CHAPTER – III

REVIEW OF RELATED LITERATURE AND STUDIES

3.1 Objectives of review of the study

As presented by Machi and McEvoy (2009), the purpose of the literature review is that it “summarizes and evaluates the existing knowledge on a particular topic”. Additionally, it serves the purpose of laying out the arguments of discovery and advocacy for the research study. While there is a substantial amount of research exists on the integration of technology into classrooms (Banister, 2010; Donovan, Green & Hartely, 2010; Holcomb, 2009; Ifenthaler & Schweinbenz, 2013; Lowther, Ross & Morrison, 2003), additional research is needed to postulate how iPad Assisted Instruction weigh specifically on the Problem Solving Behavior of Secondary level students in Mathematics and attitude towards Mathematics.

Review of related literature is the first task of a researcher or to decide on a specific problem for investigation. It facilitates the investigator to identify the research gaps if any, in order to create new ground in research. Also it helps to gather up-to-date information about the area in which the investigator intends to study.

Without a review of related literature one cannot proceed his / her research with firm ground and justification. So a review of previous studies in related area of the present study is attempted and presented in this chapter.

A systematic review of the related literature can help the researcher in the following ways. It can:

1. show how another researcher handled a similar problem.
2. suggest a method or technique of dealing with similar problem
3. reveal new sources of data, which the researcher may not have known.
4. introduce to the researcher eminent personalities whose work may not have been known before.

5. help the researcher to see the study in a historical perspective and in relation to other efforts to solve the same in similar problems.

6. provide new ideas and approaches which may not have occurred to the researcher before and

7. help the researcher to evaluate the research effort by comparing it with the efforts made by others.

Sources and types of Research Literature

Books, journals, reports, popular media, computer-based materials, memos, minutes, internal reports, letters, diaries, published and unpublished papers, contemporary and classic works, introductory and overview texts, edited collections and literature reviews, methodological and confessional writing, primary sources, secondary sources and tertiary sources form the different sources and types of research literature.
Figure 3.F.1. INFORMATION COLLECTED THROUGH REVIEWS

REVIEWS

- iPad Assisted Instruction
- Current trends in Math Education
- Current Challenges in Teaching Math
- Instructional Design
- Multicultural Students in UAE
- Education System in UAE
- Integration of Technology in Teaching Math
- Technology in Educational Field
- What is Problem Solving?
- What is Problem Solving Behavior?
- Different Components of Problem Solving Behavior
The main purpose of the present study is to develop Problem-Solving Behavior among the secondary level students through the iPad apps with cognizance of different stages of instructional design in its development of instructional model. In particular, the study has reused the concepts based on Dick & Carey, ADDIE, Keller’s Arc, Ross and Kemp, Robert Gagne’, Assure, and Merrill Devid’s First principles of instruction, and adopted several learning theories, which helped in the development of an instructional model for the Problem Solving Behavior in Mathematics. This envisages a detailed study of instructional design related to problem solving and also the prerequisites for the learning problem solving. The investigator hence made an earnest effort to bring together all essential literature and related studies. Also the investigator focused on studies based on learning theories, instructional strategies and instructional designs.

In the modern times, the advancement and modification in the learning theories have influenced the instructional strategies in the field of education. The psychologists who oriented their investigation in the domain of human learning were Thorndike (1911) and Skinner (1968). For many years the dominant learning theory was the Theory of Association. After the world war the birth of the programmed instruction movement in 1950s proved to be the major factor, which helped in the development of systems approach. Then came the behavioral objective movement (Gagne, 1965). Bloom in his book ‘Taxonomy of Educational Objectives’ indicated that within the cognitive domain there were various types of learning outcomes. Later Robert Mager’s work (1962) gave spur to this behavioral objective movement. Skinner’s (1968) approach solved many educational problems.

Modern theoretical conception views learning as a set of process having the function of information processing. Many ideas about information processing had been successfully applied to the investigation of human intellectual functioning. A prominent feature of modern theory and research on learning was the idea that among the processes available to the learner were the
process of control that can manage other process of attending, learning, remembering and thinking. This notion called ‘Cognitive Strategy’ was given by the investigation of concept formation (Bruner, 1956). Problem solving activities of human being reveal the presence and use of Cognitive Strategy. In science, problems were solved by people using cognitive strategies in which the content is more or less specific to the problem on hand (Gagne, 1985).

Peterson and Reinert (1992) proposed a theory of school instruction and model types. This was based on the meaning of the term ‘instruction theory’. According to them “instruction theory” was understood as a system of propositions about instruction, which did not contradict one another and were of descriptive or explanatory nature. All the results of research until now had rather emphasized that it would not be possible for reasons intrinsic to the subject to develop a uniform instruction theory which reached beyond “didactic polygon” however the basic factors were woven together. Two reasons in particular militate against this: the first, the complexity of connections in teaching made possible a large number of different perspectives upon the subject area, which in turn gave rise to a multitude of different partial theories, second, the subject of research, namely ‘instruction’, could not be considered as “given (in the scientific sense) but as socially determined social alliance” in which rising generation are prepared in purposeful, methodical and professional manner for the requirement and possibilities of future.

A paper was presented at the Annual meeting of the American Educational Research Association (San Francisco, CA, 1994). The paper was on ‘the effects of instruction using part-whole concepts with one step and two steps word problems.’ The paper described a study designed to investigate the effects of an instructional sequence that emphasized conceptual understanding of numerical operations using part-whole concept and the integration of these understanding with student’s problem solving knowledge. The study involving 384 students of fourth grade from a large urban school, examined, mainly the effect of instruction using part-whole concepts on student’s abilities to solve a
variety of one step and two-step word problems. Data were collected through written tests, interview and attitude survey. Results indicated that instruction using part-whole concepts with word problems was effective.

As an exercise of development of mental models in learning and performance, a number of tactics useful for instruction could be thought of. Greeno (1983) & Heller (1986), Gagne (1987) and Glaser (1976) found that the acquisition of proficiency in solving arithmetic word problems have increased the semantic structure of different classes of word problem based on thinking. Glaser (1984) concluded that the more knowledge one had about a certain domain, the more inference could be drawn and used to construct mental models. Gagne’ and Glaser suggest to concentrate on building up specific knowledge structure that would aid in the construction of domain specific models. They also suggested that exploring or investigating how a large body of knowledge was organized and represented, so that it could be accessed for successful solving of problems. The importance of knowledge base indicated the need for sequencing the content required for problem solving. Sequencing of instruction in which learning occurred influences the stability of cognitive structures and thereby influences long-term retention and transfer (Gagne’ Briggs, 1979).

Gagne, Wager and Rojas (1981) asserted that the nine events of instruction suggested by them should be considered for stabilizing the cognitive structures but decision about which events to include, how to present and sequence them were dependent on the nature of learning objective and the intended learner. Pillai, (1987) in India designed the instructional strategies based on Gagne’s condition of learning, in Physics. His instructional events consisted of nine events of instruction suggested by Gagne and Briggs. The study generated the following major findings:

1. Instructional Strategies developed based on Gagne’s conditions of learning was found feasible for normal classroom teaching.

2. It was found to be more effective than traditional method of instruction.
These studies discussed about the importance of instruction theory in structuring the classroom activity in the development of the abilities and skills such as problem solving. They all indicated the importance of prerequisite information and strategies for solving problems. All these studies supported the idea that problem solving depends on the previously available knowledge and hence recallability of the pre requisites becomes an important component of problem solving. Agnihotri (1987) made a study to test the achievement of different groups of students of 10th standard taught by different methods namely lecture-cum-demonstration, laboratory, programmed instruction and assignment-cum-discussion methods. Pre-test and Post-test design was used for the study. The treatment was found to be most effective with respect to the achievement in Physics.

The measurement of problem solving performance was not an easy matter. Various investigators gave considerable attention to the study of problem solving abilities and their development. Variety of attempts to quantify behavioral measures in this area had been done. Duncun (1959) pointed out that sometimes measures appear to have the purpose of identifying process rather than product.

Problem solving skills were related to many other aspects of cognition (Frederiksen, 1984) such as schema (the ability to remember similar problems), pattern recognition (recognizing familiar problem elements) and creativity (developing new solutions). The issue of transfer is highly relevant to problem solving.

Seifi et al (2012) attempted to detect students’ difficulties in solving mathematical word problems from their teacher’s perspectives. Participants were 52 mathematics teachers of Arak middle schools who were chosen randomly. The results showed that, the causes of the student difficulties were text difficulties, unfamiliar contexts in problems and using inappropriate
strategies. Finally teachers suggested to help students in teaching them to look for a pattern, draw a picture and rewording the problems.

3.2 Theoretical and Empirical Perspective

Technology at International Secondary level Math classroom

Students in the 21st century have been called “Generation Net” for their habitual technology use (Kaiser Family Foundation, 2010). Students of the 21st century have grown up with technology at their fingertips; for example, Generation Net children often ask to see a photograph seconds after it has been taken. Digital cameras, text messaging, computers, and the Internet are daily occurrences for most Generation Net Children; they “live in a world over stimulation and absolutely love it” (Berk, 2010). Shuler (2009) found that children between 8 and 10 years of age had approximately eight hours of media exposure daily. With students’ massive intake of electronic information, teachers nationwide found ways to mould media entertainment such as television, iPods, computers, and cell phones into powerful classroom tools (Berk, 2010). In 2003, officials of the U.S. Department of Education listed technology as a component of high-quality education. With an increased influence on society, technology became essential in the classroom (National Council of Teachers of Mathematics, 2008). Educational technology devices such as the iPad could be a very powerful tool, but educators must choose to utilize technological possibilities in the classroom before they could be successfully implemented.

Academic leaders invested billions of dollars in educational technology to improve teaching and learning (Bebell et al., 2010; Cuban, 2001). Technology became apparent in many K – 12 classrooms, yet very few researchers focused on the effect of technology in the Mathematics setting. Most technology studies had been conducted in higher education settings (DeCastro-Ambrosetti & Cho, 2002; Granberg & Witte, 2005; Jones & Sinclair, 2011; Manuguerra & Petocz, 2011; Suki et al., 2010; Weaver &
Nilson, 2005) or secondary education settings (Banister, 2010; Sheehan & Nillas, 2010; Shirvani, 2010). A search through the existing literature showed a lack of research regarding mobile learning technology in elementary classrooms.

Research on iPad use is relatively new in all academic settings; but had not been specifically explored in the elementary learning environment. Modern students immersed in technology earned the designation of “digital natives” (Franklin & Peng, 2008). Teachers or “digital immigrants” who were not born in the digital era have struggled often to reach their technology-obsessed students (Bauleke & Herrmann, 2010; Berk, 2010; Franklin & Peng, 2008; Kaiser Family Foundation, 2010; O’Brien & Scharber, 2010; Suki et al., 2010; Waters, 2010). After reviewing literature, Berk (2010) found 21st century students were (a) technologically savvy, (b) experiential / Kinesthetic, (c) visually literature, and (d) emotionally open. The students were interested in multimedia resources and relied on search engines; they created Internet content, multitasked and preferred teamwork to independent work (Berk, 2010).

Teachers could tailor their lessons to the needs of students by openly accepting and willingly incorporating technology into instruction (Banister, 2010). Berk (2010) agreed to tailored lessons, but warned that simply using technology would not “automatically result in effective teaching” or student learning. Berk (2010) implied many misconceptions about technology use in the classroom. The primary misconception was that simply incorporating technology did not equate to improved student learning. Classroom technology was not designed for entertainment or babysitting purposes and should be integral part to the lessons, not supplementary (Lee & Winzenried, 2009). Unfortunately, all of the ineffective methods had been used in the classrooms (Alagic, 2003; Lee & Winzenried, 2009). With the misconceptions about technology, Cuban (2001) found that educational technologies “had little tangible effect on either classroom teaching or learning”. Many classrooms
were equipped with ceiling-mounted projectors, built-in speakers, multiple student computers, and interactive whiteboards, yet most teachers rarely used them (Berk, 2010). If available technology was not used in the classroom, it was unlikely to improve instruction or student learning (Lee & Winzenried, 2009).

The frequency and quality of educational technology used in the classroom varied from teacher to teacher (Hall, 2010; Spires, Oliver, & Corn, 2012). Hall (2010) explained that the biggest hindrance to educational technology was to have teachers use it. Many qualitative questionnaire-based studies had shown reasons that teachers chose not to use technology (Adedoyin & Oluqayomi, 2010; Banister, 2010; Cuban, 2001; DeCastro_Ambrosetti & Cho, 2002; Manning & Johnson, 2011; Ozgun-Koca, Meagher, & Edwards, 2010; Pierce & Ball, 2009; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010).

Teachers cited common reasons for not incorporating technology that included: (a) the lack of hardware or software, (b) previous failed attempts, (c) fear, (d) the necessity of additional preparation, and (e) irrelevant or non-existent technology training (Adedoyin & Oluqayomi, 2010; Banister, 2010; DeCastro-Ambrosetti & Cho, 2002; Ozgun-Koca et al., 2010; Shapley et al., 2010). Despite these reasons, Hall (2010) recommended teachers look beyond themselves to the needs of the students to teach. Teachers had to be willing to integrate technology appropriately in the classroom (Banister, 2010; Ozgun-Koca et al., 2011). According to Goddard (2002), “the teacher’s responsibility was to discover the judicious use of technology as another tool in the arsenal of teaching that would guide students to exploration, discovery, practice, appreciation, and wonder at the world they inherited”. Teachers who incorporated technology needed vigilance in selecting appropriate resources based on academic objectives (Banister, 2010). Incorporating technology meant that teachers had to develop their planning, instruction, and assessment skills to a new level (Ertmer & Otterbrbreit-Leftwich, 2010; Pierce & Bell,
Teachers were encouraged to match their instructional technology with their pedagogy (Manning & Johnson, 2011); Selecting the most appropriate technology was dependent on the teacher’s goal, objectives, and learning outcomes. Teachers could utilize the power and possibilities available with technology by using it appropriately and effectively as a learning tool (Bebell et al., 2010).

**Technology devices and Usage in the Mathematics Classroom**

National Council of Teachers of Mathematics (2000, 2008) experts considered technology one of six essential components for learning Mathematics. Technology had been viewed as a way to offer students a relevant and engaging way to practice mathematics (Zentall, 2007). The purposes of incorporating technology in the mathematics classroom could be (a) to extend and enhance planning; (b) to provide, reinforce, and enrich instruction; and (c) to assess student mathematical understanding with positive reinforcement or corrective feedback (Alagic, 2003; Allsopp, Kyger, & Lovin, 2007; Hamilton, 2007; National Council for Teachers of Mathematics, 2008). Technology could be vital to creating authentic learning opportunities (Allsopp et al., 2007).

Numerous academic studies have shown the significant positive correlation between technology, student learning, and Mathematics Achievement (Alagic, 2003; Berk, 2010; Hamilton, 2007; Hubbard, 2000; Mendicino & Heffernan, 2007; National Council of Teachers of Mathematics, 2011; Park, 2008; Rosen & Beck-Hill, 2012). Alagic (2003) found that teachers who used technology also helped students (a) to apply mathematical concepts to real world issues, (b) to associated mathematical concepts and ideas, and (c) to use a variety of concept presentations. Hamilton (2007) found that the incorporation of technology was correlated with improved student Mathematics Achievement. Hubbard (2000) found that students who used a software tutorial program significantly outperformed their classmates in the traditional setting, with a 25 % increase in algebraic skills and 100% improvement in problem-
solving skills. The National Council of Teachers of Mathematics (2008) researchers showed that technology use could support mathematics investigation. Mendicino and Heffernan (2007) found that students who had used interactive tutoring software outperformed their counterparts in computer-assisted instructional settings and traditional classroom settings. Rosen and Beck-Hill (2012) reported educational technology cloud assist in closing the achievement gap and incorporate higher order thinking skills.

According to Kennedy and Tipps (2000), technology could be considered any “tool for learning concepts” under their definition; technology had been an active part of education for many years. Seventy years ago teachers believed that radio’s auditory academic quiz showed and read aloud stories would change education for ever (Lazarsfeld, 1940). A few years later, the television exceeded the radio in popularity. In the late 1960s, Public Broadcasting Service (PBS) officials delivered educational program such as “Sesame Street”, a dynamic show specifically designed to assist and prepare children with academic, social, and cognitive skills necessary for school (Mates & Strommen, 1995 / 1996). Towards the end of the 20th century, the desktop computer with Internet capability became the ubiquitous educational technology tool (Cuban, 2001).

With the development of websites to improve students’ academic skills, teachers gained a plethora of additional resources (O’ Brien & Scharber, 2010). Learners in the 21st century used handheld mobile technology such as iPods, iPads, and smartphones (Kong, 2008). Only 25 years ago, many individuals wondered about technology applications, but now users question if they could function without technology. With the exception of the interactive whiteboard, most instructional technology was used in real-world settings before classrooms. Many technology devices such as cameras, cell phones, and global positioning systems were imported into the classroom from mainstream society (Lee & Winzenried, 2009). Teachers had a variety of instructional technology devices in Mathematics classroom from laptops to personal response systems.
to cell phone to iPads (Berk, 2010). Computer assistive instruction from private software textbook companies had become popular with both students and teachers in the 21st century (Park, 2008).

Many Mathematics textbooks were equipped with computer assistive instruction software and electronic or virtual manipulatives that were easily accessible, required minimal preparation time, and could be used to maximize learning experiences (Li & Ma, 2010). Despite all of the new technology advances, researchers noted how quickly technology becomes outdated. Berk (2010) asked the reader hypothetically to envision “distributing iPads to all of students on the first class of the semester and requesting that, at the end of class, they drop them in the big green recycle buckets as they exit because they are already obsolete”.

**Game-based learning in Mathematics Education**

Game-based learning has gained popularity as an effective and innovative instructional strategy among 21st century mathematics teachers (Lavin-Mera, Torrente, Moreno-Ger, Vallejo-Pinto, & Fernandwz - Manjon, 2009; Mansour & El-Said, 2009). Mansour & El-Said, 2008) explained that the use of game-based learning as an educational tool was still in its infancy. When teaching Mathematics, Griffin (2007) suggested that teachers might connect examples to the real world through interactive games. Elementary students typically enjoyed academic games and were excited and interested about math while playing them (Griffin, 2007). Utilizing gaming in the mathematics classroom could have benefits. Mathematics games might be used to increase engagement, motivation, and student learning (Clark & Ernst, 2009; Huizenga, Admiral, Akkerman, & Dam, 2009). Students using games had multiple opportunities for real-world content application followed by positive encouragement or corrective feedback (Allsopp et al., 2007).

According to Jackson (2009), teachers could learn about cooperative learning and problem solving from video games. Like any lesson plan based on
educational objectives, most games were objective driven, in which students had a venue for fun, interactive tools to learn educational concepts (Hoffmann, 2009). With 17% of the population reporting anxiety about mathematics, a safe environment for student learning would be important (Ashcraft, Krause, & Hopko, 2007). Individual gaming on iPads might be used as a safe atmosphere for students to explore and practice mathematical concepts (Lavin-Mera et al., 2009). Incorporating games could help teachers plan for an objective-filled, problem-based mathematics lesson (Van de Walle, Karp, & Bay-Williams, 2010). Mathematics concept knowledge is foundational for mathematics instruction. Allsopp et al., (2007) suggested that teachers teach for student understanding; teachers often had been focused on obtaining the final answer instead of ensuring students conceptually understood how to solve the entire question. Games could be used to facilitate students’ problem solving abilities and conceptual understanding of mathematics. Equally as important as playing the mathematics game was active discussion of the activity and mathematical strategies and processes with students (Van de Walle et al., 2010).

The incorporation of technology must be appropriate and strategic to be effective (National Council for Teachers of Mathematics, 2008). Most free educational games on mobile learning devices like laptops and iPads involve simple recall questions, whereas Hoffmann (2009) believed games should be designed as challenges to students’ thinking and problem-solving skills. Recall questions were useful to a degree, but the optimal power of game-based learning in a mathematics game would “require resolve, concentration, the use of a variety of strategies, imagination, and creativity” (Hoffmann, 2009). The National Council for Teachers of Mathematics (2000) experts encouraged teachers to select instructional mathematics activities to enhance student learning. The iPad had a variety of instructional mathematical game applications and virtual manipulative applications for maximized leaning with minimal preparation (Griffin, 2007). Students might benefit from additional exposure to mathematics through game-based learning using iPad applications.
(Griffin, 2007). The convenience of handheld mobile learning devices might be of benefit in the use of game-based learning (Lavin-Mera et al., 2009). Students with digital gaming experience – with applications similar to those on the iPad- learned from their experiences playing digital games (Van de Walle et al., 2010). With the release of the iPad in 2010, no research has been available to date on the incorporation of the iPad for mathematics achievement.

**Mobile Learning**

The term mobile learning is new to the field of education. No official or accepted conceptual framework, learning theory, or definition included mobile learning (Ally, 2009; Guy, 2010; Pachler, Bachmair, & Cook, 2010; Traxler, 2009, 2010; Woodill, 2011). Some researchers defined mobile learning based on a nonphysical informal location (Ally, 2009; Guy, 2010; Traxler, 2009; Woodill, 2011). Others defined mobile learning as the ability to adapt to the ever-changing learning environment (Pachler et al., 2010; Shuler, 2009). The definition of mobile learning had been popular in higher education or secondary education, but mobile learning research was limited in the elementary setting (Traxler, 2009; 2010; Woodill, 2011). An examination of a variety of qualitative and quantitative studies showed that mobile learning was popular among 21st century learners (Ally, 2009; Koole, 2009; MacCallum & Jeffry, 2010; Masrom & Ismail, 2010; Shuler, 2009; Traxler, 2009; Woodill, 2011). An array of instructional practices – as well as authentic, informal, challenging, consistent, and personalized student learning opportunities – were supported in mobile learning settings (Shuler, 2009; Traxler, 2009; Woodill, 2011). Mobile learning was considered flexible and included a variety of learning options (Koole, 2009). For example, if a student wanted to determine the equation to identify a circle’s diameter, she or he could (a) search the Internet, (b) message a friend, (c) view a video tutorial, or (d) email the teacher directly. When using mobile learning devices, students were not limited to the physical classroom, which meant learning anywhere at any time was possible (Ally, 2009; Pachler et al., 2010; Shuler, 2009). Mobile learning could be (a)
Mobile learning challenges and opponents existed within the classroom. According to Shuler (2009), most teachers have viewed handheld mobile devices such as iPods, smartphones, and iPads as a distraction instead of a potential instructional tool. The challenge was that with the hundreds of different mobile learning devices available, for teachers to master all of them would be difficult, if not impossible (Masrom & Ismail, 2010; Shuler, 2009). Since 2010, several handheld tablets with Internet capabilities and game-based learning applications had been developed and marketed, such as the Apple iPad, Blackberry playbook, Vizio, VPad, and Android tablet. Although some teachers might be comfortable and confident personally using a mobile device, they might not be as comfortable transitioning into using a mobile device as a classroom tool (Mac Callum & Jeffry, 2010). Further, technical challenges such as small fonts, cracked screens, dead batteries, and broken buttons could occur while teaching with mobile learning device (Masrom & Ismail, 2010). Masrom and Ismail (2010) also listed cost as a major barrier to incorporating mobile learning in the classroom. Because of the personalized and individual aspect of mobile learning available on devices like the iPad, a device must be purchased for each student, which could be difficult in the current economic conditions (Masrom & Ismail, 2010).

**Handheld Mobile Learning Devices**

Handheld mobile learning devices had been upgraded significantly since the days of handheld four-function calculators. Experts continued to improve handheld technology such as iPods, smartphones, tablets, cell phones, iPads, personal digital assistants, music players, and handheld gaming systems (Bell, 2007; Pachler et al., 2010). Using mobile devices like the iPad was enticing to children in a Kaiser Family Foundation (2010) study; children 8 to 10 years of
age were found to spend a total of nearly eight hours a day with media, including television, music, computers, and video games. Elementary students enjoyed media use, and handheld mobile learning devices spread into the field of elementary education. (Pachler et al., 2010).

As with any instructional device, the mobile learning device must be used in conjunction with an appropriate instructional design to be effective (Ally, 2009). Since 2005, mobile devices became more portable, functional, productive, convenient, and less expensive (Pachler et al., 2010; Traxler, 2010). Mobile devices with Internet capabilities could be used to bring classroom studies to a bus stop, lunchroom, or living room instantly (Ally, 2009; Shuler, 2009; Traxler, 2009, 2010). Use of mobile devices such as 1:1 laptops and iPods have shown positive effects on middle school and college students’ learning (Bauleke & Herrmann, 2010; Jones & Sinclair, 2011; Weaver & Nilson, 2005), but no research was available on the effects of an iPad as a one-to-one computing device within elementary mathematics.

According to the NCTM (2011), technological tools that were used strategically help to support students in exploring and identifying mathematical concepts and relationships. More generally, technology tools helped to “increase students’ access to information, ideas, and interactions that can support and enhance sense making, which was central to the process of taking ownership of knowledge”. The NCTM additionally reports that prior research had been conducted to maintain the notion that learning, mathematical procedures, skills and the development of advanced mathematical proficiencies that include problem solving and reasoning are supported by the use of technology.

Based on the research about how students think, new educational approaches, and the integration of technology into educational systems, the last few decades had seen changes in mathematics instruction in many countries (Suter, 2006). With the constant advances in technology that was available for
instruction, educators strive to ensure that students acquire extensive knowledge using iPad devices, enabling them to integrate into the world of work and meet the demands of 21st century. It is crucial for pedagogical approaches for teaching mathematics to develop and advance alongside the progression of technology.

Prior research supports the notion that the integration of technology, more specifically, tablet devices, in the higher education classroom could help to support students’ learning, attitudes and overall achievement (Conn, 2012; Donovan, Green & Hartley, 2010; Holcomb, 2009). Utilizing 21st century teaching approaches that included technology could help students’ learn new knowledge (Prensky, 2012).

The inability to settle on a single definition of technology education was due in part to the multiple definitions given to technology. The search for clarity about what technology was, and consequently about what technology education might be, was essential. There was some concern, however, that a premature crystallization of ideas resulting in a single definition might serve to limit technology rather than to reflect the rich field it actually was (Todd, 1999). This continuing process of exploration was very important because, in a sense, technology education was still being invented. Layton (1994) suggested that we might be seeing a “subject in making,” but the exact shape it would take when it came of age was far from clear at this stage. Under the heading of technology education, one could find programs and approaches with widely varying goals, depending on where, how, and under what auspices the program was created. In a review of technology education in Western Europe, de Vries (1994) identified eight approaches that could be differentiated in relation to the following factors:

- The kind of activities that pupils carry out
- The way classrooms were equipped
- The way teachers were educated
- The social contexts by which the approach was stimulated
Gender aspects

The concept of technology that students acquired

The above factors based on those recognized by de Vries, illustrate the diverse range of approaches found not only in Europe but also in the United States and Australia, where various attempts at reform in technology education took place over the last two decades. These factors were not intended to represent accurately the practices in any particular classroom or region, but rather to highlight the different directions in which technology education developed in different settings. None of these approaches was ideal, but something could be learned from each of them.

The cornerstone of behaviorist learning theory was the idea that behaviors were learned (become habitual) as a result of reinforcement. This idea was not sufficient to form the basis for an instructional technology, however, because it dealt with the strengthening of behaviors already in the repertoire of the learner, whereas the central concern of instructional technology is to promote new learning. Although the early behaviorist theories advanced by Watson and Thorndike were influential as a source of general principles that teachers might apply, it was mainly through the work of Skinner (1968) that a genuine behaviorist technology of instruction began to develop.

The history of Education in the United Arab Emirates (UAE)

The United Arab Emirates (UAE) was comprised of seven emirates. Situated on the Arabian Gulf, east of Saudi Arabia and north of Oman, the UAE had a long history of local tribal lifestyle and of later European influences. The country dramatically emerged into the mainstream of modernism over the past 40 years. The economy was driven by oil and gas and recently tourism. There was a large expatriate population. In 1951, the Trucial States Council was formed, bringing all the leaders of the various groups throughout the region together. In 1971 the formal joining of the seven emirates (Abu Dhabi, Dubai, Sharjah, Ras-Al-Kahaimah, Fujairah, Umm Al-
Qaiwain, Ajman) was completed in Dubai. There were no political parties or elections since the country is ruled by appointed families established at the time of the forming of the UAE.

The major religion of the country was Islam. In Islam there are specific human rights that were universal. Those that had the most direct impact on the education system were:

- The right to equality.
- The right to social welfare and the basic necessities of life.
- The right to dignity, and not to be abused or ridiculed.
- The right of education.

The education system of the UAE was in comparison to other countries was relatively new. In 1952, there were few formal schools in the country. In the 1960’s and 1970’s a school building program expanded the education system with separate schools for boys and girls. This still largely exist today within the public schools. Primary education is now compulsory across the UAE and secondary education is available in most areas of the country. At the same time, many of the expatriates developed private schools to meet their religious, cultural and education needs. Today, both systems are operating in almost equal numbers throughout the UAE.

The curricula vary considerably, mostly influenced by the educational curricula from the UK, Canada, USA and India. The United Arab Emirates Ministry for Education and Youth was responsible for both the public and private education systems that operate within the country’s seven emirates. For the public school system, the Ministry for Education and Youth assumes a much broader set of roles, similar to Ministries of Education in other countries. They build new buildings, hire staff, determine the standards of education, provide curricular materials and support, coordinate a variety of educationally relevant activities and ensure adequate programs are operating. The relationship of the Ministry for Education and Youth with the private education
system are mainly in licensure and supervisory roles. They ensured that the basic requirements for the physical components of schools were met and that the private schools provided sound educational programs.

The Government is committed to the welfare of children. Children who are citizens receive free health care and education, and are ensured housing. A family also may be eligible to receive aid from the Ministry of Labour and Social Welfare for sons and daughters who are under the age of 18, unmarried, or disabled. For nationals of the UAE, all tertiary education is free. To encourage nationals to contribute to their country, individuals who decide to further their education are given a generous allowance even if they choose to study abroad. The school system follows a calendar based on the same summer break as many Western countries (July & August) is along with special holidays as set out by the Islamic calendar. With respect to students with special needs, the Ministry of Education and Youth is also involved through two separate departments; one for the private school system, the other for the public domain.

At the present time, a specific categorical system for identifying and supporting students with special needs does not exist in any formal way. The public system has staff at the upper Ministry level and in each of the regional divisions across the countries that are involved in supporting the special education system. Educational psychologists and speech-language pathologists provide school-based assessments and consultative support to schools. This is accomplished usually through a referral system generated at the school level. Selected clients for special supports are determined by a screening system.

Within most Ministry schools, counselors provide support for social-emotional needs. They also act as one of the front-line resources for identifying and referring students who may have special needs. The resource room programs provide intensive, small-group remedial instructional services in a pull-out system. Groups vary from two to about five students. The resource
rooms are staffed with teachers who have studied special education in the United Arab Emirates University in Al Ain (UAE) or by equally qualified individuals who are fluent in Arabic from other countries.

The Ministry for Education and Youth also operates a night-school type of program for people who have not completed their high school education. The degree of intensiveness varies according to the resources available within the local communities around the UAE. Individuals must be at least 19 years of age to qualify for attendance. A study across the emirates (Bradshaw 2003) is examining the attitudes of teachers and pre-service teachers towards the integration of children with special needs into regular schools across the United Arab Emirates. The participants of the study were asked to comment on how they feel about children with special needs being educated in the regular schools. The respondents were asked to indicate which category of children with disability they consider would be the most difficult to integrate into the regular classroom.

While the study is ongoing, the first phase of the study, within the Abu Dhabi Education Zone, had been completed. Preliminary data analysis from the information obtained from about 100 participants indicated common concerns such as teachers’ time taken away from the rest of the students, class size, safety of children with special needs, lack of training, and resources. Hall & Loucks (1979) described the seven levels of concern that teachers experience as they adopt a new practice. Student teachers appeared to be at the CONSEQUENCES stage they need programs, which dealt with a change in attitudes based on awareness of successful integration programs. This could be done through visits to schools; Discussions with people with special needs Strategies to avoid labeling and programs were available to assist in the integration process.

The ministry of Education adopted “Education 2020”, a sense of five-year plans designed to introduce advanced education techniques, improve
innovative skills, and focus more on the self-learning abilities of students. As part of this program, an enhanced curriculum for mathematics and integrated science was introduced at first-grade level for the 2003-2004 academic years in all government schools. Recognizing a constant need for progress, the UAE sought to implement and monitor high quality education standards by undertaking new policies, programs and initiatives.

Throughout the Middle East, educational advancement was often impeded by insufficient focus on the English language, inadequate provision of technology as well as modern techniques of instruction and methodology. Stressing the importance of “modern curricula with assorted and non-monotonous means of training and evaluation”, the Emirates launched ambitious campaigns to develop each of these areas. At its foundation, lies the necessary funding, which in 2009 was earmarked at 7.4 billion dirhams ($2 billion), as well as increased teacher training. Though its Teachers of the 21st Century and a two hundred million dirham shared of this budget, the UAE hoped to train 10,000 public school teachers within the next five years, while also pursuing its scheduled goal of reaching 90% Emiratisation of its staff by 2020.

In addition, the UAE government believes that a poor grasp of English is one of the main employment barriers for UAE nationals; as a first remedial step, the Abu Dhabi Education Council has developed the New School Model, a critical-thinking oriented curriculum modeled on that of New South Wales. This program was unveiled in September 2010.

In February 2006, the Prime Minister directed the education minister to take initial steps toward improving the quality of education, including the provision of permanent classrooms, computer laboratories, and modern facilities. In April 2007, however, in a major policy speech to the nation, the UAE vice president and prime minister stated that despite the steady increase in the education budget over the previous 20 years, teaching methods and curricula were obsolete, and the education system as a whole was weak. He
demanded that the ministers of education and higher education work to find innovative and comprehensive solutions.

In 1988, the first four Higher Colleges of Technology (HCT) were opened, in Abu Dhabi and Al Ain. By the academic year 2014–15, 17 campuses offered more than 75 programs, with a combined enrollment of more than 17,000 men and women. In 2003 Dubai established a dedicated education zone, Dubai Knowledge Village. The 1 km long campus brings together globally recognized international universities, training centers, e-learning, and research and development companies in one location. As of early 2007, it had attracted 16 international university partners, which include Saint-Petersburg State, University of Engineering and Economics, University of Wollongong, Mahatma Gandhi University, and the Manchester Business School. Some of these institutions have since moved to largest free zone in Dubai, Dubai International Academic City.

With state-of-art facilities and excellent support services, the Institute of Applied Technology (IAT) offers Career-based Technical Education (CTE) in English at the secondary and tertiary levels. In addition, IAT encompasses well-established higher learning programs in aviation, logistics and nursing. The Institute has an overall of twenty campuses (Fourteen Schools, Four colleges for Fatima College Health Sciences and two colleges for Abu Dhabi Polytechnic), located in the United Arab Emirates in Abu Dhabi, Al Ain, Western Region, Dubai, Sharjah, Ajman, Umm Al Quwain, Ras Al Khaima and Al Fujairah; with its directorate based in Abu Dhabi. The Institute was founded in 2005 through Royal decree of His Highness Sheikh Khalifa bin Zayed Al Nahyan, President of the United Arab Emirates, Ruler of Abu Dhabi as a corporate body with full financial and administrative independence.

Gladwyn A. Sandiford (2013) made a phenomenological study about the Technological use in Education delivery in Haiti. There was a lack of access to technology blended with face-to-face instruction and learning. Despite this lack
of access, some Haitian college students have nevertheless leveraged technology to overcome the obstacles of poverty and obtain a higher education. The study explored the lived experiences of 20 adult participants, consisting of 8 Haitian adult college students, 4 teachers, 5 information systems technicians, and 3 administrators from the Carrefour community of Haiti, to help reveal the reasons behind these successes. The theoretical framework included transactional distance education theory, social learning theory, and use of the technology acceptance model (TAM). Data were collected through interviews that were conducted over the telephone and face-to-face. The students also saw education as the only way to avoid involvement in crime and violence, and were motivated by the ability to use technology for research, collaboration, and problem solving. The findings of the study suggested that various forms of social media, such as Facebook, ooVoo and Skype, should be integrated in the classroom to narrow the education achievement gap in Haiti. The results of the study was helpful to promote, and encourage the implementation and usage of technology in blended learning classes and provides adequate training for teachers to increase technology adoption. This study was well taken cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Kristin H. Mayfield and Irene M. Glenn (2008) in their study on Interventions to facilitate Algebra Problem Solving, three participants were trained on 6 targeted algebra skills and subsequently received a series of 5 instructional interventions (cumulative practice, tiered feedback, feedback plus solution sequence instruction, review practice, and transfer training) in a multiple baseline across skills design. The effects of the interventions on the performance of 5 problem-solving tasks that required novel combinations of two or more of the target skills were evaluated. Results showed that cumulative practice of the skills and a combination of feedback with solution sequence instruction led to limited performance increases on some of the problem-
solving tasks, with one task meeting the mastery criterion following the solution sequence intervention. The introduction of the transfer training resulted in more consistent improvements across tasks such that participants achieved the performance criterion on all remaining problem-solving tasks during a final baseline condition. The findings suggest that a structured intervention designed to transfer stimulus control from previously established discriminative stimuli to more complex, novel stimuli could facilitate problem solving without extensive direct instruction on the higher-level skills. This study was well taken cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Kay Yong Khoo (2016) studied about how iPad apps could be used in the classroom to collaboratively promote construction of mathematical knowledge in children in ways that fundamentally transform the instructional environment. The study results identify how children enact viewing skills through digital texts to acquire new knowledge in their addition and subtraction learning. These skills enable children to externalise their understanding and internalise new meaning-making when interacting with peers. The problems presented to the participants were non-routine and immersive through externalising understanding with behavioural intensity and emotional quality at optimal levels. The subsequent enactment of the viewing skills led to the internalisation of the new knowledge. However, these dual reciprocal learning approaches require due consideration of elements of the learners’ personalities, the learners’ engagement in a learning activity and active involvement in associated learning processes. This study was well taken cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.
Hsin I., Yung and Fred Paas (2015) studied about the effects of Computer-Based Visual representation on Mathematics learning. Based on the assumption that visual representations can support deeper understanding, they examined the effects of visual representations on learning performance and cognitive load in the domain of mathematics. An experimental condition with visual representations was compared to a control condition without visual representations among primary school students. The hypothesis that learning with visual representations would result in higher learning performance and lower cognitive load than learning without visual representations was confirmed by their results. Also, they predicted the positive effects of visual representation on mathematics learning were partly caused by the fact that students had more fun and were more motivated to invest mental effort in the instructional materials. As Visual representation has been recognized as a powerful learning tool in many learning domains, in the present study the researcher has well taken the cognizance of by their results in developing the iPad Assisted Instruction for Mathematics at secondary level.

Frank Achtenhagen (2001) on the study about the Criteria for the development of complex teaching–learning environments, has tried to bring together recent theory and practice in instructional design, on the one side, and curricular as well as didactic research results on the other. The focus on processes those are necessary to the modeling of 'reality', with regard to the corresponding scientific description of goals and content-units and to the teaching and learning processes. The steps in the construction and implementation processes were visualized and discussed with reference to a complex teaching-learning environment. The author emphasized that the effective use of complex teaching-learning environments demands frequent formative evaluation processes, and also the tests and feedback should mainly come directly from the CD-ROM – which also should guarantee the reliability and validity of the items. In addition to the above the summative evaluation was also necessary. This study was well taken cognizance of by the researcher
to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Kaushal Kumar Bhagat, Cheng-Nan Chang and Chun-Yen-Chang (2016) studied about the Impact of the Flipped Classroom on Mathematics Concept learning in High school. They examined the effectiveness of the flipped classroom-learning environment on learner’s learning achievement and motivation, as well as to investigate the effects of flipped classrooms on learners with different achievement levels in learning mathematics concepts. A pretest posttest quasi-experimental design was employed for this study. A total of 82 high-school students participated in this study, divided into experimental and control groups. The experimental group (41) was taught trigonometry using the flipped classroom method, while the control group (41) was taught by traditional teaching methods. The researchers employed independent sample t-test, analysis of covariance (ANCOVA), and multivariate analysis of variance (MANOVA) to analyze the data obtained. Findings indicated that there was a significant difference in the learning achievement and motivation between the two groups, with students using the flipped classroom performing better. Further analysis showed a significant difference in the performance of low achievers in the experimental and control groups. This result was consistent with previous studies (Davies et al., 2013; Mason et al., 2013; Missildine et al., 2013). In this study students were asked to watch uploaded video lessons. Students accessed the videos at their convenient time and also re-watched the lessons, which was not possible in the conventional method of teaching. In addition, they found that the students were highly satisfied with and positive about the flipped classroom. This has resulted in greater learning motivation. Previous studies (Davies et al., 2013; Mason et al., 2013) have also provided the similar results. Also in the flipped classroom mode, the low achievers got more attention from the teachers, and they discussed the problems to understand the mathematical concept. This study was well taken cognizance of
by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Danah Henriksen, Punya Mishra and Petra Fisser (2016) studied on the Systematic view for Change in Infusing Creativity and Technology in 21st Century Education. They explored creativity alongside educational technology, as fundamental constructs of 21st century education. Creativity has become increasingly important, as one of the most important and noted skills for success in the 21st century. They offered a definition of creativity; as being a process of developing something that was novel, effective and whole (NEW) and they suggested that effective infusion of creativity and technology in education might be considered in a three-fold systemic manner: at the levels of teacher education, assessment and educational policy. They provided research and practical implications with broad recommendations across these three areas, to build discourse around infusion of creative thinking and technology in 21st century educational systems. They recommended that educators have to focus on both teaching creatively and teaching for creativity. They emphasized on different stakeholders to work together, for the broader goal of integrating creativity and technology in education in a system-wide manner, that we could hope for making a change. Also they insisted that the research, practice, and policy come together in an alignment, if all truly believe that creativity was important for the future of education. This study was well taken cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Hung Wei Tseng, Yingqi Tang and Betty Morris (2016) studied about iTunes U courses. The primary purpose of their research was to evaluate iTunes U courses based on instructional design strategies and the m-learning framework. A total of 27 iTunes U courses were selected and evaluated based on the following criteria: (a) The course is provided by institutions of higher
education; (b) the course should include instructional design components. The results revealed that all courses scored notably higher means on Content Chunking and Objective and Content Structure. However, all courses were rated low mean scores on the Instructional Strategies categories of the following attributes: Learning Engagement, Feedback, and Evaluation. Moreover, the results revealed that all courses scored notably higher means on one of the m-learning framework, which was Customization, and were rated low mean scores on the Conversation attribute. The overall conclusion of this study was that the selected iTunes U courses showed some strengths but considerable weaknesses in meeting the instructional design strategies and m-learning framework. This study was well taken cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Enver Tatar, Yılmaz Zengin and Türkan Berrin Kağızmanlı (2014) have done a non-experimental correlational research on the relationship between pre-service teachers’ perceptions regarding technology use in mathematics teaching and their computer literacy levels as well as their mathematics teaching anxiety. A total of 481 pre-service mathematics teachers constitute the sample of the study. The mathematics teaching anxiety scale, a perception scale for technology use in mathematics teaching, and the computer literacy scale were used as data collection tools. Based on the analysis of the obtained data, a low-level, negative and significant relationship was found between pre-service teachers’ mathematics teaching anxiety and their perceptions regarding technology use in mathematics teaching. Also a low-level, negative and significant relationship was found between pre-service teachers’ mathematics teaching anxiety and their computer literacy levels. They concluded that pre-service teachers’ mathematics teaching anxiety decreases as their perception levels regarding technology use in mathematics teaching positively increases and their computer literacy levels increase. This study was well taken
cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Maria de Lourdes Mata, Vera Monteiro, and Francisco Peixoto (2012) studied about how certain different but interrelated variables such as background, motivation, and social support could lead to an explanation of student attitudes towards math and to an understanding of the defining characteristics of these attitudes in the school environment. Participants consisted of 1719 Portuguese students, from fifth-to-twelfth grade. The study utilizes an adaptation of the “Intrinsic Motivation Inventory” assessing main determinants of intrinsic motivation. One section of the questionnaire—“In my Math Class”—also assesses student perceptions of teacher and peer support as well as student attitudes. The results revealed that, in general, students held positive attitudes towards mathematics and also highlighted the main effects of grade and math achievement on these attitudes. A hierarchical analysis using structural equation modeling showed that motivation related variables are the main predictors of attitudes towards mathematics and that teachers and the social support of peers are also highly significant in understanding these attitudes. This study was well taken cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Aparna Lalingkar, Chandrashekar Ramnathan and Srinivasan Ramani (2015) studied about how and why ontologies could be used for teaching problem solving in Mathematics at high school level. They focused on readable Ontology for teaching word problems in Mathematics. Except in some private coaching academies, regular classroom teaching does not include problem solving in mathematics, but was limited to mere practice exercises and drills of known exercises. For describing mathematical thinking, Schoenfeld, gave a framework containing four components: resources, heuristics, controls and
beliefs. Beginning in childhood learners develops ontology for the ideas they learn, and this ontology evolves as they continue learning. Ontologies used for teaching need to incorporate elements of mathematical thinking popularized by problem solving experts. So teaching that makes use of such ontologies of problems, problem-solving strategies, and tasks would be beneficial to students. Authors developed and evaluated the MONTO ontology for Surface Area and Volume (3D Solids) problems taught as part of the national curriculum in India, and the results obtained were satisfactory: MONTO was found to be 94% robust against unseen problems in different curricula for the same domain. This study was well taken cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Rim Razzouk and Valerie Shute (2012) in their study on design thinking defined the design thinking as an analytic and creative process that engages a person in opportunities to experiment, create and prototype models, gather feedback, and redesign. They summarized and synthesized the design thinking to: (a) better understand its characteristics and processes, as well as the differences between novice and expert design thinkers, and (b) apply the findings regarding the application of design thinking to our educational system. Having good design thinking skills could assist in solving really complex problems as well as adjusting to unexpected changes. Although the design process involves in-depth cognitive processes – which might help students build their critical thinking skills (e.g., reasoning and analysis) – it also involves personality and dispositional traits such as persistence and creativity. If the educators are serious about preparing students to succeed in the world, they should not require that they memorize facts and repeat them on demand; rather they should provide them with opportunities to interact with content, think critically about it, and use it to create new information. This study was well taken cognizance of by the researcher to have developed an Instructional
Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Min Liu, Cesar C. Navarrete and Jennifer Wivagg (2014) have done a case study investigation for two years at an elementary and a middle school level, on m-learning initiative by a large school district in the United States to provide iPod touch devices 24/7 to teachers and students of English Language Learners. The results revealed the iPod touch was used to support language and content learning, provide differentiated instructional support, and extended learning time from classroom to home. However, several challenges were identified such as significant time demand on the teachers, to find appropriate apps, developing lessons that would integrate the mobile devices, managing the devices by charging, synching, downloading, and updating, and dealing with technical issues. Other main challenges were encountering technological issues such as loss of Wi-Fi capacity, the need for professional training and dedicated support staff. This study was well taken cognizance of by the researcher to have developed an Instructional Design with an innovative technology enabled learning called iPad Assisted Instruction for Mathematics learning at secondary level.

Sarah Henderson and Jeff Yeow (2012) done a case study of iPad adoption and use in a Primary school, one of the first in the world to adopt it. The iPad’s large multi-touch screen, sleek profile and the ability to easily download and purchase a huge variety of educational applications make it attractive to educators. From interviews with teachers and IT staff, they concluded that the iPad’s main strengths are the way in which it provides quick and easy access to information for students and the support it provides for collaboration. Also they found that it was most preferred tool; because of its size, portability and lack of peripherals allow it to be easily moved around the school and the classroom. They observed that students were generally very eager to use the device, and able to pick it up and use it intuitively with little instruction. They inferred that the device could be used to support engagement
and collaboration amongst groups of students working on a project although
careful attention needs to be paid to ensuring that students don’t dominate the
device in a group situation, and to ensure they stay on task and don’t get
distracted. However, staff needed to carefully manage both the teaching and the
administrative environment in which the iPad was used, and they provide some
lessons learned that can help other schools considering adopting the iPad in the
classroom. This study was well taken cognizance of by the researcher to have
developed an Instructional Design with an innovative technology enabled
learning called iPad Assisted Instruction for Mathematics learning at secondary
level.

Chris Tisdell and Birgit Loch (2016) developed online video for
learning mathematics. Closed captioning of instructional videos was a topic
that was not seen much discussion despite its importance for hearing-impaired
students and recent legal ramifications if videos were not appropriately
captioned. In particular, it was unclear what best practice in captioning videos
should be to benefit all learners in disciplines such as mathematics with a
reliance on the development of visual explanation while providing audio
narration. In this study, it investigated the perceived level of usefulness of
captions and their automatic translations in a mathematics course. It discovered
that students broadly agreed that captions are a useful learning feature: to allow
flexibility of where and when a video was watched, but also to help understand
speaker accents, and clarify explanations that are difficult to hear in the
recording. Due to the high levels of use and perceived educational benefits of
closed captions in online video but limited literature, there was a significant
need for new research in this area. An urgent discussion was needed to explore
how students engage with closed captions, how they may support learning, and
to investigate implications on instructional design of mathematical videos. This
study was well taken cognizance of by the present study to have developed an
Instructional design with an innovative technology enabled learning called iPad
Assisted instruction for Mathematics learning at secondary level.

Eva-Lena Erixon (2016) did a case study on the learning activities and
discourses in mathematics through online technology. There is increasing
interest in the provision of online professional development (OPD) for teachers. This case study contributed to the field of research on professional development in the context of activities and discourses relating to mathematics teachers’ synchronous oral communication online. The purpose of this article was to explore the activities on offer in this communication and to identify the discourses that mathematics teachers might create in their meaning-making activities. An analysis of an online community in the form of a professional development course for mathematics teachers had, therefore, been conducted. The analysis showed that there was a lack of reciprocal participation and a shortcoming in creating a reflective learning environment, which could probably be partly explained by the specific mode of digital conversation. The discourses created by the mathematics teachers in their meaning-making activities focused mainly on sharing experiences about the teaching of mathematics. In fact the investigator of the present study had been teaching Mathematics at school level through iPad apps professionally since 2011. And iPad Assisted instruction was proposed to be developed for Mathematics learning and a case analysis might also be adopted.

Merrilyn Goos (2010) urged the use of effective technologies in the Mathematics classroom. This presentation considered the extent to which technology-related research, policy and practice might usefully inform each other in supporting effective mathematics teaching and learning in Australian schools. The first part of the presentation considered key messages from research on learning and teaching mathematics with digital technologies. The second part offered some snapshots of practice to illustrate what effective classroom practice could look like when technologies were used in creative ways to enrich students’ mathematics learning. The third part analysed the technology messages contained in the draft Australian curriculum – Mathematics and the challenges of aligning curriculum policy with research and practice. It is in this way, the present study analysed the effectiveness of iPad Assisted Instruction in Mathematics Classroom, which in turn pave the
way for further policy decisions and practice on different perspectives of the technology.

**History of Mathematics**

In the late 1980s, the National Council of Teachers of Mathematics (NCTM) created an infrastructure to frame the groundwork in ways to teach children mathematics. These curriculum standards stressed the importance of problem solving, communication, and connections. More specifically, a main focal point of the standards included the significance of mathematical reasoning so that students could make sense of mathematics. The NCTM firmly believed that mathematical reasoning; sense making, problem solving, and communication should be reinforced by technologies that support learning (NCTM, 2011).

Problem Solving in elementary grades mathematics was defined primarily as drawing on knowledge, skills, and experiences to engage in a task for which the solution method was unknown (NCTM, 2000). Throughout most of the nineteenth and early twentieth centuries, the traditional educational view of problem solving was for a teacher to teach a mathematical concept or algorithm to the class through direction transmission, gave the students multiple rote exercises to complete to practice the skill, and then, if time permitted, assign word problems that required students to apply the algorithm (D’Ambrosio, 2003; Mickelson & Ju, 2011). This format of simply applying a known algorithm to a problem in context did not fit NCTM’s current day definition of problem solving. Authentic problem solving required that the solution be unknown and the student must do more than simply insert numbers from the problem in a given algorithm (NCTM, 2009). This traditional format of textbook problem solving instruction had been found to be unsuccessful in improving the learning of students at risk of mathematical difficulties (Jitendra et al., 2007).
Educationally disadvantaged children need to be given equal educational opportunities at school, including opportunities to learn how to solve problems through reasoning, evaluate decisions for soundness, persevere through difficulty, and communicate decisions with other people (Kilpatrick & Swafford, 2002; Lester Jr. & Charles, 2003; National Council of Teachers of Mathematics [NCTM], 2000, 2004; Sutton & Krueger, 2002).

Mathematics class can offer an opportunity for children to explore problem solving in a non-threatening environment. When students were given opportunities to work through teacher-selected problems in a community situation in which teachers facilitated, rather than took over the problem solving process, students were guided to understanding (Sutton & Krueger, 2002). This pedagogical approach relied on discovering and building mathematical relationships and helped students create mathematics understanding and knowledge (Carpenter, Fennema, Franke, Levi, & Empson, 1999). Accepting that students could create their own understanding of mathematics, rather than it being taught to the student, allowed connections to be made between what the student already knew and new mathematical concepts (National Research Council, 1989; Sutton & Krueger, 2002).

National Council of Teachers of Mathematics (NCTM) (2000) proposed that students should have daily opportunities to describe, discuss, and defend their thinking in mathematics. Discussing thinking would give students’ opportunities to develop appropriate mathematical vocabulary, deepen understanding of mathematical concepts, and think about alternate ways to solve problems (NCTM, 2000).

In a recent study, Hartweg and Heisler (2007) used student discussion to allow the teacher to understand student thinking and using redirecting questions to clear up misconceptions, as well as to allow other students to question the problem strategies of their classmates. Their study found that even when students discovered another student’s error, respect was shown, and the
class worked as a whole to create mathematical understanding from misconception. Partner and small group discussions created the opportunity for students to learn questioning techniques, justify work, and clear up misconceptions in a respectful, comprehension-building manner (NCTM, 2000). Perseverance, critical thinking, reasoning, planning, and justifying thinking were all skills students develop through carefully crafted and guided mathematics problem solving experiences (NCTM, 2000).

To find success in careers as adults, students required to develop mathematical problem solving abilities in school (Kilpatrick & Swafford, 2002). In one of the newspaper interview, Jason Bagley, government affairs manager for Intel, the largest private employer in Chandler, stated that the main qualities his company looked for when hiring new employees was the ability to problem solve and creative. (“Intel Wants Cities”, 2010). The worldwide integration of information and communication technology (ICT) into education advanced significantly over the last two decades. People always tried to use technology to meet their needs and today new technologies appeared almost daily.

Educators, community, government and local authorities all place great importance on integrating ICT advances into education. Many current forms of information and communication technology could become effective teaching resources if used wisely and meaningfully. If used ineffectively they would waste considerable amount of money. Therefore it was important for educators to understand how to best use ICT in teaching and learning. If we do not understand the effective use of ICT in the classroom, expenditure on computers, software, whiteboards and the like will be meaningless in terms of teaching and learning. Many things, such as social, cultural, political, economic and educational changes, affect educational technology.

Hernes (2003) mentioned that computers were now being seen as essential family and workplace technologies due to our increasing reliance on
them. Hernes also noted that the methods in which hardware had been produced and worked were expressions of globalization and there was now widespread global recognition of brand names such as Microsoft, Apple, Panasonic, Sony, Intel and Nokia. The use of ICT has become more common during the last two decades with the existence of the Internet and World Wide Web. The Internet was fast becoming the largest collection of information in the world. Importantly, teachers could use the Internet to enhance teaching and learning, but this strategy needed to be well structured and sequenced (Pachler, 1999).

ICT has changed the quality of education and it is clear for many educators that students are changing by using ICT tools (Finger, Russell, Jamieson-Proctor, & Russell, 2007). Finger et al., (2007) stated that, “the evolution of computer technology can be described in terms of ‘yesterday’, ‘today’, and ‘tomorrow’. This is helpful in reminding us where we have been and where we are today, and for alerting us of the importance of adopting a future perspective”. In support of this view Forcier & Descy, (2002) commented: Any lasting changes and reforms would need to be preceded by a vision of what future learning environments will be like. What expectations will be placed on the learner? What will the role of the teacher be? What will the physical structure of the learning environment be? Finger et al. (2007) also mentioned that the term ICT became more widely used globally to replace earlier terms such as ‘technology learning’ and ‘information technology’. However, in the United States instead of using ‘ICT in education’, educational technology was referred to as: integrating technology and curriculum to support learning; delivery, development, and assessment of instruction; effective use of computers as an aid to problem solving; school and classroom management; educational research; electronic information access and exchange; personal and professional productivity; technical assistance and leadership; and computer science education (Jamieson-Procter, Watson & Finger, 2003).
Science learning is a critical objective of modern schooling. There are a number of promising approaches to effective science learning. Among these are newly evolving computer technologies and their applications. There are number of general relationships between current technologies and approaches to science learning that lead us to consider the opportunities that technology can provide for mathematics learning.

These relationships include the following:

- **Observation and reporting:**
  
  Science and math leaning requires that one can explain what one notices and how things work. Computer technologies are fine-tuned for word processing and media report construction (Computer based reports that might include pictures, video, interactive animation, etc.). Phenomena and Media. Science learning involves understanding phenomena in the world. Media technologies such as digital cameras and digital video editing software are designed to record, present, and manipulate phenomena.

- **Analysis and mathematical capabilities.**
  
  Science learning is based on mathematical and analytic principles. Computer tools support sophisticated mathematical manipulation and a range of analyses. Collaboration and network. Scientific inquiry thrives in environments rich with collaboration and data. Computer networks connect people to resources and to each other.

- **Technology Capabilities:**
  
  A range of Opportunities: A number of capabilities of computer technologies are relevant to science learning. Science teachers can choose among these when selecting technologies for use in math learning environments. Capabilities include:

  - **Calculation:** Technology provides tools for automating basic calculations.
  - **Education:** A key enabler to deliver UAE vision 2021.
The government counts much on education as one of key enablers to deliver the 2021 Vision and smart learning has been instrumental in harnessing the power of technology to drive the UAE’s educational agenda forward. In today’s competitive economy, the UAE recognizes the paramount importance of harnessing the potential of its human capital and building a knowledge-based society in order to compete effectively on the global stage. The recent education initiatives, launched by the Cabinet Retreat, are yet another huge stride forward for the UAE towards achieving an integral element of the UAE Vision 2021, and developing a truly world-class education infrastructure and workforce.

A rapid rise in population has necessitated a considerable investment in education. Today, the UAE, under the leadership of President His Highness Sheikh Khalifa bin Zayed Al Nahyan and Vice President and Prime Minister and Ruler of Dubai His Highness Sheikh Mohammed bin Rashid Al Maktoum, offers a comprehensive education to all male and female students from kindergarten to university, with education for the country’s citizens being provided free at all levels. There is also an extensive private education sector.

Much has been achieved since the early 1970s but efforts are now being made to improve the educational environment for all the pupils, in line with a re-evaluation of the role of government. Statistics showed that the number of government schools rose from 132 in 1972 to 685 in 2013 with student body of more than 305,000, while private schools increased from 18 to 489, enrolling over 605,000 male and female students. With education continuing to get increased national priority, 21 per cent, or Dh 9.8 billion of the 2014 budget of Dh 46 billion, has been allocated to both general and higher education sectors. It will be spent on improving the general education (Dh 6 billion) and academic excellence program in local universities (3.8 billion). New initiatives are being launched at all educational levels. A key area of focus has been to transform k-12 programs, to ensure that UAE students are fully prepared to attend universities around the world and compete in the global marketplace.
The Ministry of Education’s strategy is grounded on the UAE Vision 2021, which envisages that, a diversified and flexible knowledge-based competitive economy will be powered by skilled Emiratis and strengthened by world-class talent to ensure long-term prosperity for the UAE. Education reform focuses on better preparation, greater accountability, higher standards and improved professionalism. In addition, rote instruction is being replaced with more interactive forms of learning, and English-Language education is being integrated into other subjects, such as math and science.

The Ministry of Education (MoE) is leading the reform, while preserving local traditions, principles and the cultural identity of the UAE. The ministry is constantly honing its educational strategy to ensure that the programs developed in its schools comply with international standards, with particular focus on introducing the latest IT resources at all levels. The ministry, in partnership with Etisalat and Google, launched on October 2013 a major push into online education to develop hundreds of tutorials on You Tube aimed at alleviating the burden of private tuition. The partnership is aimed at grade 11 and 12 students.

Duroosi, or “my studies”, in Arabic, is a You Tube channel with 600 tutorials, covering a variety of subjects, and intended to help families cut back on the high cost of private tuition. This is the first time that Google, which owns YouTube, has partnered with an education ministry in the region to develop a dedicated channel on YouTube.

The Ministry of Education scanned all the important topics for grades 11 and 12 and brought the material to Etisalat, which produced the YouTube videos in Arabic. This is Etisalat’s first e-education project and the company is also looking to develop similar tutorials for other age groups. “Duroosi will revolutionize conventional education tools by providing instant and convenient options of learning. Students with access to technology nowadays want information at their fingertips”, said Saleh Al Abdooli, Chief Executive of Etisalat UAE.
“The project is also unique in that it allowed us to unite government and private players for a cause of national importance”. A Google executive said Duroosi will be easy to use and should prove popular. “These things are usually successful, users can access this curriculum from anywhere in the world on any device. You don’t need to wait till you get back home to open the book. You have it in a very interactive format with visual aids and you can go at your own pace and repeat it”, said Mohamad Mourad, Managing Director of Google Middle East and North Africa.

“The unique thing about this programme is it is endorsed by the Ministry of Education, this is only the starting point in bringing more and more (Arabic) content.” Humaid Mohamend Obaid Al Qatami, the Minister of Education, said Duroosi points the way ahead. “Smart education is a key point for the government and advanced infrastructure will play a critical role in the achievement of this mission. Such strategic partnerships and unique talent development tools are critical for establishing a knowledge-based, sustainable UAE in the near future,” Mr. Al Qatami said.

A raft of reform initiatives by the Ministry of Education were taking root, while preparations were being made to face new challenges ahead. From e-lessons, smart learning program, new teacher’s codes and evaluation systems as well as curriculum revision, the ministry continued to implement large-scale reform programs in public education. Through multi-pronged reform programs, the ministry’s overall goal is to bring qualitative improvement in the education system, which refers to the way teachers are teaching as well as the way students are learning.

Among the major initiatives taken shape in 2012 was the Mohammad bin Rashid Smart Learning Program that was launched in April by His Highness Sheikh Mohammad bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai. The program, which is intended to transform the way education is imparted, is being implemented in a
phased manner, and with a pilot phase is currently underway. The pilot is going really well with Grade 7 students from eight public schools, involving around 60 teachers and 700 students. The goal is to explore the implementation of Information and Communications Technology (ICT) in delivering quality education and build a sustainable model of ICT-enabled education system.

The AED* 1 billion program is part of the UAE Vision 2021 and will be introduced in four stages over five years, covering all public schools. Preparing the schools for the goal, the ministry in association with Etisalat is equipping around 400 campuses with the latest 4G networks, e-boards, smart tablets as well as e-contents, including the textbooks on iPhones, iPads and android platforms.

The Mohammed bin Rashid initiative for Smart Learning; a joint venture between the Ministry of Education (MOE) and the UAE Telecommunications Regulatory Authority (TRA) in cooperation with the UAE Prime Minister’s office, aims to create a solid and integrated e-learning platform that actively involves teachers, students as well as parents, thus enhancing the learning experience. Sheikh Mohammed emphasized, “Investment in education is an essential component of UAE Vision 2021.” We want to provide the new generations with the skills needed for the future of the UAE begins from schools,” said Sheikh Mohammed. The initiative, which is part of the UAE Vision 2021, is set to shape a new learning environment in public schools through the launch of smart classes that will provide every student with an electronic tablet and access to high-speed 4G networks, by 2017.

A Memorandum of Understanding (MoU) was linked in Feb.2013 between the UAE’s education initiative, Smart Learning and Samsung Gulf Electronics at BETT, the world’s largest learning technology conference, in London. The MoU outlines a framework for Smart Learning to tap into Samsung’s innovative digital convergence technologies to enhance its business

---

* AED - United Arab Emirates Dirhams (UAE’s Currency)
process efficiencies, and ultimately, create a world-class educational environment in the UAE. This follows Samsung’s successful involvement in the first phase of the pilot project for the ‘Mohammad bin Rashid Smart Learning Program in 2012’.

UAE is the second highest in students’ happiness index. The PISA 2012 results showed 85 percent of Dubai’s students reported that they are happy at their schools, above the global average of 80 percent. Students in UAE schools are much happier than their counterparts in the UK and USA, according to the results of a new global study. The happiness index for students conducted as part of the global Program for International Student Assessment (PISA) evaluation ranked the UAE second highest in the Middle East.

More than 500,000 students in 65 countries, representing 80 percent of the world economy, were included in the study and the UAE ranked well above the global happiness average. The study is conducted once every three years, with each round adopting a major focus on one set of learning skills. The PISA 2012 assessment focused on mathematics, with reading, science and problem solving included in the minor areas. “The UAE will never cease, even for one day, its quest for continuous development,” Vice-President and Prime Minister and Ruler of Dubai His Highness Sheikh Mohammed bin Rashid Al Maktoum said at the session. “If it had done, we could not have reached what we are today”.

3.3 Insights gain for a research gap

An approach of instruction known as Cognitively Guided Instruction (CGI), is an approach to teaching that focuses on student thinking. Moreover, mathematics instruction is directed by what students already know and comprehend, which provides a foundation for teachers to develop students’ mathematical understanding (Chambers & Lacampagne, 1994). A classroom that exhibits Cognitively Guided Instruction has students spending much of their time on problem solving activities and application of various
mathematical concepts. Students use their mathematical thinking and problem solving strategies to complete on their own instead of direct instruction from their teacher (Franke & Kazemi, 2001).

In addition to CGI, teacher questioning to elicit students thinking is an essential methodology that is necessary in Mathematics classrooms. The level of questions asked affects the level of understanding a student achieves. The principles and standards for school Mathematics (NCTM, 2000) highlights the prominence of asking questions to challenge students thinking. Questioning students in ways to give them a chance to justify their thinking in multiple ways will help to given them a deeper mathematical understanding.

In a study conducted by Wimer et al., (2001), it was found that higher level of questioning leads to higher levels of learning. Moreover, the questioning approach to teaching mathematics promotes the development of mathematical skills. This study has concluded that through the use of this questioning technique, students are able to make sense, reason, and apply mathematics. The integration of technology can help students in analyzing, evaluating and making sense of mathematics. Integrating technology will engage students and give them the power to gain deeper understanding of new learning (Sitkins, 2003). “Technology can be defined as any tool that can be used to help promote human learning, including but not limited to calculators, tablets (such as iPads), Smart Boards, Video cameras, Digital cameras, MP3 players, Portable Digital Assistants (PDAs), and of course, the computer” (Huneycutt, 2013). Technology has been shown to improve attitudes and achievement in mathematics (Christmann & Badgett, 2003; Grinager, 2006; Li & Ma, 2010; Sanchez, Zimmerman & Ye, 2004). There are many kinds of technology that can be incorporated into a classroom.

With the introduction of computers over 30 years ago, there is much research that supports the notion that technology can help transform teaching and learning (Falloon, 2013). Educational technology has been defined by
Grinager (2006) as “the use of hardware, software and other digital technologies to advance learning, teaching and administration in K – 12 and post-secondary settings” Educational technology has significantly evolved over time, which has changed the world in which we live (Grinager, 2006). Throughout the years, technology integration has looked differently as our society progress.

The technological transformation in education began in the 1980s with the introduction of the personal computer (PC), developed by IBM. It was at this time that the benefits of using computers to support the classroom were recognized by educators. The integration of computers into the classroom was an attempt to help bridge the gap between the needs of individual students and different classroom environments (Donovan, Green & Hartley, 2010). It is often the case that students are enthusiastic and eager to utilize technology in the classroom (Conn, 2012). In years past, desktop computers served as a method to engage students. Pilli and Aksu (2013), report on a study examining the effects of computer-assisted instruction of fourth grade students’ achievements, retention, attitudes towards mathematics, and attitudes towards computer-assisted instruction. In this study, an experimental group of students were taught using computers while a control group of students received lecture-based, traditional instruction. This study relates that students who were exposed to computer-assisted instruction significantly outperformed students who were exposed to traditional instruction on the achievement post-tests. Moreover, the findings also indicate that the results of a mathematics attitude scale test that students in the experimental group participated in, gained a more positive attitude towards computer-assisted mathematics learning.

As supported by the constructivist learning theory, students are the most successful when student-centered instruction is utilized and students take an active role in the construction of their own knowledge. Research has shown that integrating technology in the classroom can be used to promote students’ learning, attitudes and overall achievement (Enriquez, 2010). In order to
achieve higher student success that supports authentic learning, many schools are transitioning towards using tablet devices such as mobile tablets as a means of enhancing instruction (Hu, 2011; Murray & Olcese, 2011).

There are many research studies that support the link between effective instruction and student achievements (Konstanopoulos & Hedges, 2004). Guskey & Sparks (1996) convey that students’ mathematics deficiencies may stem from weak foundation knowledge and concepts that are necessary for a student’s success. Teaching children mathematics is more than using a good textbook, demonstrating with manipulatives or having students work in groups (Putnam, Heaton, Prawat & Remillard, 1992). More importantly, Putnam et al., (1992) convey that the mathematical instruction that students experience is shaped by the learning environment that affords children to actively engage in exploring ideas through problem solving. Vecellio (2013) express that there is a need to place an importance on mathematics instruction as a more robust way of exposing students to the content as opposed to the actual curriculum. The best way to reach students is in the way instruction is designed and delivered (Vecellio, 2013).

The above study gave an impetus to the investigator to study on the impact of iPad Assisted Instruction as cognitive tool on enhancing the Problem Solving Behavior of multicultural secondary level students at Fujairah – UAE. The investigator felt the need of iPad Assisted Instruction as Cognitive tool to improve the Problem Solving Behavior of Multicultural Secondary level students in Fujairah – UAE. Various insights gained form the review of related literature incorporation of iPad apps in teaching Mathematics, e-learning, online learning. The investigator choose iPad Assisted Instruction to find out the impact of iPad apps enabled instructional design on Mathematics Problem Solving Behavior of Secondary level students in Fujairah – UAE. This study is unique in determining the impact of iPad Assisted Instruction on Mathematics Problem Solving Behavior of Secondary level students of Fujairah – UAE.
This study threw a light for the investigator to gain momentum to develop a tool on iPad Assisted Instruction. Hence the studies reviewed in the present study paved a way for the development of key components of research design. Although the studies reviewed are pertinent literature to the present investigation, none of them has attempted to develop iPad Assisted Instruction for enhancing Problem Solving Behavior in Mathematics among the Secondary level students of Fujairah – UAE. The investigator basically being the Mathematics teacher made use of this research gap and attempted to develop an Instructional design using the iPad Assisted Instruction to make students to solve problems in Mathematics at ease without any phobia towards problem solving. To fill this research gap, the investigator attempted this positivistic research entitled as “Impact of iPad Assisted Instruction as cognitive tool on Problem Solving Behavior of Multicultural Secondary level Students in Mathematics at Fujairah – UAE”.