	Mean	SD	T	Df	Sig.
Mathematics	Female	408	79.03	13.62	2.097	898	.036*
	Male	492	77.16	13.11			
Science	Female	408	79.08	12.24	2.754	898	.006*
	Male	492	76.81	12.34			

* The mean difference is significant at the 0.05 level.

Results of Independent Samples t-test of grade 9 students' achievement in Mathematics and Science with their gender in BYOD Schools shows the mean difference in achievement is statistically significant in both subjects at less than 1 percent level.

Table 5-22: Comparison of Grade 9 Student's Achievement in Science and Mathematics in Non- BYOD Schools Based on Gender

Subject	Gender	N	Mean	SD	t	Df	Sig.
Mathematics	Female	438	74.00	13.74	-1.068	898	.286*
	Male	462	74.98	13.84			
Science	Female	438	74.31	13.00	.652	898	.514*
	Male	462	73.74	12.39			

* The mean difference is not significant at the 0.05 level.

Results of Independent Samples t-test of grade 9 students' achievement in Mathematics and Science with their gender in Non-BYOD Schools shows the mean difference in achievement is statistically not significant in both subjects at less than 1 percent level.

5.3.2 Discriminant Analysis

This study utilized Discriminant Analysis to answer the research question 3. Discriminant Analysis is appropriate to compare the two studied groups: BYOD Schools and Non-BYOD Schools. Discriminant analysis is a statistical technique that allows the researcher to study the differences between two or more groups of objects with respect to several variables simultaneously.

Discriminant Analysis technique was used to analyse the student data with respect to critical BYOD eLearning factors such as Teaching Methods (TM), Learning Methods (LM), Technology Usage (TU) and Evaluation Methods (EM) of two studied groups: BYOD Schools and Non-BYOD Schools, to examine effectiveness of it in BYOD eLearning conceptual framework that was developed and explained in chapter 4 for the practice of private secondary schools in Dubai (question 3).

The number of total cases for analysis is 1,800, and there are no missing values, and the data are perfectly suitable for analysis. Hence it has satisfied all the assumptions of discriminant analysis, such as no outliers, normality assumption, mutually exclusive groups, independence of the predictive variables, and no multicollinearity.

Table 5-23: Group Statistics

School Type		Mean	Std. Deviation	N
BYOD School	average TM	3.53	.634	900
	average LM	4.22	.503	900
	average TU	4.55	.532	900
	average EM	4.35	.692	900
Non-BYOD School	average TM	3.31	.631	900
	average LM	3.92	.656	900
	average TU	4.45	.626	900
	average EM	4.13	.795	900
Total	average TM	3.42	.642	1,800
	average LM	4.07	.604	1,800
	average TU	4.50	.583	1,800
	average EM	4.24	.753	1,800

As shown in Table 5-23, there are two equal groups; that is, with BYOD (1) 900 cases, and non-BYOD (2) 900 cases. The Mean value of TM, LM, TU and EM are higher for Group 1 (BYOD Schools) when compared with group 2 (non-BYOD Schools), and the standard deviation is almost same for the variables on one to one comparison of the groups.

Table 5-24: Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
Average TM	.970	54.989	1	1798	.000
Average LM	.937	120.201	1	1798	.000
Average TU	.992	14.689	1	1798	.000
Average EM	.978	40.206	1	1798	.000

In the above Table 5-24, the Wilks' Lambda is statistically significant at less than 1 percent level for each of the variables. It means that the groups are not equal in TM, LM, TU, and EM and therefore the null Hypothesis was rejected. Or in

other words, accept the alternative hypothesis that the 2 groups are different in these respects.

Table 5-25: Pooled Within-Groups Matrices

		average TM	average LM	average TU	average EM
Correlation	average TM	1.000	.303	.127	.297
	average LM	.303	1.000	.352	.497
	average TU	.127	.352	1.000	.360
	average EM	.297	.497	.360	1.000

The above Table 5-25 shows the degree of correlation between the variables. It is evident that highest correlation is between LM and EM (0.497) and the weakest is between TM and TU (0.127). All the others fall in between. It shows that the variables are independent and not highly correlated with each other which again supports the suitability of the test for the data.

Box's Test of Equality of Covariance Matrices

Table 5-26: Log Determinants

School Type	Rank	Log Determinant
BYOD School	4	-4.720
Non-BYOD School	4	-3.902
Pooled within-groups	4	-4.260

The ranks and natural logarithms of determinants printed are those of the group covariance matrices. Table 5-26 shows the log-determinants are almost equal and so there is not much problem on this part to proceed further with Discriminant Analysis.

Table 5-27: Test Results

Box's M		91.415
F	**Approx.**	9.120
	df1	10
	df2	15455636.653
	Sig.	.000

Tests null hypothesis of equal population covariance matrices. As shown in the Table 5-27, the Box's M results are significant and therefore reject the Null Hypothesis that the 2 groups are equal. Or in other words, the 2 groups are not equal, and they are not similar with respect to the 4 predictor variables under the study.

Summary of Canonical Discriminant Functions

Table 5-28: Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.077[a]	100.0	100.0	.268

[a]First 1 canonical discriminant functions were used in the analysis. The eigenvalue is not high, and therefore the predictive power of the model is not so high. The canonical correlation is 0.268, and therefore the explanatory power of the model is 7.1 percent.

Table 5-29: Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
1	.928	133.489	4	.000

As shown in Table 5-29 the Chi-square is significant.

Table 5-30: Standardized Canonical Discriminant Function Coefficients

	Function
	1
average TM	.378
average LM	.807
average TU	-.018
average EM	.032

The above Table 5-30 shows the importance of each variable in prediction. LM has got the maximum value, so it is the most important, and TU is the least important.

Table 5-31: Structure Matrix

	Function
	1
average LM	.931
average TM	.630
average EM	.538
average TU	.325

As shown in Table 5-31, pooled within-groups are correlations between discriminating variables and standardized canonical discriminant functions. Variables are ordered by absolute size of correlation within the function.

The structure matrix should follow the same order of the discriminant function coefficient, and the values must be greater than 0.3.

Table 5-32: Canonical Discriminant Function Coefficients

	Function
	1
average TM	.597
average LM	1.380
average TU	-.032
average EM	.043
(Constant)	-7.703
Unstandardized coefficients	

As shown in Table 5-32, these are the unstandardized coefficients used in the regression equation.

Table 5-33: Functions at Group Centroids

	Function
School Type	1
BYOD School	.278
Non-BYOD School	-.278
Unstandardized canonical discriminant functions evaluated at group means	

These are group values as shown in Table 5-33 which distinguishes between the 2 groups

Classification Statistics

Table 5-34: Classification Processing Summary

Processed		1,800
Excluded	Missing or out-of-range group codes	0
	At least one missing discriminating variable	0
Used in Output		1,800

Table 5-35: Prior Probabilities for Groups

		Cases Used in Analysis	
School Type	**Prior**	**Unweighted**	**Weighted**
BYOD School	.500	900	900.000
Non-BYOD School	.500	900	900.000
Total	1.000	1,800	1,800.000

Table 5-36: Classification Function Coefficients

	School Type	
	BYOD School	**Non-BYOD School**
average TM	5.472	5.141
average LM	6.319	5.553
average TU	9.917	9.935
average EM	1.212	1.188
(Constant)	-48.910	-44.633
Fisher's linear discriminant functions		

Table 5-37: Classification Results[b,c]

			Predicted Group Membership		
		School Type	1	2	Total
Original	Count	BYOD School	610	290	900
		Non-BYOD School	349	551	900
	%	BYOD School	67.8	32.2	100.0
		Non-BYOD School	38.8	61.2	100.0
Cross-validated[a]	Count	BYOD School	609	291	900
		Non-BYOD School	351	549	900
	%	BYOD School	67.7	32.3	100.0
		Non-BYOD School	39.0	61.0	100.0

a. Cross-validation is done only for those cases in the analysis. In cross-validation, each case is classified by the functions derived from all cases other than that case.
b. 64.5% of original grouped cases correctly classified.
c. 64.3% of cross-validated grouped cases correctly classified.

The above tables, Table 5-34, Table 5-35, Table 5-36 and Table 5-37, shows the sensitivity and specificity of the model. In the original data, 67.8 % are correctly classified in group 1, and 61.2% are specific to group 2. Therefore, the model has pretty good sensitivity and specificity, and which is further validated in the cross-validation.

The above Discriminant Analysis results of the student data with respect to critical BYOD eLearning factors such as Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods confirm that the assumptions for

developing BYOD conceptual framework were valid with respect students' characteristics.

5.4 Chi-Square Analysis – Teachers Data

The Chi-Square statistic is commonly used for testing relationships between categorical variables. The null hypothesis of the Chi-Square test is that no relationship exists between the categorical variables in the population; they are independent.

Chi-Square Analysis technique is used here to analyse the teacher data with respect to critical BYOD eLearning factors such as Teaching Methods (TM), Learning Methods (LM), Technology Usage (TU) and Evaluation Methods (EM) to examine effectiveness of it in BYOD conceptual framework developed and explained in chapter 4 for the practice of private secondary schools in Dubai (question 3)

Table 5-38: TM class range * School Type - BYOD / Without BYOD Crosstabulation

Attitude towards using BYOD in Teaching Methods	BYOD School	Non-BYOD School	Total
Agree	24	33	57
Strongly Agree	22	41	63
Total	46	74	120

Table 5-39: LM class range * School Type - BYOD / Without BYOD Crosstabulation

Attitude towards using BYOD in Learning Methods	BYOD School	Non-BYOD School	Total
Agree	20	33	57
Strongly Agree	26	41	63
Total	46	74	120

Table 5-40: TU class range * School Type - BYOD / Without BYOD Crosstabulation

Attitude towards using BYOD in Technology Usage	BYOD School	Non-BYOD School	Total
Agree	22	47	69
Strongly Agree	24	27	51
Total	46	74	120

Table 5-41: EM class range * School Type - BYOD / Without BYOD Crosstabulation

Attitude towards using BYOD in Evaluation Methods	BYOD School	Non-BYOD School	Total
Agree	19	31	50
Strongly Agree	27	43	70
Total	46	74	120

Table 5-42: Chi-Square Test Results: Teachers' Data

Variables	Hypotheses	Chi-Square Value	df	Asymp. Sig. (2-sided)	Interpretation
Teaching Methods	H0: The agreement level of BYOD schools and Non-BYOD schools are the same towards the attitude of using BYOD in teaching methods	.653	1	0.419*	Accepted
Learning Methods	H0: The agreement level of BYOD schools and Non-BYOD schools are the same towards the attitude of using BYOD in learning methods	.014	1	0.905*	Accepted
Technology Usage	H0: The agreement level of BYOD schools and Non-BYOD schools are the same towards the attitude of using technology usage	2.857	1	0.091*	Accepted

Evaluation Methods	H0: The agreement level of BYOD schools and Non-BYOD schools are the same towards the attitude of using BYOD in evaluation methods	.004	1	0.949*	Accepted

* 0.05 level of sig.

Ho = The agreement level of BYOD schools and non-BYOD schools are the same towards the attitude of using BYOD in teaching methods. As shown in Table 5-42, based on the Chi-Square analysis, the significance value is greater than 0.05 level, and hence the null hypothesis for Teaching Methods class was accepted. The null hypothesis is that there is no difference between BYOD schools and Non-BYOD schools with respect to Teaching Methods.

Ho = The agreement level of BYOD schools and non-BYOD schools are the same towards the attitude of using BYOD in teaching methods. As shown in Table 5-42, based on the Chi-Square analysis, the significance value is greater than 0.05 level, and hence the null hypothesis for Learning Methods class was accepted. The null hypothesis is that there is no difference between BYOD schools and Non-BYOD schools with respect to Learning Methods.

Ho = The agreement level of BYOD schools and non-BYOD schools are the same towards the attitude of using BYOD in Technology Usage. As shown in Table 5-42, based on the Chi-Square analysis, the significance value is greater than 0.05 level, and hence the null hypothesis for Technology Usage class was accepted. The null hypothesis is that there is no difference between BYOD schools and Non-BYOD schools with respect to Technology Usage.

Ho = The agreement level of BYOD schools and non-BYOD schools are the same towards the attitude of using BYOD in Evaluation Methods. As shown in Table 5-42, based on the Chi-Square analysis, the significance value is greater than 0.05 level, and hence the null hypothesis for Evaluation Methods class was accepted. The null hypothesis is that there is no difference between BYOD schools and Non- BYOD schools with respect to Evaluation Methods.

The above Chi-Square Analysis results of the teacher data with respect to critical BYOD eLearning factors such as Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods confirm that the assumptions for developing BYOD conceptual framework were valid with respect teachers' characteristics. However, the above findings show that there is no difference between BYOD schools and Non- BYOD schools with respect to critical BYOD eLearning factors.

5.5 Summary

In this chapter, the results of the study were described. First, the research sample was explained. Second, the chapter provided the ranking of respondents data (students and teachers) grouped based on factors as per the survey questionnaire. Later the data analysis is shown to answers to the three research questions. The next chapter will discuss the research results in light of the existing research.

CHAPTER VI
RESULT: A BYOD ELEARNING CONCEPTUAL FRAMEWORK

This research developed a new BYOD eLearning Conceptual Framework with the support of the empirical research findings. This conceptual framework can help to create an effective and efficient BYOD learning environment for private secondary schools.

This research investigated the development of a BYOD eLearning Conceptual Framework that integrates critical BYOD factors which impact students' achievements and demographical variables by testing its validity.

This conceptual framework focused on exploring the attributes that have an influence towards student's achievements related to BYOD based learning. The framework emphases on the connection between the student and teacher attributes of BYOD which could improve the students' accomplishments.

6.1 New BYOD eLearning Conceptual Framework

Student Achievement are impacted by BYOD at School level, Curriculum and every component of this framework.

The identified students and teachers' factors of BYOD eLearning Conceptual Frameworks that had a significant impact on student achievement were Teaching Methods, Learning Methods and Evaluation Methods. The researcher tested and confirmed that these student and teacher factors had an impact on students'

achievements scores of science and mathematics and it became part of the BYOD eLearning Conceptual Framework.

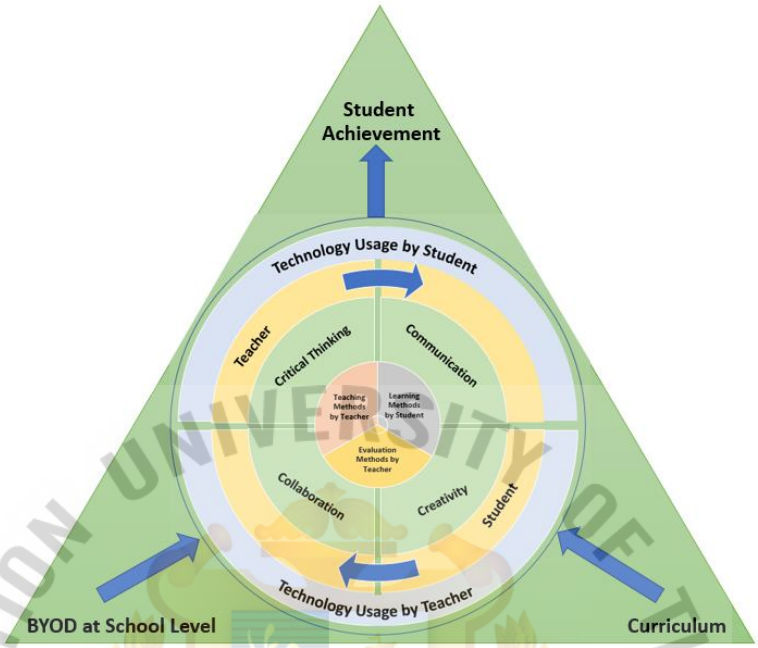

Figure 6-1: New BYOD eLearning Conceptual Framework

The 4Cs components of this framework consisted of students' creativity, critical thinking, collaboration and communication on Science and Mathematics subjects was found to have a positive influence on student achievements and BYOD based eLearning. This was recorded by students and teachers in their responses to this research, and it became part of the BYOD eLearning Conceptual Framework.

The key stakeholders of BYOD eLearning identified were the teachers and students and became part of the framework; their characteristics such as gender, qualification (teacher) and experience (teacher) are key points of the success of this framework. The researcher tested and confirmed this during this study.

Technology Usage by the key stakeholders, student and teachers are another key factors in this framework. It was measured by the following; type of technology devices used to learn by student and teach by teacher; type of Operating System used to learn by student and teach by teacher, students' and teachers' perception of the type of technology devices can help with better learning by student and better teaching by teacher in the classroom, type of Operating System can help with better learning by student and better teaching by teacher in the classroom, student's awareness of how technology can be used for their learning and their awareness of how Technology can be explored and integrated into their learning, teacher's awareness of how technology can be used for their teaching and their awareness of how Technology can be explored and integrated into their teaching practice. These factors become part of this framework based on the findings of this empirical study.

6.2 Implementation of New BYOD eLearning Conceptual Framework

Factors impacting effective implementation of the new BYOD eLearning Conceptual Frameworks is described below

6.2.1 Student's Characteristics

The identified student factors of BYOD eLearning Conceptual Frameworks that had a significant impact on the student achievements were Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods related to students. These factors confirmed with the findings of this empirical research. The successful implementation of BYOD was heavily depended on the student's characteristics.

Teaching Methods factor of student characteristics measured by the following; type of technology devices used by teachers for teaching Mathematics and Science, its duration, student perception on the effectiveness of Teaching Methods such as conventional chalk and talk, perception on enhancing the learning experience with the support of Technology.

Learning Methods factor of student characteristics measured by the following; students' using their own technology device for learning Science and Mathematics duration of student use, students' perception of learning with the help of using own technology device during the school hours can enhance their 4Cs components; ability to think creatively, ability to think critically, ability to collaborate effectively with other students and ability to communicate effectively with teachers and student groups on Science and Mathematics subjects.

Technology Usage factor of student characteristics measured by the following; type of technology devices used to learn; type of Operating System used to learn, students' perception of the type of technology devices can help with better learning in the classroom, type of Operating System can help with better learning in the classroom, student's awareness of how technology can be used for their learning and their awareness of how Technology can be explored and integrated into their learning.

Evaluation Methods factor of student characteristics measured by the following; student perception of BYOD as a suitable tool for doing self-assessment for their Science and Mathematics learning, use BYOD for study was more convenient and time-saving in assessing their learning than the traditional method

and assessment through BYOD can be used more frequently than that of traditional methods.

6.2.2 Teacher's Characteristics

The teacher factors of BYOD eLearning Conceptual Frameworks that impacted the student achievements were Teaching Methods, Learning Methods, Technology Usage and Evaluation Methods related to teachers. These factors confirmed with the findings of this empirical research. The successful implementation of BYOD was heavily depended on the teacher's characteristics.

Teaching Methods factor of Teacher characteristics measured by the following; type of technology devices used for teaching Mathematics and Science, its duration, teacher perception on effectiveness of Teaching Methods such as conventional chalk and talk, perception on enhancing learning experience by teaching with support of Technology, teaching with support of technology devices can enhance self-directed learning and teaching with support of technology device can enhance innovative teaching practices.

Learning Methods factor of teacher characteristics measured by the following; students using their own technology device for learning Science and Mathematics and its duration, teacher perception on student learning with the help of using their technology device during the school hours can enhance their 4Cs components; ability to think creatively, ability to think critically, ability to collaborate effectively with other students and ability to communicate effectively with teachers and student groups on Science and Mathematics subjects.

Technology Usage factor of teacher characteristics measured by the following; type of technology devices used to teach , type of Operating System used to teach, teacher perception of the type of technology devices can help with better teaching in the classroom, type of Operating System can help with better teach in the classroom, teacher's awareness of how technology can be used for their teaching and their awareness of how technology can be explored and integrated into their teaching.

Evaluation Methods factor of teacher characteristics measured by the following; teacher perception of BYOD as a suitable tool for doing self-assessment for student Science and Mathematics learning, use BYOD for study was more convenient and time-saving in assessing student learning than the traditional method and assessment through BYOD can be used more frequently than that of traditional methods.

6.2.3 Demographic Characteristics

Student demographic characteristics such as gender and teacher demographic characteristics such as gender, years of experience and qualifications have been included in this empirical research to understand its impact on student achievements, and therefore it forms part of the new BYOD eLearning Conceptual Framework.

CHAPTER VII
CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

The body of literature presented in Chapters II demonstrates various studies related BYOD factors and absence of studies of Conceptual Frameworks concerning BYOD eLearning with the in-depth understanding of students' characteristics, and teachers' characteristics. This empirical study has examined various attributes for better realisation of BYOD eLearning considering critical BYOD factors such as TM, LM, TU and EM.

The data required to assess the BYOD eLearning Conceptual Framework was presented in Chapter 5, and the framework was presented in Chapter 4 in order to accomplish the objective of this research study.

This chapter sought out to synthesise the initial findings with the help of a literature review and revised BYOD eLearning Conceptual Framework proposed in Chapter 4, based on the factors found to be most influence BYOD eLearning factors. A revised BYOD eLearning Conceptual Framework was proposed and which can further be used as a tool for reference for the implementation and development of future BYOD projects.

7.1 Conclusions

7.1.1 Summary of the Study

This quantitative research aimed to (1) to study the impact of grade 9 student's achievement in Science and Mathematics in BYOD schools and Non-BYOD

schools, (2) to examine the variation in grade 9 students' achievement in Science and Mathematics based on gender in BYOD schools and Non-BYOD schools, and (3) to develop a BYOD eLearning Conceptual Framework for private secondary schools in Dubai, UAE based on documentary research and confirm it with an empirical research.

This study was conducted using seven steps model research methodology (Brahmawong & Vate-U-Lan, 2009) based on the principles of quantitative nonexperimental design. The population was 20,000 students and 1,200 teachers. The samples were 1,800 students and 120 teachers. Probability sampling method was used in this research. The data collecting instruments were questionnaires designed based on LoTi Framework and 4Cs. The data were analyzed using descriptive statistical methods such as mean, standard deviation, independent t-test, discriminant analysis, and Chi-square test. Reliability and Validity tests were conducted on the research instrument, survey questionnaire using Cronbach's Alpha.

The findings were as follows: 1) student's achievement in Mathematics and Science in BYOD Schools vs Non-BYOD shows there was a significant difference in both subjects score with BYOD schools students score are higher (Mean score, Mathematics – BYOD School – 78.01, Non-BYOD School – 74.50, Science – BYOD School – 77.84, Non-BYOD School – 74.01) ; 2) comparison of student's achievement in Mathematics and Science with their gender in BYOD Schools shows there were significant difference whereas the Non-BYOD Schools shows the difference was not significant ; 3) the BYOD critical factors such as TM

(Teaching Method), LM (Learning Method), TU (Technology Usage) and EM (Evaluation Method) of BYOD Schools has a positive impact on student achievement in BYOD schools and hence in the BYOD eLearning Conceptual Framework has been proved valid.

7.1.2 Major Findings of Study

The major finding of this empirical study related student and teacher characteristics and critical BYOD eLearning factors which impacted the student achievements and the BYOD eLearning Conceptual Framework were summarised in the following section. Major finding related to research questions also summarised thereafter.

Student achievements in Mathematics and Science - The research findings show that the grade 9 students achievement in Mathematics and Science in BYOD Schools were better than Non-BYOD schools in both subjects.

Internet connection at home - The research findings indicated that students from BYOD schools and Non-BYOD Schools have very good internet connections at their home. This was a very positive trend for BYOD implementation since the student will be able to utilise the internet for home-based learning using their own device. The research findings also indicated that teachers from BYOD schools and Non-BYOD Schools have very good internet connections at their home.

School ICT Infrastructure factors - The research results show that students from BYOD schools reported their school have very good ICT Infrastructure and the school provides them with the very good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for their learning. Students from Non-

BYOD schools also reported their school have good ICT Infrastructure and the school provides them very good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for their learning. This was a very good trend for BYOD implementation since the student will get ICT Infrastructure support from schools. Teachers from both category of schools also reported similarly, and this confirms students feedback.

Teaching methods factors - The research findings indicated that students from BYOD schools and Non-BYOD Schools reported that their teachers used technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching them Mathematics and Science. This was another good news for BYOD success. Teachers findings both the schools also concur students feedback. Students' and teachers' perception of the effectiveness of teaching method such as conventional chalk and talk for Mathematics subject was positive but both groups not in favour of the same for Science. Both groups perception on enhancing the learning experience with the support of Technology find as positive.

Learning method factor - The research findings indicated that students from BYOD schools using their own technology device for learning Science and Mathematics whereas students from Non-BYOD Schools reported that they don't use it. The same feedback found from teachers about this matter. Students' and teachers' perception on learning with the help of using students' technology device during the school hours can enhance their ability to think creatively, ability to think critically, ability to collaborate effectively with other students and ability to

communicate effectively with teachers and student groups on Science and Mathematics subjects were reported as positive.

Technology usage factor - The research findings indicated that students and teachers perception on awareness of how technology can be used for their learning and teaching and their awareness of how Technology can be explored and integrated for their learning and teaching was very positive.

Evaluation method factor - The research findings showed that students' and teachers' perception of BYOD as a suitable tool for doing self-assessment for students' Science and Mathematics learning, use BYOD for study more convenient and time-saving in assessing student learning than the traditional method and assessment through BYOD can be used more frequently than that of traditional methods were reported similar feedback and very positive.

The above findings could help to answer research questions of this study. The first research question was about student's achievement in Mathematics and Science within BYOD Schools vs Non-BYOD. The research finding based the Mathematics and Science score of this two groups of schools show that there was a significant difference in both subjects and BYOD Schools had a higher percentage of marks for both subjects compare to Non-BYOD schools.

The second research question was about the comparison of student's achievement in Mathematics and Science with their gender in BYOD Schools and Non- BYOD schools. The research findings show that there was a significant difference in BYOD Schools for both subjects whereas no significant differences found in Non-BYOD Schools.

The third research question was on how an effective BYOD eLearning Conceptual Framework can be developed for the practice of schools in UAE. The research findings show that there were critical factors such as TM (Teaching Method), LM (Learning Method), TU (Technology Usage) and EM (Evaluation Method) that impacted student achievements positively and could be part of the BYOD eLearning Conceptual Framework as critical factors of the framework.

7.2 Discussion

This section offers a discussion of finding under the same broad factors of research questions and literature. The study's results were supported by the literature per se.

The first research question was investigating the difference of grade 9 student's achievement in Science and Mathematics in BYOD schools and Non-BYOD schools. Many researchers reported technology could help as a catalyst to improve student achievements in Science and Mathematics. Earlier studies reported the implementation of technologies increased student achievement (Disney et al., 2013). Another research study by Li's (2008) found that students gained new perspectives on the application of personal interest and career options connected to the math and science fields when technology was integrated into a classroom in a dynamic way, as opposed to just drill. Song (2014) found BYOD was not only a feasible instructional practice for elementary science students it leads to increased levels of understanding and positive attitudes. Research by Patricia (2017) on BYOD impact study in two middle schools in South Texas also found score higher on standardized mathematics achievement in BYOD schools.

Results of this study were supported by literature cited in chapter 2. This research finding showed that Mathematics and Science score of BYOD Schools were higher than the Non-BYOD schools.

The second research question was investigating the gender difference cause any variation in student achievement in Science and Mathematics in BYOD schools and Non-BYOD schools. As given in literature review, many researchers have reported mixed and neutral findings of student's achievement with regarding gender. However, most of the findings that support female students' achievement score were significantly higher than male students. Technology usage and its connection between gender variances were reported in an earlier study by Jung (2012). The study reported female students performed better in technology-based learning than male students. A different study by Keller et al. (2007) confirmed Jung's study (2012), females have more performance expectancy than males did. In a study conducted by Pascual (2016) and his colleagues found that female students tend to have better grades in core classes such as mathematics, science, history, and reading than do males. Results of this study were supported by literature cited in chapter 2. This research study also found that there was a significant difference in BYOD Schools for both subjects in terms of gender and technology usage whereas no significant differences found in Non-BYOD Schools. Achievement score of female students in BYOD schools was found higher than that of male students.

The third research question was how an effective BYOD Conceptual Framework could be developed for the practice of schools in UAE. Earlier studies

show that Teaching Method using technology have a positive impact on student learning and student achievements. A study by Neubert (2010) reported that the teachers get engaged and lead various types of teaching and learning activities. This help student's practise new learning based on same methodologies and theoretical practices.

Earlier studies show that Learning Method that used technology have a positive impact on student learning and student achievements. In a previous study of mobile device use in Malaysia, the researchers Mahamad, Ibrahim, Foad, and Taib (2008) demonstrated that an m-learning environment allowed for the improvement of tracking and monitoring of student performance. Other scholars also provided further evidence of mobile device classroom use facilitating a building of mathematical knowledge across European borders (Granic, Cukusic, & Walker, 2009). Hwang and Chang (2011) conducted a study on formative assessment-based approach to mobile learning in elementary school in Taiwan and found that technologies have the potential for enhancing the learning achievements of students. Earlier studies reported four Cs (Collaboration, Creativity, Critical Thinking and Communication) (nea.org, 2017) were developed and supported by BYOD. Researchers also report that laptops have facilitated the development of 21st-century skills, digital literacy, creativity and innovation skills, critical thinking and problem-solving skills, communication and collaboration, and self- directed learning) among students (Argueta et al., 2011). Another study says, technology-enhanced learning for educational purposes combined with social media will be an important factor for today's students to enhance creativity, knowledge, innovation

and collaboration in the classroom and outside the classroom (Friesen & Lowe, 2011).

Studies show that technology usage has a positive impact on student learning and student achievement. A study on “Mobile Math: Math Educators and Students Engage in Mobile Learning” by Franklin and Peng had reported how technology helped to improve the teaching and learning experiences (Franklin & Peng, 2008). Another study reported digital culture had influenced students learning skills (Oblinger, 2003). Another study found technology-based education as an important factor for today’s students to enhance creativity, knowledge, innovation and collaboration in the classroom and outside the classroom (Friesen & Lowe, 2011).

Earlier studies show that Evaluation Method using technology has a positive impact on student learning and student achievements. A study conducted in Irish primary and post-primary schools in the period 2015-2020, by the Department of Education and Skills to embed Information and Communications Technologies (ICT) in teaching, learning and assessment shows there were rising signs that digital technologies make changes to way school students learn, the way school teachers teach and the location where learning takes place and its time (Amos, Copeland, Fidow, & Langford, 2014). Other researcher found ICT can connect educational policy with economic and social development and ICT has the potential to support transformation in learning, assessment practices and teaching in schools (Butler, Leahy, Shiel, & Cosgrove, 2013).

This study and its results were also supported by the literature as discussed above regarding TM (Teaching Method), LM (Learning Method), TU (Technology Usage) and EM (Evaluation Method) critical BYOD factors. These research findings also show that these factors impacted student achievements positively and hence part of the BYOD eLearning Conceptual Framework as critical factors of the framework.

7.3 Recommendations

This research was conducted on a sample set of students & teachers representing private secondary schools in Dubai following Indian curriculum. It is recommended to future researchers in other curricula schools or a mixed mode to understand the wider implication of critical factors and its influence on student achievements and hence on the framework.

This study was focused on Science and Mathematics subject of grade 9 students, and a future study with wider subject sample and grades also recommended to see the similar or related influence. This study was conducted in Dubai, UAE and future studies may include other cities or countries since there may be cultural and geographical related influences on the critical factors.

New questions which require new research may result from this study and future researchers focussing on BYOD can explore result for those new questions. Further research around pedagogy and instructional design specific to the BYOD would be useful. Key attributes that that may help successful implementation of BYOD in individual school can be obtained from this empirical study finding and BYOD eLearning Conceptual Framework. Focus on providing training for teachers

on BYOD based teaching and student learning process is an important factor for schools to focus.

The educators should give importance to the development and design of the curriculum that supports BYOD by using DCC and VLE. It will help utilization of BYOD bases teaching and learning effectively. Schools authorities should make sure that they have good Technical Infrastructure, Administrative Process and Policies and availability of learning and teaching materials & tools to support BYOD programme of their school. A separate study of each one these factors is also recommended. Finally, successful implementation of any framework is a team effort of all stakeholders, and it requires commitment and willingness along with continuous evaluation and improvement.

The future study should consider a new role of BYOD in eLearning which might be influenced by the Internet of things, disruptive technology, big data and blockchain for example.

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APPENDICES

APPENDIX 1:

Operational definition and questionnaire items analysis

Operational definition and questionnaire items analysis

Student Questionnaire (SQ)

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
Independent Variable – Demographic Information	Demographic Information Of Students	Developed by the researcher	Demographic Information Of Students such as Student ID, School Name, Gender (SQ-1.1, 1.2, 1.3)	Developed by Researcher	Nominal Scale
Independent Variable – Demographic Information	This is to understand the availability of reliable Internet access at home.	Developed by the researcher	I have reliable Internet access at home (SQ-1.4)	Developed by Researcher	5-point Likert / Interval Scale
Independent Variable – School ICT Infrastructure	This is to understand the availability of School ICT Infrastructure	Developed by the researcher	I believe that my school provide good IT Infrastructure for learning (SQ-2.1)	Developed by Researcher	5-point Likert / Interval Scale
Independent Variable – School ICT Infrastructure	This is to understand the kind of platform are you using to enhance learning on a day to day basis	Developed by the researcher	What kind of platform are you using to enhance learning on a day to day basis? (SQ-2.2)	Developed by Researcher	Nominal Scale
Independent Variable – School ICT Infrastructure	This is to understand the preferred platform to maximize the learning outcome on a day to day basis	Developed by the researcher	What kind of platform that you prefer to maximize the learning outcome on a day to day basis? (SQ-2.3)	Developed by Researcher	Ordinal Scale
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of conventional chalk and talk	Developed by the researcher	Teaching method by conventional chalk and talk is effective in	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
	method in learning Mathematics		learning Mathematics (SQ-4.1)		
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of conventional chalk and talk method in learning Science	Developed by the researcher	Teaching method by conventional chalk and talk is effective in learning Science (SQ-4.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of teaching with the support of technology device in enhancing student learning experience in Mathematics	Developed by the researcher	I believe teaching with the support of technology device will enhance my learning experience in Mathematics (SQ-4.3)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of teaching with the support of technology device in enhancing student learning experience in Science	Developed by the researcher	I believe teaching with the support of technology device will enhance your learning experience in Science (SQ-4.4)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance my creativity on	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
	creativity on Science Subjects.		Science Subjects (SQ-5.1)		
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student critical thinking on Science Subjects.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance my critical thinking on Science Subjects (SQ-5.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student collaboration with peers on Science Subjects.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance my collaboration with peers on Science Subjects (SQ-5.3)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with help of using students own device during the school day can enhance student communication with teachers &	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance my communication with teachers & peers on	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
	peers on Science Subjects.		Science Subjects (SQ-5.4)		
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student creativity in Mathematics.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance my creativity in Mathematics (SQ-5.5)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student critical thinking on Mathematics.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance my critical thinking on Mathematics (SQ-5.6)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student collaboration with peers in Mathematics.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance my collaboration with peers in Mathematics (SQ-5.7)	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student communication with teachers & peers in Mathematics.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance my communication with teachers & peers in Mathematics (SQ-5.8)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how much student aware of how technology can be used for student learning process.	Developed by the researcher	I believe that I am aware of how technology can be used for my learning process (SQ-6.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how student's understanding of how technology can be explored for their learning process.	Developed by the researcher	I believe that how technology can be explored for my learning process. (SQ-6.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how student's understanding of how technology can be integrated into their learning process.	Developed by the researcher	I believe that how technology can be integrated into my learning process. (SQ-6.3)	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
Independent Variable – Technology Usage	This is to understand how student's understanding of how technology can be expanded and refined for their learning process.	Developed by the researcher	I believe that how technology can be expanded and refined for my learning process. (SQ-6.4)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Evaluation Method	This is to understand how teachers give students Assignments in Science & Mathematics for evaluating their learning outcome	Developed by the researcher	I satisfy that the teachers give me Assignments on Science & Mathematics for evaluating my learning outcome (SQ-7.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Evaluation Method	This is to understand how teachers give students quizzes and test papers on Science & Mathematics for evaluating their learning outcome	Developed by the researcher	I satisfy that teachers give me quizzes and test papers on Science & Mathematics for evaluating my learning outcome (SQ-7.2)	Developed by Researcher	5-point Likert Scale/ Interval
Dependent Variable – Student Achievements	It is the score obtained by a 9^{th}-grade student at the end of second term / semester for Mathematics and Science	Developed by the researcher	Grade (score) for Science and Mathematics at the end of Second term/ Semester will be collected from School Authorities	Developed by Researcher	Grade/ Ratio Scale

Science Teachers Questionnaire (TQ)

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
Independent Variable – Demographic Information	Demographic Information Of Teachers	Developed by the researcher	Demographic Information Of Teacher such as Teacher ID, Teacher Name, School name, Gender (TQ-1.1, 1.2, 1.3, 1.4)	Developed by Researcher	Nominal Scale
Independent Variable – Demographic Information	This is to understand the availability of reliable Internet access at home.	Developed by the researcher	Do you have reliable Internet access at home? (TQ-1.6)	Developed by Researcher	5-point Likert / Interval Scale
Independent Variable – School ICT Infrastructure	This is to understand the availability of School ICT Infrastructure	Developed by the researcher	I believe that my school provide good IT Infrastructure for teaching (TQ-2.1)	Developed by Researcher	5-point Likert / Interval Scale
Independent Variable – School ICT Infrastructure	This is to understand the kind of platform are you using to enhance teaching on a day to day basis	Developed by the researcher	What kind of platform are you using to enhance teaching on a day to day basis? (TQ-2.2)	Developed by Researcher	Nominal Scale
Independent Variable – School ICT Infrastructure	This is to understand the preferred platform to maximize the learning outcome of students on a day to day basis	Developed by the researcher	What kind of platform that you prefer to maximize the learning outcome of students on a day to day basis? (TQ-2.3)	Developed by Researcher	Ordinal Scale
Independent Variable – Teacher Qualification	This is to understand teacher qualification	Developed by the researcher	What is your highest qualification? (TQ -3.1)	Developed by the researcher	Ordinal Scale

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
and Experience					
Independent Variable – Teacher Qualification and Experience	This is to understand teacher's experience	Developed by the researcher	How many years of teaching experience do you have in education? (TQ - 3.2)	Developed by the researcher	Interval Scale
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of conventional chalk and talk method in teaching Science	Developed by the researcher	Teaching method by conventional chalk and talk is effective in teaching Science (TQ-4.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of teaching with the support of technology device in enhancing student learning experience in Science	Developed by the researcher	Teaching with the support of technology device will enhance student learning experience in Science (TQ-4.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of teaching with the support of technology device in enhancing the student-centric learning process	Developed by the researcher	Teaching with the support of technology device will enhance student-centric learning process (TQ-4.3)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Teaching	This is to understand the effectiveness of	Developed by the researcher	Teaching with the support of technology	Developed by Researcher	5-point Likert

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
Methods By Teachers	teaching with the support of technology device in enhancing curriculum centric learning process		device will enhance curriculum centric learning process? (TQ – 4.4)		Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student creativity on Science Subjects.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance student creativity on Science Subjects (TQ-5.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student critical thinking on Science Subjects.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance student critical thinking on Science Subjects (TQ-5.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance student	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
	student collaboration with peers on Science Subjects.		collaboration with peers on Science Subjects (TQ-5.3)		
Independent Variable – Learning Methods By Students	This is to understand how learning with help of using students own device during the school day can enhance student communication with teachers & peers on Science Subjects.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance student communication with teachers & peers on Science Subjects (TQ-5.4)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how many students aware of how technology can be used for teaching process.	Developed by the researcher	I believe that I am aware of how technology can be used for my teaching process (TQ-6.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how student's understanding on how technology can be explored for teaching process.	Developed by the researcher	I believe that how technology can be explored through teaching process. (TQ-6.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how student's understanding	Developed by the researcher	I believe that how technology can be integrated	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
	of how technology can be integrated into the teaching process.		into the teaching process. (TQ-6.3)		
Independent Variable – Technology Usage	This is to understand how student's understanding of how technology can be expanded and refined for teaching process.	Developed by the researcher	I believe that how technology can be expanded and refined for teaching process. (TQ-6.4)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Evaluation Method	This is to understand how teachers give students Assignments in Science & Mathematics for evaluating student learning outcome	Developed by the researcher	I prefer give Assignments in Science & Mathematics for evaluating student's learning outcome (TQ-7.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Evaluation Method	This is to understand how teachers give students quizzes and test papers on Science & Mathematics for evaluating student learning outcome	Developed by the researcher	I prefer to give quizzes and test papers on Science & Mathematics for evaluating student's learning outcome (TQ-7.2)	Developed by Researcher	5-point Likert Scale/ Interval

Mathematics Teachers Questionnaire (TQ)

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
Independent Variable – Demographic Information	Demographic Information Of Teachers	Developed by the researcher	Demographic Information Of Teacher such as Teacher ID, Teacher Name, School name, Gender (TQ-1.1, 1.2, 1.3, 1.4)	Developed by Researcher	Nominal Scale
Independent Variable – Demographic Information	This is to understand the availability of reliable Internet access at home.	Developed by the researcher	Do you have reliable Internet access at home? (TQ-1.6)	Developed by Researcher	5-point Likert / Interval Scale
Independent Variable – School ICT Infrastructure	This is to understand the availability of School ICT Infrastructure	Developed by the researcher	I believe that my school provide good IT Infrastructure for teaching (TQ-2.1)	Developed by Researcher	5-point Likert / Interval Scale
Independent Variable – School ICT Infrastructure	This is to understand the kind of platform you are using to enhance teaching on a day to day basis	Developed by the researcher	What kind of platform are you using to enhance teaching on a day to day basis? (TQ-2.2)	Developed by Researcher	Nominal Scale
Independent Variable – School ICT Infrastructure	This is to understand the preferred platform to maximize the learning outcome of students on a day to day basis	Developed by the researcher	What kind of platform that you prefer to maximize the learning outcome of students on a day to day basis? (TQ-2.3)	Developed by Researcher	Ordinal Scale
Independent Variable – Teacher Qualification	This is to understand teacher qualification	Developed by the researcher	What is your highest qualification? (TQ -3.1)	Developed by the researcher	Ordinal Scale

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
and Experience					
Independent Variable – Teacher Qualification and Experience	This is to understand teacher's experience	Developed by the researcher	How many years of teaching experience do you have in education? (TQ - 3.2)	Developed by the researcher	Interval Scale
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of conventional chalk and talk method in teaching Mathematics	Developed by the researcher	Teaching method by conventional chalk and talk is effective in teaching Mathematics (TQ-4.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of teaching with the support of technology device in enhancing student learning experience in Mathematics	Developed by the researcher	Teaching with the support of technology device will enhance student learning experience in Mathematics (TQ-4.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Teaching Methods By Teachers	This is to understand the effectiveness of teaching with the support of technology device in enhancing the student-centric learning process	Developed by the researcher	Teaching with the support of technology device will enhance student-centric learning process (TQ-4.3)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Teaching	This is to understand the effectiveness of	Developed by the researcher	Teaching with the support of technology	Developed by Researcher	5-point Likert

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
Methods By Teachers	teaching with the support of technology device in enhancing curriculum centric learning process		device will enhance curriculum centric learning process? (TQ – 4.4)		Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student creativity on Mathematics Subjects.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance student creativity on Mathematics Subjects (TQ-5.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student critical thinking on Mathematics Subjects.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance student critical thinking on Mathematics Subjects (TQ-5.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance student	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
	student collaboration with peers on Mathematics Subjects.		collaboration with peers on Mathematics Subjects (TQ-5.3)		
Independent Variable – Learning Methods By Students	This is to understand how learning with the help of using students own device during the school day can enhance student communication with teachers & peers on Mathematics Subjects.	Developed by the researcher	I believe learning with the help of using students own device during the school day can enhance student communication with teachers & peers on Mathematics Subjects (TQ-5.4)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how much student aware of how technology can be used for teaching process.	Developed by the researcher	I believe that I am aware of how technology can be used for my teaching process (TQ-6.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how student's understanding on how technology can be explored for teaching process.	Developed by the researcher	I believe that how technology can be explored through teaching process. (TQ-6.2)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Technology Usage	This is to understand how student's understanding	Developed by the researcher	I believe that how technology can be integrated	Developed by Researcher	5-point Likert Scale/ Interval

Variable	Operational Definition	Source Reference	Operational/ Questionnaire Items	Source Reference	Type of data/ Scale
	of how technology can be integrated into the teaching process.		into the teaching process. (TQ-6.3)		
Independent Variable – Technology Usage	This is to understand how student's understanding of how technology can be expanded and refined for teaching process.	Developed by the researcher	I believe that how technology can be expanded and refined for teaching process. (TQ-6.4)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Evaluation Method	This is to understand how teachers give students Assignments in Mathematics & Mathematics for evaluating student learning outcome	Developed by the researcher	I prefer give Assignments in Mathematics & Mathematics for evaluating student's learning outcome (TQ-7.1)	Developed by Researcher	5-point Likert Scale/ Interval
Independent Variable – Evaluation Method	This is to understand how teachers give students quizzes and test papers on Mathematics & Mathematics for evaluating student learning outcome	Developed by the researcher	I prefer to give quizzes and test papers on Mathematics & Mathematics for evaluating student's learning outcome (TQ-7.2)	Developed by Researcher	5-point Likert Scale/ Interval

APPENDIX 2:

Questionnaire validity and reliability test result

Cronbach's Alpha Co-efficiency test

Cronbach's Alpha Co-efficiency based on standardized Items of a questionnaire for Student

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	30	83.3
	Excluded[a]	6	16.7
	Total	36	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.963	.959	20

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	4.367	4.233	4.500	.267	1.063	.006	20

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation
I have a good internet connection at my house	82.83	50.489	.577
I believe that my school provides me good Internet,	83.03	52.654	.303
I believe teaching method by conventional chalk and talk is effective in learning Math	83.10	53.817	.145
I believe teaching method by conventional chalk and talk is effective in learning Science	83.10	53.817	.145
I believe teaching with the support of...Math	83.10	53.817	.145
I believe teaching with the support of...Sci	83.10	53.817	.145
My ability to think creatively about Science subjects	82.93	48.202	.935
My ability to think critically on Science subjects	82.93	48.202	.935
My ability to collaborate effectively with other students on Science subjects	82.93	48.202	.935
My ability to communicate effectively with teachers and student groups on Science	82.93	48.202	.935
My ability to think creatively about Math subjects	82.93	48.202	.935
My ability to think critically on Math subjects	82.93	48.202	.935
My ability to collaborate effectively with other students on Math subjects	82.93	48.202	.935

My ability to communicate effectively with teachers and student groups on Math	82.93	48.202	.935
I am aware of how technology can be used for my learning.	82.93	48.202	.935
I am aware of how Technology can be explored and integrated into my learning.	82.93	48.202	.935
BYOD ...for doing self-assessment for my Mathematics learning	82.93	48.202	.935
BYOD ...for doing self-assessment for my Science learning	82.93	48.202	.935
BYOD ...for study is more convenient and time-saving	82.93	48.202	.935
BYOD ...can be used more frequently than that of traditional methods	82.93	48.202	.935

Item-Total Statistics

	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
I have a good internet connection at my house	.	.963
I believe that my school provides me good Internet,	.	.966
I believe teaching method by conventional chalk and talk is effective in learning Math	.	.967
I believe teaching method by conventional chalk and talk is effective in learning Science	.	.967
I believe teaching with the support of...Math	.	.967
I believe teaching with the support of...Sci	.	.967
My ability to think creatively about Science subjects	.	.958
My ability to think critically on Science subjects	.	.958
My ability to collaborate effectively with other students on Science subjects	.	.958
My ability to communicate effectively with teachers and student groups on Science	.	.958
My ability to think creatively about Math subjects	.	.958
My ability to think critically on Math subjects	.	.958
My ability to collaborate effectively with other students on Math subjects	.	.958

My ability to communicate effectively with teachers and student groups on Math	.	.958
I am aware of how technology can be used for my learning.	.	.958
I am aware of how Technology can be explored and integrated into my learning.	.	.958
BYOD ...for doing self-assessment for my Mathematics learning	.	.958
BYOD ...for doing self-assessment for my Science learning	.	.958
BYOD ...for the study is more convenient and time-saving	.	.958
BYOD ...can be used more frequently than that of traditional methods	.	.958

Cronbach's Alpha Co-efficiency based on standardized Items of a questionnaire for Science teacher

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	10	100.0
	Excluded[a]	0	.0
	Total	10	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
1.000	1.000	15

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	4.200	4.200	4.200	.000	1.000	.000	15

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation
I have a good internet connection at my house	58.80	34.844	1.000
I believe that my school provides me good Internet,	58.80	34.844	1.000
I believe teaching method by conventional chalk and talk is effective in teaching Sci.	58.80	34.844	1.000
BYOD will enhance student learning experience in Sci.	58.80	34.844	1.000
BYOD will enhance self-directed learning.	58.80	34.844	1.000
BYOD will enhance innovative teaching practices.	58.80	34.844	1.000
Enhance ability to think creatively about SCi subjects	58.80	34.844	1.000
Enhance ability to think critically about Sci subjects	58.80	34.844	1.000
Enhance ability to collaborate effectively with other students on Sci subjects	58.80	34.844	1.000
Enhance ability to communicate effectively with teachers and student groups on Sci	58.80	34.844	1.000
I am aware of how technology can be used for my teaching.	58.80	34.844	1.000
I am aware of how Technology can be explored and integrated into my teaching.	58.80	34.844	1.000

BYOD ...suitable tool for self-assessment of student learning.	58.80	34.844	1.000
BYOD ...more convenient and time-saving in assessing students learning than the traditional method	58.80	34.844	1.000
BYOD ..more frequently than that of traditional methods	58.80	34.844	1.000

Item-Total Statistics

	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
I have a good internet connection at my house	.	1.000
I believe that my school provides me good Internet,	.	1.000
I believe teaching method by conventional chalk and talk is effective in teaching Sci.	.	1.000
BYOD will enhance student learning experience in Sci.	.	1.000
BYOD will enhance self-directed learning.	.	1.000
BYOD will enhance innovative teaching practices.	.	1.000
Enhance ability to think creatively about SCi subjects	.	1.000
Enhance ability to think critically about Sci subjects	.	1.000
Enhance ability to collaborate effectively with other students on Sci subjects	.	1.000
Enhance ability to communicate effectively with teachers and student groups on Sci	.	1.000
I am aware of how technology can be used for my teaching.	.	1.000
I am aware of how Technology can be explored and integrated into my teaching.	.	1.000

BYOD ...suitable tool for self-assessment of student learning.	.	1.000
BYOD ...more convenient and time-saving in assessing students learning than the traditional method	.	1.000
BYOD ..more frequently than that of traditional methods	.	1.000

Cronbach's Alpha Co-efficiency based on standardized Items of a questionnaire for Mathematics teacher

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	10	35.7
	Excluded[a]	18	64.3
	Total	28	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.924	.931	13

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	4.277	4.200	4.700	.500	1.119	.035	13

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation
I believe that my school provides me good Internet,	51.40	16.933	-.179
I believe teaching method by conventional chalk and talk is effective in teaching Mathematics.	50.90	16.544	-.074
BYOD will enhance self-directed learning.	50.90	16.544	-.074
BYOD will enhance innovative teaching practices.	51.40	13.378	.951
Enhance ability to think creatively about Math subjects	51.40	13.378	.951
Enhance ability to think critically about Math subjects	51.40	13.378	.951
Enhance ability to collaborate effectively with other students on Math subjects	51.40	13.378	.951
Enhance ability to communicate effectively with teachers and student groups on Math	51.40	13.378	.951
I am aware of how technology can be used for my teaching.	51.40	13.378	.951
I am aware of how Technology can be explored and integrated into my teaching.	51.40	13.378	.951
BYOD ...suitable tool for self-assessment of student learning.	51.40	13.378	.951

BYOD ...more convenient and time-saving in assessing students learning than the traditional method	51.40	13.378	.951
BYOD ..more frequently than that of traditional methods	51.40	13.378	.951

Item-Total Statistics

	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
I believe that my school provides me good Internet,	.	.946
I believe teaching method by conventional chalk and talk is effective in teaching Mathematics.	.	.947
BYOD will enhance self-directed learning.	.	.947
BYOD will enhance innovative teaching practices.	.	.908
Enhance ability to think creatively about Math subjects	.	.908
Enhance ability to think critically about Math subjects	.	.908
Enhance ability to collaborate effectively with other students on Math subjects	.	.908
Enhance ability to communicate effectively with teachers and student groups on Math	.	.908
I am aware of how technology can be used for my teaching.	.	.908
I am aware of how Technology can be explored and integrated into my teaching.	.	.908
BYOD ...suitable tool for self-assessment of student learning.	.	.908

BYOD ...more convenient and time-saving in assessing students learning than the traditional method	.	.908
BYOD ..more frequently than that of traditional methods	.	.908

APPENDIX 3:

Student survey

STUDENT SURVEY – TECHNOLOGY

1. PERSONAL INFORMATION

1.1 Student ID		1.2 Student Name							
1.3 Grade & Section		1.4 School Code		1.5 Gender		Female	☐	Male	☐

1.6 I have good internet connection at my house.	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
	☐	☐	☐	☐	☐

2. SCHOOL ICT INFRASTRUCTURE

2.1 I believe that my school provides me good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for my learning.	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
	☐	☐	☐	☐	☐

3. TEACHING METHODS BY TEACHERS

3.1 Are your teachers using any kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching you Mathematics?	Yes	No
	☐	☐

3.2 If yes, how long they have been using it for teaching you Mathematics?	a. Less than three months	☐	b. Less than six months	☐
	c. Less than nine months	☐	d. More than nine months	☐

3.3 Are your teachers using any kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board / Interactive LED) for teaching you Science?	Yes	No
	☐	☐

3.4 If yes, how long they have been using it for teaching you Science?	a. Less than three months	☐	b. Less than six months	☐
	c. Less than nine months	☐	d. More than nine months	☐

	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
3.5 I believe teaching method by conventional chalk and talk is effective in learning Mathematics.	☐	☐	☐	☐	☐
3.6 I believe teaching method by conventional chalk and talk is effective in learning Science.	☐	☐	☐	☐	☐
3.7 I believe teaching with support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance my learning experience in Mathematics.	☐	☐	☐	☐	☐
3.8 I believe teaching with support of Technology (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance my learning experience in Science.	☐	☐	☐	☐	☐

4. LEARNING METHODS BY STUDENTS

4.1 Are you using your own technology device (Computer/Laptop/ Tablet) for learning Mathematics?	Yes	No
	☐	☐

4.2 If yes, how long you have been using your own technology device (Computer/Laptop/ Tablet) for learning Mathematics?	a. Less than three months	☐	b. Less than six months	☐
	c. Less than nine months	☐	d. More than nine months	☐

4.3 Are you using your technology device (Computer/Laptop/ Tablet) for learning Science?	Yes	No
	☐	☐

4.4 If yes, how long you have been using your technology device (Computer/Laptop/ Tablet) for learning Science?	a. Less than three months	☐	b. Less than six months	☐
	c. Less than nine months	☐	d. More than nine months	☐

I believe learning with help of using my own technology device (Computer / Laptop / Tablet) during the school hours can enhance ….	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
4.5 My ability to think creatively on Science subjects	☐	☐	☐	☐	☐
4.6 My ability to think critically on Science subjects	☐	☐	☐	☐	☐
4.7 My ability to collaborate effectively with other students on Science subjects	☐	☐	☐	☐	☐
4.8 My ability to communicate effectively with teachers and student groups on Science subjects	☐	☐	☐	☐	☐
4.9 My ability to think creatively in Mathematics	☐	☐	☐	☐	☐
4.10 My ability to think critically in Mathematics	☐	☐	☐	☐	☐
4.11 My ability to collaborate effectively with other students in Mathematics	☐	☐	☐	☐	☐
4.12 My ability to communicate effectively with teachers and student groups in Mathematics	☐	☐	☐	☐	☐
5. TECHNOLOGY USAGE					
5.1 What type of technology devices are you using to learn? (Choose more than one option if applicable)	a. Desktop Computer ☐	b. Laptop ☐	c. Mobile device(Tablet/Phone) ☐		
5.2 What type of Operating System are you using to learn? (Choose more than one option if applicable)	a. iOS ☐	b. Android ☐	c. Windows ☐		
5.3What type of technology devices do you think can help with better learning in the classroom? (1= 1st Choice, 2= 2nd Choice, 3= 3rd Choice)	a. Desktop Computer ☐	b. Laptop ☐	c. Mobile device(Tablet/Phone) ☐		
5.4 What type of Operating System do you think can help with better learning in the classroom? (1= 1st Choice, 2= 2nd Choice, 3= 3rd Choice)	a. iOS ☐	b. Android ☐	c. Windows ☐		
I believe that	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
5.5 I am aware of how technology can be used for my learning.	☐	☐	☐	☐	☐
5.6 I am aware of how Technology can be explored and integrated for my learning.	☐	☐	☐	☐	☐
6. EVALUATION METHODS					
	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
6.1 I believe BYOD (Bring Your Own Device) is a suitable tool for doing self-assessment for my Mathematics learning	☐	☐	☐	☐	☐
6.2 I believe BYOD (Bring Your Own Device) is a suitable tool for doing self-assessment for my Science learning	☐	☐	☐	☐	☐
6.3 I believe using BYOD (Bring Your Own Device) for study is more convenient and time saving in assessing my learning than the traditional method	☐	☐	☐	☐	☐
6.4 I believe that assessment through BYOD (Bring Your Own Device) can be used more frequently than that of traditional methods	☐	☐	☐	☐	☐

APPENDIX 4:

Teacher survey - Science

SURVEY FOR SCIENCE TEACHER - TECHNOLOGY

1. PERSONAL INFORMATION

1.1 Teacher ID		1.2 Teacher Name				
1.3 School Code		1.4 Gender	Female	☐	Male	☐
1.5 I have good internet connection at my house.		5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
		☐	☐	☐	☐	☐

2. TEACHER QUALIFICATIONS & EXPERIENCE

2.1 What is your highest qualification?	a. PhD with B.Ed.	☐	b. PhD Only	☐	c. Masters with B.Ed.	☐
	d. Masters Only	☐	e. Bachelors with B.Ed.	☐	f. Bachelors only	☐
	g. Others	☐				
2.2 How many years of teaching experience do you have in education?	a. Less than five years	☐	b. Five to Nine Years	☐	c. Ten to Fourteen Years	☐
	d. Fifteen to Nineteen Years	☐	e. Twenty years or more	☐		

3. SCHOOL ICT INFRASTRUCTURE

3.1 I believe that my school provides me good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for teaching.	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
	☐	☐	☐	☐	☐

4. TEACHING METHODS BY TEACHERS

4.1 Are you using any kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) for teaching Science?				Yes	No
				☐	☐
4.2 If yes, how long you have been using it?	a. Less than three months	☐	b. Less than six months		☐
	c. Less than nine months	☐	d. More than nine months		☐

	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
4.3 I believe teaching method by conventional chalk and talk is effective in teaching Science.	☐	☐	☐	☐	☐
4.4 I believe teaching with support of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance student learning experience in Science.	☐	☐	☐	☐	☐
4.5 I believe teaching with support of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance self-directed learning.	☐	☐	☐	☐	☐
4.6 I believe teaching with support of technology device (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance innovative teaching practices.	☐	☐	☐	☐	☐

5. LEARNING METHODS BY STUDENTS					
5.1 Are your students using their own technology device (Computer/Laptop/ Tablet) for learning Science?				Yes ☐	No ☐
5.2 If yes, how long they have been using your own technology device (Computer/Laptop/ Tablet) for learning Science?	a. Less than three months ☐		b. Less than six months ☐		
	c. Less than nine months ☐		d. More than nine months ☐		
I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
5.3 Students' ability to think creatively in Science	☐	☐	☐	☐	☐
5.4 Students' ability to think critically in Science.	☐	☐	☐	☐	☐
5.5 Students ability to collaborate effectively with other students in Science	☐	☐	☐	☐	☐
5.6 Students ability to communicate effectively with teachers and student groups in Science	☐	☐	☐	☐	☐
6. TECHNOLOGY USAGE					
6.1 What type of technology devices are you using to teach? (Choose more than one option if applicable)	a. Desktop Computer ☐	b. Laptop ☐	c. Mobile device(Tablet/Phone) ☐		
6.2 What type of Operating System are you using to teach? (Choose more than one option if applicable)	a. iOS ☐	b. Android ☐	c. Windows ☐		
6.3 What type of technology devices do you think can help with better teaching in the classroom? (1= 1st Choice, 2= 2nd Choice, 3= 3rd Choice)	a. Desktop Computer ☐	b. Laptop ☐	c. Mobile device(Tablet/Phone) ☐		
6.4 What type of Operating System do you think can help with better teaching in the classroom? (1= 1st Choice, 2= 2nd Choice, 3= 3rd Choice)	a. iOS ☐	b. Android ☐	c. Windows ☐		
I believe that	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
6.5 I am aware of how technology can be used for my teaching.	☐	☐	☐	☐	☐
6.6 Technology can be explored and integrated for my teaching.	☐	☐	☐	☐	☐
7. EVALUATION METHODS					
	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
7.1 I believe BYOD (Bring Your Own Device) is a suitable tool for self-assessment of student learning.	☐	☐	☐	☐	☐
7.2 I believe students using BYOD (Bring Your Own Device) for study is more convenient and time saving in assessing students learning than the traditional method	☐	☐	☐	☐	☐
7.3 I believe that assessment through BYOD (Bring Your Own Device) can be used more frequently than that of traditional methods	☐	☐	☐	☐	☐

APPENDIX 5:

Teacher survey - Mathematics

SURVEY FOR MATHEMATICS TEACHER - TECHNOLOGY

1. PERSONAL INFORMATION

1.1 Teacher ID		1.2 Teacher Name							
1.3 School Code		1.4 Gender	Female	☐		Male	☐		
1.5 I have good internet connection at my house.		5 Strongly Agree	4 Agree	3 Neutral		2 Disagree	1 Strongly Disagree		
		☐	☐	☐		☐	☐		

2. TEACHER QUALIFICATIONS & EXPERIENCE

2.1 What is your highest qualification?	a. PhD with B.Ed.	☐	b. PhD Only	☐	c. Masters with B.Ed.	☐	
	d. Masters Only	☐	e. Bachelors with B.Ed.	☐	f. Bachelors only	☐	
	g. Others	☐					
2.2 How many years of teaching experience do you have in education?	a. Less than five years	☐	b. Five to Nine Years	☐	c. Ten to Fourteen Years	☐	
	d. Fifteen to Nineteen Years	☐	e. Twenty years or more	☐			

3. SCHOOL ICT INFRASTRUCTURE

3.1 I believe that my school provides me good Internet, Computer & Projector/ Interactive Board/ Interactive LED facility for teaching.	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree
	☐	☐	☐	☐	☐

4. TEACHING METHODS BY TEACHERS

4.1 Are you using any kind of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) for teaching Mathematics?							Yes	No	
							☐	☐	
4.2 If yes, how long you have been using it?	a. Less than three months	☐			b. Less than six months			☐	
	c. Less than nine months	☐			d. More than nine months			☐	
	5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree				
4.3 I believe teaching method by conventional chalk and talk is effective in teaching Mathematics.	☐	☐	☐	☐	☐				
4.4 I believe teaching with support of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance student learning experience in Mathematics.	☐	☐	☐	☐	☐				
4.5 I believe teaching with support of technology devices (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance self-directed learning.	☐	☐	☐	☐	☐				
4.6 I believe teaching with support of technology device (Computer/ Laptop/ Tablet/ Projector/ Interactive Board/ Interactive LED) will enhance innovative teaching practices.	☐	☐	☐	☐	☐				

5. LEARNING METHODS BY STUDENTS										
5.1 Are your students using their own technology device (Computer/Laptop/ Tablet) for learning Mathematics?								Yes ☐	No ☐	
5.2 If yes, how long they have been using your own technology device (Computer/Laptop/ Tablet) for learning Mathematics?	a. Less than three months	☐	b. Less than six months	☐	c. Less than nine months	☐	d. More than nine months	☐		
I believe learning with the help of using student's own technology devices (Computer/Laptop/ Tablet) during the school hours can enhance	5 Strongly Agree		4 Agree		3 Neutral		2 Disagree		1 Strongly Disagree	
5.3 Students' ability to think creatively in Mathematics	☐		☐		☐		☐		☐	
5.4 Students' ability to think critically in Mathematics.	☐		☐		☐		☐		☐	
5.5 Students ability to collaborate effectively with other students in Mathematics	☐		☐		☐		☐		☐	
5.6 Students ability to communicate effectively with teachers and student groups in Mathematics	☐		☐		☐		☐		☐	
6. TECHNOLOGY USAGE										
6.1 What type of technology devices are you using to teach? (Choose more than one option if applicable)	a. Desktop Computer	☐	b. Laptop	☐	c. Mobile device(Tablet/Phone)	☐				
6.2 What type of Operating System are you using to teach? (Choose more than one option if applicable)	a. iOS	☐	b. Android	☐	c. Windows	☐				
6.3 What type of technology devices do you think can help with better teaching in the classroom? (1= 1st Choice, 2= 2nd Choice, 3= 3rd Choice)	a. Desktop Computer	☐	b. Laptop	☐	c. Mobile device(Tablet/Phone)	☐				
6.4 What type of Operating System do you think can help with better teaching in the classroom? (1= 1st Choice, 2= 2nd Choice, 3= 3rd Choice)	a. iOS	☐	b. Android	☐	c. Windows	☐				
I believe that	5 Strongly Agree		4 Agree		3 Neutral		2 Disagree		1 Strongly Disagree	
6.5 I am aware of how technology can be used for my teaching.	☐		☐		☐		☐		☐	
6.6 Technology can be explored and integrated for my teaching.	☐		☐		☐		☐		☐	
7. EVALUATION METHODS										
	5 Strongly Agree		4 Agree		3 Neutral		2 Disagree		1 Strongly Disagree	
7.1 I believe BYOD (Bring Your Own Device) is a suitable tool for self-assessment of student learning.	☐		☐		☐		☐		☐	
7.2 I believe students using BYOD (Bring Your Own Device) for study is more convenient and time saving in assessing students learning than the traditional method	☐		☐		☐		☐		☐	
7.3 I believe that assessment through BYOD (Bring Your Own Device) can be used more frequently than that of traditional methods	☐		☐		☐		☐		☐	

BIO-DATA

Doctor of Philosophy: Major in eLearning Methodology

Manoj Mechankara Varghese

Dissertation Title:

DEVELOPMENT OF A BRING YOUR OWN DEVICE (BYOD) ELEARNING CONCEPTUAL FRAMEWORK FOR PRIVATE SECONDARY SCHOOLS IN DUBAI, UNITED ARAB EMIRATES.

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