EXPLORING KUWAITI MATHEMATICS STUDENT-TEACHERS' BELIEFS TOWARD USING LOGO AND MATHEMATICS EDUCATION

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Copyright Statement

ABSTRACT

The main objective of this study is to explore the effect of one taught course, a Logo module, on Kuwaiti elementary mathematics student-teachers' beliefs about Information and Communication Technology (ICT) and Logo. The Logo module incorporated ICT, in particular the Logo programming language, as a cognitive tool, that supports the constructivist perspective for mathematics instruction

The Logo module comprised of 24-sessions (deducted from the hours of the Methods of Teaching Mathematics course) and was non-compulsory and non-credit bearing. It was developed and taught by the researcher during the Fall semester 2007 at the College of Basic Education in the State of Kuwait. The researcher was not employed by the College of Basic Education: his only relationship with the College was to conduct his research there.

The intention of the module was to give student- teachers the opportunity to experiment with a powerful innovation in a practical mathematics instruction context, both as students and as teachers, thus, enable them to reflect on and re-evaluate their beliefs about the nature of mathematics, the teaching and learning of mathematics, and using Logo as an ICT tool. The study explores how participation in the Logo module course may have influenced these beliefs and promoted more positive beliefs toward using ICT and in particular Logo programming language in their future mathematics classroom, and its potential to reform education and enhance students' learning. The fact that Logo is not used yet in Kuwaiti schools for mathematics education is one of the drivers of this study.

A mixed methodology was used, to explore mathematics student-teachers' beliefs. Two instruments for collecting quantitative and qualitative data were used to

explore student-teachers' beliefs prior to and following their participation in the Logo module:

1. A beliefs questionnaire, administered to thirty-two (32) mathematics student-teachers as a pre- and post-test;
2. A Semi-structured interview, administered to six (6) student-teachers as a pre- and post-test.

Specifically, data collected by these instruments, in this study, attempted to investigate and answer the following two key questions:

1. What are Kuwaiti mathematics student-teachers' beliefs about mathematics teaching and learning and the impact of ICT?
2. What is the effect of using Logo in a mathematics education course on Kuwaiti mathematics student-teachers' beliefs about Logo and the teaching of mathematics?

Analysis of the results showed a strong change in beliefs in support of the use ICT in general and in particular the use of Logo in their future mathematics instruction, as well as toward using constructivist teaching pedagogies.

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CHAPTER 1
INTRODUCTION

This research is based on data collected from 32 mathematics student-teachers prior to and following their practise in a Methods of Teaching Mathematics course that incorporated a non-compulsory non-credit-bearing Logo module, of 24 hour sessions, during the fall semester from September 2007 to January 2008 at the College of Basic Education in the State of Kuwait.

1.1 Original Contribution to Knowledge

This research will contribute to the field of mathematics education and the use of Logo programming language as an Information and Communication Technology (ICT) cognitive tool in mathematics education by:

- Clarifying Kuwaiti mathematics student-teachers' beliefs, accepting the sample was all female, about using Logo as an ICT cognitive tool for mathematics education since as of yet no study has been done on this topic in Kuwait.
- Clarifying Kuwaiti mathematics student-teachers' beliefs about the nature of mathematics, teaching mathematics, learning mathematics, the use of Logo for the teaching and learning of mathematics, and the use of ICT in mathematics education.
- Shedding light on Kuwaiti student-teachers' beliefs about integrating Logo in their future classrooms.
- Helping to build a more complete theory on mathematics student-teachers' beliefs about of the nature of mathematics, the teaching and learning of mathematics, and the use of Logo and ICT.

- Providing background and underlying data to assist the College of Basic Education to develop a strategy for student-teachers to use ICT and its cognitive tools such as Logo to help improve the teaching and learning of mathematics (especially in the schools of Kuwait).
- Providing background and underlying data to help the Ministry of Education to develop a scheme to incorporate ICT in general and Logo programming language in particular in the mathematics curriculum.
- Providing background and underlying data for further research on mathematics student-teachers' beliefs and mathematics teaching methods with the use of ICT.
- Providing background for further research to explore if using Logo in the mathematics classroom helps pupils learn more effectively in Kuwait.

1.2 Wider Context and Background Issues

Like many modern countries, the State of Kuwait views education as a keystone for the development and progress of individuals and society. Since the beginning of the 20th century, Kuwait has accorded a great deal of attention to education; a centralized body called the Ministry of Education (MOE) sets the educational standards for the country and oversees the system of public and private education throughout Kuwait. However, in spite of the fact that mathematics is considered an important part of the school curriculum in Kuwait, both national and international benchmarks show that Kuwaiti learners, (grade 4, 5, 8 and 10 to 12), lag far behind in mathematics. Kuwaiti students are ranked at or near the bottom of mathematics achievement scales. The international comparisons of the achievement surveyed by the Trends in International Mathematics and Science Study ( ) and the

International Mathematics Olympiad (IMO) revealed an astonishing result about students' attainment; Kuwaiti student levels are placed at the end of the overall rank order of the countries in the survey (TIMSS, 1995, 2007; IMO, 1982-2010). A recent national study (Eid and Koushki, 2005) has also confirmed that students, (grade 12), have comparatively poor grades in mathematics.

As part of its education strategy, between 1986-87, the MOE developed an ICT education program in secondary schools with the aim of providing awareness of computer technologies. By the mid-1990s, the addition of Information Technology (IT) courses to the intermediate school curriculum was initiated, and in the 2004-2005 academic year, the curriculum was extended to include primary schools as well. The intent of such IT programs was to introduce students to IT functions such as email, the Internet, and basic computer usage.

However, Kuwait's ICT standard was neither initially intended, nor later expanded, to specify the use of ICT to augment or enhance subject curricula such as mathematics. In the last two decades, many revisions to mathematics education strategies have been made in other countries as a result of research and findings about the benefits of incorporating ICT in the classroom; nevertheless, Kuwait has continued to keep ICT, including programs such as Logo, and the subject disciplines as separate and unrelated entities. Benefits of integrating technology into the classroom, have been documented by several researchers such as Murchie (1986); Hoyles and Sutherland (1989); Clements and Sarama (1997); Ying-Shao, Yeong-Jing and Guey-Fa, 2003; Glazer (2004); Lindroth (2006); Lin (2008a and b).

Kuwait's teaching methodology remains based in the traditionalist teaching model, employing a rote-method teaching style (Alajmi and Reys, 2007). However, many mathematics educators in other countries have migrated to constructivist teaching strategies based on research findings that espouse the benefits, to teachers and students, of this teaching strategy (Acredolo, 1997; Bickhard, 1997; Berger, 2005; Steele, 1999; Marsigit, 2009).

Researchers such as Hersh (1986),Wilcox et al. (1990), Thompson (1992), Ernest (1996), Norton, McRobbie and Cooper (2000), Peter (2005), Speer (2005) Golafshani and Ross (2006), and Levin and Wadmany (2006), have provided significant evidence to show that teachers' and student-teachers' beliefs about the nature of mathematics, and the teaching and learning of mathematics, are deep-rooted ideas formed as a result of their previous experience as learners or professionals, and that these influence the teachers' classroom practise and their integration of ICT into subjects. Hersh (1986) has emphasized that individual teachers' conceptions about the nature of mathematics would influence how they teach: "one's conceptions of what mathematics *is* affects one's conceptions of how it should be presented" (p.13).

This study grew from the wish to investigate whether the use of the Logo module in a hands-on constructivist teaching environment would provide an opportunity previously not experienced by the student-teachers whereby they could have both a teaching and learning experience that might lead them to re-evaluate their existing beliefs as future mathematics educators.

In order to investigate the issues of ICT and the use of programmes such as Logo in mathematics teaching, and the nature of beliefs about both mathematics and the teaching and learning *of* mathematics, the study attempted to answer the following two key questions:

1- What are Kuwaiti mathematics student-teachers' beliefs about mathematics teaching and learning and the impact of ICT?

2- What is the effect of using Logo in a mathematics education course on Kuwaiti mathematics student-teachers' beliefs about Logo and the teaching of mathematics?

To accomplish this, the study investigated the following hypothesis:

It will be shown that some Mathematics student-teachers in Kuwait change their guiding educational belief after using the Logo programming language in the Methods of Teaching Mathematics course. The student-teachers will gravitate away from the traditionalist approach towards the constructivist approach, with potentially far-reaching implications for student-teacher training courses in mathematics and teaching of mathematics in schools.

1.3 Personal Context and Motivation for this Research

During the pursuit of my Master's degree in the United States in the late 1990s, I was exposed to a body of literature in support of constructivist principles and the use of ICT as part of an integrated learning strategy for mathematics education, which was vastly different from the method of teaching mathematics in Kuwait. In my experience in Kuwait as a mathematics teacher, prior to my graduate research, I had made some effort to change the existing traditional-based teaching model for mathematics, but at that time I was not well enough versed in the pedagogical tools that could be applied in a different teaching model. I believed that teachers and student-teachers constructed their beliefs about mathematics and its teaching and learning based on their own experience as students. The development of my own initial beliefs about mathematics had been formed based on the way I viewed and interacted with my mathematics teachers and the way I experienced the mathematical skills they taught me. Initially, my own education method was also influenced by my previous teachers' methods and included a personal construction of methods which I believed to be ideal in my classrooms. Following receipt of my Masters degree in Computer Information Systems at the Florida Institute of Technology in 1999, I was keen to set about examining whether a different teaching model, such as constructivist teaching when coupled with ICT and Logo would affect long-held traditional teaching and learning beliefs in Kuwaiti mathematics education.

As a result, the focus of my research was to develop and present mathematics education instruction that incorporated ICT, in particular Logo, as a cognitive tool for constructivist learning to a group of mathematics student-teachers enrolled in a course entitled Methods of Teaching Mathematics at Kuwait's College of Basic Education. Through participation in this course, which I taught, these mathematics education students had the opportunity to use Logo, both as students and through peer-to-peer teaching, following principles of constructivism.

1.4 Organization of this Dissertation

This dissertation is organised into chapters. Chapter 1 includes the background issues, context for this research, and organization of the study.

Chapter 2 contains a brief history of the State of Kuwait as well as a discussion of the development of its system of education, mathematics education and ICT in Kuwaiti schools, student- teacher education programs in Kuwait, the use of ICT as a cognitive tool, in particular the Logo programming language in Kuwait's teacher education programs, and Kuwaiti mathematics teachers' and student-teachers' beliefs.

Chapter 3 contains a review of the literature related to teachers' beliefs, including a definition of beliefs, a description of how beliefs versus knowledge are measured, and strategies that can be employed to effect change in beliefs. The chapter also sheds light on teachers' beliefs about the nature of mathematics and mathematics education, including how beliefs affect instruction. Teachers' beliefs and their relation to ICT are also explored. Critical topics that can affect or impede change, such as the effect of workshops and training as well as challenges or barriers that may affect one's ability to teach with ICT, receive attention. The literature review examines theories of constructivism, with specific focus on the theories of Piaget and Vygotsky, the implications of a constructivist philosophy for mathematics education, and criticisms of constructivist theories. The chapter attempts to consider the concepts of belief systems, constructivism, and ICT in an integrated way. The chapter ends with a discussion of Logo, and how it supports the development of mathematical knowledge and understanding of education.

Chapter 4 addresses the research design, ethics and methodology used in this study. The research design, rationale for selection of research methods and participants are described. It also contains a description of the beliefs questionnaire administered to the study participants, and information about the questionnaire validity and reliability, translation issues and the pilot study are included. A semi-structured beliefs interview was also administered as part of this study; discussion related to this instrument, including validity and reliability, translation issues, and the pilot study is included. The chapter concludes with procedures used for data collection and data analysis.

Chapter 5 examines the Logo module course, and includes the rationale for its selection and a description of the discrete sessions used to administer the Logo module parts.

Chapter 6 provides an analysis of these data and a discussion of the findings revealed by the data analysis. Pre-test and post-test findings about traditional and constructivist views are given, as well as views about Logo and ICT. Provided are Chronbach's Alpha and inter-item correlations for the questionnaire reliability, paired-samples t-test for equality of means, as well as mean, standard deviation and t-test results. The results of the hypothesis and null hypotheses are also presented. The chapter concludes with findings related to the interview analysis, including pre-test and post-interview responses.

Chapter 7 is the final chapter for this study, and contains a summary and conclusions about the findings uncovered in the pre-test and post-test beliefs questionnaires and interviews. Lastly, recommendations for Kuwaiti teacher education programs and the Kuwaiti school system are included, as well as recommendations for future research, a discussion of the limitations of this study, and reflections on my experience gained as a result of this work.

CHAPTER 2
EDUCATION SYSTEM IN STATE OF KUWAIT

2.1 Introduction

The aim of this chapter is to shed light on the state of Kuwait and its education system to provide the readers with background knowledge about the state of Kuwait, as well as its education system which might be dissimilar to other countries' education systems. In addition, it explains better what this study about.

This chapter contains the following sections: a brief history of Kuwait, the development of Kuwait's system of education, mathematics education in Kuwaiti schools, ICT in the Kuwaiti Schools, student-teacher education programs in Kuwait, the use of ICT as a cognitive tool, in particular Logo programming language in Kuwait's student-teacher education programs, and Kuwaiti mathematics teachers' and student-teachers' beliefs.

2.2 A Brief History of Kuwait

Kuwait, officially the State of Kuwait, as an independent political entity dates back almost four centuries. Despite its small size, Kuwait maintains a significant global importance as a major exporter of crude oil and natural gas. The country of Kuwait, which is only 6,880 square miles, extends from north to south along the Arabian Gulf for 120 miles, from east to west for 110 miles and has nine offshore sovereign small islands in the Persian Gulf. It is situated northeast of Saudi Arabia, south of Iraq and in the northern end of the Persian Gulf.

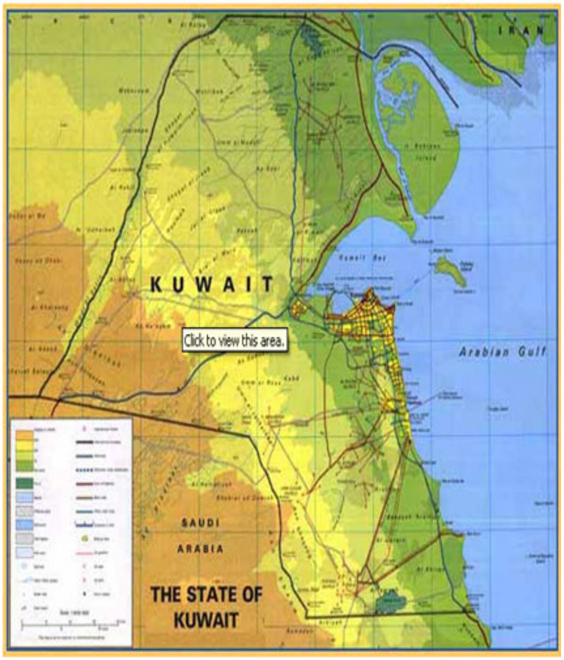

Figure 1. The State of Kuwait

(Adapted from Kuwait Information Office, 2011)

This small country has an estimated population of 3,566,437 (The Public Authority for Civil Information (PACI), 2010) of this, 48 percent are younger than 25 years, and there is a very high population growth, rated at 2.4 percent in 2009 (World Bank. 2009). In this Islamic country, Kuwaitis consider Islam as their religion, philosophy, and lifestyle (Al-Ahmad et al. 1987, cited in Al-Enezi, 2002). Kuwait was originally inhabited by different Arab tribes. It has been ruled by the Al-Sabah family since 1756 when Sabah Bin Jaber was elected as the Amir of Kuwait to administer justice and the affairs of the town; his descendents continue to rule to this day (Kuwait Information Office, 2007; Al-Diwan Al-Amiri, 2009).

In 1897, Kuwait obtained British protection in response to Sheik Mubarak Al Kabeer's fears that the Turkish Empire would expand its hold over Kuwait. On the 19th of July 1961, British protection ended and Kuwait became an independent country. In that same year, on the following day, which is the 20th of July, Kuwait joined the Arab League and in 1963, Kuwait became a member of the United Nations (Infoplease, 2007; Al-Diwan Al-Amiri, 2009).

Although oil was discovered in 1938, export did not start until 1946. Following the Second World War, oil became the major source of income. The resulting massive inflow of oil funds were spent developing the country's infrastructure and improving living standards. In 1956, Kuwait City was redesigned beyond its ancient walls, and a modern infrastructure rose from the arid desert: roads, cities and suburbs, ports, factories, power generating stations, and desalination plants that had never previously existed came into being.

2.3 The Development of Kuwait's Education System

Like many modern countries, Kuwait has viewed education as a keystone for the development and progress of individuals and society. Kuwait has accorded education a great deal of attention since the beginning of the 20th century, prior to the discovery of oil in Kuwait, to keep its society economically and culturally strong (AL-Sahel, 2005). In the early 1900s, and until the discovery of oil in 1938, there were very few informal educational facilities in the country. A small number of Quranic centres were convened in homes known as Al-Katatib where, for a small payment, men tutored boys and women tutored girls in reading, writing, and basic arithmetic (Ministry of Education (MOE), 2007).

In 1911, the first school, called Al-Mubarkiya School, was established for boys, followed by the establishment of the Al-Ahmadiya School in 1921. However, both schools concentrated merely on arithmetic and other subjects such as religion, reading, writing, and history. Kuwaiti teachers, as well as teachers from Palestine and Egypt who were hired because of a shortage of Kuwaiti teachers, taught in those schools. As a result of the development of the educational system, a need arose for a central body to supervise the development of a system. In 1936, the Council of Education was established. Its responsibility was to supervise the development of the educational system and maintain its standards. In 1938, the education system was extended to accommodate the first school for girls, called Al-Wosta School, and also the opening of the first private school; the number of students reported at that time was 146 girls and 620 boys (MOE, 2007).

As mentioned above, the development of Kuwait can be largely attributed to the wealth that oil funds have brought to the country since its discovery in 1938. This wealth has led to changes in almost all aspects of life, and in particular formal education. More schools were established and the number of students enrolled in schools grew at an accelerated rate. For example, in the academic year 1945-1946, the number of schools increased to 12, and the numbers of students enrolled were 3635, among whom were 2815 boys and 820 girls (MOE, 2007). In 1956, the government adopted a major education plan that divided formal education into four categories: First, kindergarten with a duration of two academic years; second, primary with a duration of four academic years; third, intermediate with a duration of four academic years; and fourth, secondary with a duration of four academic years. In addition, it called for free education to cover all four stages and compulsory education to be required for the first eight years of schooling, covering primary and intermediate education (age 6-14 years) (Kuwait information office, 2007). In 2004, as a result of educational reform efforts, the duration of school years changed from 4-4-4 to 5-4-3 and the age-range for compulsory education was changed to 6-15 years (MOE, 2004).

In Kuwait, both public and private schools have same structure. Except for the kindergarten years, separate schools exist for male and female students; however, the curriculum and the school years are the same for both.

Kuwait has a strong commitment to education. In fact, 4.8 percent (2005 estimate) of its gross national product is spent on education (Brown, 2007). Citizens of Kuwait “do not pay taxes, not even to fund public education, because the government fully subsidizes the budget for Kuwait’s education via the centralized Ministry of Education” (Al-Enezi, 2002, p. 17).

Oil funds have permitted Kuwait to develop an extensive educational system, with a total number of 305,080 students in 779 schools (MOE, 2009), categorised as follows:

- 197 Kindergarten schools, accommodating 42305 boy and girl students.
- 286 boys schools for other stages (primary, intermediate and secondary), accommodating 165592 students.
- 493 girls’ schools for other stages, accommodating 181830 students.

In addition, teachers number 57694, divided as follows:

- 4975 female teachers for Kindergarten.
- 13429 male teachers, for other boys schools stages.
- 39290 female teachers, for other girls schools stages.

It also was recognised that Kuwait has achieved a literacy rate of 98.4 percent for 15-24 year-olds (World Bank, 2007).

Before 1966, the Ministry of Education sent Kuwaiti students abroad to pursue higher education, as no universities or higher learning institutions existed in Kuwait. However, in order to meet the ever-increasing demand for higher education by Kuwaiti students as well as the country’s need for well-trained professionals, the

Kuwaiti leadership realised that greater efforts had to be made. Therefore, in 1966 Kuwait University was established with the aim of providing academic, professional and technical development, and supplying the country with scientifically and practically qualified manpower in different fields. In response to the need to develop and upgrade Kuwaiti manpower and to meet the challenge of shortage in Kuwaiti technical's manpower which was created by expansion of the industrial and economical development of the country, The Public Authority for Applied Education and Training (PAAET) was established in 1982. It aimed to fulfill this need through its four colleges: College of Basic Education, College of Business Studies, College of Technological Studies and the College of Health Sciences (Kuwait Information Office, 2007).

2.4 Mathematics Education in Kuwaiti Schools

As with many other countries, mathematics is held in high esteem in the Kuwaiti education system. Hussein (1987) wrote concerning the development of the Mathematics curriculum in Kuwait, and pointed out that until late 1950s Kuwait completely depended on Egypt to author textbooks for mathematics and other subjects.

In 1969, a project aided by UNESCO named "School Mathematics in Arab Countries" revealed a rapid expansion of education in the Arab states, yet confirmed that mathematics curricula was traditional and methods of teaching mathematics were characterized by rote learning rather than creativity; mathematics textbooks were unsatisfactory, and a shortage of trained mathematics teachers existed. By the end of 1960s, UNESCO aided another project whose aim was to rewrite textbooks and develop mathematics in Arab states. As a result, in 1971 two secondary schools in Kuwait started teaching modern mathematics using a new curriculum and new textbooks (UNESCO, 1969). According to Hussein (1987), by 1974 all secondary schools were teaching modern mathematics in all classes.

The Ministry of Education, which sets the educational goals for Kuwait, considers mathematics an important discipline to be taught and learned; nevertheless, the fact remains that the Kuwaiti educational system is confronted with the sad reality of Kuwaiti learners' poor performance in mathematics; both national and international benchmarks show that Kuwaiti learners, (grade 4, 5, 8 and 10 to 12), lag far behind in mathematics. Kuwaiti students are ranked at or near the bottom of mathematics achievement scales. The international comparisons of the achievement surveyed by the Trends in International Mathematics and Science Study (TIMSS) and the International Mathematics Olympiad (IMO) revealed an astonishing result, shown below in Table 1, about students' attainment; Kuwaiti student levels are placed at the end of the overall rank order of the countries in the survey (TIMSS, 1995, 2007; IMO, 1982-2010).

Table 1. Kuwaiti Students Rank on the 15th IMO 2010

Country	**Team size**			**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**Total**	**Rank**	**Awards**			
	All	**M**	**F**									**G**	**S**	**B**	**HM**
People's Republic of China	6	5	1	41	42	23	42	24	25	197	1	6	0	0	0
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bolivia	4	3	1	5	1	0	2	0	0	8	94	0	0	0	0
Montenegro	4	4		0	0	0	7	0	0	7	95	0	0	0	1
Kuwait	5	5		1	1	0	0	0	0	2	96	0	0	0	0
Democratic People's Republic of Korea	6										Disqualified				

A recent national study (Eid and Koushki, 2005) has also confirmed that students, (grade 12), have comparatively poor grades in mathematics. The other fact is that Kuwaiti students are still taught mathematics by rote learning and memorization (Alajmi and Reys, 2007) rather than, for example, creatively through constructivist learning methods with the use of ICT programs, in particular, Logo. Alajmi (2009) also stated, “In all schools from elementary through high school, mathematics teachers in Kuwait follow the national textbook series and the curricular plan of the Ministry of Education about what, when, and how to teach mathematics. Therefore, there is little variation in what is taught in their classrooms” (p. 266).

Besides these facts, MOE has confirmed that Kuwaiti students’ underachievement in mathematics can be attributed to traditional methods of teaching, which are characterized by rote learning and memorization and which do not incorporate ICT programs (Al-Turkey, 2006a,b), nor ICT tools such as Logo. In addition, the MOE has noted that educational reform in the above aspect will be its priority in developing education in Kuwait.

2. 5 Information and Communication Technology (ICT) in Kuwaiti Schools

Al-Sadoun and Haj-Issa (1993) commented that the “Kuwaiti Ministry of Education has realized the potential and importance of computers to education since 1980s” (p. 135). They also noted the development of ICT implementation in secondary schools. Al-Sadoun and Haj-Issa clarified that in 1986-1987, Kuwait MOE started its gradual implementation of ICT education programs in secondary schools with the aim to provide ICT awareness. Presently, all Kuwaiti secondary schools have ICT education courses. During the 1994-1995 year, as a result of Kuwait Intermediate School Information Technology Project (KISITP) developed by MOE, the official addition of IT courses to the intermediate school curriculum was initiated. The initial implementation was in four intermediate girls’ schools with the aim of teaching students about IT (Al-Furaih et al., 1997, cited in Almahboub, 2000). At present, all students, boys and girls, in the intermediate schools study IT.

Following the implementation of ICT in the secondary and intermediate schools, the MOE concerned itself with the implementation of ICT in primary schools. As a result, the Project of Computerizing the Education in the Primary Stage was the product of MOE's concern for ICT dissemination in all primary schools (MOE, 2007b). The project reached its aim in implementing ICT education and computerizing all primary schools in the 2004-2005 academic years.

According to the Ministry of Education (MOE) (2007a,b,c), the general objectives for the implementation of ICT in Kuwait schools can be summarized as follows: students should

1- Acquire awareness of the computer and its components, hardware/software, and the skills of operating the computer and uses its component.
2- Use ICT tutorials such as drills and practise and simulation games to enhance and support their learning throughout the various subject areas.
3- Acquire awareness of ICT innovations such as the Internet and the E-mail as well as master the ability to use them and employ them as a tool for serving their learning.
4- Employ ICT applications such as MS Word, MS Excel, MS Paint, MS PowerPoint, and MS Publisher as a tool to support their learning and help them in their everyday life.
5- Utilize ICT to develop students' skills of problem-solving and their analytical thinking through the use of Logo programming language and Excel.
6- Use ICT to encourage students' cooperative and collaborative learning.

The implementation of ICT confirms the Ministry of Education's commitment to provide Kuwaiti students with a high standard of education through it educational reform strategy, yet ICT in Kuwaiti schools is considered as a subject to be taught independently; the inclusion of ICT applications, in particular Logo programming language, as a tool for constructivist learning in other disciplines such as mathematics is not addressed within the above-mentioned objectives.

2.6 Student-Teacher Education Programs in Kuwait

In Kuwait, the MOE depends on two main institutes to prepare qualified national teachers for the field of education. These two institutes are related to different educational establishments as follows: the College of Education, which is part of Kuwait University, and the College of Basic Education, which is part of The Public Authority for Applied Education and Training (PAAET). The College of Education provides programs that include courses to prepare Kindergarten, Primary, Intermediate and Secondary stage teachers in mathematics and other subject areas. In contrast, the College of Basic Education within the last few years discontinued its Secondary stage program, and now provides programs that include courses to prepare Kindergarten, Primary, and Intermediate stage teachers in mathematics and other subject areas. In addition, the College of Basic Education has added a new program to prepare ICT teachers. At both institutes, student-teachers must complete four years of study in order to obtain a Bachelor's degree in Education.

2.7 The Use of ICT as a Cognitive Tool, in Particular Logo Programming Language, in Kuwait's Student-Teacher Education Program

Currently, in both the College of Education and the College of Basic Education, there is no plan in place to implement ICT, in particular the Logo programming language, as a cognitive tool, either in the mathematics student-teacher preparation program or in other subjects. In addition, Kuwaiti mathematics student-teachers at the College of Basic Education, where the empirical study was conducted, have no training or experience in the use of Logo programming language as an ICT cognitive tool for constructivist learning in mathematics instruction. In fact, general instruction (Farjon, 2007; cited in Al-Salama, 2007) and specifically the methodology course called Methods of Teaching Mathematics are still based on traditional methods of teaching which are characterized by rote learning and memorization and with no use of Logo programming language. Furthermore, no research has been conducted to explore the beliefs of Kuwaiti elementary student-teachers at the College of Basic Education about the use of Logo programming language as a cognitive tool for constructivist learning in their future mathematics instruction.

2.8 Kuwaiti Mathematics Teachers' and Student-Teachers' Beliefs

Alajmi and Reys (2007) wrote, "Little is known about Kuwaiti mathematics teachers' views of the mathematics they teach or the way they teach it" (p. 79). They pointed out that Kuwaiti teachers teach mathematics using traditional methods and their focus is on following standard algorithms and finding exact answers. Beaton et al. (1996), cited in Alajmi and Reys, 2007), showed that approximately 70 percent of Kuwaiti mathematics teachers of intermediate stage believed that memorizing formulae and procedures is important in learning mathematics. In contrast, less than 50 percent of the teachers believed that creative thinking and the ability to provide reasons to support conclusions are important.

According to my experience as a mathematics and ICT teacher, it is my opinion that Kuwaiti teachers' and student-teachers' beliefs would be varied and can be linked to Ernest's (1991) categories of mathematics education ideologies: First, the "industrial trainer" ideology views mathematics as a body of true facts, skills and theories. Learning of mathematics can be achieved by paper and pencil work, drill and practise, and rote learning and memorizing. Hence the teacher's role is to transmit mathematical knowledge as a stream of facts to be learned and applied. Finally, the "old humanist" ideology perceives mathematics as a body of pure structured knowledge. Students learn mathematics through reception and understanding of a large logically structured body of mathematical knowledge and the modes of thoughts associated with it. The teacher's role is that of lecturer and explainer, communicating the structure of mathematics meaningfully. For both ideologies, teaching-aid tools are comprised of magnetic boards and visual aids, with no use of ICT programs, and this can be found in Kuwaiti schools as well.

In fact, by analysing and evaluating my own beliefs about mathematics, the teaching and learning of mathematics based on my experience as a mathematics and ICT teacher and my reading during my Master's degree and the current review of literature, I have come to the view that teachers and student-teachers construct their own beliefs about mathematics and its teaching and learning based on their own experience as students. In addition, I would say that the development of my own beliefs about mathematics and the teaching and learning of mathematics is based on the way I viewed and interacted with my teachers in their instruction and experienced the mathematical skills the way they taught me. Furthermore, in my opinion my own instruction method was also influenced by my teachers' methods and includes a personal construction of methods which I believed to be ideal in my classrooms. This view can be linked to the views of researchers such as Hersh (1986) Wilcox et al. (1990), Thompson (1992), Ernest, (1996), Norton, McRobbie and Cooper (2000), Peter (2005), Speer, (2005) , Golafshani and Ross (2006) and Levin and Wadmany (2006) who state that teachers' and student-teachers' construction of beliefs about the nature of mathematics, and the teaching and learning of mathematics as well as the use of ICT, is formed as a result of their own previous experience. From this we can conclude that this could be applicable in general to other teachers and student-teachers as well as to Kuwaitis.

2.9 Summary

This chapter provided a brief background to the context of this study. A brief historical background of Kuwait and the development of its system of education were presented. In addition, the teaching of mathematics and the status of ICT in Kuwaiti schools, along with the student-teacher education program and the failure to use ICT as a cognitive tool with special emphasis on Logo in student-teacher education programs was discussed. The context of the beliefs of present mathematics teachers and student-teachers also came under discussion. The next chapter will shed light further light on these issues through an expanded literature review.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

The aim of this literature review is to examine the specific topics that are pertinent to my study: teachers' beliefs, constructivist theories, and how they relate to teachers' beliefs, mathematics education and ICT; and how Logo supports the development of mathematical knowledge.

The chapter begins with a general discussion of teachers' beliefs, including a definition of beliefs, a description of how beliefs as apposed to knowledge is measured, and strategies that can be employed to effect change in beliefs. The chapter next sheds light on teachers' beliefs about the nature of mathematics and mathematics education, including how beliefs affect instruction. Teachers' beliefs and their relation to Information and Communication Technology (ICT) are also explored. Within this section, critical topics that can affect or impede change, such as the effect of workshops and training as well as challenges or barriers that may affect one's ability to teach with ICT, receive attention.

Next, my literature review examines theories of constructivism, with specific focus on the theories of Piaget and Vygotsky, the implications of constructivism for mathematics education and criticisms of constructivist theories. Next, the chapter attempts to consider the concepts of beliefs systems, constructivism, and ICT in an integrated way. The chapter ends with a discussion of Logo, and how it supports the development of mathematical knowledge and understanding of education.

3.2 Teachers' Beliefs

Numerous studies in educational research are devoted to investigating teachers' beliefs (For example, Thompson, 1992; Nespor, 1987; Pajares, 1992; Ernest, 1996; Norton, McRobbie and Cooper 2000; Spilelm and Lloyd, 2004; Remillard and Bryans, 2004) all offer persuasive evidence to show that teachers' beliefs are one of the most significant factors that influence and shape teachers' instructional practises. Understanding teachers' decisions requires an awareness of what knowledge or methods or tools the teachers possess, and also how they decide what knowledge or methods or tools to invoke and when and how to do so. Pajares (1992) declared that those decisions reflect what a teacher believes to be important and reasonable. He also claims, a claim which was strengthened by Norton, McRobbie and Cooper (2000), Hart (2002), and Nathan and Knuth (2003), that educational researchers must pay attention to the beliefs of teachers and student-teachers because such attention can inform educational practise in ways that prevailing research has not addressed, and also that it is crucial to improve their professional preparation and teaching practise as well as the reform in teaching and learning.

Definition of Beliefs, and How They are Formed

Educational research literature shows that the idea of "belief" has been expressed in several ways. As Pajares (1992) points out, terms such as beliefs, values, attitudes, judgments, opinions, ideologies, perceptions, conceptions, conceptual systems, preconceptions, dispositions, implicit theories, personal theories, and perspectives have frequently been used almost interchangeably.

Sometimes it is rather difficult to identify the distinguishing features of beliefs, and how they differ from knowledge. Thompson (1992) stated, "One explanation for the scarcity of reasoned discourses on beliefs in the educational literature is the difficulty of distinguishing between beliefs and knowledge" (p. 129). This was caused by "the close connection that exists between beliefs and knowledge; distinguishing between them is fuzzy" (Scheffler; cited in Thompson, 1992, p.129). However, Nespor (1987) viewed it differently. He argued that belief systems differ from knowledge systems in that belief systems do not require general or group consensus regarding the validity and appropriateness of their beliefs. Individual beliefs do not even require internal consistency within the belief system, and this sets them apart from knowledge. Pajares (1992) adds further that enculturation and social construction provide the fertile ground for the construction of beliefs: an intense experience, chance occurrence, or a combination of events can lead or aid their formation. Likely, this explains why beliefs may not be grounded in logic or fact; they are personally held views formed over time through experience and exposure to the beliefs of others.

Beliefs As Opposed to Knowledge

Nespor (1987) points out four features that can be used to distinguish beliefs from knowledge. He terms those features, which are defined below, as (1) existential presumption, (2) alternatively, (3) affective and evaluative loading, and (4) episode structure. In existential presumption, beliefs frequently emphasize the existence or non-existence of entities. For example, teachers are found to have beliefs that a student's attainment may be associated with his or her ability or maturity. In this case, teachers attribute the student's success to relatively stable characteristics such as ability and maturity. The second feature, alternatively, shows that beliefs incorporate a view of an ideal or alternative situation that contrasts with reality and provides a means of summarising objectives and paths. In this respect, "beliefs serve as means of defining goals and tasks, whereas knowledge systems come into play where goals and the paths to their attainment are well-defined" (Nespor, 1987, p. 319). The third feature, which is affective and evaluative loading, considers beliefs as more strongly associated with affective and evaluative components than knowledge systems. As a result, knowledge of a domain can be distinguished from feelings about a domain such as subject areas that the teacher teaches. For example, teachers' beliefs about the nature of a subject such as history are found to be associated with strong feelings about what students should be taught and learn in history classes. Therefore, teachers' feelings and values frequently affect what they teach as well as the methods they use and may conflict with their knowledge. Finally, episodic structure distinguishes beliefs from knowledge since beliefs are often found to be derived from personal experience, episodes or events which continue to influence a particular comprehension of events at a later time. In addition, Nespor (1987) noted that beliefs are relatively static and when they do change it is likely to be because of conversion or gestalt shift, not as a result of argument or provision of evidence. In contrast, knowledge is dynamic and frequently changes. Furthermore, while there is a lack of agreement about how beliefs are to be evaluated, knowledge can be evaluated and judged. Nespor (1987) added that since beliefs are loosely-bounded systems with highly variable and uncertain linkages to events, situations and knowledge systems, the rules for determining their relevance to real-world events and situations are imprecise. This larger belief system might include inconsistencies and might be relative to one's peculiar and individual character. He also gave beliefs a practical role in dealing with complex and ill-defined contexts. Knowledge of beliefs will help to interpret and simplify classroom life, identify relevant goals, and orient teachers and student-teachers to particular problem contexts. Since the nature of classroom life is complex and multidimensional, knowledge alone would be insufficient in making sense of classroom context.

Strategies that Can Effect a Change in Beliefs

Although beliefs are not readily changed, this doesn't mean that they never change, according to Nespor (1987) and Pajares (1992), cited in Ertmer (2005). If so, Ertmer asks, "How then is belief change most likely to happen? What experiences will teachers need in order to question, and to be dissatisfied with, existing beliefs? " (p. 32). Ertmer suggests three strategies that may effect change in teachers' beliefs about teaching and learning in general and, specifically, beliefs about technology: (1) personal experiences, (2) vicarious experiences, and (3) social-cultural influences.

In describing episodic structure as one component of beliefs, Nespor (1987) pointed out that personal beliefs are often derived from personal experience. Expounding on this point, Ertmer (2005) suggests that if beliefs are formed through personal experience, then changes in beliefs might also be facilitated through experience (p. 32). Ertmer cites Guskey (1986) who belevied that changes in beliefs *follow* practise, rather than precede it. If so, the implication for professional development of teachers is very important here: when a teacher is helped to adopt new successful practises, the teacher's associated beliefs may also change as confidence is built. Instructional change is not a matter of completely abandoning beliefs, but of gradually replacing them with more relevant beliefs (Nespor, 1987, cited in Ertmer, 2005, p. 33). Richardson (2003; cited in Bai and Etmer, 2008) also suggested that the most important source of teacher candidates' beliefs about teaching and learning was their personal experiences with schooling and instruction (p. 95). Richardson noted that they may enter preservice teacher preparation programs with strongly held beliefs formed during their early student years. Nevertheless, through the course of their involvement in the teacher education program, they could be inspired to think about teaching and learning more deeply and critically.

Vicarious experiences have been noted as a powerful force in building teacher confidence and competence (Elmore, Peterson, and McCarthey, 1996; Zhao & Cziko, 2001; Schunk, 2004; Bair and Ertmer, 2008). Elmore, Peterson, and McCarthey state, "…teachers' practices are unlikely to change without some exposure to what teaching actually looks like when it's being done differently" (p. 241). In this case beliefs change occurs vicariously, following successful practise. Similarly, Bai and Ertmer believe that teacher educators must act as role models for preservice teachers and prepare them to use technology in their future professional practises (p. 94). The preservice teacher is thus given the opportunity to gain experience indirectly through watching their professors model good practise

Social-cultural influences are the third strategy with the potential to effect a change in beliefs. Professional organizations and social networking environments available to today's teachers provide ample opportunity for exposure to new ideas and practises that can influence beliefs. For instance, websites that support teaching, curriculum development, and student interaction, such as www.mathforum.com and aamath.com, can do much to address teacher isolation issues. In these virtual math communities, teacher idea sharing and caring can occur.

Definition of Beliefs used in This Study

The definitions and findings of other researchers, especially Nespor (1987), Pajares (1992), Thompson (1992), Aguirre and Speer (1999), Zhao and Cziko (2001), Schunk (2004), Kynigos and Argyris (2004), Ertmer (2005), and Way and Webb (2006) contributed to providing a definition of teachers' beliefs which the researcher used for the context of this research. In this study, beliefs comprise of the personal opinions, conceptions, and ideas expressed by Kuwaiti elementary mathematics student-teachers who participated in the study. These were evaluated from the empirical context resulting from their exposure through vicarious experience to the use of Logo programming language in the teaching and learning of mathematics, set within a social-cultural context which is Kuwaiti mathematics student-teachers.

3.2.1 Teachers' Beliefs about Mathematics and Mathematics Education

As to beliefs about the nature of mathematics and mathematics education, Thompson (1992) articulates two essential views: firstly, for some educators mathematics has been viewed as a discipline characterized by accurate results and algorithms and its basic elements are the expressions and theorems of arithmetic, algebra, and geometry. This view of mathematics emphasises that learning occurs as a result of mastery of symbols and procedures and performing mathematical operations exactly. In contrast, other educators have viewed mathematics as an intellectual activity, a social construction involving conjectures, proofs, rejections, and its results are subject for an open change and validity and must be judged in relation to a social and cultural setting. Mathematics is "cultural-bound, value-laden, interconnected and based on human activity and enquiry" (Ernest, 1991, p.197).

Within those two views, Thompson echoes Lerman's (1990) categories of mathematics: the "absolutist" perspective, which perceives mathematics as a "paradigm of knowledge, certain, absolute, value-free and abstract, with its connection to the real world perhaps of a Platonic nature" (p. 54) and, in contrast, the "fallibilist" or constructivist perspective which perceives mathematics as based on conjecture, proof and reflections and says that certainty is not absolute, hence the emphasis on the practise of mathematics and the reconstruction of mathematical knowledge. Other categorisations have been driven by different views of the nature of mathematics. Ernest (1988), for example, defines three conceptions of mathematics:

> "First of all, there is the instrumentalist view that mathematics is an accumulation of facts, rules and skills to be used in the pursuance of some external end. Thus mathematics is a set of unrelated but utilitarian rules and facts.
>
> Secondly, there is the Platonist view of mathematics as a static but unified body of certain knowledge. Mathematics is discovered, not created.
>
> Thirdly, there is the problem-solving view of mathematics as a dynamic, continually expanding field of human creation and invention, a cultural product. Mathematics is a process of enquiry and coming to know, not a finished product, for its results remains open to revision" (p. 250).

As psychological systems of belief, according to Ernest, these three philosophies of mathematics can be conjectured to form a hierarchy where instrumentalism, which involves knowledge of mathematical facts, rules and methods as separate entities, is lowest; Platonist, which involves a global understanding of mathematics as a consistent, connected and objective structure, is in the middle; and the problem-solving view, which sees mathematics as a dynamically organised structure located in a social and cultural context, is at the highest level.

In fact, there is a particular relationship between teachers' beliefs about the nature of mathematics and the methods of teaching and learning, and the teacher's perceived role and objectives. For the instrumentalist view, the teacher is an instructor and his objective is to enable the students to acquire mastery of the skills with correct performance. In contrast, for the Platonic view, the teacher is an explainer and the goal is for the students to acquire conceptual understanding with unified knowledge. For the problem-solving view, the teacher's role is that of a facilitator and stimulator of the students' learning whose objective is for the students to acquire confidence in problem posing and problem solving. This latter view correlates with constructivist pedagogy, which is discussed in detail later in this chapter. (for example, Fosnot, 2005; Levin and Wadmany, 2006; Tasouris, 2009; Margisit, 2009;).

How Beliefs Affect Instruction

In addition to the discussion above about the diverse beliefs regarding the nature of mathematics and mathematics education, many researchers such as Hersh (1986), Kuhs and Ball (1986), Thompson (1992), Ernest, (1996), Norton, McRobbie and Cooper (2000), Peter (2005), Speer (2005) and Golafshani and Ross (2006) have reported on how teachers' beliefs affect the way they give instruction. For example, Thompson, as well as Golafshani and Ross, argue that differences in teachers' beliefs about mathematics prove to be related to the differences in their views about mathematics teaching and that their beliefs about mathematics teaching are also likely to reflect their views of how students can learn mathematics. They emphasise that it is difficult to conceive of teaching models without some underlying theory of how students learn mathematics since there seems to be a logical and natural connection between the two. In addition, Kuhs and Ball (1986) identified "at least four dominant and distinctive views of how mathematics should be taught:"

1. Learner-focused: mathematics teaching that focuses on the learner's personal construction of mathematical knowledge; where the teacher's role is viewed as that of a facilitator and stimulator of students learning, posing interesting questions and situations for investigation, challenging students to think, and helping them uncover inadequacies in their own thinking.
2. Content-focused with emphasis on conceptual understanding: mathematics teaching that is driven by the content itself but emphasizes conceptual understanding. Unlike the Learner-focused where students' ideas and interests are the primary considerations; the content here is organized according to the structure of mathematics, following some notions of scope and sequence that the teacher may have.
3. Content-focused with an emphasis on performance: mathematics teaching that emphasizes student performance and mastery of rules and procedures. This view of teaching can be linked naturally to the conception of the nature of mathematics as instrumentalist. The content, in this context, is organized according to a hierarchy of skills and concepts and is presented sequentially to the whole class, where the teacher's role is to demonstrate, explain, and define material, presenting it in an expository style, and do exercises or problems using procedures that have been modeled by the teacher or the textbook.

4. Classroom- focused: mathematics teaching based on knowledge about the effective classroom. The main center of this view is the notion that classroom activity should be well-structured and efficiently organised, assuming that the content is established by the school curriculum where the teachers' role is to "skilfully explain, assign tasks, monitor student work, provide feedback to students, and manage the classroom environment, preventing, or eliminating, disruptions that might interfere with the flow of the planned activity" (Kuhs and Ball, 1986, p. 26)

Hersh (1986) emphasized that individual teachers' conceptions about the nature of mathematics would influence how they teach: "one's conceptions of what mathematics *is* affects one's conceptions how it should be presented. One's manner of presenting it is an indication of what one believes to be most essential in it" (p.13). Levin and Wadmany (2006) concur; they too are of the opinion that the educational beliefs of teachers filter their decisions and determine their classroom practise.

3.2.2. Teachers' Beliefs and their Relationship to the Use of ICT

The National Council of Teachers of Mathematics Professional Standards for School Mathematics (2000) states that the use of technology cannot replace conceptual understanding, computational fluency, or problem-solving skills; yet, in a balanced mathematics learning environment, strategic use of technology enhances mathematics teaching and learning. It says, "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning." (p. 24).

A number of researchers such as Knapp and Glenn (1996); Kersaint and Thompson (2002); Levin and Wadmany (2006); and Golafshani and Ross (2006) have provided significant evidence to show that teachers' and student-teachers' beliefs about the nature of mathematics and the teaching and learning of mathematics are deep-rooted ideas formed as a result of previous experience as learners or as professionals, and that these influence the teacher's instructional practise as well as their integration of ICT into their classrooms. Kersaint and Thompson (2002) believe that it is important to explore the role that beliefs play in technology integration. Russell et al. (2003) concur, stating that belief about the importance of technology for teaching is the strongest predictor of delivery in the classroom and teacher-directed student use (p. 303). Russell et al. (2003) and Swan and Dixon (2006) have confirmed the positive correlation between the extent of teachers' and student-teachers' experience with ICT and positive beliefs towards ICT use. In this researcher's opinion, a word of caution is in order here. Whilst it is true that many current teachers do not have prior experience in the use of technology as part of their own educational experience, and this could influence their beliefs, it is also true that in today's world, technology is a ubiquitous presence, and the power of technology to affect beliefs is greater than ever before, regardless of past experience. Earlier research must now be evaluated with recognition that this paradigm shift has occurred.

Knapp & Glenn (1996, cited in Levin and Wadmany, 2006) state that other studies explore how using educational technology can actually have an effect on teachers' beliefs. They note that following implementation of technology-based educational reforms, some teachers found that technology encourages greater student-centeredness, greater openness toward multiple perspectives on problems, and greater willingness to experiment in their teaching (p. 161). Gusky (2002, cited in Levin and Wadmany, 2006) is of the opinion that change in the beliefs of teachers is primarily an experientially-based learning process. From this, Levin and Wadmany deduce that “when teachers translate the abstract ideas concerning the integration of technology in their teaching practices they are likely to broaden their ideas or views on learning, teaching, and technology” (p. 161).

Levin and Wadmany (2006) reported on a three-year study that analyzed the evolution of the beliefs of six teachers regarding learning, teaching and technology, and the instructional practises of the teachers following integration of technology-based tasks within their classrooms. The researchers reported that changes occurred in both the beliefs and educational practises of all six teachers. Further, they reported that their study showed that developments in teachers’ beliefs regarding teaching and learning occur on several different dimensions, reflecting changes on a continuum: from teacher-centered teaching and learning to student-center teaching and learning; from relating mainly to individual students to relating mainly to groups or learning communities; from relating to externally imposed knowledge to appreciating authentic issues; and from viewing technology as a technological tool to regarding it as a partner capable of empowering the student, teacher and learning environment (p. 174).

We can infer that the relationship between teacher beliefs and technology practise is actually bi-directional, with either capable of having an effect on the other, based on experiences and circumstances. Large-scale, longitudinal studies such as the Apple Classrooms of Tomorrow (ACOT) (Ringstaff, Yocam and Marsh, 1996) program have provided teachers with an opportunity to observe changes in their students as a result of technology use and though this laboratory setting to reflect on their own beliefs about teaching and learning. Today’s students are “digital natives” (Prensky, 2001, p. 1) and expect to use technology in their learning environments. Regardless of how teachers came to hold their original beliefs about technology, this truth and its persuasive power can not be ignored.

Effect of Workshops and Training

Swan and Dixon found (2006) that teachers who participated in mentor-supported technology training increased the amount and level of technology use in their own practise. Following training, their level of accommodation, interest, comfort and confidence related to technology use improved. Lin (2008a) also addressed the issue of fostering teachers' confidence and competence in the use of information technology, thereby promoting more positive attitudes toward using computers and Internet resources in the mathematics classroom (p. 135). Lin's study investigated the efficacy of providing web-based workshops on elementary school mathematics topics as a means of enhancing teacher comfort with the subject matter. In-depth interviews were conducted with the pre-service elementary teachers who participated in the study, and all participants reported that the workshops helped them to become more confident in using computers to teach mathematics. The pre-service teachers further stated their belief that computers and technology constitute an important part of teaching mathematics. When asked why, the respondents felt that computers and technology were an important visualization tool, they allowed students visual representations not attainable with pen and paper or a chalkboard, they allowed for manipulation of geometric figures and they felt that computers were a motivator for students, making mathematics more interesting (p. 139).

Paraskeva et al. (2008) point out that "the development of modern technologies and their extension to every domain of our daily life nowadays is an indisputable fact" (p. 1084). As such, the widespread use of computers renders training in these technologies necessary. These researchers also believe that teacher training in technology as an educational tool “can change teachers’ attitudes toward and confidence with technology and can also provide them with skills they did not previously have” (p. 1090). They feel that teachers who have more experience in technology-aided teaching, especially in practise, are more likely to integrate technology into the classroom. In short, focused technology training begets an increase in confidence and a strengthening in the belief that technology can and should be used in the classroom.

Teo (2008) examined variables which affect pre-service teachers’ level of technology acceptance, and found that perceived usefulness, attitude towards computer use, and computer self-efficacy directly affect behavioural intention to use technology, while perceived ease of use, technological complexity, and facilitating conditions indirectly affect behavioural intention (p. 309). However, Teo cautions that although perceived usefulness and perceived ease of use have been found to predict acceptance, these variables do not remain static. He states, “Teachers who perceive computers to be useful and easy to use may soon experience limitations if they do not participate in continuing professional development to keep abreast with more advanced skills and knowledge on the use of computers” (p. 310).

Tasouris (2009) reported on an ambitious multi-year plan by the Cyprus Ministry of Education and Culture (MOEC) to promote and introduce ICT in the Cypriot Educational System. The initial five-phase effort, which began in 1991, was the country’s first organized governmental attempt to train teachers to take advantage of the use of ICT (p. 50). A five-year training plan for teacher training in the use of ICT took place in 2004-2009. The training sessions, which were not compulsory, aimed to make teachers computer literate and enable them to use ICT tools during lessons. However, Tasouris noted that interaction within the workshops was minimal, and no training sessions were held to discuss the topic of teaching and learning issues which might interact with the use of ICT. In spite of the effort to provide training, Tasouris stated, “it might be assumed that teachers’ beliefs are not taken to a great extent into account and that the sessions are developed following a specific seminar pattern. Consequently, fascinated teachers might feel disappointed and change attitude towards the use of ICT. An investigation of teachers’ beliefs is required for the development of successful training sessions as the obtained knowledge will support Ministry’s efforts for the actual introduction and use of ICT in Cyprus” (p. 51). Tasouris examined, via a questionnaire, ten teachers who had previously participated in training workshops administered by the Cyprus MOEC. The question “Can you describe the current conditions regarding the use of ICT in Physics Education” elicited the following response from one of the teachers: “The use of ICT is something good but being trained just how to use a tool is not the right way to do it. For example, a tool might not be good for my students as they are regarded as low-achievers. I need something very basic to engage them … and I have no time and knowledge to set up something on my own. I am disappointed as I feel that nobody is listening to what I think is better for me and my class” (p. 56). Tasouris’ point is clear: workshops and training are important, but they are not enough. Teachers’ attitudes and beliefs must also be taken into account as part of program development.

Challenges or Barriers that May Affect Ability to Teach with ICT

Although beliefs can inform instructional practises, perceived or actual challenges within the classroom environment can impede the teacher’s willingness to incorporate technology in the classroom, regardless of beliefs held (Levin and Wadmany, 2006). Slough & Chamblee (2000, cited in Levin and Wadmany, 2006), reported that the view of technology as unstable and always changing can present a barrier that impedes its adoption in the classroom.

As stated earlier, Swan and Dixon (2006) reported that following participation in mentor-supported technology training, teachers increased their amount and level of technology use in their teaching. Nevertheless, these same teachers continued to be concerned with barriers such as lack of release time for training, planning and collaboration, and the need for ongoing support.

Tasouris (2009) also spoke of the difficulty that may arise when a teacher's beliefs conflict with policy demands or educational standards within the school system. The author referred to the Cyprus Educational System, where the need to prepare students for centralized examinations might constrain teachers to minimise risk by following Ministry teaching standards despite their own teaching beliefs. Tasouris indicated that there might be cases where a teacher feels that ICT would be a better fit for his/her audience (p. 50). There is also the concern that a teacher who delivers lessons that are not in accord with his/her beliefs might teach less effectively and with less commitment. Tasouris also noted that the curriculum plan, textbooks, available time, inadequate teacher training and poor ICT equipment are additional constraints that influence teaching and learning.

Ertmer (1999) summarizes the barriers to technology integration noted above as first-order (external) and second-order (internal) barriers. First-order barriers include constraints that are external to the teacher, such as lack of adequate hardware, software or technical support, and lack of training or preparation time. Second-order barriers, however, are intrinsic to teachers, encompassing teachers' belief systems about teaching and learning, and their familiar teaching practises, both of which can affect technology integration. Ertmer concludes, "While many first-order barriers may be eliminated by securing additional resources and providing computer-skills training, confronting second-order barriers requires challenging one's belief systems and the institutionalized routines of one's practice." (p. 48).

Conclusions drawn about Teachers' beliefs and Use of ICT

The National Council of Teachers of Mathematics (NCTM) (2008) holds the following position on the role of technology in the teaching and learning of mathematics:

> "Technology is an essential tool for learning mathematics in the 21st century, and all schools must ensure that all their students have access to technology. Effective teachers maximize the potential of technology to develop students' understanding, stimulate their interest, and increase their proficiency in mathematics. When technology is used strategically, it can provide access to mathematics for all students"

The use of ICT plays a crucial role in today's mathematics classrooms. The teaching and learning of mathematics can be enhanced by the integration of technological advancement, thereby changing students' beliefs and perceptions about the classroom, the roles of teachers and students and instructional strategies. In addition, it transforms learners to become critical thinkers and active individuals in the competitive world of technology. It also implies a shift from student's efforts toward computational tasks to an exercise in thinking critically, communicating clearly, designing solutions to mathematical problems and applying mathematics to solve complex scientific problems.

The literature shows that teachers' and student-teachers' beliefs about mathematics and mathematics education is a significant factor that influences and shapes their instructional practises. It is the factor that plays a crucial role in their response to new ideas, knowledge and theories, and innovation such as ICT and Logo programming language as a cognitive tool in mathematics instruction. Therefore, in order to implement new ideas, knowledge and theories, and innovation such as ICT and Logo programming language as a cognitive tool, mathematics teachers and student-teachers should be able to accept these changes in their opinions and beliefs. If we are to have teachers and student-teachers evaluate and reflect on their beliefs, we must incorporate opportunities and create situations to engage them in reflective practises, and active mathematics knowledge building with the use of ICT, which is precisely what I attempted to achieve in my study.

Almost thirty years ago, a report published by Her Majesty's Inspectors (HMI) on mathematics teaching in the sixth form (DES, 1982a) discussed the potential of microcomputers to reshape mathematics education:

> "As microcomputers become more readily available, they will be capable of changing significantly the way mathematics is presented visually in the classroom. Programming procedures will influence the methods used for solving problems and there will be a greater emphasis on numerical techniques. … The consequences for mathematics teaching are of the greatest significance and all concerned need to consider carefully how this expensive resource can be used to the best effect" (p. 30).

Later, Johnston-Wilder and Pimm (2005) referred to the above report and lamented "the HMI prediction of greater emphasis on numerical techniques has not manifested itself in the curriculum over the past 20 years. This is primarily due to the centralized controllers of the mathematics curriculum, especially at A level which has remained relatively free of numerical techniques" (p. 12). The authors further reported that as a result students were migrating away from pure mathematics to statistics or business courses. The Office for Standards in Education (Ofsted, 2008) report also painted bleak findings. In the section entitled "The contribution of information and communication technology to the mathematics curriculum" they stated: "Several years ago, inspection evidence showed that most pupils had some opportunities to use ICT as a tool to solve or explore mathematical problems. This is no longer the case; mathematics makes a relatively limited contribution to developing pupils' ICT skills. Moreover, despite technological advances, the potential of ICT to enhance the learning of mathematics is too rarely realised." (p. 27).

3.3 The Constructivist Perspective

3.3.1 The Concept of a Theory of Constructivism

In recent decades, the constructivist paradigm has become a fundamental element of educational practise. Proponents of education reform, researchers, educators and authors actively engage in supporting constructivist principles for designing and implementing new learning environments to improve learning (Murphy, 1997). Constructivist principles have also received considerable attention and support by mathematics educators. According to Lerman (1993), "constructivism is the dominant view of learning, at least within the mathematics education community" (p. 20). Constructivism and implications for mathematics education, which is an important focus of my research, will be discussed later in this chapter.

According to Fosnot (2005), constructivism is an epistemological theory of learning that sheds light on how people learn, and on the nature of knowledge. Further, it assumes that knowledge cannot exist outside of cognitive beings and that people construct new knowledge, ideas, and experiences based upon their current and previously acquired knowledge and experiences (Doolittle, 1999; Robins, 2005). Constructivist theory holds that knowledge is constructed in a dynamic interactive context, not solely by rote learning where memorizing or repeating or mastering facts and techniques are emphasized (Taylor and Fraser, 1997; Hackmann, 2004). In essence, the learning context requires that learners be provided with opportunities for concrete and contextually meaningful experience to construct new knowledge through "reasoning and creative thinking, gathering and applying information, discovering, inventing, and communicating ideas, and testing those ideas through critical reflection and argumentation" (Thompson, 1992, p.128).

The constructivist teacher is a facilitator who creates experiences, asks questions, supports and provides guidelines, and thus helps students make meaningful connections between previous and new knowledge, and guides them through the learning process to arrive at their own ideas and conclusions. For example, during a teaching session, the teacher guides students' learning by providing them with a range of contexts which includes:

- Regular and predictable concrete or experience context.
- Cognitive conflict context since "learning required when the new information to be learned comes in conflict with the learners' prior knowledge, usually acquired on the bases of everyday experiences" (Vosnadiou and Lieven, 2004, p. 445; cited in Rolka, Rösken and Liljedahl, 2007).
- Metacognition contexts that allows students to consider and reflect on their thinking process for learning a new concept.

- Negotiation contexts where students share their prior and new knowledge and ideas with each other, resulting in students' construction of a new reasoning process.

As a philosophy of learning, constructivism has been developed over the course of many centuries by philosophers including Socrates (470-399 B.C.), Kant (1724-1804), Piaget (1896-1980), and Vygotsky (1896-1934). More recently, several projects such as CLISP (Children's Learning in Science Project, 1982-1989) developed by University of Leeds, CASE (Cognitive Acceleration through Science Education, 1981 to present) developed by King's College London, CAME (Cognitive Acceleration in Mathematics Education) developed by King's College London, and AKSIS (ASE-King's College Science Investigations in Schools), were based on the foundations of constructivist principles and aimed to improve pupils' ability to learn. To further understand constructivism, the theories of Piaget and Vygotsky, who have greatly influenced approaches to teaching and learning, are explored on the following pages.

Jean Piaget's theory of cognitive constructivism and Lev S. Vygotsky's theory of social constructivism illustrate two diverse contexts concerning individual cognitive development. Piaget believed that individuals build understanding by a process of active interaction and interpretation of experience with their environment. Vygotsky emphasized that knowledge development is a result of social interaction and language usage between individuals, and thus it is shared. Although they were essentially contemporaries, Piaget and Vygotsky were unaware of each other. Still, Vygotsky's work complemented Piaget's contributions in the field. They share some common ideas such as a learning perspective in the context of constructivism which Kafai and Resnick (1996) referred to as "constructionism" (p.1); yet major differences exist between them. For example, concerning the topic of stages of development, Piaget is of the view that development precedes learning, whereas Vygotsky holds the opposite opinion. Especially in the development of speech, Piaget states that the egocentric speech of children disappears with maturity, when it changes into social speech; for Vygotsky the child's mind is innately social in nature and so speech moves from communicative social to inner egocentric. Since for Vygotsky speech precedes the development of thought, he claimed that thought develops from society to the individual and not the other way (Boundaries, 1998). The following sections shed further light on the underlying principles of the two perspectives, namely cognitive constructivism and the social constructivism.

3.3.2 Piaget's Theory of Cognitive Constructivism

Jean Piaget was one of the twentieth century's most influential researchers in developmental psychology (Bernstein, 2005). His research focused on the theory of knowledge regarding cognitive development in children. Piaget viewed the child as a lone scientist, constructing his or her own knowledge of the world (Clark, 2000). He believed that the child's mental structure, conceptual categories or schemas, develop as a result of the child's active interaction and experiences with his or her environment (Piaget, 1972). Piaget believed in "adaptation" and "organization" as a mechanism by which changes in cognition and understanding occur. Adaptation involves two complementary processes: "assimilation" and "accommodation" (Piaget, 1953/1966, p. 5-6). Learners first interpret new experiences and events in terms of pre-existing cognitive structures. Then learners integrate novel and typical experiences into their mental structure, finally changing their cognitive structure to create a new mental organization. Piaget associated knowledge with active contradictions between what is already known and what is new to the learner.

From birth, individuals explore the environment with whatever level of capability they have, and through these explorations learn context, so that their views of the environment change. Piaget identified four cognitive development stages, identified below in Table 2. For complete intellectual development, he considered it essential that the child experience these stages.

Piaget believed that growth and learning proceed in a relatively orderly sequence and demonstrated that learning generally proceeds from the concrete to the abstract. Further he believed that individuals learn by discovery, organizing, and assimilating new information to prior knowledge and rejected the idea that the individual is a passive recipient of knowledge. He stated, "To understand is to discover, or reconstruct by rediscovery, and such conditions must be complied with if in the future individuals are to be formed who are capable of production and creativity and not simply repetition" (Piaget, 1973, p. 20). Piaget observed this in children; he intensively studied the reasoning processes of children at various ages to find out how they reached their answers. He was not interested in the child's answer, but rather what forms of logic and reasoning the child used to get to the answer (Plucker, 2006). For Piaget, a child's reasoning is not merely less exact than adult reasoning; it is qualitatively different (Wadsworth 1996).

Prior to Piaget, the premise was that a child's knowledge results from senses as a source of perception and language. However, Piaget found that the actions of the child were the origin of knowledge rather than perception and language (Beilin, 1992). Piaget also argued that language depends on thought for its development. As a result, Piaget considered that the learning process proceeds from action to language through thoughts. He pointed out that "it is very difficult to 'teach' a child logical operations; he must construct them for himself through his own action. Then, and only then, can he assimilate the full meaning of the language that describes these action or transformations" (Pulaski, 1980, p. 95-96). Consequently, language serves essentially to communicate what is already understood.

Table 2. Piaget's Stages of Cognitive Development

Stages	Approximate Age
1. Sensori-motor	0 – 2 years
2. Pre-operational	2 -7 years
3. Concrete operations	7 – 11 years
4. Formal operations	11 - adult

In the sensori-motor stage, children's learning occurs as a result of their sensory perceptions and motor actions on objects. Their initial schemes, "the basic building blocks of thinking… organized systems of actions or thought that allow us to mentally represent or 'think about' the objects and events in our world" (Woolfollk, Hughes & Walkup, 2008, p. 39) are forming during this stage. Initial innate actions of a baby, such as sucking and grasping, are common examples of initial schemes. In the next, or pre-operational stage, key elements include the rapid growth of speech, and child's ability to use symbols (words, gestures, and images). At this stage, the child's behaviours and thinking is egocentric. Logical thinking is limited in one direction only and the child lacks the ability of reversible thinking. For example, the sequential relation ships such as A<B<C (A is less than B is less than C) are too difficult to be handled at this stage. Besides, the child is not able to understand the principle of conservation "that some characteristics remain the same despite changes in appearance" (Woolfollk, Hughes & Walkup, 2008, p. 42) and can only focus on one aspect at a time. This focusing or fixing of attention on a limited aspect of the stimulus illustrates a child's lack of decentration to explore all the

aspects of the stimulus throughout this stage. In short, in the pre-operational stage, mental operations are largely intuitive, involving high imaginations, but this is not an inferior type of thought, since “intuition and free association are important aspects of creative or original problem solving” (Sprinthall and Sprinthall, 1981, p. 181). Child-active involvement with “objects (such as the Logo program as a cognitive tool) and processes will help the child to build the cognitive structures necessary for logical thought” (Webb, 1980, p. 94). Proceeding towards the end of this stage, the basis for logical mathematical thinking has been laid in the use of language, yet the child is still far from reaching operational thinking (Becker, et al., 1975; cited in Marsigit, 2009) which develops during the next stage, concrete operations.

In the third stage, which is the concrete operations stage, the child understands the different aspects of reasoning and becomes capable of dealing with the problem of conservation, and in addition masters the operation of classification that helps the child in categorizing objects. In addition, the child will develop a logical system of thinking which will help him to construct logical sequential relationship (seriation), that is, understanding the notion of $A<B<C$ (that B can be greater than A but still less than C. Piaget considered that the child in this stage becomes able to perform logical operations such as reversibility, classifications and seriation; however, these logical operations can only be applied to concrete objects and events in present and not to hypothetical, purely verbal, or abstract problems (Wadsworth, 1996). Consequently, this stage is viewed as a transition between pre-logical thinking to the fully attained logical thinking during the last stage, the formal operations stage.

The fourth, and final, stage is the formal operations stage; however, there are different views expressed by the writers concerning the child approximate age for this stage. For example, Sprinthall and Sprinthall (1981) suggest that this stage starts at 11-16 years of a child's age, while Woolfollk, Hughes & Walkup (2008) considered it from eleven years to adulthood. In this stage, the child can develop a formal pattern of thinking. He or she fully attains logical thinking or what Woolfollk, Hughes & Walkup (2008) termed "hypothetico-deductive reasoning" (p. 47), that is, logical, rational, and abstract strategies that allow him or her to identify the factors affecting a problem and then deducing and systematically evaluating different solutions. That helps in terms of the formal propositions of symbolic logic and mathematics (Becker et al., 1975; cited in Marsigit, 2009).

There are, however, some critics of Piaget's theory of cognitive development, especially Margaret Donaldson, 1978; Light, 1988; and Siegal, 1991; cited in Butterworth and Harris, 1994. They believe that children's lack of reasoning, in Piaget's experiments, is not because of their inability to think logically, but because the children lack the ability to comprehend the adult's language and as a result the tasks selected make little sense to them. Donaldson (1978, cited in Moore, 2000) believed that children's logical or abstract reasoning, in Piaget's experiments, could be achieved "as long as the questions were put to them in a way that related to their familiar world and in a language that they understood" (p. 64). However, the stages of cognitive development, comprising different age levels, have been applied to the hierarchy of educational "sequential developmentalism" (Kwon, 2002, p. 7) in most countries, for example, the United Kingdom and Kuwait. In addition, it is essential to familiarize teachers with Piaget's stages of cognitive development. This helps teachers to understand that during a particular age students are most likely to be at a certain level of cognitive development and capable of a certain type of thinking. Recognition must also be given to the fact that not all students' level of cognitive structure within a certain stage is the same, since “intelligence and / or environment may cause variations” (Webb, 1980, p. 93). According to educational sequential developmentalism, “a child must be "ready" to move on to the next developmental stage and cannot be forced to move to a higher level of cognitive functioning” (Kwon, 2002, p. 7). Considering children’s level of cognitive structure within the stages of cognitive development, it is essential not to accelerate children’s progress throughout the stages so that they can progress successfully from one stage to the next. This can be linked to Piaget (1962; cited in Lloyd and Fernyhough, 1999) when he said, “In some cases… instruction is presented too soon or too late, or in a manner that precludes assimilation because it does not fit in with the child’s spontaneous constructions. Then the child’s development is impeded, or even deflected, into barrenness” (p. 310). Therefore, giving more time for children to develop their cognitive structures, if required, is essential so that they can proceed to the next stage acquiring solid cognitive structure.

The main concept of Piaget’s work centered on illuminating the context of knowledge acquisition, which is that knowledge is constructed by individuals based on their prior knowledge and not by passive learning, as well as the progressive cognitive structuring of individual. Yet, the social interaction context on learning process was not Piaget’s main emphasis. Piaget (1970, cited in Fosnot, 2005) believed, “There is no longer any need to choose between the primacy of the social or that of the intellect; the collective intellect is the social equilibrium resulting from the interplay of the operations that enter into all cooperation” (p. 22).

The consideration of social interactions between the individual and society has led to a different philosophy of cognitive development, which is the social constructivism theory developed by Lev Vygotsky.

3.3.3 Vygotsky's Theory of Social Constructivism

The Soviet psychologist and philosopher Lev Semyonovich Vygotsky's research in developmental psychology was repudiated in his own country because of Russian government repression. His works became known to the western world only during the 1960s; nevertheless, his theory of developmental psychology has had a profound influence on Russian schools and is a focus of interest all over the world (Davydov and Kerr, 1995). He believed, as did Piaget, that knowledge is developmental and constructed by individuals based on their prior knowledge, yet he considered social interaction central for the development of individuals' intelligence: "a specific social nature and process by which children grow into the intellectual life of those around them" (Vygotsky, 1978). It is "representative of a paradigmatic shift towards viewing the construction of meaning or psychological events through the reciprocal influence of individual and context" (Shulman and Carey, 1984, cited in Sivan, 1986, p. 211). This prospective of mediation shifts the locus of individual cognitive development from the interior region of the mind, Piaget's perspective of process as from inside out, to the processes and structure of individuals' interaction (Sivan, 1986). Vygotsky believed, "What goes from outside in is schooling because we never find a child who would naturally develop arithmetic functions in nature. These are external changes coming from the environment and are not in any way a process of internal development" (Vygotsky, 1930a/1981, cited in DeVries, 2000, p.194). Vygotsky considered that social interaction and culture constitute the environmental elements that shape an individual's thinking and activities (Fosnot, 2005). Social interaction affects the individual's cognitive development by "explaining reality, transmitting cultural messages and mediating the learning of environmental rules" (Kouzulin & Presseisen, 1995, cited in Firstater, 2005, p. 56).

Culture facilitates cognitive development, as Vygotsky considered that "human activities take place in cultural settings and cannot be understood apart from these settings" (Woolfolk et al., 2007, p. 52), where "intellectual abilities as being much more specific to the culture in which the child (individual) was reared" (Vasta et al., 1995, cited in Kristinsdóttir, 2000). Consequently, "Culture makes two sorts of contributions to the child's (individual's) intellectual development. First, children (individuals) acquire much of their thinking (knowledge) from it. Second, children (individuals) acquire the processes or means of their thinking (tools of intellectual adaptation) from the surrounding culture. Therefore, culture provides children (individuals) with the tools to develop what to think and how to think" (Kristinsdóttir, 2000). Sivan (1986) provides three key elements of social constructivist theory, namely: (a) cognitive activity, (b) cultural knowledge, tools and signs, and (c) assisted learning (p. 21). These elements are interconnected; however, in order to understand the process of social constructivists it is necessary to discuss them separately, as follows:

3.3.3.1 Cognitive Activity

Cognitive activity is the individual's process of constructing meaning within a certain context, not as a result of psychological event (Sivan, 1986). Cognitive activity, from a social constructivist perspective, cannot be considered as separated from the context in which the individual thinks (Rogoff, 1982, cited in Sivan, 1986). In this sense, it sheds light on the reciprocal influential relation between the individual and the context of construction meaning. Furthermore, cognitive activity is considered as "becoming increasingly complex in structure as the tools (such as ICT) and signs (such as numbers, graphs and language) of culture… are implemented" (Luria, 1962, 1977; cited in Sivan, 1986, p. 212). It is formed in association with adult help. In addition, Cole and Scribner (1974, cited in Sivan, 1986) believed that cognitive activity mediates context and behaviour and as a result it shapes and regulates behaviour. The social constructivist view about cognitive activity differs from the Piagetian view. Piagetian theory holds that cognitive development results from an individual's adaptation to the environment, while social constructivism views it as a process that is constructed in a social context with other individuals in society.

In short, cognitive activity is a dynamic process that becomes more complex as it progresses with the aid of another member of society. It is a process that shapes and regulates individuals' behaviour through mediating culture and behaviour. It is a product of the culture.

3.3.3.2 Cultural Knowledge, Tools and Signs

Social constructivists consider language an indispensable thinking and cognitive activity tool. Vygotsky (1978) believed "the most significant moment in the course of intellectual development, which gives birth to the purely human forms of practical and abstract intelligence, occurs when speech and practical activity, two previously completely independent lines of development, converge" (p. 24). It is a cultural tool that serves as both a means of communication and a way to shape thought, since "it provides (individuals) a way to express ideas and ask questions, the categories and concepts for thinking, and the link between the past and the future" (Woolfolk et al. 2007, p. 54). Thus, the social and cultural environment, where language evolves, facilitates individuals to use language to express themselves and develop further intellectual operations. The influence of language in mathematics education linked to Bruner (1953, cited in Ellerton and Clarkson, no date) stated, "Words are links in the chain of communication," and "mathematical words often represent mental constructs rather than tangibles," and "spoken words are symbols," and "words represent agreements among people" (p. 987). Therefore, students should be provided with the context where they communicate, discuss and exchange the mathematical knowledge. Language and knowledge are culturally productive activities and the means by which an individual's psychological functioning develops. Since knowledge, tools, and signs of a culture are not inherited genetically, the learner needs assistance and guidance to acquire them.

3.3.3.3 Assisted Learning

In Vygotsky's view, assisted learning occurs as the more mature member of society interacts with a child and leads the child to the internalization of knowledge, and resultant independent behaviour. This active interaction process between the more knowledgeable member and the person who is being socialized illustrates the first distinguishing characteristic of assisted learning, called scaffolding. Scaffolding is the context of support provided by a more mature adult, such as a teacher or peer collaborator, (or the use of ICT tools), which the child cooperates with in the learning interaction to extend the child's knowledge and skills to a competence level to solve a problem or complete a goal that can not be accomplished alone (Vygotsky, 1978**;** Bruner, 1986; Stuyf, 2002, Sivan, 1986). Scaffolding takes place in the zone of proximal development (ZPD), shown in Figure 2 below, which represents the second distinguishing characteristic of assisted learning. It is "the distance between the actual developmental level, as determined by independent problem solving, and the level of potential development, as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

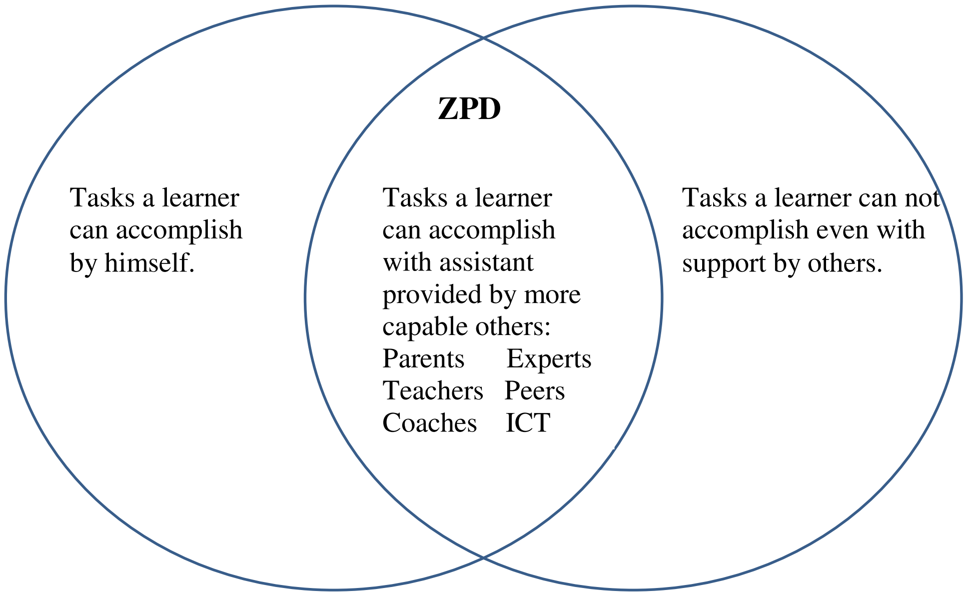

Figure 2. Zone of Proximal Development (ZPD)

To illustrate this in mathematics education, suppose a child can draw a square independently, and can draw a right angle triangle with assistance and guidance from a teacher or peer. We can say that drawing a right angle triangle is within the child's zone of proximal development (ZPD) where the scaffolding process within assisted learning is to pull the child "along to levels beyond those the child could achieve alone" (Sivan, 1986, p. 215). In this essence, the child is being supported to the next intended level of learning. The third distinguishing characteristic of assisted learning is internalization. While socialization contributes to behaviour change, in contrast, assisted learning contributes intra-psychological changes through joining the cultural knowledge with individual knowledge which develops an internalized ability for activity without any external social regulation (Sivan, 1986). Independent functioning is the fourth characteristic of assisted learning. Through scaffolding and internalization, assisted learning transmits to the child the task of meaning making (Sivan, 1986).

In short, assisted learning is a way of socialization that transfers cultural tools through scaffolding within the zone of proximal development (ZPD) to help develop an independent functional individual.

3.3.4 Piaget and Vygotsky: A Comparative Perspective

Both Piaget's cognitive constructivism and Vygotsky's social constructivism implied an alternative perspective for knowledge acquisition, one that embraces dynamic interactive context along with the use of more recent tools such as ICT, in which knowledge is constructed by individuals and which rejects rote learning in general, and in particular for mathematics education. Hence, "do"(ing) mathematics is to conjecture – to invent and extend ideas about mathematical objects - and to test, debate, and revise or replace these ideas" (Davis and Harsh, 1980; Ernest, 1991; Lakatos, 1976; Lampert, 1988; Latour, 1987; and Tymoczko, 1986; cited in Fosnot, 2005, p. 85).

Green and Gredler (2002, p. 55) compare Piaget and Vygotsky based on: (a) classroom goal, (b) focus, (c) teacher role, and (d) learner role, as shown in Table 3. To Piaget, the student's thinking undergoes various reconstructions as logical reasoning develops. The learner's manipulation of objects provides fertile ground for this experience and recognizing conflict between his or her perceptions and the data allows the learner to gradually forgo illogical ways of thinking. Piaget believed that schooling should include independent and collaborative spontaneous experimentation. Piaget believed that student-directed experimentation was of particular importance in mathematics and science because it showed that these subjects consist of testable principles instead of inert facts (Piaget, 1973). Vygotsky, in contrast to Piaget, identified particular complex skills (categorical perception, conceptual thinking, logical memory, self-regulated attention) as the goal of cognitive development (Green and Gredler, p. 56). To Vygotsky, “the teacher, working with the child, explains, informs, inquires, corrects, and forces the child himself to explain” (Vygotsky, 1987, p. 215-216). In solving a problem, the child makes use of an earlier collaboration.

Major Characteristics	**Piagetian Classroom**	**Vygotsky’s Perspective**
Goal	Develop logical thinking	Develop self-regulated attention, conceptual thinking, logical memory
Classroom focus	Spontaneous, student-directed experimentation	Interaction with subject-matter concepts to develop advanced cognitive capabilities
Role of the teacher	Create and organize challenge experiences; ask probing questions to facilitate learner rethinking of ideas	Model, explain, correct, and require the learner to explain
Role of the learner	Manipulate objects and ideas; experience cognitive conflict between one’s ideas, experimental results, and teacher questions; re-organize one’s thinking	Interact with the teacher in instruction to develop conscious awareness of and mastery of one’s thinking; learn to think in subject-matter concepts
Example	Some math and science curricula	Reciprocal teaching

Table 3. Comparison of Characteristics: Piaget/Vygotsky Classrooms

Cairns (2001, p. 21) cites Bruner’s comparison between the developmental stages of Piaget which unfold faster or slower depending on the quality of the experience, and Vygotsky’s 'zone of proximal development' in which the learner uses hints and the help of others to organise his or her thought processes, thus developing the conceptual means to 'make a leap to higher ground'. Through the help of others, the learner can gain increasing understanding and control of knowledge (Bruner, 1983).

3.3.5 Constructivism in Mathematics Education

The work of both Piaget and Vygotsky has received considerable attention by mathematics educators who view their constructivist theories valuable for the development of mathematical understanding. The National Council of Teachers of Mathematics Standards document (NCTM) (1989, 1991; cited in Steele, 1999, p. 38) emphasizes the importance of both social interaction and communication in learning mathematics. ”Communication plays an important role in helping children construct links between their informal, intuitive notions and the abstract language and symbolism of mathematics; it also plays a key role in helping children make important connections among physical, pictorial, graphic, symbolic, verbal, and mental representations of mathematical ideas“ (NCTM, 1989, 1991). So we can conclude that both perspectives offer an essential conceptual framework for the educational process in general, and for mathematics in particular, as well as for the use of ICT and its cognitive tools such as Logo programming language for mathematics education.

According to Piaget’s perspective, an individual’s cognitive structure develops as a result of active interaction and experiences with his or her environment, which leads to reorganization in the individual’s intellectual structure. These reorganizations of thoughts happen because of the contradiction between the individual’s cognitive structure that are representative of his or her prior knowledge and new knowledge during the individual’s interaction with the learning environment. “Every schema (intellectual structure)… coordinated with all the other schemata and itself constitutes a totality with differentiated parts" (Piaget, 1953, p. 7). These reorganizations are essential since they allow the individuals to hypothesize and test the hypotheses to find successful solution to the situation or problem about reality based on their new learning experiences. Piaget believed that "teaching is the creation of environments in which students' cognitive structures can emerge and change" (Joyce, Weil with Calhoun, 2000, p. 266). From this prospective, education in general and mathematics education specifically should not be "a routine habit forming and conditioning… (but an) intelligent inquiry and thought" where "development of knowledge … resides in doing (experimenting), in activity, in interacting with the problems" (McNally, 1974, p. 80) in a social context where dissection and disparagement is a necessary source of disequilibration. Consequently, the mathematics teacher comes to play an essential role as a facilitator and stimulator for students' learning. The teacher's objective is to create practical experiences as a context to facilitate exploration, discovery, and intervention of mathematical knowledge, allowing students to construct relations between new mathematical experiences and prior mathematical cognitive structures. As such, "it is obvious that the teacher as organizer remains indispensable in order to create the situations and construct the initial devices (such as ICT) which present useful problems to the child. Secondly, he is needed to provide counter-examples that compel reflection and reconstruction of overhasty solution. What is desired is that the teacher cease being a lecturer satisfied with transmitting ready-made solutions; his role should be that of a mentor stimulating initiative and research" (Piaget, 1973, p. 16).

Vygotsky gives primary importance to the social interaction and cultural tools in the development of individuals' cognitive structure. His viewpoint is that the individual's development learning construction is the result of internalization. The mediation provided though social interaction and by psychological signs tools such as language, numbers, and graphs, as well as material tools such as ICT, enables individuals to internalize the new knowledge such as mathematical knowledge and learn. Thus, the individual is not alone in the learning construction process. Teachers have responsibility for students' learning. Their responsibility is to identify students' current level of achievement and move them from that point to the achievement of well defined educational objectives. For Vygotsky, the teacher's role is "didactic" (Marsigit, 2009, p. 5) and not to narrate; his role is to construct meaning alongside the student and so "emphasise the importance of language and communication in the construction of an understanding of the world" (Galloway and Edwards, 1991; cited in Marsigit, 2009, p.5). In addition, the teacher creates an interactive educational environment where social meaningful interactions and use of psychological sign tools and material tools such as ICT can lead the children to new zones of proximal development.

Steele (1999) asks, "What do communication and interaction in the classroom have to do with Vygotsky's ideas about learning mathematical language? In what ways must new words be learned to enrich a child's understanding of mathematics?" (p. 38). Steele suggests that when students use language to describe their thinking, they supply their teachers with valuable information about what they do understand. Teachers have an opportunity to make use of students' oral language in classroom activities to provide a meaningful context for learning. In this case, the teacher enters the child's zone of proximal development (ZPD). Steele further cautions that students should not be moved too quickly toward new mathematical language without having the opportunity to explore, investigate, describe, and explain ideas, as the reorganization of concepts goes on during these opportunities. Students should learn mathematical language to describe real world actions related to their own experiences.

Berger (2005) also credits Vygotsky's theory of concept formation with being able to "bridge the divide between an individual's mathematical knowledge and the body of socially sanctioned mathematical knowledge" (p.153). Further, Berger believes that Vygotsky's theory can be used to explain how idiosyncratic usages of mathematical signs by students, especially as they are just being introduced to it, get transformed into mathematically acceptable usage; this can be used to explain the link between the use of mathematical signs and the individual's attainment of meaningful mathematical concepts.

Marsigit (2009) discusses the implication of both Vygotsky's and Piaget's work to mathematics education. The author feels that in order to provide assistance in the ZPD, the teacher must remain in close touch with opportunities presented for assisted performance, for using small groups and a positive classroom experience that will increase student independent task involvement. Margisit agrees that children need to actively engage with mathematics, posing as well as solving problems, discussing the mathematics which is embedded in their own world. Margisit summarizes by stating, "Instead of giving the children a task and measuring how well they do or how badly they fail, one can give the children the task and observe how much and what kind of help they need in order to complete the task successfully; in this approach, the child is not assessed alone; rather, the social system of the teacher and child is dynamically assessed to determine how far along it has progressed."

Marsigit (2009) also discusses Piaget, and suggests these beliefs are essential: that the intellectual development of children passes through well-defined stages that children develop their concepts through interacting with their environment, and that for the primary years most children are in the stage of concrete operations. Elkind (2003) also discusses Piaget's concrete operations. As young children progress from nominal, to ordinal to interval numbers, they build their concept of numbers. At age two or three, numbers are used in their nominal sense and number words used as names. By age four or five, numbers are used in their ordinal sense, for instance, to identify position in a series, but the child's understanding is still based on visual differences. By age six or seven, when children attain what Piaget refers to as concrete operations, they are able to build units and can achieve interval understandings of numbers in which numerical terms represent equal units. Others, including Acredolo (1997) and Bickhard (1997) have found Piaget's theories helpful to explain how children arrive at meaningful understanding of mathematics principles.

3.3.6 Constructivism Critique

Although constructivism is much valued in education, criticism of constructivist theories also exists. According to Confrey (1990), it is criticized for being "overly relativistic." The argument that follows is that "if everyone is capable of their own constructs, and if no appeal to an external reality can be made to assess the quality of those constructs, then everyone's constructs must be equally valid" (p. 110). Confrey refutes this statement for two reasons: the constructive process is subject to social influences, since we do not think in isolation, our language, the methods and resources we use for problem-solving and even our acceptance are social processes. Also, one person can not know with any certainty what another person's constructs are. To explain, Confrey uses the example of a mathematics teacher: "In mathematics education, a teacher needs to construct a model of a student's understanding given what the student knows, while gauging how like the teacher's own constructs the student's constructs are. Thus, a teacher must always give consideration to the possibility that a student's constructs, no matter how different they appear from the teacher's own constructs, may possess a reasonable level of internal validity for that student and therefore must adapt the instruction suitably" (p. 110). As a constructivist and mathematics educator, Confrey states, "I am not teaching students about the mathematical structures which underlie objects in the world; I am teaching them how to develop their cognition, how to see the world through a set of quantitative lenses which I believe provide a powerful way of making sense of the world … I am trying to teach them to use one tool of the intellect, mathematics" (p. 111).

Lerman (1993) offers a similar criticism in simpler prose: "one of the major weaknesses of constructivism is that it offers no connection between its theoretical foundations, that children construct their own knowledge, and what the teacher should do" (p. 20). Lerman also sees social constructivism as "incoherent and inconsistent" in the manner in which it sometimes takes one view of learning as observably occurring and sometimes the other (p. 22). Lerman does voice approval for Lev Vygotsky, and Lerman's view is summarized as follows: "knowledge isn't in the individual's mind, nor 'out there' in objects or symbols. knowledge is as people use it, in its context, as it carries individuals along in it and as it constructs those individuals. knowledge is fully cultural and social. and so too is what constitutes human consciousness. communication drives conceptuallsatlon." (p. 23).

The science education community also takes some exception to Jean Piaget's view, in particular with respect to his developmental-stage component. A second argument, by (Matthews, 2000), is the notion that constructivists pay attention to how students learn (construct concepts), but not to what knowledge (wrong or correct) they construct (p. 493).

One final criticism readily illustrates the power of constructivist theories to incite condemnation by at least some educators. Matthews (2003) states, "Developmental notions of the natural proclivity toward learning and the importance of not interfering with the natural learning process are key assumptions that underpin current constructivist teaching practices. One key notion contends that since the learner has an active role in interpreting the learning process, education should be *child directed* and not teacher directed" (p. 57). Further, constructivist teaching assumes that motivation to learn is internally generated by the child. My own opinion is that too simplistic a view of constructivism is a disservice. In my view, constructivism offers a blueprint that considers the entire picture of the learning process and the interaction between teacher and learner. It does not attempt to limit the teacher's role nor to undervalue the quality of constructs or the quality of knowledge that is disseminated.

3.4 Teachers' Personal Beliefs, Constructivist Pedagogy and ICT

The above sections dealt with beliefs, constructivism and ICT. Repeatedly, the inter-connection among the three issues and how one teaches was noted. Research that explores beliefs systems and pedagogy styles consistently attest that teachers with more traditional beliefs resist the implementation of technology within their classrooms (Hermans et al., 2008) or implement it at a lower level than those teachers holding constructivist beliefs (Judson, 2006, and Roehrig et al., 2007; cited in Ertmer and Ottenbreit-Leftwich, 2009). Levin and Wadmany (2006) also report research findings that show a strong correlation between computer use and a constructivist view of learning. Becker (2000, cited in Ertmer, 2005) tells us that computers serve as a “valuable and well-functioning instructional tool” (p. 29) in those classrooms where teachers (a) have convenient access; (b) have adequate preparation; (c) have some freedom within the curriculum; and (d) hold personal beliefs aligned with constructivist pedagogy. An additional factor that must be considered, which has also been reported earlier, is the need for adequate time. Ertmer (2005) sates that it takes five to six years for teachers to accumulate enough expertise to use technology in ways advocated by constructivist reform efforts (p. 27).

Nevertheless, as has been noted, barriers may exist that impede technology implementation. Although traditional beliefs can pose a barrier, they are not the only barrier. As a matter of fact, teachers with constructivist beliefs may resist technology if certain barriers exist, such as lack of confidence in the availability of hardware or software. Existing school standards and sanctioned practises can pose a formidable barrier.

What is demonstrated in this chapter is that an appreciation of the inter-connected nature of all three issues must be considered if we are to make other than marginal gains in technology implementation within the educational system.

3.5 How Logo Supports the Development of Mathematical Knowledge and Understanding of Education

3.5.1 Introduction

Incorporating information and communication technology (ICT) into mathematics teaching and learning is accomplished using the latest generation of computation tools in order to make mathematical computations easier, more accurate and faster, from counting aids to the abacus, to logarithms, to the slide rule, to the pascaline (earliest mechanical calculating device) and, more recently, the change to digital processing in the calculator and computer. Moreover, existing and emerging ICT teaching tools, software and web sites provide further opportunities to support and enhance mathematics teaching and learning.

The first emergence of information and communication technology tools was the SMILE computer programs for mathematics teaching and learning in the mid-1980s (Johnston-Wilder and Pimm, 2005). In 1997, the United States Department for Education and Employment and National Council for Education Technology (NCET) published a review of software for curriculum use; in their review of mathematics – key stage 3 and 4 ages 11-14, years 7, 8 and 9; and ages 14- 16 years 10 and 11) (p. 35-38) they describe the following types of software: small computer programs; programming languages (Logo); spreadsheets; graph plotting software; computer algebra systems; dynamic geometry software; data handling software; courseware; graphic calculators; CD-ROMs and the Internet as source data. The Internet offers various opportunities such as allowing access to online mathematical resources, using real-world mathematical applications and collaborative learning. It also provides an interactive environment that promotes students' conceptual development and thinking by allowing students to manipulate mathematical systems, observe patterns, form conjectures, and validate findings (Ying-Shao, Yeong-Jing and Guey-Fa, 2003; Glazer, 2004).

3.5.2 Logo Software and Mathematics

Logo computer language was first developed in 1966 by Seymour Papert, and is currently available in various versions for Windows, Macintosh, and every major brand of computer operating system. It is derived from LISP, the language of artificial intelligence, and is designed and rooted in the constructivist educational philosophy to support constructive learning. Papert, who was strongly influenced by Jean Piaget, claims that in his own thinking he “placed a greater emphasis on two dimensions implicit but not elaborated in Piaget’s own work: an interest in intellectual structures that could develop as opposed to those that actually at present do develop in the child, and the design of learning environments that are resonant with them” (Papert, 1993. p.161), a context “where learners can become the active, constructing architects of their own learning” (p.122). It is better to think of it as a language for learning; a language that encourages students to explore, to learn, and to think**,** a programming language that empowers students to construct their own knowledge, hence the term constructivism. While Logo is not limited to any particular topic or subject area, it can be a powerful tool for exploring and learning mathematics (Papert, 1993; Clements and Sarama, 1997).

Logo provides a mathematical environment. The cursor, which is a turtle graphic, provides a natural mathematical environment. Students move the cursor to create graphic objects such as lines and curves or composite figures such as circles, angles, and polygons on the screen. In addition, it is a language the student uses to learn geometry or algebra or functions or fractals or other mathematical topic. Using the Logo programming language enables students to think about the process involved in learning mathematics. This is important as it reduces the focus on the mechanics of programming. Further, Logo provides an awareness of the structure of mathematics. This helps students to think mathematically and give a formal description language of mathematical concepts (Papert, 1993). To illustrate this, when students use Logo they deliberately learn to imitate the turtle's thinking by the use of a descriptive language while at the same time they would be directed by Logo to formalise their ideas in a descriptive mathematical language to solve the problem.

3.5.2.1 Description

Logo has been described as a programming language for constructing, investigating, and analyzing mathematics. Students can generate interactive mathematical representations ranging from basic explorations about shapes and numbers to advanced simulations and animations of complex problems. Logo provides a computational context in which mathematics takes place and it can provide access to otherwise unattainable mathematical ideas (Hoyles and Noss 1989). There is no doubt that Logo is a powerful, extensible, and creative tool to be used by the teachers in mathematics classrooms. It contains "powerful ideas in mind-sized bites" (Papert, 1993, p. 135) and …. "it is much more than a programming language, it is also a philosophy of education" (Goldberg, 1991, p. 68).

The benefits of interactive programming language software such as Logo have been well documented. Murchie (1986), Clements and Sarama (1997), Bigge and Shermis (1999), Lindroth (2006) all agree that Logo is rich in mathematical context that enhances students' interest and enthusiasm for meaningful intellectual engagement, creates new opportunities to sharpen students' thinking, increases nonverbal reasoning and the conception of mathematical ideas, problem-solving abilities, and supports learners in coming to understand a wide range of mathematical concepts.

Logo provides an intellectual environment for thinking and epistemological reflection. Further, it provides an opportunity for students to master deliberate thinking as they proceed step-by-step to solve mathematical problems and learn. Jean Piaget's' theory of constructivist epistemology, which is that learning is a constructive process in which learners are the creators of their intellectual knowledge through a personal interpretation of their experience with the environment around them, provides the structural underpinnings for Logo. This can be linked to Papert's (1993) claim that Logo provides an:

> "interactive learning environment where the prerequisites are
> built into the system and where the learners can become the
> active, constructing architects of their own learning" (p.122).

In addition, it offers another way for students to reflect on their action thinking prior to starting to teach the turtle, how to act or think and engage in more complex aspects of their own thinking, as well as self-referential discussion about their own thinking along the way as they use the program to solve the problem.

In the process of working with Logo, a student determines how one idea is connected to another idea. Students relate new concepts to existing concepts, moving through self-chaining, assimilation and accommodation, and generating growth in their intellectual development. Seymour Papert also claims that in learning to program the computer, a learner also learns how his learning is achieved. Piaget's Theory of Cognition suggests that the learner is the builder of his intellectual structures. It seems therefore that the activity of programming in Logo could accelerate and enhance this process.

In their study, Yellend and Masters (1995) contend that when using Logo, students and teachers become engaged in a learning context which is characterized by exploration and investigation that is not possible without the technology. For example, students' use of Logo to write a recursion procedure for defining a spiral may result in representing a spiral in an infinite number of ways. Variables in the procedure can be manipulated to investigate the effects of the changes in the spiral, as a result generates a new design of spiral which some of can be highly sophisticated. Accordingly, this investigation's context motivates the students to experience algebraic and geometric thinking. By students seeing and interacting with various shapes in a dynamical context wherein numerical and geometric thinking intertwine with aesthetic this would promote their aesthetic qualities. Overall, this enables students to have a liberating sense of the possibilities of doing a variety of things that may have seen as hard to do in using paper-and-pencil either because of labour, tiredness or failure to retain properties across objects thus failure in representation.

Experiencing Logo allows students to externalize their intuitive expectations and allows them to remodel them. Students, with Logo, would have the opportunity to translate their intuition into a program and have the chance to visualize it; consequently, their intuition becomes more noticeable and more accessible to reflection. Hence, they have the chance to take up their computational ideas as resources to the work of remodeling their intuitive knowledge; this would bridge the gap between formal knowledge and intuitive understanding. This was affirmed by Clements and Battista (1989, cited in Clements and Sarama, 1997):

> "Logo experiences can help students to become cognizant of their mathematical intuitions" (p. 3).

Another aspect is the context of “syntonic learning”, a term which is sometimes used with qualifiers that refer to kinds of syntonicity. The phrase was introduced by Seymour Papert but derived from Sigmund Freud, the Austrian neurologist and psychiatrist, who provided a description of individuals’ intuition or ideas that are acceptable and compatible to his ego’s integrity and its demands (Papert, 1993). For example, “body syntonic” where students’ use of Logo programming language to express ideas which are compatible with their own feeling and knowledge about their own bodies to learn or “ego syntonic” to express ideas which are compatible with their own experience of themselves as people with intentions, goals, desires, likes and dislikes. As a result, the Logo context provides the means for the learners to interact with and take it as a psychological system rather than a physical one; a context that is characterized by a high degree of emotional responsiveness that support different mathematical areas such as geometry and algebra.

Logo can provide a concrete structure of procedures and visual images which help students to create their own intellectual imagery for the concept of variable, for example, and retain their acquired algebraic understanding based on the intellectual imagery of previous algebraic concepts they have developed. Noss (1985; cited in Clements and Sarama, 1997, p. 17) agree that with the use of Logo, students would begin to construct a conceptual structure based on intuitions and primitive conceptions of algebraic notion upon which they can build later algebraic learning; this can illustrate an early strategy that can be seen as an initial stage of later sophisticated mathematics algebraic understanding. A student’s difficulty in accepting the fact that a letter in algebraic expression can represent a range of values and different letters, as well as lack of closure in algebraic expression such as $x^2 + 3^b$

might effectively be addressed in a Logo context where students appear to accept these facts through use of simple procedure (Hoyles and Noss, 1992). Comparisons between Logo and non-Logo students in a study by Barry-Joyce (2001) showed that Logo students scored significantly higher on measures of problem solving, numeric reasoning, problem-solving retention, and numeric-reasoning retention than the non-Logo student group who received the same practical training of metacognitive skills as Logo students but with the use of a spreadsheet program.

The call for appropriate pedagogical practise to improve learning about geometry dates back to Plato's *Meno*, written in 380 B.C.E. In spite of this long tradition, much of the current interest in the improvement of teaching and learning of geometry can be traced to the development of innovative computer software environments designed to enhance various areas of mathematics, including geometry. The National Council of Teachers of Mathematics (NCTM, 2004) calls for geometry to be "learned using concrete models, drawings, and dynamic software." Karakirik & Durmus (2005) point out that "technology enables students to visualize geometric concepts and relations in a more concrete sense" (p. 62). Using Logo helps students to engage in inductive geometrical thinking, since they can engage in exploring a context and have the chance to develop understanding from the experience within mathematical situation. For example, using Logo to represent an angle would require students to rotate the turtle; this rotation allows the student to discover that 360 degrees is the largest meaningful rotation and that the shape of a figure is determined by its angle size input (Papert, 1993). In addition, Papert argued that experiencing with a Logo turtle enables students to "bring their knowledge about their bodies and how they move into the work of learning formal geometry" (cited in Hoyles and Noss, 1992, p. 101).

Clements, Battista and Sarama (2001) describe the three major curriculum goals of Logo, which are (1) to help students achieve higher levels of geometric thinking; (2) learn major geometric concepts and skills; and (3) develop power and beliefs in mathematical problem solving and reasoning. Papert (1993) argues that Logo programming language is a potential catalyst of peer interaction and collaboration. Interaction with other students who have greater skills in mathematics may lead to improved cognitive skills within a student's zone of proximal development (ZPD). Vygotsky (1978) explained ZPD as the difference between actual development levels as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Slavin, 1995; Schunk, 2004). A student who has a stronger understanding of mathematics may serve as a model for other group members. Then he can monitor other group members' reading to assist them.

Logo is interactive in that programming syntax is immediately interpreted. Hence, feedback is not delayed and is often useful. The immediate non-judgmental visual feedback support encourages and helps students to make their own conjecture, test out and modify their thoughts, and that increases the exploration ability and opportunity to teach and students to learn something new (Goldstone et al., 1996). Norte et al. (2005, p. 172) suggest that Logo can be beneficial and offers the ability to improve the daily life of disabled people in learning environments. Brous (1995) concurs that Logo's user-friendly language, interactive programming and procedural description provides a productive milieu for the learning disabled child. Brous states further that in its design it has the potential for isolating the difficulties which the learning disabled child frequently manifests in assimilating and using new learning.

In spite of the many positive assertions about Logo, it is not without detractors. Clements and Sarama (1997) noted that not all research has been positive. For instance, few studies report that students "master" the mathematical concepts and, without guidance, misconceptions can persist. Clements and Sarama also cite Johnson's (1986) findings that some studies show no significant differences between Logo and control groups. It was also noted that following participation in Logo, limited transfer of skills was achieved on subsequent geometry tests and grades. The authors summarize with these thoughts, "studies that have shown the most positive effects involve carefully planned sequences of Logo activities. Teacher mediation of students' work with those activities is necessary for successful construction of geometric concepts" (website).

Sinclair and Jackiw (cited in Johnston-Wilder and Pimm, 2005) are of the opinion that ICT tools such as Logo "appear to have achieved individual learning experiences at the cost of neglecting classroom practice, teacher habits and beliefs, as well as the influence of the curriculum, by imposing entirely new and perhaps inappropriate classroom practices (p. 238). Further, the authors report that others have criticized the fact that Logo is not sufficiently transparent in relation to mathematics and the school; for example, the Logo computer screen, which bears little relation to a traditional geometry textbook, serves "to emphasize the difficulties many teachers find in bridging first-wave technologies (such as Logo) in their teaching practice" (p. 238). They did concede that following inclusion in the UK mathematics national curriculum, "Logo was able to push classroom practice to evolve, at least in part, towards its singular vision of mathematics learning, although neither as rapidly nor as radically as some had hoped" (p.239).

It should be noted that Sinclair and Jackiw did not specify what kind of preparation the UK teachers received in order to prepare them to incorporate Logo in their teaching practise, and whether that preparation took into account supporting the teachers beyond simply being trained in the use of the software. Stevens et al. (2008) commented a few years later that workshops typically aimed to increase teachers' knowledge about the topic under consideration; however, teachers' belief in their ability to actually use that knowledge, or self-efficacy, was not well developed (p. 212). They felt that external demands placed on teachers to take training didn't necessarily result in the motivation or self-determination to add that new knowledge into their teaching. The authors described Logo workshops that were specifically developed to use a more embracive approach: (1) train the teachers in using Logo software; (2) gradually increase the teachers' confidence in their ability to use Logo; and (3) encourage and motivate teachers to actually use Logo in their teaching (p. 215). The authors' findings revealed that Logo workshops administered using the three-pronged approach was effective in building self-efficacy and self-determination. Further, the teachers who took the workshops indicated that their students benefitted too. The authors did concede that the small sample size (N=15) was a limitation in their study; nevertheless, they felt confident in stating that their findings suggest that teachers need ample time in order to believe that they can use new knowledge effectively, in particular because teachers are aware that changes they make in their teaching have important implications in the lives of their students. This study, which was directed at Logo, emphasizes again the message delivered earlier in this chapter: teachers' beliefs must also be considered as an integral component when ICT is to be added to the curriculum.

Agalianos, Noss and Whitty (2001), who reported on the place that Logo occupied within the US and UK organizational and institutional cultures following its introduction in the 1980s, also warrant mention here. The authors do not focus on inherent weaknesses in Logo; rather, they report that Logo 'was implicated in the politics of educational innovation at a time of conservative restoration" (p. 479). According to the authors, Logo was utilised in different ways in different schools as well as within the classrooms, and very different results were realized. Reaction to Logo ran the gamut from enthusiasm and commitment to complete resistance and rejection. Their reactions depended a great deal upon the culture of the school environment in which it was introduced. To many educators Logo was seen as "a substantial threat to the stability of educational institutions" (p. 485). Logo called for innovation that went contrary to the routine that was currently in place in the majority of mainstream schools. Teachers' authority and control were threatened. In addition, "Logo presented a challenge to the traditional fragmentation of knowledge into separate subjects and to traditional assumptions about 'worthwhile knowledge', 'good students', 'effective teaching', and 'excellent results' … Logo set off a range of culture classes" (p. 488). As shown in this dissertation, implementation of technology must be a holistic endeavor; attending to attitudes and beliefs are an equally important component of any change.

It is my opinion that Logo can make a significant difference in the teaching and learning of mathematics and students' understanding of mathematical concepts, based on personal experience, as well as the arguments given earlier in this chapter. This educational programming language provides a dynamic context for constructing, investigating, and analyzing mathematics, thus empowering students to construct their own knowledge. It is the language that helps bridge the gap between formal knowledge and intuitive understanding. Moreover, in my experience as a mathematics and ICT teacher, I believe Logo can contribute significantly in teaching mathematics and in students' learning of mathematics, in particular for Kuwaiti students who up to this time have had little exposure to ICT as an adjunct to teaching and learning.

3.6 Summary

This chapter reviewed the literature about teachers' beliefs, including their beliefs about the nature of mathematics education and ICT. Next, the chapter looked at the topic of constructivism. In particular, the theories of these two constructivist researchers were discussed: Jean Piaget's theory of cognitive constructivism and Lev S. Vygotsky's theory of social constructivism. Their constructivist theories were compared, and the manner in which constructivism relates to mathematics education discussed. The chapter concluded with a discussion of how Logo supports the development of mathematical knowledge and understanding of education. This combined body of research formed the underpinnings that were used to inform the remaining chapters of this study.

The next chapter delineates the research design and methodology employed in this study.

CHAPTER 4
RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

The aim of this chapter is to illuminate the methodology used to conduct this research. This chapter contains the following sections: the research design, the rationale for choice of the research methods, the study participants, data collection instruments, study field procedures, and the procedures followed in the statistical analysis of the data collected.

4.2 The Research Design

Each study will have its own constraints which, in turn, may drive the researcher towards a given paradigm and methodology. However, this study's questions and constraints did not lead to a definitive paradigm. Rather, elements of both case study and action research paradigms combined to synergize the study.

It could be argued that treating the cohort of trainee teachers as a single entity draws on the case study paradigm. Yin (1984) described the case study as an empirical approach that allows investigation of contemporary phenomena within its real-life context and where multiple sources of evidence are to be used (p. 23). Yin (2003) later offered these applications for a case study model: (1) To explain the presumed causal links in real-life interventions that are too complex for survey or experimental strategies; (2) To describe the real-life context in which the intervention has occurred; (3) To illustrate certain topics with an evaluation; (4) To explore those situations in which the intervention being evaluated has no clear set of outcomes (p.15). Each of these applies to this study.

However, an equally compelling case can be made for action or practitioner research. This methodology is sometimes seen as being about the development of practise. Hammersley (2007) states, “Action research is a form of research carried out by practitioners into their own practices” (p. 167). The author states further, “Knowledge achieved in this way (action research) informs and refines both specific planning in relation to the practice being considered and the practitioner’s general practical theory” (p. 173). Action research is also sometimes seen as being about the creation of new knowledge. Reason and Bradbury (2008) provide the working definition that action research is “a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview” (p. 1)

Action research is often associated with insider researchers. Ferrance (2000) states that action research “specifically refers to a disciplined inquiry done by a teacher with the intent that the research will inform and change his or her practises in the future. This research is carried out within the context of the teacher’s environment—that is, with the students and at the school in which the teacher works—on questions that deal with educational matters at hand” (p. 1). McNiff, Lomax and Whitehead (1996) begin with the simple definition that “practitioner research simply means that the research is done by individuals themselves into their own practice” (p. 8).

However, action research is actually more expansive than this. Ferrance adds, “While a teacher may work alone on these studies, it is also common for a number of teachers to collaborate on a problem, as well as enlist support and guidance from administrators, university scholars, and others” (p. 2). McNiff, Lomax and Whitehead also describe situations which are embedded in the action research paradigm where the research is manifestly outside of the organisation. These authors clearly describe situations, similar to the context of the research in this study, where external researchers undertake teaching in places where they are not members of staff, in order to pursue research questions relevant to that institution. In this instance McNiff described how as an external facilitator she worked in a school with a group of teachers and parents, jointly exploring the topic of a code of behaviour for the home-school community (p. 8). McNiff concludes with the statement that "action research involves many people other than the researcher, and the way in which these people are involved is crucial for the methodology" (p.11). Phelps and Graham (2010) observe that the "definitions, interpretations and the implementation of action research can be as diverse and variant as those embracing and participating in it" (p. 3).

The research study was certainly empirical, involved contemporary phenomena in its real life context, developed practise and had the intended aim of creating new knowledge. The researcher was not a member of the institution in which the study was carried out but served as a teacher who was responsible for teaching the Logo module. With this in mind the author would argue that the study resided within the action research paradigm with an external researcher.

The researcher employed mixed methods, both quantitative and qualitative, to explore the beliefs of the study participants, who were mathematics student-teachers enrolled in the Methods of Teaching Mathematics course (College of Basic Education, The Public Authority for Applied Education and Training (PAAET) State of Kuwait) that incorporated a 24-session non-compulsory non-credit bearing Logo module concerning (a) the nature of mathematics, (b) the learning of mathematics, (c) the teaching of mathematics (d) the use of Logo programming language as an

ICT tool for cognitive learning and (e) the use of information and communication technology (ICT). To inquire about the student-teachers' beliefs, Likert-type scale questionnaires (quantitative method) were administered as a pre-test and post-test. Data gathered from the questionnaires were analyzed quantitatively, as discussed fully in Section 4.7. In addition, to find out about the student-teachers' beliefs in more depth, semi-structured interviews (qualitative method) were conducted prior to and following the Logo module. Data gathered from qualitative methods were analyzed qualitatively, as discussed fully in section 4.8, by analysing themes and issues. Since a mixed methods research design was used to collect and analyze the data, this chapter begins with a discussion about aspects of mixed methods in general, and the rationale for using such a design in this study.

Mixed methods research is a general type of research in which the researcher "focuses on collecting and analyzing both quantitative and qualitative data in a single study" (Creswell, 2003, p. 210). For example, the researcher might conduct a questionnaire (quantitative data) and following that conduct a series of interviews (qualitative data) with a small number of participants. Use of this approach by researchers goes back to early 1959 and is referred to in the literature with various terminologies such as: "multitrait-multimethod research, integrating qualitative and quantitative approaches, interrelating qualitative and quantitative data, multimethodological triangulation, multimethodological research, multimethods design and linking qualitative and quantitative data, combining qualitative and quantitative research, and mixed methods research" (Creswell et. al, 2003 cited in Tashakkori and Teddlie, 2003, p.165). The essential principle of this design is that combining quantitative and qualitative methods provides better understanding of the research problem under study (Creswell and Plano Clark, 2007) by expanding the study's scope or breadth to neutralize some disadvantages of either approach alone (Tashakkori and Teddlie, 2003; also Driscoll et al., 2007, p. 19, who cite Blake, 1989; Greene, Caracelli, and Graham, 1989; and Rossman and Wilson, 1991). For example, on one hand, the detail of qualitative data can provide insights not available through a general quantitative questionnaire. On the other hand, quantitative questionnaire coverage for a large targeted population allows the researcher to draw generalizations about the wider population, while a qualitative approach would not enable the same generalizations because of the small targeted number of the individuals or groups being studied. Since all methods have weaknesses, it is obvious that, with mixed methods, the strengths of one method potentially neutralize the weakness of the other method, and vice versa. Similarly, results of precise, instrumental-based measurements may be augmented by contextual, field-based information (Greene and Caracelli, 1997, cited in Hanson et. al., 2005).

There are a variety of classifications metrics by which mixed methods research designs can be described. These classifications are distinguished by: (a) Implementation: the sequence used to collect both quantitative and qualitative data, such as whether the option of data collection consists of gathering the information at the same time, that is, concurrently or over a period of time, that is, sequentially; (b) Priority: the level of priority given to the quantitative or qualitative phase as it occurs throughout the data collection process; and (c) Stage of Integration: refers to the stage in the process of research procedure (such as data collection, analysis) in which the quantitative and qualitative data are combined (Creswell, Fetters and Ivankova, 2004; Creswell et al., 2003, cited in Tashakkori and Teddlie, 2003). Johnson and Onwuegbuzie (2004) have cited several researchers (Creswell, 1999; Morgan, 1998; Morse, 1991; Patton, 1990; and Tashakkori and Teddlie, 1998) who have developed several different metrics to develop mixed methods designs to study the investigated phenomenon. Johnson and Onwuegbuzie point out that in spite of the number of researchers who have addressed the issue, as of yet there is no precise list of mixed methods design; therefore, researchers should mindfully plan to develop a design that effectively answers their underlying research questions.

4.3 Rationale for Choice of Research Methods

There has been substantial debate between researchers and scholars about the respective merits of the two most well known research methodologies, namely quantitative research and qualitative research (Cohen, Manion and Morrison, 2007; Burns, 2000). Some researchers and scholars consider that qualitative research is best employed for discovering themes and relationships at the case level and that quantitative research is best employed for validating those themes and relationships in samples and populations. From this perspective, qualitative research takes part in the "discovery role," while quantitative research supports the "confirmatory role" (Gall, Borg and Gall, 1996, p. 29). In addition, some quantitative researchers and scholars criticise qualitative research for being less rigorous, unrepresentative, unreliable, and subjective; conversely, some qualitative researchers and scholars consider quantitative research superficially rigorous and lacking validity (Glaser and Strauss, 1999; Fry, Chantavanich and Chantavanich, 1981). The methodology used in the research is not usually determined by the researcher's own philosophical preferences but by the nature of the phenomenon being studied and the related research questions (Bell, 2005). Hammersley(1992; cited in Silverman, 2010, p. 14) goes further and states, "We are not faced then with a stark choice between words or numbers, or even between precise and imprecise data; but rather with a range from more to less precise data. Furthermore, our decisions about what level of precision is appropriate in relation to any particular claim should depend on the nature of what we are trying to describe, on the likely accuracy of our descriptions, on our purposes, and on the resources available to us, not on ideological commitment to one methodological paradigm or another."

Each research, either quantitative or qualitative, has its own specific approach to collect and analyse the data of the phenomenon being studied; consequently, each method has its own advantages and disadvantages, and each has been seen to be suitable for a particular context. However, in this study the researcher felt that both quantitative and qualitative research methods of data collection would play a valuable role in educational research and no single research method was essentially more suitable than any other method because "both approaches (i.e., quantitative and qualitative), have helped educational researchers make important discoveries (about the researched phenomenon)" (Gall, Borg and Gall, 1996, p. 32). Many researchers currently advocate the employment of both quantitative and qualitative research methods within one study (Creswell, 1994; Strauss and Corbine, 1998). Walker (1985; cited in Kervin et al., 2006, p.39) states, "Certain questions cannot be answered by quantitative methods, while others cannot be answered by qualitative ones." Turning to Strauss and Corbine, one finds that the combination of methods may be done for various reasons; for example, "supplementary, complementary informational and developmental" (p. 28). Besides, Creswell (1994) stated that a combination of methods is effective for the purpose of triangulating or converging the research findings, elaborating on results, using one method to inform another, discovering paradox or contradictions, and extending the breadth of the inquiry (p. 185). Merton and Kendall (1946, cited in Cohen, Manion and Morrison, 2007) believed in "a combination of both which makes use of the most valuable feature of each" (p. 45). In addition, this combining provides what Kaplan and Duchon (1988, p. 575) referred to as a "richer, contextual basis" for analysing and validating the study results, as well as "breadth" and "depth" in order for its results be grasped (Schulze, 2003, p. 12). The many findings in favour of mixed methods lent support to employing it as the research design for this study. Nevertheless, the notion of merging quantitative and qualitative data within a single study required that the researcher develop an in-depth understanding of all potential ramifications of mixed methods research. Consequently, the pros and cons of mixed methods research are described in some detail below.

4.3.1 Mixed Methods Research: Pros

Driscoll et al., (2007) state that through concurrent design "the collection and analysis of embedded qualitative responses can augment and explain complex or contradictory survey responses" (p. 24). Further, the authors cite another opportunity afforded by sequential design. "The collection and analysis of structured survey and open-ended key informant interviews in an iterative analytic process can provide important information on emergent and unexpected themes" (p. 24).

Support for the mixed methods approach can also be found on the British Educational Research Association website (BERA, 2009): "Combining methods can provide some corroboration or offer fuller understanding than can be achieved through a single method. Similarly, if unexplained or inconsistent findings begin to emerge in data collected by one method, introducing a second method may help to clarify the situation." Johnson and Onwuegbuzie (2004, p. 21) concisely present their support in a bulleted list which is reproduced in adapted form below:

- Words, pictures, and narrative can be used to add meaning to numbers.

- Numbers can be used to add precision to words, pictures, and narrative.
- This approach can provide quantitative and qualitative research strengths (e.g. quantitative methods allow the researcher to construct a situation that eliminates the confounding influence of many variables, allowing one to more credibly assess cause-and-effect relationships. Qualitative methods can describe, in rich detail, phenomena as they are situated and embedded in local contexts).
- The researcher can generate and test a grounded theory.
- A broader and more complete range of research questions can be answered because the researcher is not confined to a single method or approach.
- A researcher can use the strengths of an additional method to overcome the weaknesses in another method by using both in a research study (this is the principle of complementarity)
- Stronger evidence can be provided for a conclusion through convergence and corroboration of findings (this is the principle of triangulation).
- Further insights and understanding can be added, that might be missed when only a single method is used.
- The generalizabilty of the results can potentially be increased.
- Qualitative and quantitative research used together produces more complete knowledge necessary to inform theory and practise..

4.3.2 Mixed Methods Research: Cons

In spite of all the support offered for employing mixed methods research, weaknesses may also exist. Johnson and Onwuegbuzie (2004) offer the following potential weaknesses:

- It can be difficult for a single researcher to carry out both qualitative and quantitative research, especially if two or more approaches are expected to be done concurrently (i.e., it might require a research team).
- The researcher has to learn about multiple methods and approaches and understand how to appropriately mix them.
- Methodological purists contend that one should always work within either a qualitative or a quantitative paradigm.
- It is more expensive.
- It is more time consuming.
- Some of the details of mixed research remain to be fully worked out by research methodologists (e.g., problems of paradigm mixing, how to qualitatively analyze quantitative data, how to interpret conflicting results.

Driscoll et al. (2007) also voice concerns about disadvantages. They cite the concern commonly raised by qualitative researchers, which is the "loss of depth and flexibility that occurs when qualitative data are quantitized" (p. 25).

In summary, after reviewing the current research both in support of and in opposition to mixed methods research, the researcher came to the conclusion that this research study would be enriched through the utilisation of a mixed methods research design. Data were collected prior to and following administration of the Logo module using a sequential mixed methods strategy. The quantitative method (questionnaires) was used first to collect data, followed by the qualitative method (semi-structured interviews). The advantage of combining quantitative and qualitative methods was that it enabled the researcher to make use of the most valuable features, breadth and depth, of each method and develop a comprehensive knowledge base and understanding of the inquiry (student-teachers' beliefs) that may not have been possible to attain if a single method was used. "Collecting different kinds of data by different methods … provides a wider range of coverage that may result in a fuller picture of the item (concept) under study than would have been achieved otherwise" (Bonoma, 1985; cited in Esteves and Pastor, 2004, p. 73). Finally, triangulation of the research findings could provide further corroboration of the results. The drawback for the researcher of the need for extensive data collection (i.e., numerical and text), and additional intensive time and work imposed by analysis of multiple methods, was more than warranted by the additional insight it might yield.

4.4 The Study Participants

Participants for this study consisted of thirty-two (32) Kuwaiti mathematics student-teachers registered during the Fall semester 2007 in a Methods of Teaching Mathematics course that incorporated a 24-session non-compulsory non-credit bearing Logo module at the College of Basic Education, The Public Authority for Applied Education and Training (PAAET), State of Kuwait. All thirty-two (32) students-teachers were female since the course was discontinued for male students after a new education law (MOE, 1994) changed the teaching system in Kuwait elementary schools. According to the new regulation, boys and girls in elementary school are to be taught by female teachers; previously, there were female teachers for girls' schools and male teachers for boys' schools. Therefore, the College of Basic Education made a decision to stop teaching the mathematics discipline for male students because the Ministry of Education would no longer recruit male teachers.

4.5 Data Collection Instruments

Two data collection instruments were used to collect the data: a beliefs questionnaire, which yielded data that the researcher analyzed quantitatively, and a semi-structured interview, which yielded data that the researcher analyzed qualitatively. Findings supportive of the mixed methods approach, described above, provided confidence that these two methods combined would help the researcher to achieve an accurate picture, and in light of the discussion in Section 4.3, these instruments appeared to be the most suitable and practical to use for this research. The aim of using questionnaires and interviews was to explore student-teachers beliefs involved in this study.

A questionnaire was chosen as one of the research tools because its layout enabled the questions to be divided into categories for subsequent data analysis, the questionnaire format supported asking a large number of closed-ended beliefs questions, and could be used to cover a large number participants. Besides, selection of a semi-structured interview as a second research tool was found suitable to enable the researcher to probe more deeply with individual questionnaire respondents based on the category into which they fell: expressed mainly traditional beliefs, expressed mainly constructivist beliefs, or expressed a mixture of both beliefs. The semi-structured interview enabled additional information to be elicited from some of the participants about their beliefs, opinions, and future classroom practise, which they were better able to explain during an interview.

4.5.1 The Beliefs Questionnaire

Questionnaires are possibly one of the most frequently used instruments in educational research. A questionnaire is "a list of questions to be asked by the researcher" (McNeill, 1985, p. 20), and an instrument that "can be used to obtain information concerning facts, beliefs, feelings, intensions and so on" (Ary, Jacobs, and Razavieh, 1979, p. 173). Westat (2002) also notes that a questionnaire at spaced intervals of time allows researchers to quantify changes in human behaviour and beliefs. For example, questionnaires can be used as a pre-test prior to the inquiry and as a post-test following inquiry completion to examine the modified changes in participants' beliefs or attitudes.

The merits of using questionnaires rather than interviews as a means of gathering data have been pointed out by a number of researchers. According to Denscombe (2006), questionnaires are more certain and more objective than interviews because of the standardised way in which the responses are gathered. Denscombe further believes that questionnaire findings in number form enable the researcher to present confident results with statistically significant outcomes that can be presented as tables and graphs. As Denscombe states, "It conveys a sense of solid, objective research" (p. 236). Questionnaires also provide both time- and fiscally-efficient ways to reach a large audience. A further advantage over interviews is that the questionnaire respondent is able to reply without face-to-face interaction with the questionnaire administrator. As Denscombe points out, this context reduces pressure on the respondent for an immediate and often socially acceptable answer and enables them to have some time to think before answering a question (p. 236).

However, questionnaire disadvantages also exist. For instance, they may not be suitable when complex replies are warranted. Bell (2005) emphasizes the need to avoid confusion and be careful of assumptions. Bell warns, "if respondents are confused, irritated or even offended, they may leave the item blank or even abandon the questionnaire" (p. 140). Good design and unambiguous language are critical. Since the researcher is not actually present to answer questions and clear up misunderstandings, the same questions may have a variety of meanings for different people. Lastly, low questionnaire return rate is also a distinct possibility and the number of returned questionnaires may be too low to permit a valid study.

The beliefs questionnaire used in this research, which is included in Appendix E, aimed to explore and identify mathematics student-teachers' beliefs. Anonymity was not desired of the student-teachers who completed the questionnaire since some respondents would be selected to participate in a follow-up semi-structured interview based on the responses they supplied in the beliefs questionnaire. The criteria by which the respondents were categorized were: student-teachers who mainly showed traditional beliefs, student-teachers who mainly showed constructivist beliefs, student-teachers who mainly showed a mixture of traditional and constructivist beliefs. Two student-teachers were randomly selected from each of these three groups, for a total of six students who would later participate in semi-structured interviews. The main reason for selecting six (6) student-teachers for the semi-structured interview was based on the fact that this number provided a representative sample of the overall 32 participants.

4.5.1.1 Developing the Beliefs Questionnaire

After identifying the study's aims and deciding which aspects needed exploration, subsequent steps were to review the related literature concerning the type and structure of questions that would be asked, as well as the questionnaire layout. Research textbooks were reviewed (e.g. Bell, 2005; Cohen, Manion and Morrison, 2007) for more information concerning the process for designing and administering questionnaires. In addition, various studies using belief questionnaires that explored beliefs or discussed issues on the nature of mathematics, the teaching and learning of mathematics, and the use of ICT and Logo programming language such as Ernest (1988, 1989, 1991, 1996); Hoyles and Noss (1992); Thompson (1992); Papert (1993); Clements, Battista and Sarama (2001); Goos and Bennison (2002); Hart (2002); Becta (2003); Quillen (2004); Jones (2005); Seaman et al. (2005); and Barton and Haydn (2006) were reviewed in order to increase the researcher's fund of knowledge about administering questionnaires on these topics. Following this, the researcher developed a questionnaire consisting of five sections of closed structured belief questions with a 5-point Likert scale. All questions on the questionnaire were developed by the researcher, with some questions originally created, and some modifications of the reviewed questions. The questionnaire was administered as a pre-test prior to the Logo module, and as a post-test following completion of the Logo module, to explore student-teachers' beliefs.

The five sections of the questionnaire focused on the student-teachers' beliefs on (1) the nature of mathematics, (2) the teaching of mathematics, (3) the learning of mathematics, (4) Logo programming language as a tool for the teaching and learning of mathematics, and (5) information and communication technology (ICT). Of these five sections, sections 1-3 were divided into two implicit subsections, namely "Constructivist" and "Traditional," in order to elicit participants' beliefs on these two educational trends. The following illustrates the main titles of the first three sections and their structures:

- Nature of Mathematics (20 questions): 10 questions (1, 3, 5, 7, 9, 13, 14, 16, 17 and 19) that described the nature of mathematics from the constructivist perspective; and 10 (2, 4, 6, 8, 10, 11, 12, 15, 18 and 20) that described the nature of mathematics from the traditional perspective.

- Teaching of Mathematics (20 questions): 10 questions (3, 5, 6, 7, 9, 10, 11, 15, 18 and 19) that described the nature of mathematics from the constructivist perspective; and 10 (1, 2, 4, 8, 12, 13, 14, 16, 17, and 20) that described the nature of mathematics from the traditional perspective.
- Learning of Mathematics (21 questions): 10 questions (2, 3, 5, 6, 7, 8, 10, 11, 17 and 20) that described the nature of mathematics from the constructivist perspective; and 11 (1, 4, 9, 12, 13, 14, 15, 16, 18, 19 and 21) that described the nature of mathematics from the traditional perspective.

Sections 4 and 5 consisted of 26 questions and 24 questions, respectively, (with no subsections). The aim of these sections was to explore student-teachers beliefs about using Logo and ICT in the teaching and learning of mathematics:

- Section 4 was entitled Logo Programme Language, and
- Section 5 was entitled Information and Communication Technology (ICT).

For each question, student-teachers were asked to identify on the Likert scale the level to which their beliefs about the section were consistent with each statement. The Likert scale that was used employed five (5) choices of different degrees of agreement or disagreement: 1 = Strongly disagree; 2 = Disagree; 3 = Undecided; 4 = Agree; 5 = Strongly agree. In discussing the Likert-type format, Lozano, García-Cueto and Muñiz (2008) report "there is no definitive agreement on the number of response categories that optimizes the psychometric properties of the scales" (p. 73). Their research findings suggested the optimum number of response options to be between four and seven. However, when choosing the appropriate number of response alternatives, they caution that it is "advisable to complement the psychometric criterion with consideration of the particular characteristics of the sample in question" (p. 78) in order not to exceed the subject's discriminatory capacity. Based on this, in consideration of the large number of survey questions (111) the researcher chose to use a semantic differential of five choices. In addition, it was essential to use Undecided as a choice since student-teachers were not experienced in the use of either the Logo programming language or ICT as tools for the teaching and learning of mathematics, and may not have held another opinion. The total number of questions within the questionnaire was one hundred and eleven (111) questions divided into five sections, with each section consisting of a specific topic. The number of sections necessitated a lengthy questionnaire; however, its division into multiple topics enabled the participants to complete a section and then advance to the next section, relieving the tedium of a single string of questions. Following the development of the beliefs questionnaire draft, the next step was to examine to what extent it was valid and reliable before the final version of the questionnaire was developed.

4.5.1.2 Beliefs Questionnaire Validity and Reliability

Bell (2005) argued that an item or question is valid if it “measures or describes what it is supposed to measure or describe” (p.117). Bell acknowledges that this statement is vague and leaves unanswered questions; however, Sapford and Jupp (1996) pointed to a more precise definition of validity to “mean the design of research to provide credible conclusions: whether the evidence which the research offers can bear the weight of the interpretation that is put on it” (p.1).

A questionnaire that does not gather valid data does not allow the researcher to address the research problem being studied (Sheatsley, 1983; cited in Bork and Francis, 1985). Therefore, assessing validity of the questionnaire was done through its content validity. The validity of the content was assessed through email and face-to-face consultation with the researcher's supervisors and colleagues. The questions were checked to ensure that they measured the various concepts that needed exploration in the study. This process was followed because "content validity is most often determined on the basis of expert judgment" (Burns, 2000, p.352). Reliability and validity are discussed in more detail in the validity and reliability of the Semi-Structured Interview section below.

Hammersley (1992; cited in Silverman, 2010) defines reliability as "the degree of consistency with which instances (such as administering a questionnaire) are assigned to the same category by different observers (researchers) or by the same observer (researcher) on different occasions" (p.275) and, hence, confirms the consistency of the questionnaire as a measurement instrument (Brislin, 2000). Assessing reliability of the questionnaire was done using SPSS Cronbach's Coefficient Alpha function during the pilot study.

According to Reynaldo and Santos (1999; cited in Turner, 2007), "When you have a variable generated from such a set of questions that return a stable response, then your variable is said to be reliable. Cronbach's alpha is an index of reliability associated with the variation accounted for by the true score of the 'underlying construct.' Alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability factors extracted from dichotomous (that is, questions with two possible answers) and/or multi-point formatted questionnaires or scales (i.e. rating scale). The higher the score, the more reliable the generated scale is. Nunnally (1978) has indicated 0.7 to be an accepted reliability coefficient but lower thresholds are sometimes used in literature" (p. 70). For this study, a value of 0 .7 or above was established as an acceptable reliability coefficient.

The final draft of the beliefs questionnaire was written in English and checked by the researcher's supervisors for spelling, grammar, question validity and cultural validity. Cultural validity issues include commonly used English idiomatic expressions, jargon, colloquial phrases and word meanings which can affect validity, according to McDermott and Plachanes (1994, p. 113). Bracken and Barona (1991) add that in addition to the source language (English), cultural bias potential within the target language (language to be translated to) must also be considered.

When all comments and suggestions were incorporated, the final beliefs questionnaire was ready for translation.

4.5.1.3 Translating the Beliefs Questionnaire

Since the study was conducted in the State of Kuwait where the official language is Arabic, it was essential to translate the beliefs questionnaire into Arabic. Translation validity is a crucial process. Mertens (1997) emphasises the concept of equivalence; that is, the necessity for the translated materials (such as a questionnaire or interview) to reflect all the concepts of the wording items in the original materials (questionnaire or interview).

To determine the validity of the translated beliefs questionnaire, a "back-translation" (Brislin, 2000, p. 79) procedure was followed. Chen, Snyder and Krichbaum (2002, p. 620) called back translation "the most commonly used procedure for verifying the translation of an instrument and is recommended by many researchers (Brislin, 1970; Chapman and Carter, 1979; Werner and Campbell, 1970)." Brislin (1970) provided a foundation for testing the translation equivalence of quantitative measures in 1970 when he outlined a seven-step procedure to help researchers provide adequate translation from English to other languages. The steps included (1) Write in a form that can be easily translated. Use simple sentences and add redundancy when presenting terms that can be difficult to translate across languages; (2) Use competent translators who have familiarity with the content of the material to be translated; (3) Use one bilingual translator to translate from the source to the target language, and use another to blindly translate back from the target to the source; (4) Use raters to examine for errors the original, target and/or back-translated versions. If errors are found, repeat step 3, making changes in the original source language if necessary. Dismiss or retain translators based on errors; (5) When no meaning errors are found, pretest the translated materials on target language subjects, and be prepared to make further revisions based on pretest results; (6) Administer both source-language and target-language versions to bilingual subjects, with some subjects receiving the source-language version, some the target-language version, and some receiving both versions. Similar responses should be found across groups, with similar means, standard deviations, and correlation coefficients; (7) Compare the results of the step 5 pretest and the more lengthy process outlined in step 6. (p. 214).

A number of studies reported achieving statistically valid results using three or more of Brislin's recommended transaction steps (Hansen and Fouad, 1984; Bracken and Fouad, 1987; and McDermott and Palchanes, 1992; cited in McDermott and Palchanes, 1994).

In this study, the beliefs questionnaire was first translated into Arabic by a bilingual graduate student who is a native Arabic speaker. Then, the Arabic version was translated into English by a bilingual professor at the College of Basic Education, and compared with the original English version in order to check whether the Arabic version had the translation content equivalency. After checking the translation content equivalency, which showed compatibility between the Arabic version and English version contents, translation validity for the Arabic version was attained, and the Arabic version beliefs questionnaire was ready for the pilot study stage.

4.5.1.4 The Pilot Study of the Beliefs Questionnaire

Conducting a pilot study of a questionnaire is a crucial procedure before developing the final questionnaire version. Its main objective is to determine the unambiguous character of the questionnaire. Cohen, Manion and Morrison (2007) considered a pilot study of a questionnaire as a process to test the clarity of language, validity and reliability, as well as to measure the required time for completion. This provides the researcher the opportunity to find out the appropriateness and practicality of the questionnaire and help him or her to improve it through clarifying any ambiguities. According to MacNeill (1985) "this stage of questionnaire-based research should never be omitted. In it, the researcher tries out the questionnaire on a number of people who are similar to those who will be investigated in the actual research. Any problems with the drafting, and perhaps the layout, of the questionnaire should show up at this stage and can be corrected before the real investigation starts" (p. 31).

The pilot study was conducted during the summer semester in July 2007 with eight (8) mathematics student-teachers at the College of Basic Education who were registered in the Methods of Teaching Mathematics course. Conducting a pilot study enabled the researcher to identify ambiguous questions and revise them in a simple and unambiguous format for the final version of the beliefs questionnaires. The pilot study also enabled the researcher to practise administering the questionnaire, determine how long it would require the participants to complete it, and practise responding to student-teacher inquiries while the questionnaire was being administered. Lastly, the researcher was able to assess the reliability of the questionnaire using SPSS Cronbach's Coefficient Alpha function.

After the ambiguous questions were revised, the beliefs questionnaire was given to a professor at the College of Basic Education to check the revision. A final beliefs questionnaire version was developed and prepared to be used for the study. (The Beliefs Questionnaire, English and Arabic versions, is included as Appendix E).

The beliefs questionnaire was administered to the participants in the study in fall semester 2007 during the first session of the Logo module course as a pre-test to explore their initial beliefs, and during the last session of the Logo module course in January 2008 as a post-test to explore their current beliefs after their practise experience with Logo programming language. A consent letter for participation in the study, which is included in appendix B, was signed by each student-teacher in which they acknowledged their willingness to answer the questionnaire; the ethical issues concerning the administration process is mentioned below in Section 4.6, entitled Study Field Procedures.

4.5.2 Beliefs Interview

The beliefs interview was the qualitative data gathering instrument employed by the researcher to explore and identify mathematics student-teachers' beliefs. Various terminologies such as "research interview" (Cannel and Kahn, 1968; cited in Triandis and Berry, 1980, p. 142), "survey interview" (Moser and Kalton, 1971, p. 271) and "interview" (Mouly, 1978, p 201) exist. For example, Cannel and Kahn (1968, cited in Triandis and Berry, 1980, p.142, section Interviewing as a Research

Method) state, “a research interview is a two-person conversation; it is initiated by the interviewer for the purpose of obtaining research-relevant information and focused by him on the content specified by research objectives of systematic description, prediction, or explanation.”

Mouly (1978) states “an interview is a conversation carried out with the definite purpose of obtaining certain information” (p. 201). Finally, Moser and Kalton (1971) described “the survey interview as a conversation between interviewer and respondent with the purpose of eliciting certain information from the respondent” (p. 271). Although different terminologies exist, it was obvious that the definitions are almost the same and the authors referred to the same object, which is the interview. However, for this research, the researcher adapted Cannel and Kahn’s definition because it contains more detail.

Cannel and Kahn (1968, cited in Triandis and Berry, 1980, in the section Interviewing as a Research Method) define “research interview as a two-person conversation; it is initiated by the interviewer for the purpose of obtaining research-relevant information and focused by him on the content specified by research objectives of systematic description, prediction, or explanation” (p.142), “about the feeling, motivations, attitudes, accomplishments, and experiences” (Gall, Borg and Gall, 1996, p.288). In addition, through the interview, we can also learn the individual’s “own point of view” (Cohen, Manion and Morrison, 2003, p. 267). Using interviews as a research method for data collection can serve a wide range of purposes; however, as Denscombe (2003) pointed out, two of the three most frequently occurring purposes for using interviews as a data collecting method are: first, as a “Follow-up to a questionnaire”, that is, to follow up interesting lines of inquiry discovered by the questionnaire in more detail and depth; and second, "triangulation with other methods", that is, to be used in conjunction with other methods in the research to confirm facts identified using a different method (p. 166). Besides, McNamara, (1999; cited in Valenzuela and Shrivastava, 2002), considered interviews particularly useful to obtain a story behind a participant's experiences. The researcher's objective for using interviews in this study was to explore in more detail and depth the student-teachers' initial beliefs after the pre-test questionnaires (prior to their Logo module experience), and their current beliefs after the post-test questionnaire (following their Logo module experience), i.e., what did student-teachers believe about the Logo module, as well as to confirm the results of student-teachers beliefs as identified through the questionnaires.

The interview usage in this study was also based on its advantages. For instance, in considering the interview as a data-gathering tool to be compared with a questionnaire, an interview is considered more flexible, and allows the interviewer to follow up on ideas, probe responses and ask for explanation (Bell, 2005). Consequently, it helps the interviewee clarify his belief on a given point so that he will give a response when he would normally claim ignorance about or assign more importance to it (Mouly, 1978). Hence, interviews facilitate the interviewer to explore interesting or unexpected ideas or themes raised by the interviewee, and obtain data that is potentially richer and more complete (Slavin, 1984) and "in depth" (Engelhart, 1972, p. 108).

Compared to observation, the interview is considered the means of data collection that helps the researcher to ask individuals about things that cannot be directly observed. The interview is supported by Patton (1990, cited in Ghere and York-Barr, 2003, p.7) who stated, "The purpose of interviewing is to find out what is in and on someone else's mind….We interview people to find out from them those things (such as beliefs and intention) we cannot directly observe."

The considerable advantage of a face-to-face interview is that it allows the researcher the opportunity to change the structure of the questions if the situation demands, make clear or clarify questions, inquire about unclear answers, and ensure the interviewee's answers are clear and understandable. In addition, the interview allows the researcher to develop a rapport with the interviewee which can help him or her obtain better and fuller responses (Robson, 2007) because "people tend to enjoy the rather rare chance to talk about their ideas at length to a person whose purpose is to listen and note the ideas without being critical" (Denscombe, 2003, p. 190). The personal interview not only gives the researcher the chance to listen but also to observe the interviewees. Consequently, it gives the interviewer the chance to assess the value of the interviewee's answers through observing the "non-verbals" signals or "throw-away comments" (Robson, 2007, p. 77). According to Wise, Nordberg and Reitz (1967) "very often inferences about a person's genuine feeling (about the topic under investigation) can be drawn by a competent interviewer from such relatively minor behavior reactions as the tone of voice, posture, facial expressions, or by the deliberate avoidance on the part of the interviewee of certain words or referents in conversation" (p. 105).

The interview has a number of important advantages in certain situations over other data collection tools; however, it is still fraught with some disadvantages. One obvious disadvantage of interviews can be related to the bias of the interviewer (Mouly, 1978; Cohen, Manion and Morrison, 2007). This is because interviews are a highly subjective technique (Bell, 2005) and because "interviewers are human beings and not machines, and their manner may have an effect on respondents" (Selltiz et al.

1962; cited in Bell, 2005, p. 166). On some occasions the interviewer may "project his (or her) own personality into the situation, and thus influence -- by means of intention and emphasis, gesture, facial expression, and various subtle cues -- the responses he (or she) receives" (Mouly, 1978; p. 203). The interviewer may tend to seek out the answers that support his/ her preconceived notions (Borg 1981, p.87); this might encourage or guide the responses of interviewees towards answers that support the interviewer's beliefs instead of their own opinion. Interviewers might also emphasis interviewee answers that support their own perception and discard what contradicts them since, as Mouly (1978, p.204) states, "Not only do we give preferential attention to certain aspects of the reality that is "truly out there," but we also interpret sensory inputs in terms of their meaning in our self-structure." As Cohen, Manion, and Morrison (2003, p. 279) point out, the researcher must pay attention to the ethical dimension of the interview, including ensuring informed consent, confidentialty and non-maleficence. A further ethical consideration involves the data itself. Then researcher must determine what is to count as data, and this must be clarified before the interview begins. For instance, some participants may say something after the interview has been completed, or may request that a comment be off the record.

Interviewees may also be a source of bias. For example, interviewees might orient their answers in order to please the interviewer, thus providing answers that deviate to some extent from the truth. This can be linked to what Borg (1981) identified as "Eagerness of the respondent to please the interviewer" (p. 87). This study attempted to ameliorate this possibility by clearly stating in the consent letter that each student-teacher received prior to participation in the interview that their responses and names would remain anonymous. Thus interviewees felt secure to respond as they wished without fear of reprisal. Further, the interviewer was an external researcher, so there was no issue related to fear of their responses adversely affecting their grades. In addition, the researcher had no teaching or other relationship to the establishment (College of Basic Education) where the intervention took place other than conducting his research study there.

There are other disadvantages: interviews are usually more time-consuming, especially in relation to interviewing, transcribing and analyzing (Drever, 2003). Besides, in contrast with questionnaires that can be mailed or e-mailed, interviews require securing permission and scheduling the time as well as a confirmation with the interviewee, and in case of interviewee's absence the appointment needs to reschedule, thus changing the researchers' schedule to accommodate the interviewee's time.

Nevertheless, the interview is widely used for data gathering and viewed as a "powerful and useful tool" (Mouly, 1978, p. 202) that "allows for greater depth than other methods" (Cohen, Manion and Morrison, 2003; p.269) and when it is combined with other methods such as questionnaire, it "can often put flesh on the bones of questionnaire responses" (Bell, 2005; p.157).

There are three types of interview: structured, semi-structured and unstructured (Burns 2000; Denscombe 2003). This study used a semi-structured interview.

4.5.3 The Semi-Structured Interview

The use of this study's semi-structured interview (see Appendix F), was based on its advantages as contrasted with the structured and the unstructured interviews. For example, a structured interview or "interview schedule" (Burns, 2000, p. 571) begins with a series of previously established questions, usually in the form of a predetermined and closed-ended structure with specific answers, has a rigid control over the wording and arrangement of questions and probes (Burns, 2000); it is considered “like a questionnaire which is administered face to face with a respondent” (Denscombe, 2003; p. 166). The interviewees have no scope in which to express their beliefs, feelings and perceptions that do not fit into the predetermined response categories and, consequently, give no scope for the interviewer to explore in more depth about these beliefs, feelings and perceptions (Burns, 2000). In the unstructured interview, there is no predetermined form of question topic or wording; rather, questions emerge from the immediate context between the interviewer and the interviewee and are asked in the natural course of things (Patton, 2002). This flexibility provides few restrictions on the interviewee’s answers, which can lead to a loss of focus on the relevant issue of the study, or make the interviewer open to the vagaries of the interviewee’s interpretation and perceptions of reality (Burns, 2000). In the semi-structured interview, there is an interview guide developed by the interviewer through a predetermined clear list of issues to be addressed and questions in an open-ended form to be answered by the interviewee (Burns, 2000; Denscombe, 2003; Bryman, 2004). In addition, the interviewer is free to change the order of the questions or probes, and ask new questions of interest that are not included in the interview guide to obtain more information (Bryman, 2004) or omit questions as the need arises (Robson, 2002). Interviewees are also given the flexibility to express their beliefs about the issues and topics under study within the scope of the interview guide. Arksey and Knight (1999) describe the semi-structured interview as a type that “falls between the structured and unstructured format” (p. 7).

Disadvantages have also been identified for semi-structured interviews. Like other interviews, they are time consuming, and require interviewing, transcribing and analyzing skills (Cohen, Manion and Morrison, 2003). Bush (2002, cited in Wang, 2008) notes another concern: the flexibility that semi-structured interviews afford may actually create difficulty in ensuring reliability because of the "deliberate strategy of treating each participant as a potentially unique respondent" (p. 63). The issue of bias is yet another possible threat to reliability of semi-structured interviews. This can be manifested through the interviewer's attitudes and opinions, tendency to seek specific types of answers from the interviewees, or physiological characteristics of the interviewer, such age or race. (Cohen and Manion, 1994). Careful design of interview questions and development of interviewing skills can reduce bias. The interviewee too can bias the results. Borg 1987) mentioned that eagerness of the respondent to please the interviewer and even a vague antagonism that sometimes arises between interviewer and interviewee may occur (p. 111). Although the student-teachers were completely free to express their own line of thought, the researcher nevertheless maintained control of the direction of the interview. The researcher's objective was to explore definite types of information; therefore, it was essential to have control and confine the respondents to a discussion of the issues about which the researcher desired knowledge

After the advantages and disadvantages were weighed, the choice of semi-structured interview was made in this study because it allowed the researcher to probe and ask more questions of interest in order to obtain more in-depth information about student-teachers' beliefs.

4.5.3.1 Developing the Semi-structured Interview

After choosing the semi-structured interview to explore student-teachers' beliefs in more depth, the next step was to review the related literature and consult with the researcher's supervisors concerning the type and structure of questions that would be used. In light of the nature of this study, the semi-structured interview with open-ended questions was developed.

The aims of the semi-structured interview were as follows:

1- The pre-interview intended to explore in more depth student-teachers initial beliefs before administration of the Logo module.

2- The post-interview intended to explore in more depth student-teachers' current beliefs after administration of the Logo module, in particular to establish if the student-teachers' responses changed after the Logo module, illustrating modified student-teachers' beliefs through the Logo programme module.

The questions in the semi-structured interview focused on student-teacher beliefs with regard to the same topics that were dealt with in the questionnaire, providing yet an additional way to gather in more depth beliefs information about these specific topics:

- The nature of mathematics
- The learning of mathematics
- The teaching of mathematics
- Logo programming language as a tool for the teaching and learning of mathematics
- The advantages and disadvantages of the use of Logo program
- Information and communication technology (ICT)

Furthermore, an additional question was added concerning:

- Student_teachers'previous mathematics classroom experience.

The aim of this question was to learn from the student-teachers about their past experience and beliefs to have clearer picture about the effect of their classroom experience on their beliefs.

4.5.3.2 The Semi-Structured Interview Validity and Reliability

As discussed in Section 4.5.1.2, validity and reliability are important issues within both quantitative and qualitative research paradigms. Kumar (1999) defines validity as "the ability of an instrument to measure what it is designed to measure… and reliability is the degree of consistency and stability in an instrument" (p.137-140). Since in this study the researcher used methods from both quantitative and qualitative research paradigms, it is important to shed light on the issues of validity and reliability for each paradigm, as each holds its own view. Sparkes (1992) describes this issue as follows:

"In interpretive (qualitative research paradigm) research, the researcher is the instrument. Brown (1988, cited in Sparkes, 1992) reminds us, "There are no reliability and validity coefficients for the researcher who is observing or interviewing participants in the natural setting" (p. 95). In view of this, it should come as no surprise to find that, for interpretivists, methods (techniques) are not seen as guarantors of truth as they are in positivist (quantitative research) paradigm. As Reason and Rowan (1981) have argued, validity (and reliability) in new paradigm research lies in the skills and sensitivities of the researcher, in how he or she uses herself as a knower and inquirer. Validity (and reliability are) more personal and interpersonal, rather than methodological (p. 244)" (p. 30).

Therefore, as Creswell (1994) points out, some qualitative researchers argue that the terms of validity and reliability are not applicable to the qualitative research paradigm. At the same time, they also realise the need to develop an alternative means to check or measure for their research. As a result of this, the concept of “Trustworthiness” was established (Lincoln and Guba, 1985). Trustworthiness, according to Lincoln and Guba (1985), consists of four aspects: first, credibility, which refers to the extent to which the research findings represent a “credible” conceptual interpretation of the original data collected from the participants; second, transferability, which refers to the extent to which the findings can be transferred or applied in other contexts or with other participants; third, dependability, which is the extent to which the findings of the study are consistent and accurate; and fourth, confirmability, which refers to the degree to which findings are the product of the inquiry in focus and not of the biases of the researcher. (p. 289-300).

According to Cohen, Manion and Morrison (2007), the most practical way to attain greater validity is to (1) minimise the amount of bias as much as possible because the sources of bias are the characteristics of the interviewer, the characteristics of the respondent, as well as the substantive content of the questions; and (2) increase the researcher’s truthfulness concerning a proposition about the social phenomenon under study to achieve the validity of qualitative research (Denzin, 1978; cited in Golafshani, 2003).

Maxwell (1992) describes three types of validity in qualitative research:

1- Descriptive validity: determines the researcher’s accuracy of reporting what he or she saw or heard that is typically indicative of descriptive information.

2- Interpretive validity: concerned with the degree to which the researcher and his or her interpretation accurately captures the participant's viewpoints, thoughts, feelings, intentions, and experience.

3- Theoretical validity: the extent to which a theoretical explanation developed from the study fits the data and is therefore credible and defensible.

In addition, Bryman (2004) referred to two types of validity in qualitative research: first, internal validity: the degree of the good match between researcher and the theoretical ideas he or she develops, and second, external validity: referring to the study findings and the degree of generalising these findings. Borg (1987) also describes in depth the notion of internal and external validity. Regarding internal validity, he warns that the researcher must "consider the degree to which weaknesses in the design can distort the results" (p. 223). Further, Borg states that internal validity is the degree to which the design of an experiment controls extraneous variables (p. 224). He cites Campbell and Stanley (1963) who have identified eight such extraneous variables that can affect internal validity: (1) history, or the amount of time over which experimental treatment occurs, and other mitigating events that may happen during this same time; (2) maturation, or the amount of biological or physiological changes that may occur in the subjects; (3) testing, or becoming test-wise through test practice; (4) instrumentation, or benefit gained because of differences in follow-up testing instruments; (5) statistical regression, or gains made as a result of test-retest procedures; (6) differential selection, which means that the same criteria must be used to select both the control and the experimental groups; (7) experimental mortality, also called attrition, in which loss of subjects can occur while a study is being conducted; and (8) selection-maturation interaction, which is similar to differential selection in that maturation can be a confounding variable when control and experimental subjects differ.

Building on the previous discussions, validity in this study is perceived as the adequacy with which the researcher accurately understands, interprets, and reports initial and final participant student-teachers' beliefs in regard to (a) the nature of mathematics, (b) the learning of mathematics, (c) the teaching of mathematics, (d) Logo programming language as a tool for the teaching and learning of mathematics, (e) the advantages and disadvantages of the use of Logo program, (f) information and communication technology (ICT), and (g) student-teachers' previous mathematics classroom experience. As Janesick (2000) noted, "Validity in qualitative research has to do with description and explanation and whether or not the explanation fits the description" (p. 393).

Borg (1987) defines external validity as the "degree to which research results can be generalized to persons, settings, and times different from those of the research" (p. 227). He points to Bract and Glass (1968) who cite these aspects of external validity which the researcher needs to consider: (1) population validity, or the level to which the research findings can be generalized to a larger population; and (2) ecological validity, or whether environmental conditions present during the study can be generalized to other environments.

In quantitative research, reliability is considered "scientific evidence" (Creswell, 1994, p. 157). However, in qualitative research, LeCompte and Goetz (1982) referred to two types of reliability, external and internal. The first, external reliability refers to "whether independent researchers would discover the same phenomena or generate the same constructs in the same or similar settings"; this, in a sense, confirms the findings' consistency and stability; and consequently, determines the successful replication of the research findings (Bloor and Wood, 2006). The second, internal reliability, is the "degree to which researchers, given a set of previously generated constructs, would match them with data in the same way as did the original researcher" (LeCompte and Goetz, 1982, p. 23).

The use of a semi-structured interview as a qualitative method for data collection in this study was to explore the student-teacher participant's beliefs in more depth prior to and following the Logo module experience, and to combine its finding with the questionnaire finding for more validity. According to Kerlinger (1970, cited in Cohen, Manion and Morrison, 2007) the use of an interview in conjunction with other methods (such as a questionnaire) in research validates these methods.

4.5.3.3 The Semi-Structured Interview Sample

After the semi-structured interview questions were developed and approved by the researcher's supervisors, the next steps were to decide on the size of the interviewee sample and translation of the interview questions. Following discussion with the researcher's supervisors, the sample size was set to six (6) participants as it provided an appropriate representative number of the overall 32 student-teachers. The participants would be placed in one of three categories based on their responses to the questionnaire, with two student-teachers in each category. The three categories were as follows: student-teachers who mainly showed traditional beliefs, student teachers who mainly showed constructivist beliefs and student-teachers who mainly showed a mixture of traditional and constructivist beliefs. The semi-structured interview objective was to more deeply explore the beliefs each of the six (6) student-teachers manifested in their questionnaire responses, allowing the researcher to more fully comprehend their initial beliefs prior to the Logo module experience and their final beliefs following the Logo module experience. The interviewer was an external researcher and not employed by the College of Basic Education; his only relationship with the College was to conduct his research there. Therefore, there was no issue for student-teachers to fear their responses would adversely affect their grades.

4.5.3.4 Translating the Semi-structured Interview

The semi-structured interview questions were translated to Arabic and the validity of the translated questions was determined following the same "back-translation" (Brislin, 2000, p. 79) procedure used for translating the beliefs questionnaire (mentioned above in 4.5.1.3, Translating the Beliefs Questionnaire).

The semi-structured interview was first translated into Arabic by a bilingual professor at the College of Basic Education who is a native Arabic speaker. Then, the Arabic version was translated into English by another bilingual professor at the College of Basic Education, and was compared with the original English version in order to check whether the Arabic version has the translation content equivalency. After checking the translation content equivalency which it showed there is compatibility between the Arabic version and English version contents, the translation validity for the Arabic version was attained. At this point, the Arabic version beliefs interview was ready for the pilot study stage.

4.5.3.5 The Pilot Study of the Semi-Structured Interview

The pilot study of the semi-structured interview was conducted with one (1) Mathematics student-teacher at the College of Basic Education during the fall semester in September 2007. The pilot study enabled the researcher to: (1) make sure that interview questions were understood and not ambiguous; (2) determine the length of time needed to administer the interview; (3) practise conducting the interview; (4) practise responding to student-teachers inquiries during the interview; and (5) practise recording and analyzing responses. The pilot study of the semi-structured interview showed that the interview questions, in Arabic, were understandable and clear. As a result, the semi-structured interview was ready to be used for the study. (The Beliefs Interview, English and Arabic versions, is included as Appendix F).

The semi-structured interviews were conducted at the College of Basic Education with six (6) Kuwaiti mathematics student-teachers prior to and after the Logo module was implemented. The process and the aims of the interviews were as follows:

1- The initial (pre) interviews were conducted before participation in the Logo module and after the student-teachers completed the pre-test beliefs questionnaire to explore their beliefs in more depth.
2- The final interview (post) interviews were conducted after student-teachers completed the post-test beliefs questionnaire to explore their beliefs in more depth after the Logo module, and in particular to establish if the student-teachers' responses changed after the Logo module, illustrating modified student-teachers' beliefs through the Logo programme module.

A consent letter agreeing to participate in the interview (please see Appendix D), was signed by each student-teacher in which they acknowledged their willingness to participate in the interview and permission for the interview to be audio tape-recorded. In addition, written notes were taken by the researcher during the interview.

4.6 Field Study Procedures

Only student-teachers from Kuwait's College of Basic Education who were registered in the Methods of teaching Mathematics course were considered in this study. To facilitate the researcher's carrying out a field study, a letter from the graduate school at Nottingham Trent University (NTU), as well as a personal letter from the researcher in Arabic, was delivered to the Dean of the College of Basic Education, seeking permission for the study to be performed. Permission was received from the Dean of the College of Basic Education, as well as from the professor who teaches the Methods of Teaching Mathematics course, to facilitate the Logo module sessions. (The letter from NTU, as well as the researcher's personal letter, is included as Appendix A). Finally, participation letters were delivered to each participant to request their willingness to participate in the study, and acknowledgements were received from each participant. (Arabic and English versions of the Participation Consent Letter, Questionnaire Consent Letter, and Interview Consent Letter are included as Appendix B, C and D).

The Methods of Teaching Mathematics course period was twelve (12) weeks in length and consisted of four hours instruction per week for a total of forty-eight (48) instruction hours. Within the forty-eight instruction hours, two hours per week over a three-month time frame were assigned to the researcher's Logo module sessions for a total accumulation of twenty-four (24) session hours. The module sessions were taught and practised in an ICT laboratory setting. During the sessions, students-teachers were introduced to an ICT teaching module that incorporated the use of Logo programming language as an ICT cognitive tool to support the constructivist perspective for teaching and learning mathematics, experienced the use of Logo in solving mathematics activities, and developed a practise teaching lesson plan that incorporated Logo.

Prior to participation in the Logo module, each student-teacher completed a pre-test beliefs questionnaire. Following completion of the Logo module, each student-teacher completed a post-test beliefs questionnaire. In addition, semi-structured pre-interviews and post-interviews were conducted with six (6) student-teachers prior to participation in and following completion of the Logo module course, enabling the researcher to explore in more depth student-teachers' beliefs before and after receipt of the Logo module.

4.7 The Statistical Data Analysis Procedure: Questionnaire

A questionnaire was used to collect information about the beliefs of the student-teachers on topics: (a) the nature of mathematics, (b) the learning of mathematics, (c) the teaching of mathematics (d) the use of Logo programming language as a tool for the teaching and learning of mathematics, and (e) the use of information and communication technology (ICT). A questionnaire, arranged in the five sections administered to each participant and the SPSS statistical programme was used to compute and assess the mean of student-teachers answers, as follows:

1- The first three sections were divided based on the question type into two subsections, namely: "Constructivist subsection" and "Traditional subsection."

   For each subsection the Paired-Samples t-test (SPSS statistical function) was used to compute the mean of student-teachers answers. This Paired-Samples t-test function was used to assess whether the means of the two subsections when analysed separately, as pre-test and post-test, are statistically different from each other, as well as to explore which view student-teachers lean toward -- Constructivist or Traditional concept.

2- A Paired-Samples t-test (SPSS statistical function) for equality of means was used to assess whether the means between the subsections (pre-test and post-test) had changed and so illustrate modified student-teachers' beliefs.

3- A Paired-Samples t-test for equality of means for the Logo programming language section was used to assess whether the means between the pre-test and post-test changed and so illustrate modified student-teachers' beliefs.

4- A Paired-Samples t-test for equality of means for the (ICT) section was used to assess whether the means between the pre-test and post-test had changed and so illustrate modified student-teachers' beliefs.

It needs to be recognised that using multiple t-tests for means comparison increases the risk of type one errors. However, a p value of 0.01 for significance level was, in all cases, used to compensate for this.

The computed means of student-teachers' beliefs were interpreted using the scale reflected in Table 4, shown below. Additionally, Cronbach's Coefficient Alpha function was used to assess the reliability of the questionnaire.

Table 4. Interpretation for the Computed Means of Student-Teachers' Beliefs

Mean	Interpretation
4.50 – 5.00	Strongly Agree
3.51 – 4.50	Agree
2.51 – 3.50	Neither Agree nor Disagree
1.51 – 2.50	Disagree
1.00 – 1.50	Strongly Disagree

4.8 The Statistical Data Analysis Procedure: Interview

The six student-teachers selected for the Interview were categorised into one of the following:

1. Student-teachers with mainly traditional beliefs.
2. Student-teachers with mainly constructivist beliefs.
3. Student-teachers with both traditional and constructivist beliefs.

The student-teachers were categorised and grouped based on the responses they supplied in the Questionnaire regarding the nature of mathematics, mathematics education perspectives (traditional and constructivist), the use of Logo and ICT, and classroom experience.

Themes and issues developed through analysing student-teachers beliefs were categorised according to: perceived nature of mathematic (e.g. as absolutist or fallibilist); perceived teaching and learning of mathematics, that is, either in favour of traditional or constructivist perspective; view of the usefulness, as well as the advantages and disadvantages of Logo programming language; beliefs of the role of ICT; and perspective of classroom experience. This procedure was applied for the pre- and post interviews. In addition, the post-interview analysis was compared with the pre-interview to determine if any changes in student-teachers beliefs occurred. Pre- and post-interview data analysis results were also compared with the student-teachers questionnaire analysis results.

Data preparation was as follows: the raw data (recorded data) was transcribed to be easy to work with and help the researcher to extract the answers to the research questions (A sample transcript of interview (English and Arabic version), is included in Appendix L).

4.9 Summary

This chapter discussed the study's research design, quantitative and qualitative research methodologies, as well as the researcher's rationale for combining quantitative and qualitative data collection methods of investigation. The context of the study and the participants were also identified. Data collection instruments, which included a questionnaire and a semi-structured interview, were used to explore student-teachers' beliefs, and the advantages and disadvantages of these instruments were identified. The development, translation, and piloting of the questionnaire and semi-structured interview were described. The discussion also examined the reliability and validity of both quantitative and qualitative research tools. In addition, the study field procedure described ways of ensuring ethical consideration in this research. The chapter concluded with a description of the statistical data analysis employed in the study. The next chapter discusses the Logo session module.

CHAPTER 5
THE LOGO MODULE COURSE

5.1 Introduction

This chapter discusses the Logo programming language module course presented to the mathematics student-teachers at the College of Basic Education in State of Kuwait during their participation on this study. The chapter contains the following sections: rational for the Logo programming language module course and the Logo module.

5.2 Rationale for the Logo Programming Language Module Course

The use of information and communication technology (ICT) plays a crucial role in today's mathematics classrooms. The teaching and learning of mathematics can be enhanced by the integration of technology, thereby changing the students' beliefs and perceptions about the classroom, the roles of teachers and students and instructional strategies. In addition, it transforms the learners to become critical thinkers and active individuals in the competitive world of technology. It also implies a shift in the student's efforts from computational tasks to exercises in thinking critically, communicating clearly, designing solutions to mathematical problems and applying mathematics to solve complex scientific problems.

Successful implementation of ICT and its use in teaching relies deeply on teachers' beliefs and attitudes about using ICT, as evidenced by research findings. Kersaint and Thompson (2002) and Russell et al. (2003) agree that it is important to explore the role that beliefs play in technology integration. In addition, Russell et al. (2003) and Swan and Dixon (2006) have confirmed the positive correlation between the extent of teachers' and student-teachers' experience with ICT and positive beliefs towards ICT use.

In order to implement the use of ICT, teachers should have the ability to accept these changes in their opinions and beliefs. Wilcox et al. (1990) clarify that teachers' beliefs are deep-rooted ideas developed during their previous experience and attached to their personalities which make them resistant to change. As a consequence, the more important a teaching belief is to a teacher, the more resistant to change that belief becomes. Therefore, if we are to motivate teachers and student-teachers to evaluate and reflect on their beliefs, we must incorporate opportunities and create situations to engage them in reflective practises, and active mathematics knowledge building with the use of ICT. Teachers' beliefs are one of the most significant factors that play an important role in influencing and shaping their instructional practises (Thompson, 1992; Nespor, 1987; Pajares, 1992; Ernest, 1996; Norton, McRobbie and Cooper, 2000; Spilelm and Lloyd, 2004; Remillard and Bryans 2004). This assertion formed the main guidance decision for the design of the Logo module course. In addition, the decision to choose the Logo program was based on its potentials as a cognitive tool where:

- The turtle graphics microworld provides the best available introduction to computer programming for mixed (pupils) ability classes; it is accessible and highly motivating.
- The procedural and extensible nature of Logo encourages the breaking down of problems into parts and the use of the part solutions as building blocks of alternative structures – all important mathematical activities (building new knowledge based on the prior knowledge).
- Debugging is aided by the procedural nature of Logo and is encouraged

because of the powerful editing and interactive facilities available in Logo (Hoyles and Sutherland, 1989; p.7).

In addition, Logo is available in the Kuwaiti schools and that makes it accessible for student-teachers to use in their future mathematics instruction.

The researcher's rationale for using the Logo module in this study was that it would provide student-teachers the opportunity to experiment with a powerful innovation of mathematical instruction context, and would allow them to reflect on and re-evaluate their beliefs about the nature of mathematics, learning and teaching of mathematics, and the use of ICT in general and Logo programming language in particular as a cognitive tool in their future mathematics instruction.

The main objectives of the Logo module course were to:

- First, introduce and familiarize student-teachers with the use of Logo programming language as an ICT cognitive tool that supports the constructivist perspective for the learning and teaching of mathematics.
- Second, provide student-teachers with an intervention opportunity where they could reflect on and re-evaluate their initial beliefs towards the nature of mathematics, learning and teaching of mathematics, using ICT in general and Logo programming language in particular as an ICT cognitive tool in their future mathematics instruction.
- Third, provide student-teachers the opportunity to prepare a mathematics lesson plan that incorporates the use of Logo programming language as a cognitive tool for mathematics education.

- Fourth, provide student-teachers the opportunity to practise teaching mathematics with the use of Logo programming language.

If we believe that mathematics student-teachers in their future classrooms should allow their students to develop understandings of mathematical concepts through new methods such as using Logo as an ICT cognitive tool that allows investigation which supports further development of students' current levels of thinking and backgrounds, then we should not anticipate that new insights about these pedagogical methods would transfer to student-teachers by way of traditional lectures during their mathematics teacher education program in general and, more specifically, in a methods of mathematics education course. Rather, the researcher believes that student-teachers need practise and experience using these new methods and they also need to play the role of the mathematics learners during their practical practise and experience before they are ready to implement such educational context in their future classrooms. Therefore, to achieve this principal during the Logo module, student-teachers were placed in the situation of being pupils while the researcher played the role of facilitator to encourage the student-teachers to be responsible for solving the mathematical activities with the use of the Logo. The researcher's aim was to provide student-teachers with the following opportunities: first, experience the role of pupil in a direct context of experience and engagement with new practise of ICT integration. Second, to have practical experience of Logo mathematical activities as pupils. Third, to consider the Logo-based mathematical activities from the pupil's perspective. Forth, to recognise the potential of this learning process as supported by the programming language Logo's capability to provide an environment for cognitive learning of mathematics. Fifth, to recognise pupils' collaborative learning context, either when an individual pupil works with

Logo or when small groups of pupils work with Logo, and how collaboration dialogue allows the construction of mathematical knowledge. Finally, to provide student-teachers with the opportunity to reflect on and re-evaluate their beliefs about the mathematics teacher's role in the classroom.

In general, it was hoped that the Logo module would provide student-teachers with hands-on opportunities to familiarise Logo use skills, solve mathematical Logo-based activities, practise preparation of a mathematics lesson plan that integrates Logo, and practise teaching mathematics using Logo. As a consequence, it was hoped that these experiences would enable student-teachers to reflect on and re-evaluate their beliefs about the nature of mathematics, the learning and teaching of mathematics and the use of Logo in their future class.

After identifying the goals for the Logo module, the next step for the researcher was to consult with his supervisors concerning topics to include in the Logo module, and review the related literature to develop the Logo module (see sections 3.5 to 3.5.2.1 in Chapter 3). Further, Kuwaiti mathematics textbooks on topics in mathematics (Al-Sharkawi et al., 2005 and 2006) were reviewed for transformation geometry activities. The predefined transformation geometry procedures prepared by Herr (2006) have been adopted and modified for this study. Following development of the Logo module draft, the next step was to consult with the researcher's supervisors for additional suggestions before preparing the final version of the Logo module. The final Logo module draft was written in English and was reviewed by the researcher's supervisors. Based on their comments and suggestions, necessary modifications were made and the final version was approved by the researcher's supervisors. Finally, the Logo module was translated to Arabic to be used for the study. (The Logo Module, English and Arabic versions, is included as Appendix G).

5.3 The Logo Module

The Logo module consisted of six parts: (a) Welcome meeting and administration of the pre-test Beliefs Questionnaire; (b) Introduction to Logo programming language; (c) Mathematical Logo-based activities; (d) Preparation of mathematical Logo-based lesson plan; (e) Teaching practise with the use of Logo programming language; and (f) Thanking meeting and administration of the post-test Beliefs Questionnaire. The Logo module consisted of a twelve-week (12) session in the Logo programming language, with a one-hour (1) session for two (2) days a week, amounting to a total of twenty-four (24) session hours distributed throughout the Logo module parts, as shown in Table 5.

Table 5. Logo Module Parts and Number of Session Hours

Session Number	Logo Module Parts	Session Hours
1	Welcome meeting and administration of pre-test Beliefs Questionnaire	1
2-9	Introduction to Logo programming language	8
10-17	Mathematical Logo-based activities	8
18-20	Preparation of mathematical Logo-based lesson plan	3
21-23	Practise teaching mathematics with the use of Logo programming language	3
24	Thanking meeting and administration of post-test Beliefs Questionnaire	1

5.3.1 The Logo Module Parts

5.3.1.1 Welcome Meeting and Administration of Pre-Test Beliefs Questionnaire

In this part, which occurred in the first session, the researcher introduced himself to the student-teachers and gave general information about the study. In addition, the participants' willingness to participate in the study was solicited and a signature requested to acknowledge their willingness to complete the pre-test belief questionnaire. Then a pre-test belief questionnaire with cover letter was administered to the student-teachers. (The Beliefs Questionnaire is included as Appendix E).

5.3.1.2 Introduction to Logo Programming Language

In this part, which followed the Session one (1) Welcome meeting, student-teachers were introduced to the Logo programming language in eight (8) one-hour sessions. The aim of the sessions was to introduce the Logo programming language to student-teachers and familiarise them with its use as an ICT tool. A brief description of the Logo module sessions, which are numbered sessions 2-9, follows (For a detailed description of the Logo module sessions, see Appendix G).

- In the second and third sessions a Logo hands-on practise instruction worksheet named "Starting MSLogo and Getting Comfortable" was provided for student-teachers to introduce them to the Logo window interface. In the second session, students practised the basic Logo commands, and in the third session they learned the commands of changing the screen background colour and turtle pen colour, controlling the turtle pen (lift up and put down the turtle pen), and filling in an enclosed space with the preferred colour.

- In the fourth and fifth sessions, using the Logo hands-on practise instruction worksheets called “Exploring Logo REPEAT command” and “Writing PROCEDURE, Saving and Opening a Predefined Procedure” student-teachers practised the Logo repeat command, writing a procedure in the editor mode and modifying or debugging it. In addition, they learned to save a new procedure and open predefined Logo procedures.
- In the sixth session, student-teachers were provided with a Logo hands-on practise instruction worksheet titled “Exploring using Variables” with which they practised defining and using one variable within a procedure. Students-teachers also learned and practised defining and using more than one variable within a procedure.
- In the seventh session, titled “Superprocedure and Subprocedure” student-teachers were introduced to two different types of procedures, namely: (a) superprocedure and (b) subprocedure. Student-teachers practised learning about each type following the instructions provided by the Logo hands-on practise instruction worksheet.
- In the eighth session, student-teachers followed the Logo hands-on practise instruction worksheet titled “Using Coordinate notation and drawing a circle,” and learned about coordinate notation and practised its use as well as drawing a circle either through writing a procedure or using “circle” commands to call the Logo predefined circle procedure that draws a circle with a size based on the radius number given by the user.
- In the ninth session, “Exploring Recursion,” student-teachers were introduced to the recursion technique and practised learning using recursion following the Logo hands-on practise instruction worksheet. In addition, they practised

learning how to print an image created on the drawing area or predefined procedure on the editor window.

Having introduced and familiarized student-teachers with using the Logo programming language, the next step was to place student-teachers in a mathematical Logo-based activities context to investigate, as pupils, the learning of mathematical topics with the use of Logo activities.

5.3.1.3 Mathematical Logo-Based Activities

During the mathematical Logo-based activities part, student-teachers were introduced in eight (8) one-hour sessions to mathematical Logo-based activities on three different mathematical areas: (a) geometry, (b) algebra and (c) transformation geometry; The aim of mathematical Logo-based activities was to place student-teachers in a practical context where they could solve mathematical activities based on the topics included in the Kuwaiti elementary, middle and high school curriculum and view Logos' potential as an ICT cognitive tool to facilitate pupils' understanding and learning of mathematical topics in the school curriculum. A brief description of the eight (8) one-hour sessions of the mathematical Logo-based activities (sessions 10-17) follows (For detailed description mathematical Logo-based activities, see Appendix H).

- In the tenth session, student-teachers were introduced to the first Logo hands-on activities worksheet in geometry, in which the topic was to investigate the properties of parallelograms. During this activity student-teachers were placed in a context where they used Logo sequence commands to investigate what properties of a parallelogram can help one to depict that it is a parallelogram, thus, perceive how the use of Logo sequence commands would facilitate pupils' learning about parallelogram properties and compute its obtuse angle, acute angle and the sum of the angles.

- In the eleventh session, student-teachers were introduced to the second Logo hands-on activities worksheet in geometry on the topic of rectangles and squares. This activity provided student-teachers with Logo procedures where they investigated (a) what properties of a rectangle can help to depict a rectangle, and (b) what properties of a square can help to depict a square, using Logo procedures where the user inputs values and Logo's interactive feedback guides learning the concept. Student-teachers were thus able to perceive how the use of Logo procedures would facilitate pupils' learning about the properties of the two shapes, as well as the common and different properties between the two shapes.
- In the twelfth session, student-teachers were introduced to the third Logo hands-on activities worksheet in geometry, on the topic of parallelograms and rhombus. This activity provided student-teachers with a Logo procedure where they investigated what properties of both a parallelogram and rhombus can help to depict each shape with the use of Logo procedure. Thus they perceive how the use of a Logo procedure would facilitate pupils' learning about shape properties, as well as how common and different properties can distinguish two shapes from each other.
- In the thirteenth session, student-teachers were introduced to the last Logo hands-on activities worksheet in geometry, on the topic of angles. The Logo activity provided student-teachers a context where they investigated the concept of angles with the use of a Logo procedure to perceive how the use

of a Logo procedure would facilitate pupils' investigation and learning about various angles and their properties.

- In the fourteenth sessions, student-teachers were introduced to the Logo hands-on activities worksheet, this time on the topic of variables in algebra. The aim of the Logo activity was to provide a context for student-teachers where they could investigate variables and see how the Logo interactive context would facilitate pupils' understanding of the variables topic.
- In the fifteenth and sixteenth sessions, student-teachers were introduced to the topic of reflection in the area of transformation geometry. The objective of this activity was to provide student-teachers with a context where they could investigate the reflection of shapes and explore the properties of the mirror image with the original image in an interactive environment that is not possible with the use of paper and pencil.
- In the seventeenth session, student-teachers were introduced to the topic of rotation in the area of transformation geometry. Student-teachers investigated the concept of rotation of shapes and how pupils using Logo can depict a shape and see how rotations of a shape perform with the desirable angle and direction.

As mentioned above, for detailed description of mathematical Logo-based activities see Appendix H.

Having introduced and familiarized student-teachers with the use of the Logo programming language and providing them with a practical practise context as pupils using mathematical Logo-based activities, the next step was to place student-teachers in a context where they could learn about and experience the preparation of a mathematics lesson plan that incorporated the Logo programming language.

5.3.1.4 Preparation of Mathematical Logo-Based Lesson Plan

- In the eighteenth, nineteenth and the twentieth sessions, student-teachers were taught how to prepare a lesson plan and how to incorporate Logo programming language as an ICT tool in the lesson plan. In addition, student-teachers were asked to work in either in a group of two students or individually to practise lesson plan preparation. In the twentieth session, some of the student-teachers' lessons plans were discussed and student-teachers were asked to prepare an individual lesson plan for the next session where they would practise teaching a mathematics lesson.

5.3.1.5 Practise Teaching Mathematics with the Use of Logo Programming Language

- The twenty-first, twenty-second and twenty-third sessions were devoted to the practical practise of teaching. The aim of these sessions was to place student-teachers, as formal teachers, in a context where they practised teaching a mathematics lesson using the Logo programming Language. During these sessions, six (6) student-teachers, two (2) in each session, used the lesson plan they had individually prepared and practised teaching their colleagues according to the mathematics lesson plan they developed using Logo programming language as an ICT tool for mathematics education.

5.3.1.6 *Thanking Meeting and Administration of Post-Test Beliefs Questionnaire*

In this last part, the twenty-fourth session, student-teachers were thanked for their participation in the study. As a final step, a post-test belief questionnaire with cover letter was administered to the student-teachers, with a request for participants' signature to acknowledge their willingness to participate in the study and complete the post-test belief questionnaire.

5.4 Summary

This chapter discussed the Logo programming language module that was employed in the study. The chapter began with literature findings that formed the rationale for selection of Logo as the ICT module for the study. Following this was a description of the administration of the Logo module in the classroom setting, including an overview of the six component parts that constituted the Logo sessions. The next chapter illuminates the results of the data analysis.

CHAPTER 6
DATA ANALYSIS AND FINDINGS

6.1 Introduction

The aim of this chapter is to illuminate the study's findings about Kuwaiti mathematics student-teachers' beliefs. This chapter contains the following sections: the pre-test and post-test beliefs questionnaire results and analysis and the pre-test and post-test semi-structured interview results and analysis. It also illustrates the statistical procedure used to analyse the research questions and their related results.

6.2 Pre-Test and Post-Test Beliefs Questionnaire

The beliefs of Kuwaiti mathematics student-teachers were examined using a Likert-type questionnaire containing 111 questions, a copy of which is included in Appendix E. The questionnaire, which was administered as a pre-test and post-test, was arranged in five sections that focused on the student-teachers' beliefs on (1) the nature of mathematics, (2) the teaching of mathematics, (3) the learning of mathematics, (4) Logo programming language as a tool for the teaching and learning of mathematics, and (5) information and communication technology (ICT). Of these five sections, sections 1-3 were each divided into two subsections, namely "Constructivist" and "Traditional," that is rote learning and memorization, in order to elicit participants' beliefs on these two educational approaches. The following illustrates the main titles of the first three sections and their content:

- The Nature of Mathematics (20 questions): 10 questions (1, 3, 5, 7, 9, 13, 14, 16, 17 and 19) that described the nature of mathematics from the constructivist perspective; and 10 (2, 4, 6, 8, 10, 11, 12, 15, 18 and 20) that described the nature of mathematics from the traditional perspective.

- The Teaching of Mathematics (20 questions): 10 questions (3, 5, 6, 7, 9, 10, 11, 15, 18 and 19) that described the nature of mathematics from the constructivist perspective; and 10 (1, 2, 4, 8, 12, 13, 14, 16, 17, and 20) that described the nature of mathematics from the traditional perspective.
- The Learning of Mathematics (21 questions): 10 questions (2, 3, 5, 6, 7, 8, 10, 11, 17 and 20) that described the nature of mathematics from the constructivist perspective; and 11 (1, 4, 9, 12, 13, 14, 15, 16, 18, 19 and 21) that described the nature of mathematics from the traditional perspective.

Sections 4 and 5 consisted of 26 questions and 24 questions, respectively, (with no subsections). The aim of these sections was to explore student-teachers' beliefs about using Logo and ICT in the teaching and learning of mathematics:

- Section 4 was entitled Logo Programme Language, and
- Section 5 was entitled Information and Communication Technology (ICT).

Statistical Analyses Performed

Chronbach's Alpha was computed for each Section (1-3), as well as for each subsection (Constructivist and Traditional). The purpose of the measurement was to provide evidence of reliability for the questionnaire. As previously discussed in Section 4.5.1.2, Nunnally (1978) considers 0.7 to be an accepted reliability, although lower thresholds have sometimes been used in the literature (p. 70). For example, Moss et al. (1998, cited in Sturmey et al., 2005) suggest that a value of 0.60 is generally acceptable. Hair et al., (2006) also argue that an alpha of 0.60 and above is adequate for research.

The computed means of student-teachers' beliefs were interpreted using the rank order Likert scale found in Table 3: Interpretation of the Computed Means of

Student-Teachers' Beliefs, which is presented in Section 4.7 of Chapter 4 (Research Design and Methodology). When using ordinal data from the Likert-like scale, the use of the mean warrants discussion. Jamieson (2004) states that for ordinal data the median or mode should be used as the measure of central tendency rather than the mean, since the intervals between values cannot be considered equal for the mean. Kislenko and Grevvholm (2008) also discuss the use of Likert scales in research and observe, "There is no common agreement on what statistical methods are appropriate in relation to the use of the Likert scale." Within this study, there is symmetry around the neutral point (Neither Agree nor Disagree) and the 'common use' of mean values; therefore, a justification can be argued see, for example, Davison and Sharma (1988, 1990).

The Paired-Samples t-test was used to assess whether the means of the two subsections, when analysed separately as both pre-test and post-test, were statistically different from each other as well as to explore which view student-teachers lean toward. In addition, a Paired-Samples t-test for equality of means was used to assess whether the means between the subsections (pre-test and post-test) had changed and so illustrate modified student-teachers' beliefs. For the SPSS Analysis output, and the Raw Frequencies for pre-test and post-test, see Appendix I, J and K.

6.2.1 Beliefs of the Mathematics Student-Teachers Derived from the Pre-Test Questionnaire

Chronbach's Alpha

In the pre-test questionnaire, Chronbach's Alpha yielded an alpha value of .943 for the Constructivist view in sections 1-3 (Nature of Mathematics, Teaching of

Mathematics, and Learning of Mathematics). For these same sections, an alpha value of .837 was found for the Traditional view. Both of these values provide statistical evidence of reliability.

Alpha values were also found for the subsections (Constructivist and Traditional) for Sections 1-3.

For subsection 1 Constructivist view, a reliable alpha value of .764 was found. However, for subsection 1 Traditional view, the alpha value of .494 did not meet the reliability standard of 0.60 or above. This is discussed below in the inter-item correlations. While this value is low at subsection level, it did not have a large effect on the alpha value of the total scale.

For subsection 2 Constructivist view and subsection 2 Traditional view, reliable alpha values were found in both cases, with .905 for Constructivist and .744 for Traditional.

For subsection 3, a reliable alpha value of .884 was found for the Constructivist view, while an alpha value of .612 for the Traditional view also met the reliability standard of 0.60 or above.

Alpha values were found for section 4 Logo programming language and section 5 ICT, reliable alpha values were found in both cases, with .986 for Logo programming language and .908 for ICT.

Inter-item correlations

The inter-item correlation function was used to identify statements that failed to correlate with other items in the scale, as shown below in Table 6. This failure to correlate could be due to the following: (1) student-teachers misinterpreted the statement, (2) student-teachers did not understand the statement, and (3) the statement was compound (that is, having more than one idea).

In addition, an inter-item correlation might also be affected and could provide a low value as a result of dividing the scale into subsections as it reduces the number of items in the scale; "the large number of items which constituted the questionnaire would contribute to its Cronbach alpha value" (DeVellis, 1991; Lewis-Beck, 1995; cited in Kwok-wai, 2000, p. 6).

Table 6. Identified Statements that Failed to Correlate with other Statements in the Questionnaire for Pre-test

View	Part and Statement No.	Statement
Constructivist View	Part1 Statement 7	The mathematical ideas can be explained in everyday words that anyone can understand.
	Part1 Statement 13	Many of the important functions of mathematician are being taken to provide a foundation for information and communication technology.
	Part3 Statement 5	Use of physical tools and real life examples to introduce mathematics ideas is an important component of learning mathematics
Traditional View	Part1 Statement 2	Mathematicians are hired mainly to make precise measurement and calculations for scientist and other people.
	Part1 Statement 6	Mathematics problems can be solved in only one approach.
	Part1 Statement 18	Mathematics is essentially the same all over the world.
	Part2 Statement 16	Good mathematics teachers always show students the quickest way of solving a mathematics problem.
	Part3 Statement 15	Mathematics is learnt in schools only.
	Part3 Statement 19	A quiet classroom is generally needed for effective mathematics learning.
Logo programming language	Part4 Statement 6	Sophisticated mathematical concepts are made accessible by Logo.
ICT	Part5 Statement 5	The use of ICT reduces interaction and collaboration between learners.
ICT	Part5 Statement 8	ICT is not an affective instructional tool for students of all abilities.

p Value

The means on the constructivist and traditional beliefs in each of the three subsections and their respective total means have a slight mean difference equal to a maximum of [0.38], as shown below in table 7. To find out whether the differences between the means are significant, the constructivist and traditional beliefs mean scores for each section were compared with regard to the two- tailed significance (Sig. (2- tailed)) levels. The following gives the two tailed paired t-test results.

- The p value for the "Nature of mathematics" section was $p>0.05$. Hence we fail to reject the null hypothesis and find no significant difference between the mean scores for constructivist and traditional beliefs in "Nature of mathematics."
- The p value for the "Teaching of mathematics" section was $p>0.05$. Hence we fail to reject the null hypothesis and find no significant difference between the mean scores for constructivist and traditional beliefs in "Teaching of mathematics."
- The p value for the "Learning of mathematics" section was $p>0.05$. Hence we fail to reject the null hypothesis and find no significant difference between the mean scores for constructivist and traditional beliefs in "Learning of mathematics."
- The p value level for the total means of the three sections was $p>0.05$. Hence we fail to reject the null hypothesis and find no significant difference between the total mean scores for constructivist and traditional beliefs in "Nature of mathematics," the "Teaching of mathematics" and the "Learning of mathematics."

Computed Means

Table 7 below shows that the student-teachers (N = 32) agree with constructivist beliefs in terms of the "nature of mathematics" mean score [$\overline{X}$ = 3.58 on the Likert scale], "teaching mathematics" mean score [$\overline{X}$ = 3.69], and "learning mathematics" mean score [$\overline{X}$ = 3.83)]. Similarly, they also agree with traditional beliefs in terms of the "nature of mathematics" mean score [$\overline{X}$ = 3.88], "teaching mathematics" mean score [$\overline{X}$ = 4.07], "learning mathematics" mean score [$\overline{X}$ = 4.12]. The student-teachers neither agree nor disagree with the "Logo programming language" when it comes to its use as a cognitive tool for constructivist learning in mathematics instruction with a mean score of [$\overline{X}$ = 3.48]. The same ambivalence emerged for the information and communication technology (ICT) with a [mean score of [$\overline{X}$ = 3.45].

When the respective totals for constructivist and traditional belief mean scores for the "nature of mathematics", "teaching mathematics" and "learning mathematics" were computed, it was found that student-teachers agreed with both beliefs. Their constructivist and traditional belief means were [$\overline{X}$ = 3.70] and [$\overline{X}$ = 4.02] respectively. The higher traditional belief mean is in accord with the remarks of Beaton et al. (1996), cited in Alajmi and Reys, 2007). They reported that approximately 70 percent of Kuwaiti intermediate stage mathematics teachers believed that memorizing formulae and procedures is important in learning mathematics. They stated further that fewer than 50 percent of the teachers believed that creative thinking and the ability to provide reasons to support conclusions are important, providing evidence that some teachers, although less than 50 percent, do value constructivist principles. This may explain why the student-teacher responses agreed with constructivist beliefs, although to a lesser extent than with traditional beliefs. These student-teachers might have had some exposure to both constructivist and traditional teaching practises, and at this point they are not fully committed to either.

Paired Samples t-Test

The results of the Paired-Samples t-test for the responses of student-teachers (N = 32) on the pre-test beliefs questionnaire are summarized in Table 7.

Table 7. Summary of Student-Teachers (N = 32) on the Pre-Test Beliefs Questionnaire

No.	Questionnaire sections	Subsection	Mean	Std. D.	Mean difference	Sig. (2-tailed)
1	Nature of Mathematics	Constructivist	3.58	0.83	- 0.30	0.056
		Traditional	3.88			
2	Teaching of Mathematics	Constructivist	3.69	1.18	- 0.38	0.08
		Traditional	4.07			
3	Learning of Mathematics	Constructivist	3.83	0.84	- 0.29	0.06
		Traditional	4.12			
4	Logo programming language		3.48	0.65		
5	Information and Communication Technology (ICT)		3.45	0.52		
Total Means		Constructivist	3.70	0.88	- 0.32	0.051
		Traditional	4.02			

The data also reveal that the standard deviations (the variation or dispersion from the mean) from the subsections and the total mean are low and have a highest score of [1.18]. This shows that the responses of student-teachers on the pre-test belief questionnaires are not very varied (which shows that the data score are more concentrated and less spread out). The limited variation may be explained by Alajmi's (2009) observation that all teachers in Kuwait use a national textbook and follow the same instructional plans, which are supplied by the Ministry of Education. As a result, one might assume that since curriculum and its delivery is standardized, students learn the same things and are likely to give similar responses to questions.

The results of the pre-test questionnaire indicate that the student-teachers did not lean towards either constructivist or traditional beliefs. They also were ambivalent about the use of Logo programming language and ICT for mathematics education. Since the student-teachers had little or no experience with ICT for mathematics education, this ambivalence conforms to the opinions of Russell et al (2003) and Swan and Dixon (2006) who found a positive correlation between student teachers' experience with ICT and positive beliefs towards its use.

6.2.2 Beliefs of the Mathematics Student-Teachers Derived from the Post-Test Questionnaire

Following administration of the pre-test questionnaire, the student-teachers undertook a mathematics education instruction module. The module incorporated using Logo as an ICT cognitive tool for constructivist learning and allowed the student-teachers to experience its use. During this module, student-teachers were trained in mathematics using Logo, solved mathematics activities with it, developed a practise teaching lesson plan that incorporated Logo and practised peer-to-peer teaching using Logo following principles of constructivism (please see Chapter 5: The Logo Module Course). Upon completion of the teaching module, a questionnaire which was identical to the pre-test one was administered to the student-teachers as a post-test to explore student-teachers' beliefs after their exposure to the teaching module.

Chronbach's Alpha

In the post-test questionnaire, Chronbach's Alpha yielded a value of .824 for the Constructivist view in sections 1-3 (Nature of Mathematics, Teaching of Mathematics, and Learning of Mathematics). For these same sections, an alpha value of .777 was found for the Traditional view. Both of these values provide statistical evidence of reliability.

Alpha values were also found for the subsections (Constructivist and Traditional) for Sections 1-3.

For subsection 1 Constructivist view, a reliable alpha value of .679 was found. However, for subsection 1 Traditional view, the alpha value of .478 did not meet the reliability standard of 0.60 or above. Possible reasons have been noted above in Section 6.2.1. For subsection 2 Constructivist view and subsection 2 Traditional view, reliable alpha values were found in both cases, with .656 for Constructivist and .643 for Traditional.

For subsection 3 Constructivist view, a reliable alpha value of .662 was found. However, for subsection3 Traditional view, the alpha value of .616 has met the reliability standard of 0.60 or above.

Alpha values were found for section 4 Logo programming language and section 5 ICT, reliable alpha values were found in both cases, with .963 for Logo programming language and .912 for ICT.

Inter-item correlations

The inter-item correlation function was used to identify statements that failed to correlate with other items in the scale, as shown in Table 8 below.

Table 8. Identified Statements that Failed to Correlate with other Statements in the Questionnaire for Post-test

View	Part and Statement No.	Statement
Constructivist View	Part1 Statement 9	In different cultures around the world there are different models of mathematics.
	Part2 Statement 10	Good mathematics teachers often consider the student preferences when planning lessons.
	Part2 Statement 18	Good mathematics teachers frequently give student assignments which require creative or investigative work.
	Part3 Statement 11	Students' mathematics mistakes always reflect their current understandings of ideas or procedures.
Traditional View	Part1 Statement 6	Mathematics problems can be solved in only one approach.
	Part1 Statement 2	Mathematicians are hired mainly to make precise measurement and calculations for scientist and other people.
	Part1 Statement 4	In mathematics something is either right or it is wrong
	Part2 Statement 14	Good mathematics teachers always work sample problems for students before making an assignment.
	Part3 Statement 1	Students who have access to information and communication technology learn to depend on them and do not learn mathematics properly.
	Part3 Statement 15	Mathematics is learnt in schools only.
Logo programming language	Part4 Statement 26	Logo will make my instruction difficult to manage.
ICT	Part5 Statement 8	ICT is not an affective instructional tool for students of all abilities.

p Value

The standard deviation results from the subsections and the total mean are low and have a high score of [0.69] as shown below in table 9. This shows that the responses of student-teachers on the post-test beliefs questionnaires are not very varied. Furthermore, the means in the constructivist and traditional beliefs in each of the three parts “the nature of mathematics”, “the teaching of mathematics” and “the learning of mathematics” as well as their total means have a maximum differential of [1.06]. To examine whether the differences between the means are significant, the constructivist and traditional beliefs mean scores in each section were tested using two-tailed significance (Sig. (2- tailed)) levels. The following gives the two tailed paired t-test results.

- The p value for the “Nature of mathematics” section was $p < 0.01$. Hence we reject the null hypothesis and we accept that there is a difference between the mean scores for constructivist and traditional beliefs for “Nature of mathematics.”
- The p value for the “Teaching of mathematics” section was $p < 0.01$. Hence we reject the null hypothesis and we accept that there is a difference between the mean scores for constructivist and traditional beliefs for “Teaching of mathematics.”
- The p value for the “Learning of mathematics” section was $p < 0.01$. Hence we reject the null hypothesis and we accept that there is a difference between the mean scores for constructivist and traditional beliefs for “Learning of mathematics.”

The p value for the total means of the three sections were $p < 0.01$. Hence we reject the null hypothesis and we accept that there is a difference between the total mean scores for constructivist and traditional beliefs for “Nature of mathematics”, “Teaching of mathematics” and “Learning of mathematics.”

Computed means

Table 9 for the post-test beliefs questionnaire shows that the student-teachers agree with the constructivist beliefs in terms of the “nature of mathematics” mean score [$\overline{X}$ = 4.15], the “teaching of mathematics” mean score [$\overline{X}$ = 4.17], and the “learning of mathematics” mean score [$\overline{X}$ = 4.22]. In contrast, they neither agree nor disagree with the traditional beliefs in terms of the “nature of mathematics” mean score [$\overline{X}$ = 3.16], the “teaching of mathematics” mean score [$\overline{X}$ = 3.11], and the “learning of mathematics” mean score [$\overline{X}$ = 3.36]. The student-teachers agree with the “Logo programming language” when it comes to its use as a cognitive tool for constructivist learning in mathematics instruction mean score [$\overline{X}$ = 4.11], and with the information and communication technology (ICT) when it comes to its use in the teaching and learning of mathematics mean score [$\overline{X}$ = 3.93].

Paired Samples t-Test

The results of the Paired-Samples t-test for the responses of student-teachers (N = 32) on the post-test beliefs questionnaires are summarized below in Table 9.

Table 9. Summary of Student-Teachers (N = 32) on the Post-Test Belief Questionnaires

No.	Questionnaire Sections	Subsection	Mean	Std. D	Mean difference	Sig. (2-tailed)
1	Nature of mathematics	Constructivist	4.15	0.61	+ 0.99	0.00
		Traditional	3.16			
2	Teaching of Mathematics	Constructivist	4.17	0.69	+ 1.06	0.00
		Traditional	3.11			
3	Learning of Mathematics	Constructivist	4.22	0.59	+ 0.86	0.00
		Traditional	3.36			

No.	Questionnaire Sections	Subsection	Mean	Std. D	Mean difference	Sig. (2-tailed)
4	Logo programming Language		4.11	0.55		
5	Information and Communication Technology (ICT)		3.93	0.51		
Total Means		Constructivist	4.18	0.52	+ 0.97	0.00
		Traditional	3.21			

As for the total of constructivist and traditional belief mean scores for the "nature of mathematics", "teaching of mathematics" and "learning of mathematics", it was found that student-teachers hold constructivist beliefs. However, they neither agree nor disagree with traditional beliefs. Their constructivist and traditional belief means are [$\overline{X}$ = 4.18] and [$\overline{X}$ = 3.21] respectively. The increase in the student-teachers' post-Logo mean towards constructivist beliefs conforms to Nespor's (1987) statement that personal beliefs are often derived from personal experience. After the student-teachers experienced Logo in their classroom sessions, their beliefs changed. Ertmer (2005) too held the opinion that if beliefs are formed through personal experience, then experience might also facilitate changes in beliefs. Ertmer also cited Guskey's (1986) assertion that changes in beliefs *follow* practise, rather than precede it.

The results of the post-test questionnaire indicate that the student-teachers lean toward the constructivist beliefs in terms of the "Nature of mathematics", "Teaching of mathematics" and "Learning of mathematics". They also lean toward the use of Logo programming and ICT in teaching mathematics. In contrast, the student-teachers were ambivalent about the traditional beliefs.

6.2.3 Beliefs of the Mathematics Student-Teachers Derived from the Pre-Test and Post-Test Beliefs Questionnaires

A Paired-Samples t-test was conducted using two sets of data, namely, the pre-test and post-test results to check whether quality of means had changed between the subsections of the pre-test and post-test beliefs questionnaires.

p Value

The standard deviation results for the pre-test and post-test subsections of sections 1, 2 and 3 and their respective total means, as well as the Logo programming language and ICT, are low, with a highest score of [0.76]. This shows that the responses of student-teachers on the pre-test and post-test beliefs questionnaires are not very varied. The means of the constructivist and traditional beliefs on the pre-test and post-test for sections 1, 2 and 3 and their total means have a difference of [0.96] (the higher) and [0.39] (the lower). In addition, the means of the Logo programming language on the pre-test and post-test have a difference of [0.63] while that for the ICT is [0.48].

To determine if the differences between the means were significant, the two-tailed significance (Sig. (2- tailed) level was applied for the constructivist and traditional beliefs mean scores in each section; the same considerations were used for the Logo programming language mean score and the ICT mean score (please see Table 12 below for the two-tailed significance (Sig. (2- tailed) scores).

The following hypotheses were tested using the two-tailed levels, at [0.05] level of significance, as shown below in Table 10.

Table 10. Hypothesis and Null Hypothesis for Each Questionnaire Section

Section	Focus	Hypothesis / Null Hypothesis	Change
1	Nature of Mathematics: Constructivist beliefs	*Hypothesis:* Respondents' mean scores have changed	√
		Null Hypothesis: Respondents' mean scores have not changed	X
1	Nature of Mathematics: Traditional beliefs	*Hypothesis:* Respondents' mean scores have changed	√
		Null Hypothesis: Respondents' mean scores have not changed	X
2	Teaching of Mathematics: Constructivist beliefs	*Hypothesis*: Respondents' mean scores have changed	√
		Null Hypothesis: Respondents' mean scores have not changed	X
2	Teaching of Mathematics: Traditional beliefs	*Hypothesis:* Respondents' mean scores have changed	√
		Null Hypothesis: Respondents' mean scores have not changed	X
3	Learning of Mathematics: Constructivist beliefs	*Hypothesis:* Respondents' mean scores have changed	√
		Null Hypothesis: Respondents' mean scores have not changed	X
3	Learning of Mathematics: Traditional beliefs	*Hypothesis*: Respondents' mean scores have changed	√
		Null Hypothesis: Respondents' mean scores have not changed	X
4	Logo Programming Language	*Hypothesis:* Respondents' mean scores have changed	√
		Null Hypothesis: Respondents' mean scores have not changed	X
5	Information and Communication Technology (ICT)	*Hypothesis:* Respondents' mean scores have changed	√
		Null Hypothesis: Respondents' mean scores have not changed	X

The total mean hypotheses and null hypotheses for Constructivist and Traditional beliefs were also evaluated, as shown below in Table 11:

Table 11. Total Mean Scores for Constructivist and Traditional Beliefs: Hypotheses and Null Hypotheses

Constructivist Beliefs	Hypothesis / Null Hypothesis	Change
Nature of Mathematics, Teaching of Mathematics, and Learning of Mathematics	*Hypothesis*: Respondents' total mean scores have changed	√
	Null Hypothesis: Respondents' total mean scores have not changed	X
Traditional Beliefs	**Hypothesis / Null Hypothesis**	
Nature of Mathematics, Teaching of Mathematics, and Learning of Mathematics	*Hypothesis*: Respondents' total mean scores have changed	√
	Null Hypothesis: Respondents' total mean scores have not changed	X

Findings for Hypotheses and Null Hypotheses

The two-tailed levels resultfor each mean score in the five sections of the questionnaire, and for the combined mean scores for Constructivist and Traditional beliefs, is described below.

Section 1: Nature of Mathematics

Constructivist beliefs mean scores: The value of $p < 0.01$. Hence, this value supports this study's hypothesis. The respondents' mean scores have changed. In contrast, the value rejects the null hypothesis.

Traditional beliefs mean scores: The value of $p < 0.01$. Hence this value supports this study's hypothesis. The respondents' mean scores have changed. In contrast, the value rejects the null hypothesis.

Section 2: Teaching of Mathematics

Constructivist beliefs mean scores: The value of $p < 0.01$. Hence this value supports this study's hypothesis. The respondents' mean scores have changed. In contrast, the value rejects the null hypothesis.

Traditional beliefs mean scores: The value of $p < 0.01$. Hence this value supports this study's hypothesis. The respondents' mean scores have changed. In contrast, the value rejects the null hypothesis.

Section 3: Learning of Mathematics

Constructivist beliefs mean scores: The value of $p < 0.01$. Hence this value supports this study's hypothesis. The constructivist beliefs mean scores have changed. In contrast, the value rejects the null hypothesis.

Traditional beliefs mean scores: The value of $p < 0.01$. Hence this value supports this study's hypothesis. The respondents' mean scores have changed. In contrast, the value rejects the null hypothesis.

Section 4: Logo Programming Language mean scores

The value of $p < 0.01$. Hence this value supports this study's hypothesis. The respondents' mean scores have changed. In contrast, the value rejects the null hypothesis.

Section 5: Information and Communication Technology (ICT) mean scores

The value of $p < 0.01$. Hence, this value supports this study's hypothesis. The respondents' mean scores have changed. In contrast, the value rejects the null hypothesis.

Total Mean Scores for Nature of Mathematics, Teaching of Mathematics and Learning of Mathematics

Constructivist Beliefs: The value of $p < 0.01$. Hence this value supports this study's hypothesis. The respondents' total means have changed. In contrast, the value rejects the null hypothesis.

Traditional Beliefs: The value of p <0.01, the level of significance. Hence this value supports this study's hypothesis. The respondents' total means have changed. In contrast, the value rejects the null hypothesis.

Computed means

First, table 12 below shows that student-teachers agree with the constructivist beliefs concerning the "Nature of mathematics" on the pre-test and post-test. Their pre-test and post-test belief means are [$\overline{X}$ = 3.58] (the lower) and [$\overline{X}$ = 4.15] (the higher) respectively, with a difference in the respective means equal to [0.57]. Additionally, the student-teachers agree with the traditional beliefs on the pre-test mean score [$\overline{X}$ = 3.88] (the higher) while they neither agree nor disagree on the post-test mean score [$\overline{X}$ = 3.16] (the lower) with a difference of [0.72] between the respective means.

Second, student-teachers **ALSO** agree with the constructivist beliefs in terms of the "Teaching of mathematics" on the pre-test [$\overline{X}$ = 3.69] (the lower) and post-test [$\overline{X}$ = 4.17] (the higher), **AND** the difference between the respective means is [0.48]. In addition, they agree with the traditional beliefs on the pre-test [$\overline{X}$ = 4.07] (the higher) yet neither agree nor disagree on the post-test [$\overline{X}$ = 3.11] (the lower) with a difference of [0.96] between the two means.

Thirdly, student-teachers agree with the constructivist beliefs in the pre-test and post-test when it comes to "Learning of mathematics." Their pre-test and post-test belief means are [$\overline{X}$ = 3.83] (the lower) and [$\overline{X}$ = 4.22] (the higher) respectively, with a difference in the respective means equal to [0.39]. The student-teachers agree with the traditional beliefs on the pre-test [$\overline{X}$ = 4.12] while they neither agree nor disagree in the post-test [$\overline{X}$ = 3.36] with a difference in the respective means equal to [0.76].

In sections 4 and 5, the student-teachers neither agree nor disagree on the pre-test with “Logo programming language” as a cognitive tool for constructivist learning in mathematics instruction mean score [$\overline{X}$ = 3.48] and with information and communication technology (ICT) used in the teaching and learning of mathematics mean score [$\overline{X}$ = 3.45]. In contrast, on the post-test they agree with both tools. Their post-test belief means are [$\overline{X}$ = 4.11] and [$\overline{X}$ = 3.93] respectively. In addition, the difference in the respective means for the “Logo programming language” is [0.63] and for the information and communication technology (ICT) is [0.48].

As for the total of constructivist beliefs mean scores for sections 1, 2 and 3, it was found that student-teachers agreed with the constructivist beliefs in the pre-test and post-test. Their constructivist beliefs total means for the pre-test and post-test were [$\overline{X}$ = 3.70] (the lower), [$\overline{X}$ = 4.18] (the higher) respectively, with a mean difference of .48**.** Following participation in the Logo module, there was a positive shift toward constructivist practise, Logo and ICT**.** This conforms with Ertmer (2005) who suggested that if beliefs are formed through personal experience, then changes in beliefs might also be facilitated through experience.

Paired Samples t-Test

The results of the Paired-Samples t- test for the responses of student-teachers (N = 32) in the pre-test and post-test belief questionnaires are summarized below in Table 12.

Table 12. Summary of Student-Teachers (N = 32) on the Pre-Test and Post-Test Beliefs Questionnaires

No.	Questionnaire Section	Subsection	Test	Mean	Std. D.	Mean difference	Cohen's d Size effect	Sig. (2-tailed)
1	Nature of Mathematics	Constructivist	Pre-test	3.58	0.51	- 0.57	- 1.30	0.00
			Post-test	4.15	0.35			
		Traditional	Pre-test	3.88	0.39	+ 0.72	+ 1.79	0.00
			Post-test	3.16	0.41			
2	Teaching of Mathematics	Constructivist	Pre-test	3.69	0.76	- 0.48	- .82	0.00
			Post-test	4.17	0.31			
		Traditional	Pre-test	4.07	0.55	+ 0.96	+ 1.71	0.00
			Post-test	3.11	0.57			
3	Learning of Mathematics	Constructivist	Pre-test	3.83	0.67	- 0.39	- .75	0.00
			Post-test	4.22	0.30			
		Traditional	Pre-test	4.12	0.36	+ 0.76	+ 1.79	0.00
			Post-test	3.36	0.48			
4	Logo Programming Language		Pre-test	3.48	0.65	- 0.63	- 1.04	0.00
			Post-test	4.11	0.55			
5	Information and Communi-cation Technology (ICT)		Pre-test	3.45	0.52	- 0.48	- .93	0.00
			Post-test	3.93	0.51			
Constructivist Total Means			Pre-test	3.70	0.59	- 0.48	- 1.05	0.00
			Post-test	4.18	0.26			
Traditional Total Means			Pre-test	4.02	0.37	+ 0.81	+ 2.15	0.00
			Post-test	3.21	0.38			

In summary, the results of the pre-test and post-test beliefs questionnaire indicate a change in the respondents' mean scores on the constructivist and traditional beliefs in terms of section 1 (Nature of mathematics), section 2 (Teaching of mathematics), and section 3 (Learning of Mathematics). The respondents' constructivists mean score in the post-test increased significantly while the traditional mean score decreased significantly. In addition, a significant change accrued in the mean scores of the section 4 (Logo programming language) and section 5 (ICT). Consequently, this suggests that student-teachers favoured constructivist beliefs in terms of sections 1, 2 and 3; they also favoured the use of Logo programming and ICT, thus leaning towards constructivist beliefs. In contrast, the student-teachers became ambivalent about the traditional beliefs. Nespor (1987) observed that instructional change is not a matter of completely abandoning beliefs, but of gradually replacing them with more relevant ones. Richardson (2003, cited in Raths and McAninch, 2003) also suggested that the most important source of teacher candidates' beliefs about teaching and learning was their personal experiences with schooling and instruction (p. 5). Richardson noted that student-teachers may enter teacher preparation programs with strongly held beliefs formed during their student years; nevertheless, in their teacher education program they could be inspired to think about teaching and learning more deeply and critically.

It must be noted that earlier studies showed that beliefs and conceptions did not always change as a result of instruction in the academic classroom (Richardson, 2003; cited in Raths and McAninch, 2003; Civil, 1992). Richardson pointed out that unless classroom experience is followed by "significant and structured involvement in a field experience" changes in belief will not happen (p. 11). The authors also question the possibility of changing teacher beliefs in one class or even one program. Civil (1992) cited the conflicting messages that the prospective teacher receives: their own K-12 experience, field experience, education courses, teachers, and the community itself. Civil wondered whether teachers would follow the practices that make them feel more secure: “Too many teachers rely on textbooks with the answers printed in black and white. Most teachers teach this way because it is less scary for teachers” (p. 21). Civil too recommended a coordinated and collaborative approach to teacher education if changes in existing beliefs were to be achieved.

6.3 Pre-Test and Post-Test Semi-Structured Interview

The semi-structured interview was the second source of data gathering used in this research, in addition to the Questionnaire. The interviews (pre-Logo module and post-Logo module) were conducted with six Kuwaiti mathematics student-teachers (who were assigned labels A-F) at the College of Basic Education prior to and after the Logo module was implemented. The aims of the interviews were as follows:

1- The pre-module interview explored in more depth student-teachers’ beliefs before they participated in the Logo module.

2- The post-module interview explored in more depth student-teachers beliefs after participation in the Logo module, in particular, to ascertain whether student-teachers’ responses changed after the Logo module.

The six participants were each categorised based on their questionnaire responses (mainly traditional beliefs, mainly constructivist beliefs, or both traditional and constructivist beliefs). For more details about the interview analysis procedure, please refer to the Research Methodology chapter, Section 4.8 Statistical Data Analysis Procedure: Interview.

6.3.1 Type of Questions for the Interview

During the pre- module and post-module interviews, the interviewees were asked eight questions in order to elicit their current beliefs on sections 1-5 of the questionnaire. The interview questions were developed using recurring themes that surfaced during the review of the literature described in Chapter Three. (Please see Appendix F for Beliefs Interview Questions, English and Arabic versions. In addition, a sample transcript of interview (English and Arabic version), is included in Appendix L.

6.3.2 Student-Teachers Pre-test Interview Analysis

The following illustrates beliefs held by student-teachers during the pre-module interview, which was administered before participation in the Logo module. The interview questions focused on the sections of the questionnaire, as well as the student-teachers' previous mathematics classrooms experience.

1- Student-teachers' beliefs about the nature of mathematics

Before participating in the Logo module, the student-teachers were asked the following question: "How would you describe mathematics?" All student-teachers **A** to **F** articulated a common belief of mathematics; they described mathematics as rules and procedures. Although these student-teachers articulated (the view of rules and procedures) an exact view about the nature of mathematics, they also indicated their view of the importance of mathematics. All student-teachers shared in a belief in using mathematics for computation. For example, student-teacher **C** said, "Mathematics represents groups of rules and procedures to be used for computation." This respondent's view aligns with the Instrumentalist view as defined by Ernest (1988) and Leung (1995) which sees mathematics as "an accumulation of rules and skills to be used in the pursuance of some external end. Thus mathematics is a set of unrelated but utilitarian rules and facts" (Ernest, 1988) and "processes to be memorized" (Leung, 1995; cited in van der Sandt, 2007, p. 345).

In addition to the beliefs revealed above, two-thirds of the student-teachers (**C, D, E and F)** referred to mathematics and used expressions like "allows us to think," "broadens thinking," "helps us to think" and "opens human thinking". Underlying these expressions was a broader view about the nature of mathematics that can be seen as rejecting the instrumentalist view (the use of memorized rules and procedures) and showed that doing mathematics is a process that frees and widens human thinking when solving mathematical problems and which also leads to creativity. This view can be linked with the constructivist view that "emphasizes the practice of mathematics and the reconstruction of mathematics knowledge… and sees mathematics as continually growing, changing and being revised, as solutions to new problems are explored by the learners" (Golafshani, 2002, p. 4).

In summary, the pre-interview showed that student-teachers, in their beliefs about the nature of mathematics, articulated two differing views at the same time. First, we can see that all students-teachers shared a common belief in which mathematics is described as rules and procedures for computation. Additionally, two-thirds of student-teachers who held the rules and procedures view also implied that mathematics frees and broadens human thinking. The first view shows mathematics as a rigid discipline and implies that to do mathematical computation and attain an answer to a problem we need to apply the right rule and follow a procedure. In contrast, in the second view students-teachers showed that mathematics is not rigid but rather it is a discipline that allows us to develop, create and use our own methods to attain the problem's answer. The first view can be associated with the instrumentalist view. The second view associated mathematics with the constructivist perspective and was akin to the third conception of mathematics defined by Ernest (1988),"The problem solving view of mathematics as a dynamic, continually expanding field of human creation and invention". Specifically the pre-interviews showed that prior to the Logo Module, the group of student-teachers' held a mixture of traditional beliefs and constructivist beliefs about the nature of mathematics.

2- Student-teachers' beliefs about the learning of mathematics

Before participating in the Logo module, the student-teachers were asked the following question: "In your opinion, how are mathematical concepts (e.g. computation, geometry, algebra, etc.) best learned?"

The student-teacher answers showed different views about learning mathematics. In addition, some of the student-teachers shared similar views in ways that made it possible to categorise views according to their beliefs. For example, the responses of student-teachers **A** and **B** could be described as "mathematics concepts would be best learned in a lecture setting" and "learning mathematics is better through rote learning." These verbal expressions about learning suggested that they believe in the learning method supported by the instrumentalist perspective, a traditional approach that encourages rote learning and memorisation; they believe that learning mathematics concepts happens as a result of mastery of rules and procedures and performing a mathematical process exactly, reflecting a teacher-centred context for learning and seeing the teacher as an instructor. Student-teacher A and B's responses align with one the four views identified by Kuhs and Ball (1986) of how mathematics is taught: Content-focused with an emphasis on performance.

Student-teachers **C** and **D** expressed two different perceptions of learning mathematics. On the one hand, they held a compatible view with student-teachers **A** and **B**; they considered following rote learning beneficial for understanding mathematics concepts, which is the traditional perception. On the other hand, they embraced the social context perspective linked to the non-traditional constructivist approach, believing that social interaction between students that allows students to discuss and share knowledge plays an essential role in acquiring mathematics knowledge. For example, **D** said, "We should learn by rote learning but not always. We should also learn through discussions." This second view suggested a relationship between their beliefs and the theoretical framework of Vygotsky's social constructivism theory. In addition, they perceive and support the teacher role as a facilitator of students' learning. Student-teacher C and D's responses align with two of the four views of how mathematics is taught identified by Kuhs and Ball (1986): Content-focused with an emphasis on performance (as did student-teachers A and B), and Learner-focused.

Student-teachers **E** and **F** expressed a broader view that rejects the rote methods of learning mathematics. **E** and **F** believed that students need to investigate and do mathematics to learn the concepts best; that is, they have a constructivist perspective that the learning of mathematics concepts is "a process of inquiry and coming to know" (Ernest, 1988, p. 2) and utilizing technology, not a process of memorizing. For example, student-teacher **E** believed in learning mathematics through "group discussion settings, where students would think and discuss in groups, exchange ideas, use educational aids such as calculators and computers (ICT type) to learn mathematics". In addition, student-teacher **F** said "I entirely do not agree and reject rote learning. Students forgot what they learned by memorising.

Students should think and explore when learning (that is, learn with the use of exploration)." Student-teacher E and F's responses suggest Learner-Focused beliefs Kuhs and Ball (1986).

3- Student-teachers' beliefs about the teaching of mathematics

Before participating in the Logo module, the student-teachers were asked the following question: "How do you think mathematics should be taught?" The responses demonstrated that the beliefs student-teachers held about the teaching of mathematics reflected the beliefs they held in their answers about the learning of mathematics. Thompson (1992) claimed that "it is difficult to conceive of teaching models without some underlying theory of how students learn" (p.135) and the student-teachers who were interviewed reflected Thompson's view.

For example, student-teachers with traditional views of learning mathematics, such as **A** and **B,** hold beliefs about teaching mathematics that aligned with traditional methods. Their response to the question about teaching mathematics was to "follow the lecture setting. We are used to a lecture setting" and "the rote method for teaching is suitable for me; if the teacher told me one rule with a procedure I can solve the problems given based on this rule and the procedure" respectively. This belief conformed to Kuhs and Ball (1986) third identified view of how mathematics should be taught, that is, "Content-focused with an emphasis on performance": with "mathematics teaching that emphasizes student performance and mastery of mathematical rules and procedures" (p.2). This view of teaching can be linked to the conception of the nature of mathematics as instrumentalist, and supports the teacher role as a lecturer.

Student-teachers **C** and **D** both considered the instrumentalist and constructivist approaches as suitable methods for teaching of mathematics. Their instrumentalist views were patterned after a “Content-focused with an emphasis on performance” view of teaching mathematics; and their constructivist views were patterned after what Kuhs and Ball (1986) describe as “learner-focused” where “mathematics teaching that focuses on the learner’s personal construction of mathematical knowledge” (p.2) and mathematics knowledge and ideas are shared and the teachers is seen as a facilitator (Thompson, 1992).

Student-teacher **C’s** answer about teaching of mathematics was “using the lecture. Since students love pictures and shapes we also can use these to demonstrate the concept. Also follow the group work style.” Furthermore, **D** said that she “explain the topic slowly step by step with the use of visual aids, making sure the students understand, and ask the students to use pencil and paper to solve the problems” and uses discussions where the teacher “discusses with the students, explains through the use of visual aids, and asks the students not to follow only the approach the teacher provided to solve the problem; on the contrary, he will accept any approach as long as the answer is correct.”

Finally, the personal beliefs for teaching mathematics expressed by student-teachers **E** and **F** reflected their constructivist perspective (group discussion and exploration respectively) of mathematics learning and rejection of rote methods. **E** and **F** believed that teachers should teach using methods that allow students to investigate and do mathematics, hence reflecting the “learner-focused” perspective (Kuhs and Ball, 1986) where the teacher’s role is to facilitate and motivate students’ learning (Ernest, 1988) and provide an environment for “student’s active involvement in doing mathematics- in exploring and formalizing ideas” (Thompson, 1992, p. 136). In addition, student-teacher **E** believed in utilising ICT. She said, “During the math class the teacher needs to present the topic and provide students with calculators and computers and have the students discuss the topic in groups and ask for the teacher's help if needed."

Student-teacher **F**'s approach was "exploration methods. I give students mathematical problems and let them think how to and explore to solve them. Teachers need to provide a hint when students had a problem and need a help. That helps them (students) to proceed and learn."

In summary, the pre-interview suggested that student-teachers' beliefs about the learning and teaching of mathematics were varied, and they can be placed into three categories for the learning and teaching of mathematics:

1- Traditional (rote learning and memorization) (**A** and **B**).

2- Constructivist (non-traditional) (**E** and **F**).

3- Both instrumentalist and constructivist (**C** and **D**).

In addition, the beliefs of the student-teachers were consistent for both learning mathematics and teaching mathematics. For example, student-teachers whose perspective was instrumentalist believed that the best way to learn mathematics concepts was through mastery of rules and procedures and performing mathematical process exactly; they also believed that demonstration and explanation of mathematical concepts, and enabling students to acquire mastery of rules and procedures, was an effective process for teaching mathematics. This belief reinforced the teacher's role as a transmitter of knowledge.

In contrast, student-teachers who believed in the constructivist perspective that mathematics is best learned as a result of inquiry, discussion, group work, and exploration but not memorisation, also believed that teachers should provide students with situations for investigation and challenge them to think and learn as an effective process for teaching mathematics. Underlying this belief is the role of the teacher as a facilitator.

Finally, two student-teachers believed in a combined instrumentalist and constructivist perspective for mathematics education.

The student-teachers' answers suggested that their personal beliefs about mathematics education were acquired through their previous educational experience. This was so since there was a consistency between beliefs they expressed and their classroom experience. For example, student-teacher **F,** who held the constructive perspective, said,"I saw her (teacher) as special because she taught the way that made me understand mathematics. She gave a problem and asked us to solve it; this gave me the interest and the ability to think flexibly and fluently. In contrast, a rote method that was used by other teachers did not help me to understand (mathematics)". (Please also see below, point 7- Student-teachers' previous mathematics classroom experience).

4- Student-teachers beliefs about the Logo program as an ICT tool for the teaching and learning of mathematics

Before participating in the Logo module, the student-teachers were asked the following question: "What do you think about the use of Logo as an ICT tool for the teaching and learning of mathematics?"

All student-teachers indicated that they used Logo in ICT classes, not in mathematics class; therefore they could not express their views about the Logo program. However, student-teacher **F** stated the need to include ICT and its tools such as Logo to develop mathematics instruction. She said, "students should be taught and learn (mathematics) with the use of advanced technology (ICT) and its learning aid programs." Student-teacher **B** used the term "easy and entertaining," these expressions suggest the potential for Logo to help to enhance students' interest and enthusiasm for mathematics education as well as suggest that ICT is useful in mathematic education.

In summary, student-teachers were not aware of the use of the Logo program as a tool for the teaching and learning of mathematics since they did not use the program during their mathematics classes. As both Al-Turkey (2006a, b) and Alajmi (2009) pointed out, Kuwaiti students are still taught mathematics by rote-learning and memorization. Further, Al-Turkey (2006a) noted that the use of ICT is not part of the curriculum. Given the use of rote-learning and the absence of ICT, the students would not have had any prior exposure to Logo in the mathematics classroom and their responses reflect this.

5- Student-teachers beliefs about the advantages / disadvantages of the Logo program for the teaching and learning of mathematics

Before participating in the Logo module, the student-teachers were asked the following question: "In your opinion, what do you consider to be the advantages / disadvantages of the use of Logo in the teaching and learning of mathematics?"

All student-teachers were unable to express any opinions about the advantages and disadvantages of Logo, which was expected since they lacked experience using the program during mathematics classes.

6- Student-teachers' beliefs about the use of ICT for the teaching and learning of mathematics

Before participating in the Logo module, the student-teachers were asked the following question: "What do you think about the use of ICT for the teaching and learning of mathematics?"

From the student-teachers' answers, student-teacher **E** had a single experience in the use of ICT in her college mathematics class, as well as exposure to ICT as a subject in ICT classes. The remaining five students only had exposure to ICT as a subject in their ICT classes. In addition, all six had additional ICT experience through the use of their own laptops. The views that they articulated about using ICT were shared by others in the group and categorised student-teachers according to their beliefs. For example, student-teachers **A** and **C's** response to the question was "maybe a positive idea (for the teaching and learning of mathematics)" and "might be proper for the teaching and learning of mathematics" respectively. This hesitancy about ICT possibly suggested that their beliefs were undecided about the use of ICT for mathematics.

Student-teachers **D** and **E** expressed different perceptions about ICT. **D** and **E** believed that ICT is a beneficial tool for mathematics education and helps students and teachers. **D** responded, "It (ICT) is useful… The teacher prepares for the lesson using an (educational) aide such as a PowerPoint presentation, and uses it (PowerPoint) when teaching. This attracts students' attention and makes them interact with the lesson." **E** commented "I used calculators and the QBasic program during the mathematics class at college and found it very helpful" respectively. Underlying this view is the suggestion that utilising ICT because of its potential for mathematics teaching and learning.

Student-teacher **F** appeared to strongly value using ICT for mathematics education. She said, "Using ICT is necessary in this domain (teaching and learning of mathematics). When ICT came into existence it became necessary in our lives and could not be rejected; it was impossible to reject it as it is so essential in the educational process." However, **F** did not justify the necessity of using ICT, except relating it to current ICT use, perhaps because she did not use ICT in her mathematics classes.

Student-teacher **B** said, "I did not use ICT during mathematics class; therefore I could not express my views about ICT".

In summary, most of the student-teachers were unaware of the potential for using ICT as a tool for the teaching and learning mathematics. Only student-teacher **E** had used QBasic program during her mathematics class at the college.

In addition, the pre-interview showed that student-teachers' beliefs about using ICT were varied, and they could be categorised according to their beliefs into four categories:

1- ICT is useful and a helpful tool (**D** and **E**)
2- ICT is an essential tool (**F**)
3- Undecided beliefs about the use of ICT as a tool (**A and C**)
4- Did not express any beliefs about the use of ICT as a tool (**B**)

Except for student-teachers **D** and **E**, other student-teachers did not provide any justification about their views possibly because they did not experience the use of ICT in their mathematics classes.

7- Student-teachers' previous mathematics classroom experience

Before participating in the Logo module, the student-teachers were asked the following question: "You may still recall some memories about one or more mathematics teachers. What was so special about him or her?" This question was posed because of Richardson's (2003) assertion that personal experience with schooling and instruction was the most important source of teacher candidates' beliefs about teaching and learning. Richardson noted they may enter preservice teacher preparation programs with strongly held beliefs formed during early student years.

The students-teachers' answers demonstrated that they remembered different classroom experiences as a result of their teacher or their teacher's educational methods. In addition, these approaches were found to be common among some of the student-teachers and categorised student-teachers according to their previous classrooms experiences. For example, the mathematics classrooms context described by student-teachers **A** and **B** reflected the "Content-focused with an emphasis on performance" perspective of Kuhs and Ball (1986) where "mathematics teaching emphasizes student performance and mastery of mathematical rules and procedures" (p.2) for students to acquire the mathematical knowledge. Describing her special teacher's method, student-teacher **A** said, "She (teacher) taught mathematics using lectures and demonstrations. She also encouraged us to memorise information and she encouraged us to go to her office if we needed more help. It was also very important for her that we did all the homework".

Student-teacher **B** said, "The teacher follows a rote learning style when explaining the concept. We do practical practise for questions and do the home work." This suggested that their teachers held a conception of the nature of mathematics teaching as "instrumentalist" (Ernest, 1988) and viewed their role as lecturers. Teaching mathematical knowledge is a process of transmission and learning mathematical knowledge acquired as a process of doing a lot of drill and practise, memorisation without utilising ICT as a tool for the teaching and learning of mathematics (Norton, McRobbie and Cooper, 2000).

In contrast, the described mathematics classrooms context from student-teachers **E** and **F** was found to be reflective of the "learner-focused" Kuhs and Ball

(1986) prospective, constructivist view, where "mathematics is teaching that focuses on the learner's personal construction of mathematical knowledge" (p.2) Hence, mathematics knowledge is acquired through *"making"* mathematics (Thompson, 1992, p. 128) and mathematics knowledge and ideas are shared in a social interaction between the learners (Thompson, 1992). Describing their special teacher's methods, student-teachers **E** and **F** said respectively, "All grade seven, eight and eleven teachers used group discussion. The teacher placed us (students) in groups and asked us (students) to discuss together and with her. With my college teacher we used the QBasic program" and "I saw her (teacher) as special because she taught the way that made me understand mathematics. She gave a problem and asked us to solve it; this gave me the interest and the ability to think flexibly and fluently. In contrast, a rote method that was used by other teachers did not help me to understand (mathematics)."

This suggests that their teachers held the "problem solving" concept of the nature of mathematics (Ernest, 1988) where mathematics knowledge is a process of enquiry and coming to know in a discussion context their role as facilitators who support and guide students' mathematical knowledge construction process instead of transmitting the knowledge. Within this assisted learning environment of guidance by the teacher, scaffolding is taking place within the student's zone of proximal development (ZPD) (Vygotsky, 1978).

Finally, the described mathematics classrooms context from student-teachers **C** and **D** was also found to be reflective of the "Content-focused with an emphasis on performance" perspective; and the "learner-focused" prospective described by Kuhs and Ball (1986). Student-teacher **C** said, "She (teacher) used lectures (rote learning) to show us the rules and procedures and asked us to solve the problems by following the rules and the procedure (drill and practise), sometimes individually and sometimes together in groups; she also used to help us to answer the questions." Student-teacher **D** said, "My teacher in grade seven used to demonstrate a problem using PowerPoint, and solved the problem slowly step by step, making sure that we understood. After that she would demonstrate another problem and would use discussion to arrive at the answer… My teacher used to request and encourage students to use different approaches as long the answer was correct."

This suggests that their teachers held combined conceptions of the nature of mathematics: the "instrumentalist" and "problem solving" (Ernest, 1988) and view their role as lecturers and as facilitators.

In summary, students-teachers described different classroom experiences. Besides, the classroom experiences were found to be common between some of the student-teachers and they can be categorised according to their beliefs in relation to their previous classroom experience into three categories of educational context:

1- Traditional (**A** and **B)**

2- Constructivist (**E** and **F)**

3- Traditional and constructivist (**C** and **D)**

In addition, we might conclude that a relationship exists between student-teachers' previous classrooms experiences and their beliefs about the learning and teaching of mathematics, and the use of the Logo program and ICT. Nespor (1987) and Thompson (1992) argue that beliefs develop from prior experiences. Calderhead and Robson (1991) agree that pre-service teachers hold strong images of their classroom experiences and often refer to their experiences in interviews.

Finally, all student-teachers' reporting of their classroom experience showed that their mathematics teachers did not use Logo programming language as an ICT tool for teaching and learning mathematics. Teaching and learning of mathematics by Kuwaiti teachers is still conducted using rote methods, even though ICT tools do exist. The tools have not yet been incorporated into the teaching curriculum. Additionally, teachers lack training in teaching with ICT and adequate computer labs are lacking. The Ministry of Education has confirmed that Kuwaiti students' underachievement in mathematics can be attributed to traditional methods of teaching, which are characterized by rote learning and memorization and which do not incorporate ICT programs (Al-Turkey, 2006a,b), nor ICT tools such as Logo. In addition, the MOE has noted that educational reform in the above aspect will be its priority in developing education in Kuwait.

8- Student-teacher personal comments

Before participating in the Logo module, the student-teachers were asked the following question to allow them to express any additional information they wished to include: "Is there anything you would like to talk about that we have not covered?" Student-teachers made different comments. For example, student-teacher **A** commented about the teaching and learning of mathematics at the present time. She said, "Usually students forget or hate mathematics because few teachers demonstrate or encourage students to practise the rules, and consider students doing homework as not important." Underlying this concern is possibly a belief in the traditional classroom context. In contrast, student-teacher **F** held opinions in line with methods based on constructivist principles and commented that it was not a successful method. She said, "Rote learning is the style used here (at school and the college) in all the subjects including mathematics; they are taught by rote learning which is not a successful method because students needed to think, not memorise."

Student-teacher **B** showed an interest in using Logo in the mathematics classroom. She asked, “How can we teach children mathematics using the Logo program?” My response to her was, “This is what you will find out about during the Logo module sessions.”

In addition, student-teacher **C** commented about using more than one method. She said, “Teaching and learning mathematics through lectures is not inappropriate but it would also be good if another method could be used such as group work where students could work and answer the questions together.” The student-teacher’s notion of group work is in agreement with Bruner’s (1983) opinion that with the help of others, the learner can gain increasing understanding and control of knowledge. In addition, her comments agree in part with McNally (1974), who said that education in general and mathematics education in particular should not be a routine habit, but instead consist of intelligent inquiry and thought, where development of knowledge resides in doing (experimenting), in activity, and in interacting with the problems in a social context. (p. 80)

Student-teacher **D** indicated her concerns about utilising ICT for teaching and learning mathematics. She said, “I wish they (the teachers) would use computers during the teaching process as students love computers, and they are a useful tool.”

6.3.3 Student-Teachers Post-Interview Analysis

This section describes beliefs held by student-teachers during the post-interview, which was administered following participation in the Logo module to observe whether the student-teachers’ responses had changed, illustrating modified student-teachers’ beliefs as a result of participation in the Logo programme module.

The post-module interview focused on the questionnaire topics as well as student-teachers' previous mathematics classrooms experience.

1- Student-teachers' beliefs about the nature of mathematics

Following completion of the Logo module, the following question was asked: "How would you describe mathematics? Student-teachers **A**, **B**, **C** and **F** maintained their previous common "Instrumentalist view" (Ernest, 1988), in which they believed mathematics consisted of rules and procedures. I also found that a change in students-teachers' beliefs about the nature of mathematics had occurred following their experience with the Logo program. For example, in the pre-interview student-teachers **A** and **B** viewed mathematics as rules and procedures; however, in the post-interview they used new expressions such as "explore," "creative" and "logical thinking." Underlying these expressions was a new way of thinking that can be linked to a broader view about the nature of mathematics. One finds the "fallibilist" Lerman (1983; cited in Thompson, 1992) and "problem solving" (Ernest, 1988) views. Also in evidence is the constructivist perspective, which views mathematics as process of human activity, enquiry and invention; a "continually expanding field of human inquiry ... not a finished product and its result remains open to revision" (Ernest 1989, p. 21) because "solutions to new problems are explored by the learners" (Golafshani, 2002, p. 2). Student-teachers **A** and **B** stated respectively, "Logo makes students explore and be creative" and "motivates students' logical thinking".

Another example of change was also obvious in Student-teachers **D** and **E**. Student-teacher **D** said, "Mathematics is an active subject; I mean it makes the brain active when studying mathematics. It (mathematics) is an active subject and a thinking subject." In addition, student-teacher **E** said, "Mathematics is the base for other disciplines such as physics and chemistry, mathematics theories and applied application to daily living, and exercises which make the mind work. Mathematics is a subject that will develop; there will always be new theories." This suggests a new perception of the nature of mathematics that rejects the absolutist view and which considers mathematics as independent and unrelated to any other discipline, and not dynamic, and contains certain facts, procedures, and theories. Finally, student-teachers **C** and **F** believed that mathematics is not an absolute. For example, student-teacher **F** said, "I believe everything in the universe is in relation to mathematics. It not only contains rules and procedures, it opens thinking. As evidence for this, every person can define his way (approach) to answer a question. It is not static and if it is static we would not see different ways and answers."

Student-teacher **C** said, "Mathematics is rules and procedures and concepts that can be deduced by individuals since mathematics makes us think and compute." This belief can be seen following participation in the Logo mathematical activities as she stated that "Logo makes students conclude by reasoning the mathematical concepts."

In summary, the post-interview suggested that a change in student-teachers' initial beliefs about the nature of mathematics occurred following their experience with the Logo program. For example, during the pre-interview student-teachers **A** and **B** held an Instrumentalist views about the nature of mathematics. However, in the post-interview they held a combined view of the instrumentalist and the fallibilist view that associates mathematics to the constructivist perspective. Student-teachers **D** and **E** during the pre-interview considered combined instrumentalist and fallibilist views about the nature of mathematics; however, in the post-interview they considered the fallibilist perspective about the nature of mathematics. Finally, student-teachers **C** and **F** held combined views: the Instrumentalist and the fallibilist.

Specifically, the post-interviews suggested a change in the initial beliefs of student-teachers **A**, **B**, **D**, and **E** about the nature of mathematics after the Logo Module. Yet, student-teachers **C** and **F** maintained their initial beliefs.

2- Student-teachers' beliefs about the learning of mathematics

Following completion of the Logo module, the following question was asked: "In your opinion, how are mathematical concepts (e.g. computation, geometry, algebra, etc.) best learned?" Student-teachers' answers suggested that a change in beliefs about learning mathematics had occurred following their experience with the Logo module. For example, student-teachers **A** and **B** held the same previous traditional perspective mentioned on the pre-interview that encourages rote learning and memorization. Yet they became more open to accept the ideas of Logo and the constructivist perspective, which holds that learning mathematics is an active process, not a passive one; it is a process of exploring and investigating for learning mathematics concepts effectively (Ernest, 1989; Thompson, 1992) and using ICT tools such as Logo programming language to promote learning mathematics (Clements, 1999). Student-teachers **A** and **B** answers included "use the lecture and use exploration to learn mathematics, and using Logo will make students explore and be creative" and "use traditional methods and new methods like group work and the Logo program" respectively. This change in response showed that student-teachers **A** and **B** came to consider a combination of two perspectives for learning mathematics: instrumentalist and Logo program as an ICT tool that supports the constructivist perspective; however, they did not have a major change in their beliefs as did student-teachers **C**, **D**, **E** and **F**.

For example, during the pre-interview student-teachers **C** and **D** embraced the rote learning and memorisation perspective, as well as the social context perspective that echoes the constructivist (non-traditional) approach for learning mathematics. However, in the post-interview there was a change in their beliefs in a direction more consistent with the constructivist approach for learning mathematics in a social context. In addition, they supported the idea that the integration of "Technology (tools such as Logo) is essential in…learning mathematics" (NCET, 2000). Besides, student-teacher **C** considered the need for a change in learning methods. She said, "I learned by rote since I was young and sometimes through group work but I think we need to learn through different ways (methods) like group work, the use of computers (ICT) (that is) Logo, and the use of educational programs. I felt the Logo module was useful for learning mathematics." Student-teacher **D** believed that learning mathematics concepts is best achieved "through discussion, problem solving and Logo."

Student-teachers **E** and **F** in the pre-interview rejected rote methods and supported the constructivist approach, believing that students need to investigate and do mathematics to learn the concepts best. They supported the view that learning is "a process of inquiry and coming to know" (Ernest, 1988, p. 2) and utilizing technology, not a process of memorizing. In their post-interview they were more committed to the constructivist approach and believed in the use of Logo for learning mathematics. Student-teacher **E** said, "Through group discussion and the use of computer programs, Logo supports exploration." Student-teacher **F** believed that "Students need to explore to learn. Logo will motivate students' attention (thought) and make them explore. In finding the answer by doing (coding) not memorising, students better learn and understand the subject."

In summary, the post-interview suggested that a change in students-teachers' initial beliefs about the learning of mathematics had occurred after their experience with the Logo program. For example, during the pre-interview student-teachers **A** and **B** held traditional views about the learning of mathematics. However, in the post-interview they became more open to the inclusion of Logo and considered a combined view: the traditional perspective and the Logo idea that supports the constructivist perspective. Student-teachers **C** and **D** during the pre-interview held combined traditional and constructivist views; in the post-interview they showed only one view about the learning of mathematics: the Logo idea hence constructivist perspective. Finally, student-teachers **E** and **F** during the pre-interview held a constructivist perspective; in the post-interview they maintained their initial beliefs and also considered Logo valuable for the learning of mathematics. The post-interviews showed a change in the beliefs of all student-teachers (**A**, **B**, **C, D**, **E** and **F**) about the learning of mathematics after completion of the Logo Module. First, all student-teachers considered the Logo approach to the learning of mathematics. Finally, student-teachers' beliefs about the learning of mathematics were varied, and they can be placed into two categories:

1- Traditional and constructivist (**A** and **B**)

2- Constructivist (**C**, **D**, **E** and **F**)

3- Student-teachers' beliefs about the teaching of mathematics

Following completion of the Logo module, the following question was asked: "How do you think mathematics should be taught?" Student-teachers' answers demonstrated that the beliefs they hold about the teaching of mathematics reflected the beliefs they held about the learning of mathematics. Thompson (1992) claimed that "it is difficult to conceive of teaching models without some underlying theory of how students learn" (p.135). Because "model(s) of learning mathematics play a central role in the beliefs of teachers" (Ernest, 1989, p. 23-24), "it seems reasonable to expect a model of mathematics teaching to be somehow related to or derived from some model of mathematics learning" (Thompson, 1992, p.135). This was apparent in student-teachers' beliefs about the teaching of mathematics.

For example, student-teachers **A** and **B** came to consider a combined perspective: they had some traditional beliefs and they also believed in Logo as an ICT tool that supports mathematics learning. They held beliefs about teaching mathematics that aligned with their beliefs of learning. Student-teachers **A** and **B** said respectively, "Teachers need to present the lesson and let students explore. If students did not understand enough to follow the lecture, teachers also need to use Logo and the computer (ICT)" and "combine traditional methods and group work with Logo". On the one hand this belief reflected Kuhs and Ball (1986) third identified view of how mathematics should be taught, that is, the "Content-focused with an emphasis on performance": where "mathematics teaching that emphasizes student performance and mastery of mathematical rules and procedures" (p.2). This view of mathematics teaching context can be naturally linked to the instrumentalist conception of the nature of mathematics. Consequently, it supports the teacher role as a lecturer. On the other hand, it reflects the first identified view, the constructivist perspective, the "learner-focused": where "mathematics teaching focuses on the learner's personal construction of mathematical knowledge" (Kuhs and Ball, 1986). In this instance, mathematics knowledge and ideas are shared and the teacher is seen as a facilitator (Thompson, 1992); the belief is that with the use of ICT tool like Logo program "learners can become the active, constructing architects of their own learning" (Papert, 1993, p.122).

Finally, the personal beliefs for teaching mathematics expressed by student-teachers **C, D, E** and **F** reflected a belief in the idea of Logo, hence the constructivist perspective for learning mathematics. They believed that teachers should teach using methods that incorporate Logo to allow students to be active and construct their learning. Underlying this belief is a context where an ICT tool such as Logo helps in mathematics knowledge construction and not knowledge reproduction (Murchie (1986), Clements and Sarama (1997), Bigge and Shermis (1999), Lindroth (2006). They supported the "learner-focused" perspective (Kuhs and Ball, 1986) in which the teacher's role is to facilitate and motivate students' learning (Ernest, 1988) by providing an environment where students use ICT tools such as Logo to construct their own learning, and an environment for "student's active involvement in doing mathematics- in exploring and formalising ideas" (Thompson, 1992, p. 136). Student-teacher **C** said, "I believe teachers need to use methods such as group discussion and using the computer educational program Logo." The National Council of Teachers of Mathematics Standards has emphasized the importance of social interaction and communication in learning mathematics. NCTM has stated, "Communication plays an important role in helping children construct links between their informal, intuitive notions and the abstract language and symbolism of mathematics; it also plays a key role in helping children make important connections among physical, pictorial, graphic, symbolic, verbal, and mental representations of mathematical ideas" (1989, 1991; cited in Steele, 1999, p. 38).

Student-teacher **D** believed that teachers need to "employ students' discussion and use the Logo program or any other programs for mathematics education that allows students to think and be creative, to answer the problems and comprehend the mathematical topic."

Student-teacher **E** described teaching mathematics as a context where the teacher uses "group discussion, and computer programs (QBasic) that support learning by reasoning and Logo for exploration."

Student-teacher **F** said, "Teachers should employ the exploration process, utilise ICT educational programs and support students' discussions when teaching mathematics"…Logo and other educational programs." Underlying these beliefs is a new context for mathematics education; the Logo context facilitates a constructivist perspective which emphasises active involvement of students during the teaching and learning process (Papert, 1993; Clements and Sarama, 1997; Karakirik and Durmus, 2005; Lindroth 2006).

In summary, the post-interview suggested that a change in student-teachers' initial beliefs about the teaching of mathematics had occurred after their experience with the Logo program. For example, during the pre-interview student-teachers **A** and **B** held traditional views about teaching mathematics. Yet, in the post-interview they became more open to the idea of Logo and considered a combined view: the traditional perspective and Logo that supports the constructivist perspective. Student-teachers **C** and **D** during the pre-interview considered combined traditional and constructivist views; in the post-interview they considered the constructivist perspective and the use of Logo. Finally, student-teachers **E** and **F** during the pre-interview considered the constructivist perspective; in the post-interview they maintained their initial beliefs and considered the use of logo in their teaching of mathematics. Consequently, I can say that the post-interview showed that all student-teachers considered the use of Logo for teaching mathematics. Student-teachers' beliefs about the teaching of mathematics were varied, and they can be placed into two categories:

1- Traditional and constructivist (**A** and **B**)

2- Constructivist (**C**, **D**, **E** and **F**)

4- Student-teachers' beliefs about the Logo program as an ICT tool for the teaching and learning of mathematics

Following completion of the Logo module, the following question was asked: "What do you think about the use of Logo as an ICT tool for the teaching and learning of mathematics?"

Student-teachers' answers showed a change in their beliefs about using Logo programming language for the teaching and learning of mathematics had occurred after their experience with the Logo module. For example, although during the pre-interview student-teacher **F** valued the need to include ICT and its tools such as Logo to develop mathematics instruction; other student-teachers did not express their views about the Logo program because they had not experienced Logo in their mathematics class. However, during the post-interview all student-teachers expressed positive common beliefs concerning the use of Logo program as an ICT tool for mathematics education. Student-teachers **A, B, C, D, E** and **F** believed that Logo is a useful ICT tool for mathematics education. For example, student-teacher **C** described it as "good and useful for teaching and learning mathematics." It appeared that this conception of Logo aligns with the technology principle defined by NCTM (2000) "Technology (tools such as Logo) is essential in teaching and learning mathematics;" Logo "is much more than a programming language, it is also philosophy of education" (Goldberg, 1991, p. 68) where students and teachers engage in a mathematical learning context which is characterized by exploration and investigation that is not possible without the technology (Yellend and Masters, 1995). In addition, student-teachers **E** and **F** believed that using Logo facilitates teacher's instruction and student's knowledge construction. Logo allows teachers to provide a learning environment that promotes students' construction of mathematical concepts and helps students learn the mathematical concepts more effectively (Thompson, 1992; Clements and Sarama, 1997; Papert, 1993; Clements, 1994). This manner of teaching is in agreement with Piaget's (1973) view, in which the teacher ceases being a lecturer satisfied with ready-made solutions; instead, his role is that of a mentor stimulating initiative and research.

Student-teachers **E** said, "As a tool it (Logo) will make it easy for me when teaching and for students when learning. It will make it easy for students to learn geometry and angles since they will learn by inductive reasoning". Student-teacher **F** said, "Logo is a very successful tool. Logo can help teachers when teaching since they can teach in an interactive context. Students interact with the program and explore the concepts like geometry and algebra widely. This helps students understand mathematical concepts like variables, shapes and angles which it is not easy to understand when taught using traditional methods (rote learning)." This belief reflects student-teachers' conception of the teacher's role as a facilitator. Margisit (2009) also mentions the facilitator role as envisioned by Vygotsky. For Vygotsky, the teacher's role is not to narrate, but to construct meaning alongside the student. Further, this belief is supported by McCoy (1996; cited in Clements, Battista and Sarama, 2001, p. 7) who argued that "Logo programming, particularly turtle graphic…. is clearly an effective medium for providing mathematics experiences… when students are able to experiment with mathematics in varied representations, active involvement becomes the basis for their understanding. This is particularly true in geometry… and the concept of variable."

In summary, the post-interview showed that all student-teachers accepted the use of Logo; they believed that the Logo program is a useful ICT tool to support and enhance the teaching and learning of mathematics. Their views echo Papert (1993) and Goldberg (1991) who believe that Logo can offer “powerful ideas in mind-sized bites” (p. 135) and a “philosophy of education” (p. 68).

5- Student-teachers’ beliefs about the advantages / disadvantages of the Logo program for the teaching and learning of mathematics

Following completion of the Logo module, the following question was asked: “In your opinion, what do you consider to be the advantages / disadvantages of the use of Logo in the teaching and learning of mathematics?”

Student-teacher answers showed a change in students-teachers’ beliefs about using Logo programming language for the teaching and learning of mathematics had occurred following their experience with the Logo module. For example, no student-teachers expressed any beliefs about the advantages and disadvantages of Logo during the pre-interview since they did not experience using the program during mathematics classes. However, during the post-interview student-teachers discussed the instructional the advantages of using Logo for mathematics education. For example, all student-teachers **A, B, C, D, E,** and **F** believed that Logo can create a context for students to constructs their mathematical knowledge. Student-teachers considered that Logo facilitates students’ “exploring,” “logical thinking,” “concluding,” “imagination,” and “creativity.” Underlying these conceptions is a link between Logo and constructivism: a belief (philosophy) of Logo as an “object (for students) -to-think-with” (Papert, 1993, p. 11), and a tool with which to explore, imagine, conclude, and be creative, with the teacher as facilitator. Hence, a broader view of a context for teaching and learning mathematics is supported by an ICT tool like Logo. For example, student-teacher **A** believed that Logo would "change the traditional way and make mathematics attractive for the students, help students to explore and be creative; also, it would ease and help the teacher in his role as a supervisor, and make difficult concepts easy to understand." Papert (1993) and Clements and Sarama (1997) argue that Logo can provide a powerful tool for exploring and learning mathematics. Besides it is a rich mathematics educational context that enhances students' interest and enthusiasm for meaningful intellectual engagement (Murchie, 1986; Clements and Sarama, 1997; Bigge and Shermis,1999; Lindroth, 2006) in a context that supports peer interaction and collaboration (Papert, 1993).

In addition, other student-teachers like **D**, **E** and **F** considered that the Logo visual environment provides a challenging educational context and enhances students' learning. Clements (1994, cited in Sarama and Clements, 2001, p. 11) claimed that Logo is a context that "encourages (students) wondering and posing problems by providing an environment in which to test (mathematical) ideas and receive feedback about these ideas". This Logo support encourages and helps students to make their own conjectures, test out and modify their thoughts, and increases their ability to explore and learn something new (Goldstone et al., 1996) with their teachers' "scaffolding" (Sarama and Clements, 2001, p.13).

Student-teacher **D** believed that "Logo reduces students' time and effort expended in manual drawing since it allows students to draw difficult shapes. It (Logo) supports students' discussions and motivation, and also develops students' thinking, imagination and creativity… The fast and instant visual display of students' answers allows students to check and explore and correct their wrong answers and learn."

Student-teacher **E** believed that Logo has several advantages. She said, "Logo facilitates students' learning mathematical concepts by inductive reasoning and exploration, this lets students connect old concepts with current concepts to learn topics that seem difficult, like geometry and angles. It encourages students to learn mathematics and like computers. It provides an interactive immediate feedback that helps learning. Logo encourages group discussion and makes the teacher a facilitator for mathematics education."

Student-teacher **F** said, "Logo provides an interactive environment that lets students learn and understand mathematics concepts easily. In addition, it supports and enhances exploration and encourages students' self-learning and group work. Using Logo makes students see their mistakes and try to solve them; this promotes students' (mathematics) understanding and excitement about learning mathematics."

Student-teacher **B** said, "Logo is a simple program and easy to use and useful for mathematics education. Its use motivates students' logical thinking, enhances their spirit for group work and support students' self learning." Brous (1995), who discussed Logo as a tool for the learning-disable child, concurred with Student-teacher B's assessment. Brous stated that Logo's user-friendly language, interactive programming and procedural description provides a productive milieu for the learning disabled child. He stated further that in its design it has the potential for isolating the difficulties which learning disabled children frequently manifest in assimilating and using new learning.

Finally, student-teacher **C** considered that Logo "motivates students to think and imagine and helps students learn and comprehend mathematical topics such as geometry variables, and computation by allowing them to comprehend the mathematical concepts. I mean, students do all the work with teacher support as a facilitator."

Concerning student-teachers' beliefs about the disadvantages of using Logo, half of student-teachers **A**, **B**, and **D** held the view that Logo has no disadvantages. For example, student-teacher **D** said, "Based on the way I used the program, I did not see any disadvantages. Maybe there is someone who sees that the program has disadvantages but for me I do not see it has disadvantages."

In contrast, student-teacher **C** believed that Logo "might encourage students not to use the traditional drawing tools such as a compass and ruler since often these tools did not need to be used when there were computers." However, a comparison between Logo-based and non-Logo-based students in a study by Clements, Battista and Sarama (2001) showed that Logo students scored significantly higher, with about double the gains of the non-Logo students, on a general geometry achievement test. This was significant because the test was paper-and-pencil without the use of the Logo program. This suggests that it is not always the case that Logo inhibits student's use of traditional drawing tools.

Finally, because the Logo program needs typing skills from the students, student-teachers **E** and **F** believed that some students would have difficulty in using the program. Student-teacher **E** said, "Possibly the students did not know how to use the computer (ICT) so at the beginning they might find it difficult to know the directions and where to write the commands." In addition, student-teacher **F** believed teachers will have a difficult time, temporarily, to teach students how to use the program. She said, "At the beginning teachers will face difficulty teaching the commands because of students' differing ability to use the program when typing. But once students learn and know the basic commands everything will be easy."

Underlying this conception is a belief of the importance of making students ICT literate to benefit the use of ICT and its educational tools.

In summary, student-teachers considered that Logo has instructional advantages. All student-teachers believed that Logo would create a context for students to construct their mathematical knowledge. This is in agreement with Papert (1993), who stated that Logo provides an awareness of the structure of mathematics, and helps them to think mathematically. In addition, **D**, **E** and **F** considered that Logo's visual environment provides a challenging educational context and enhances students' learning. Student-teacher **B** believed that Logo is a simple, easy-to-use program that motivates logical thinking enhances group work and supports self-learning. Student-teacher **C** considered that Logo motivates thinking and imagining and help students comprehend and conclude the mathematical concepts. This thinking agrees with Noss (1985; cited in Clements and Sarama, 1997, p. 3) who stated that in using Logo students would begin to construct a conceptual structure based on intuitions and primitive conceptions of algebraic notion upon which they could build later algebraic learning.

Finally, half of the student-teachers **A**, **B** and **D** believed that Logo has no disadvantages. However, student-teachers **C**, **E** and **F** believed that Logo has disadvantages. For example, student-teacher **C** believed that Logo might encourage students not to use traditional drawing tools such as a compass and ruler. In addition, student-teachers **E** and **F** believed that some students might find it difficult to use the program because they need to type Logo commands, consequently teachers would have difficulty until students learned the commands. However, student-teachers **E** and **F** considered it a temporary disadvantage.

6- Student-teachers' beliefs about the use of ICT for the teaching and learning of mathematics

Following completion of the Logo module, the following question was asked: "What do you think about the use of ICT for the teaching and learning of mathematics?"

Student-teachers' answers showed a change in beliefs about the use of ICT for the teaching and learning of mathematics had occurred as a result of their experience with the Logo module. All student-teachers **A, B, C, D, E** and **F** believed ICT is useful for mathematics education. For example, during the pre-interviews student-teachers **A** and **C** were uncertain and student-teacher **B** also did not express any views about the use of ICT because like other student-teachers they did not experience ICT in their mathematics class. However, during the post-interview student-teachers **A**, **B**, and **C** believed that ICT supports students' learning and enhances the teacher's profession. Student-teacher **A** believed that ICT "would help students in learning, exploring, and solving problems and being creative. Also, it helps mathematics teachers in developing lesson plans, teaching, and supervising students' learning."

Student-teacher **B** said "ICT is useful, makes delivering concepts easy and makes students think… Helps teachers to deliver the concept for students and they retain the concept because they experiment themselves. This makes the subject easier and makes the classroom active and helps students solve the problem by motivating them to explore and think about the problem and participate with other students so that he benefits and gets benefited and understands the concept."

Student-teacher **C** considered that ICT "helps the teacher when teaching mathematics and facilitates students to conclude and understand, and reduces teacher's work-load by making him a facilitator. In general, ICT would assist and enhance the educational process." A concept that echoes the NCTM technology principle (2000; cited in Lin, 2008a, p.140) is that "Technology enhances mathematics learning" and "Technology supports effective mathematics teaching." Underlying these ICT instructional advantages was the belief that ICT facilitates students' thinking and exploring, experimenting, creativity, ability to conclude, and understand mathematical ideas and concepts. Consequently, students transform the learning context from a passive to an active one that enhances students' construction of their mathematical knowledge. Sarama and Clements (2001) reported that ICT "offers unique opportunities for learning (mathematics) through exploration, creative problem solving, and self-guided" (p.16) and "catalysts" (Clements, 1999, p. 92); students' social interaction with "teachers consistently mediating students interaction with computers" (cf. Samaras, 1991; cited in Sarama and Clements, 2001, p. 13).

Similarly, student-teachers **D**, **E** and **F** considered ICT useful because they can provide instructional experiences in a context that allows students to involve themselves actively with mathematics. Additionally, student-teacher **D** considered ICT as a beneficial tool not only for the teaching and learning of mathematics but also for other disciplines and would suggest it saves a teacher's time. She said, "Using ICT is useful for mathematics and other subjects because it has characteristics for education… Everybody can use it and help to enhance students' thinking and creativity. It saves students' effort and promotes discussion context, and saves teacher's time… because he supervises students' learning when teaching."

In addition, student-teacher **E** believed that ICT has the potential to play a role to support the reforming call for mathematics. She said, "ICT is important and excellent for the teaching and learning of mathematics. It provides for the use of

Logo and other educational programs. Using ICT makes the educational process easier and helps in the attainment of its objectives; it helps students to be creative and understand the mathematical concepts and helps teachers in the education process and promotes students' self learning."

Finally, student-teacher **F** said, "It is very excellent, especially because it includes educational programs that provide motivation and is useful to the student… It encourages students to explore mathematics problems more easily and try to reach a solution and learn the concepts. Further, it makes the teacher's teaching easier and would help students and teachers search the internet for information and helps teachers in developing lesson plans."

In summary, the post-interview showed that student-teachers became more open about the use of ICT, believing in its usefulness and potential to support and enhance the teaching and learning of mathematics. This viewpoint echoes the NCTM (2000) technology principle that "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning."

7- Student-teachers' previous mathematics classrooms experience

To explore student-teachers' previous favourite mathematics classroom experience and its relationship or effect on their beliefs, the following question was asked: "You may still recall some memories about one or more mathematics teachers. What was so special about him or her?" The student-teachers recall of their pre-interviews classroom experience is mentioned in section 6.3.3 (see 7- Student-teachers' previous mathematics classrooms experience). In addition, all student-teachers commented on their Logo sessions experience. For example, student-teacher

A said, "During the Logo lectures I used something new, that is, the Logo program and it has helped to enhance my abilities to think and explore. It would be better for students to explore to learn and use Logo or ICT." Student-teacher **B** revealed that "Logo session's methods were enjoyable and exciting and the enjoyment was in using the program and working in a group." Student-teachers **C** and **D** stated respectively, "The lectures (Logo sessions) showed me how mathematics teaching and learning could be with educational aids like the Logo program" and "I believe what I learned about Logo and everything I did either on drawing shapes or mathematics operations was useful and important for me."

Student-teacher **E** believed that "Logo lectures were comfortable and excellent and useful, and Logo helped to make understanding fast and easier. During using Logo we drew angles and if it was wrong we drew it until it was right which helped in understanding."

Finally, Student-teacher **F** said, "The lectures were exceptional, especially when we the learner became responsible for the knowledge and the teacher role was as the facilitator only. This is something good because knowledge that results from thinking and exploring is permanent, very useful and unforgettable."

8- Student-teachers' personal comments

To allow student-teachers express any additional information they wanted to include, the following was asked: "Is there anything you would like to talk about that we have not covered?" Student-teachers offered a number of different comments. Student-teacher **A** considered that ICT and Logo would have a positive effect on mathematics education. **A** said, "Mathematics education would be better with computer use and Logo." Student-teachers **B**, **D**, **E** and **F** believed there was a stronger need for computer labs for mathematics instruction. For example, student-teachers **B** and **D** stated respectively, “Every school needs to have a computer (ICT) lab for mathematics teaching and learning” and “When I start my job as a teacher and, also for other teachers, I would like that we would be provided with a computer (ICT) lab to enable us to teach mathematics with the use of computer (ICT).” The student-teachers’ desire for computer labs echoes the position held by the National Council of Teachers of Mathematics on the role of technology in the teaching and learning of mathematics: “Technology is an essential tool for learning mathematics in the 21st century, and all schools must ensure that all their students have access to technology….” (NCTM, 2008). Tasouris (2009), in discussing constraints that influence teaching and learning, cited poor ICT equipment, along with the curriculum plan, textbooks, available time, and inadequate teacher training. Student-teacher **E** said “I wish there would be a special lab for mathematics that had computer program to allow students use Logo.”

In addition, student-teacher **F** commented on the school’s role concerning mathematics education reform. **F** said, “Schools need to provide computers with educational programs for classrooms and for mathematics labs and provide training programmes for teachers to learn how to use these programs.”

Finally, student-teacher **C** believed that schools should facilitate students in learning about Logo. She said, “I felt sad because my brothers know that there is a program called Logo in their school but they do not know how to use it at all.”

6.4 Support for the Study Hypothesis

The findings yielded by the results of the pre-test and post-test beliefs questionnaire as well as the pre-test and post-test beliefs interviews support the study’s hypothesis, which is: It will be shown that some Mathematics student-teachers in Kuwait change their guiding educational belief after using the Logo programming language in the Methods of Teaching Mathematics course. The student-teachers will gravitate away from the Traditionalist approach towards the Constructivist approach, with potentially far-reaching implications for student-teacher training courses in mathematics and teaching of mathematics in schools.

Ertmer (2005) suggested three strategies that may effect change in teachers' beliefs about teaching and learning in general and, specifically, beliefs about technology: (1) personal experiences, (2) vicarious experiences, and (3) social-cultural influences. The student-teachers in this study experienced all three strategies. They personally experienced the Logo module which was presented using constructivist practises. They also had vicarious experience through preparing mathematical Logo-based lesson plan and practise teaching mathematics with the use of Logo programming language following principles of constructivism. As Elmore, Peterson, and McCarthey (1996) stated, "…teachers' practices are unlikely to change without some exposure to what teaching actually looks like when it's being done differently" (p. 241). In interacting with each other, with the instructor as a facilitator, and practised peer-to-peer teaching using Logo programming language in a constructivist context, the student-teachers also experienced the third strategy suggested by Ertmer, which is social-cultural influence.

6.5 Summary

This chapter illuminates the findings of the data analysis. Chronbach's Alpha and inter-item correlations for the questions reliability were provided. Paired-Samples t-tests assessed whether the means of the two subsections statistically differed, explored which view student-teachers leaned toward, and whether the means between pre- and post-test subsections changed, illustrating modified student-teachers' beliefs. Next, specific findings related to the pre-test and post-test beliefs questionnaire were presented, followed by findings for the pre-test and post-test interview analysis. The chapter concluded with a reference to the support found for the study's hypothesis. The next chapter, which concludes this document, further explains specific findings within the beliefs questionnaire and the beliefs interview. The chapter ends with a list of recommendations, a discussion of the limitations of the study, and recommendations for further research. It concludes with reflections on my experience gained as a result of conducting this research

CHAPTER 7
SUMMARY AND CONCLUSION

7.1 Introduction

The aim of this final chapter is to provide a summary and conclusions for this study derived from the findings reported in the previous chapter. This chapter contains the following sections: summary of the study, summary of findings along with conclusions that may be drawn as a result of these findings, recommendations, limitations of this study, contributions and recommendations for further research, and reflections on my experiences gained.

7.1.1 Summary of the Study

This study explored mathematics student-teachers' beliefs prior to and following their practise in a Methods of Teaching Mathematics course that incorporated a non-compulsory non-credit bearing Logo module of 24 hours sessions (see Chapter 5, The Logo Module Course) developed and tought by the researcher.

The intervention for this study was conducted by the auther, as an external researcher, during the fall semester from September 2007 to January 2008 at the College of Basic Education in the State of Kuwait. The main purpose of this study was to investigate mathematics student- teachers' beliefs and how their beliefs may have been influenced after their participation on the Logo module course. Specifically, the study attempted to answer the following questions:

1- What are Kuwaiti mathematics student-teachers' beliefs toward mathematics teaching and learning and the impact of ICT? (see section 6.2.1 and 6.3.2 of Chapter 6 Data Analysis and Findings)

2- What is the effect of using Logo in a mathematics education course on Kuwaiti mathematics student-teachers' beliefs toward Logo and the teaching of mathematics? (see sections 6.2.2, 6.2.3 and 6.3.3 of Chapter 6 Data Analysis and Findings)

The sources of data were the thirty-two (32) student-teachers from Kuwait's College of Basic Education who were registered in the Methods of Teaching Mathematics course that incorporated a non-credit bearing Logo module. The student-teachers' initial beliefs were explored and determined prior to their participation in the Logo module through analyzing their answers in the pre-test belief questionnaire and in the pre-test semi-structured interview questions. Their current beliefs were determined following participation in the Logo module through analyzing their answers in the post-test belief questionnaire and in the post-test semi-structured interview questions. Data collected provided useful descriptions and interpretations about their modified beliefs and helped to offer more insight into the Kuwaiti mathematics student-teachers' beliefs toward the nature of mathematics, teaching and learning of mathematics and the use of ICT, in particular the importance of the inclusion of Logo programming language as an ICT cognitive tool to enhance the teaching and learning of mathematics.

Weighted means, for student-teachers' beliefs questionnaire, were computed to explore and determine the modified student-teachers' beliefs, as follows:

1- The first three sections of the beliefs questionnaire were divided, based on the questions type, into two subsections, namely: "Constructivist subsection" and "Traditional subsection" that is rote learning and memorisation.

For each subsection the Paired-Samples t-test (SPSS statistical function) was used to compute the weighted mean of student-teachers' answers. This Paired-Samples t-test function was used to assess whether the means of the two subsections, when analysed separately, as pre-test and post-test, are statistically different from each other as well as to explore which view student-teachers lean towards a Constructivist or Traditional approach.

2- A Paired-Samples t-test (SPSS statistical function) for equality of means was used to assess whether the means between the subsections (pre-test and post-test) had changed and so illustrate a modified student-teachers' beliefs.

3- A Paired-Samples t-test for equality of means for the Logo programming language section was used to assess whether the means between the pre-test and post-test changed and so illustrate a modified student-teachers' beliefs.

4- A Paired-Samples t-test for equality of means for the (ICT) section was used to assess whether the means between the pre-test and post-test had changed and so illustrate a modified student-teachers' beliefs.

7.2 Summary of the Findings: Beliefs Questionnaire

The 32 student-teachers were given identical pre-test and post-test questionnaires consisting of 111 questions that used a Likert rating scale from 1 (Strongly Disagree) to 5 (Strongly Agree), with a mid-point of 3 (Neither Agree nor disagree). The questionnaire enabled examination of the following student-teacher beliefs:

1. The Nature of Mathematics, (20 questions: 10 Constructivist and 10 Traditionalist)

2. The Teaching of Mathematics, (20 questions: 10 Constructivist and 10 Traditionalist)
3. The Learning of Mathematics, (21 questions: 10 Constructivist and 11 Traditionalist)
4. Logo Programme Language (26 questions)
5. Information and Communication Technology (ICT) questions (24 questions)

7.2.1 Pre-Test Findings: Beliefs Questionnaire

As Table 7 in Chapter 6 (Summary of Student-Teachers on the Pre-Test Beliefs Questionnaire, which is included in section 6.2.1 of chapter 6 Data Analysis and Findings) showed, student-teachers agreed with both constructivist and traditional educational perspectives for these sections: The Nature of mathematics, The Teaching of mathematics, and The Learning of mathematics. The total mean for a constructivist perspective was of [$\overline{X}$ = 3.70]; however, the total traditional perspective mean exceeded it, at [$\overline{X}$ = 4.02]. Placing a higher value on traditional teaching methods is in keeping with the findings of Alajmi (2009), as well as with the report by Al-Turkey (2006a, b) regarding the Ministry of Education's statement that Kuwaiti students are still taught mathematics by rote learning, and ICT is not part of the curriculum.

The use of the "Logo programming language" as a cognitive tool for constructivist learning in mathematics instruction yielded a mean score of [$\overline{X}$ = 3.48], which indicated that student-teachers neither agree nor disagree. Student-teachers showed the same ambivalence for information and communication technology (ICT), with a mean score of [$\overline{X}$ = 3.45]. Al-Turkey (2006a,b), Alajmi

(2009) and Farjon (2007; cited in Al-Salama, 2007) reported that mathematics education in Kuwait is taught by rote learning. Furthermore Al-Turkey (2006a,b) reported that ICT programs are not part of the Kuwaiti curriculum. Their statements support the above findings; since students learn by rote and memorization, and ICT programs such as Logo are not part of the curriculum, it is not surprising that the findings reported ambivalence.

It should be noted that the mean scores for both the Logo programming language [$\overline{X}$ = 3.48] and ICT [$\overline{X}$ = 3.45] showed neither agreement nor disagreement. However, as shown in Table 4 (Interpretation for the Computed Means of Student-Teachers' Beliefs, which is presented in Section 4.7 of Chapter 4 Research Design and Methodology); both scores were closer to the bottom of the Agreement scale (3.51- 4.50) than to the neither Neither Agree nor Disagree scale (2.51-3.50). The fact that ICT education programs exist in all Kuwaiti schools may have predisposed the student-teachers to at least lean toward being favorably disposed to these technologies, even though they had not personally experienced them in their mathematics education classes. Further, one could also surmise that the rising use of personal computers and the Internet in Kuwait (World Bank, 2010) may have increased the likelihood that students-teachers had exposure to these resources and may be at least somewhat favorably inclined toward ICT. World Bank statistics indicate that Kuwait Internet users per 100 people increased from 6.8 in the year 2000 to 36.7 in 2008. In the same time frame, personal computer users per 100 people increased from 11.4 to 23.7.

The data also showed little variation among the standard deviations for all sections, indicating that student-teachers' responses were not very varied. Alajmi (2009) observed that all teachers in Kuwait use a national textbook and follow the same instructional plans supplied by the Ministry of Education. This standardized teaching may account for the lack of variation in student-teachers' responses.

Further analysis was also conducted to determine if the differences between the means for constructivist and traditional beliefs was significant. At the 0.05 level of significance of the two-tailed levels, no significant difference was noted for the first three sections between constructivist and traditional beliefs. A possible reason for this lack of variation is that although the student-teachers held beliefs about traditional experiences based on years of exposure to these in the classroom (example: student-teacher A), they also had at least limited exposure to constructivist-based education principles, as in class discussions which were mentioned in some interviews (example: student-teacher E), as well as through the media (television, the Internet); hence they were supportive of new perspectives in educational practise. Goetz (2000) pointed out, "For students, being exposed to more than one teacher's point of view might cause confusion and even bewilderment" (p. 11). The student-teachers' exposure to multiple views may have resulted in a lack of significant difference in their views about the constructivist and traditional educational perspectives.

7.2.2 Post-Test Findings: Beliefs Questionnaires

As Table 9 (Summary of Student-Teachers on the Post-Test Beliefs Questionnaire, which is included in section 6.2.2 of chapter 6 Data Analysis and Findings) showed, student-teachers showed agreement with constructivist educational perspective for these sections: The Nature of mathematics, The Teaching of mathematics, and The Learning of mathematics. For those same sections, student-teachers neither agreed nor disagreed with a traditional educational perspective. The total constructivist beliefs mean showed strong agreement [$\overline{X}$ = 4.18], while the total traditional beliefs mean was [$\overline{X}$ = 3.21]. In addition, student-teachers showed agreement with the Logo and ICT questions, with means of [$\overline{X}$ = 4.11] and [$\overline{X}$ = 3.93], respectively.

The means for The Nature of mathematics, The Teaching of mathematics and The Learning of mathematics answers were examined to determine whether the differences between constructivist and traditional beliefs mean scores were significant. The two-tailed significance test verified a significant difference between constructivist and traditional beliefs in all cases at the 0.50 level of significance. The means for Logo [$\overline{X}$ = 4.11] and ICT [$\overline{X}$ = 3.93] questions also showed agreement with the use of these technologies. In addition, the two-tailed significance test also showed a significant difference, at the 0.50 level of significance, between the pre-test and post-test for Logo and ICT.

The Pre-test and Post-test Questionnaires were also compared using the Paired-Samples t-test to assess the change in the equality of means, as shown in Table 12 (Summary of Student-Teachers on the Pre-Test and Post-Test Beliefs Questionnaires, which is included in section 6.2.3 of chapter 6 Data Analysis and Findings). Where traditional and constructivist values were measured, in all cases the post-test constructive beliefs means increased, while traditional beliefs means decreased. The respondents' constructivist beliefs mean score in the post-test was increased significantly while the traditional beliefs mean score was decreased significantly. Further, where Logo and ICT were measured, agreement means increased in both cases, from [$\overline{X}$ = 3.48] to [$\overline{X}$ = 4.11] for Logo and from [$\overline{X}$ = 3.45] to [$\overline{X}$ = 3.93] for ICT. For both Logo and ICT, the change was significant.

A comparison of the pre-test and post-test results showed resounding support for the study's hypothesis: It will be shown that some Mathematics student-teachers in Kuwait change their guiding educational beliefs after using the Logo programming language in the Methods of Teaching Mathematics course. The student-teachers will gravitate away from the Traditionalist approach towards the Constructivist approach, with potentially far-reaching implications for student-teacher training courses in mathematics and the teaching of mathematics in schools.

One possible reason for this support is because these student-teachers are among the growing population in Kuwait who use the Internet and computers, as indicated earlier (World Bank, 2010). Possibly at least some of the student-teachers were more disposed to accepting new thinking about ICT, and its programs such as Logo, because of this exposure. While it is true that many current student-teachers and teachers do not have prior experience in the use of technology as part of their own educational experience, and this could influence their beliefs, technology as a ubiquitous presence has the power to affect beliefs in a way that is greater than ever before, regardless of past experience.

Another reason that may be surmised is that the results are due to the Hawthorne effect (Merrett, 2006): student-teachers may have demonstrated increasing beliefs in the use of constructivist approaches and of logo and ICT because they were aware of the fact that these topics were being studied, and wanted to appear in agreement with the researcher.

More reason that may be surmised is that the results are due to external affective factors such as peer pressure, or something they read or the impact of another lecture or module.

However, it must also be pointed out that a wide body of existing research supports the notion that student-teachers react positively when exposed to constructivist pedagogy and teaching with ICT (Russell et al. 2003; Swan and Dixon, 2006, So and Kim, 2009). Further, the particular high and low values that were affected in this study lend credence to the idea that the student-teachers did indeed change their guiding educational beliefs. Among the questions that measured constructivist/traditionalist beliefs, the highest post-test mean achieved [$\overline{X}$ = 4.22] supported the constructivist view for "The Learning of mathematics." This supports the notion that the student-teachers' beliefs were indeed positively affected when they experienced the opportunity to learn with the use of Logo as an ICT cognitive tool in a constructivist setting that allowed exploration, investigation, analyzing and manipulating images, and cooperative learning where learners talked among themselves, discussed and shared their ideas and constructed mathematical knowledge in a way that their traditional learning environment can not offer. One is reminded of the work of Yelland and Masters (1995) and Gusky (2002, cited in Levin and Wadmany, 2006). Yellend and Masters stated that students and teachers when using Logo become engaged in a learning context of exploration and investigation that can not be achieved without the technology. Gusky observed that a change in teachers' beliefs is primarily an experientially-based learning process. Levin and Wadmany deduced that "when teachers translate the abstract ideas concerning the integration of technology in their teaching practises they are likely to broaden their ideas or views on learning, teaching, and technology" (p. 161).

For this same set of questions, the lowest post-test mean achieved [$\overline{X}$ = 3.11] was for the "The Teaching of mathematics" using a traditional perspective. It can be assumed that when the student-teachers experienced being taught using Logo as an ICT tool that supports constructivist principles, their regard for the value of teaching traditionally was lessened. As a matter of fact, the greatest mean difference (.95) was in the area of "The Teaching of mathematics", with the Traditional view dropping from a pre-test high of [$\overline{X}$ = 4.07] to a post-test low of [$\overline{X}$ = 3.11]. As the student-teachers had the chance to experience the Logo module in the class as students and as teachers, their reaction to the "Teaching of mathematics" view was the greatest. These are among the factors that underscore the likelihood that the student-teachers beliefs were altered following their participation in the Logo module in the class.

When responding to the questions about the use of Logo and ICT, in each case the student-teachers demonstrated significant changes in their beliefs between the pre-test and post-tests. Post-tests may have showed improvement because at the end of the Logo module the student-teachers felt more confident with the use of ICT and Logo, and this confidence was reflected in the mean scores. This can also be seen in the statements the student-teachers (**A to F**) made during the post-interview about wanting to use Logo and ICT in their future classroom teaching. These findings concur with Lin (2008a) who investigated the efficacy of providing web-based workshops on elementary school mathematics topics as a means of enhancing teacher comfort with the subject matter. All participants in that study stated that the workshops helped them to become more confident in using computers to teach mathematics. In addition, Dawson (2006, cited in So and Kim, 2009) asserted that student-teachers were able to integrate technology in a more desirable way as a result of their participation in technology-enhanced field experiences lessons. A number of researchers have agreed that Logo is rich in mathematical context that enhances students' interest and enthusiasm for meaningful intellectual engagement, creates opportunities to sharpen their thinking, has the ability to increase nonverbal reasoning, problem-solving abilities, supports the learner to achieve to understanding of a wide range of mathematical concepts, and ultimately improves learning outcomes (e.g. Murchie, 1986; Papert, 1993; Clements and Sarama, 1997; Bigge and Shermis, 1999; and Lindroth, 2006).

7.2.3 Summary of the Findings: Constructivist and Traditional Total Means

For the "The Nature of mathematics," "The Teaching of mathematics" and "The Learning of mathematics," questions, in both the pre-test [$\overline{X}$ = 3.70] and post-test [$\overline{X}$ = 4.18] student-teachers showed agreement with constructivist beliefs. The post-test mean went up, probably in response to the opportunity the student-teachers had to experience constructivist teaching supported by Logo, as both students and as teachers. Although their pre-test mean showed agreement with constructivist teaching, it was second to their support for traditional teaching [$\overline{X}$ = 4.02], possibly it was due to the fact that that their experience resided in traditional teaching, both as students and as teachers. Following exposure to constructivist teaching in an applied setting using Logo, the student-teachers reconsidered their beliefs, and the post-test traditional mean dropped [$\overline{X}$ = 3.21].

7.3 Summary of the Findings: Beliefs Interview

A semi-structured interview of seven questions was administered to six student-teachers as both a pre-test and post-test interview. The interview questions attempted to ascertain student-teachers' beliefs about the same topics addressed in the beliefs questionnaire: The Nature of mathematics, The Learning of mathematics, The Teaching of mathematics, Logo programming language as a tool for the teaching and learning mathematics, and information and communication technology (ICT). In addition, questions were asked about the advantages and disadvantages of using Logo, and student-teachers' previous mathematics classrooms experience. The interview concluded with an eighth open-ended question that gave the students an opportunity to add any other comments they wanted to make. For the interview analysis procedure (see section 4.8 The Statistical Data Analysis Procedure: Interview).

7.3.1 Pre-Test Findings: Beliefs Interview

Student-teachers routinely expressed traditionalist views which were in keeping with their previous classroom experience. For instance, they described mathematics as "rules and procedures." However, some student-teachers (**C, D, E,** and **F**) also demonstrated a broader view of the nature of mathematics and implied that mathematics frees and broadens human thinking. There was also a dichotomy regarding the learning of mathematics. While some espoused the lecture setting and rote learning (student-teachers **A and B**), others student-teachers (**C** and **D**) valued rote learning and discussion, and still others student-teachers (**E** and **F**) saw the value of discussion and investigation as part of learning. Not surprisingly, student-teachers such as **A** and **B** who held traditional beliefs about learning mathematics also held the same views about teaching mathematics; student-teachers such as **C** and **D** who held both traditional and constructivist beliefs about learning mathematics also held the same views about teaching mathematics. The remaining student-teachers (**E** and **F**) who embraced constructivist beliefs about learning mathematics also embraced the same view about teaching mathematics.

For the question about Logo, student-teachers were unable to supply opinions as they had no direct experience. Student-teachers did hold a variety of opinions about ICT, although only one student-teacher (**E**) had direct experience with QBasic program during her mathematics class at the college. Student-teacher (**D**, **E** and **F**) believed that ICT was beneficial.

When student-teachers were asked about their previous mathematics classroom experience, student-teachers (**A** and **B**) indicated that they had experienced traditional lectures and rote learning as their classroom experience. Student-teachers (**E** and **F**) remembered participating in group discussions. Student-teachers (**C** and **D**) as students had classroom experiences in which rote learning and groups were employed. In addition, student-teacher (**D**) as a student had a classroom experience in which PowerPoint was used, and problems were solved slowly, step by step, followed by discussion.

What we see here is some diversity within the student-teachers' experiences. Some student-teachers had exposure to constructivist-like teaching, such as group discussion, which may explain why their constructivist total means on the pre-test questionnaire were positive.

7.3.2 Post-Test Findings: Beliefs Interview

Post-test findings showed an evolution in student-teachers' beliefs (student-teachers **A** and **B**) to using more dynamic expressions such as "explore, creative and logic thinking." Their earlier positions had been to use rules and procedures. Student-teacher **C** also felt that mathematics makes us think and compute. Student-teachers (**D** and **E**) also expressed new ideas. For instance, (**D**) felt that mathematics is an active subject, while (**E**) felt it was a base for other disciplines. Student-teacher (**F**) felt that mathematics contains rules and procedures but also opens thinking.

Student-teachers also showed changes in their beliefs about learning and teaching mathematics following their exposure to the Logo module. Student-teachers (**A** and **B**) came to consider a combination of two perspectives for learning mathematics: instrumentalist approaches and approaches incorporating the Logo program as an ICT tool that supports the constructivist perspective. Student-teachers (**C**, **D**, **E**, and **F**) showed much larger changes towards constructivist perspective.

All student-teachers expressed excitement about the use of Logo following their participation in the module. Their excitement about the program was evident in the number of positive responses received. Further, their beliefs about the use of ICT in the classroom showed a new openness and a belief in its potential to support and enhance the teaching and learning of mathematics. The student-teachers' responses are in keeping with the findings of So and Kim (2009) following their work with pre-service teachers in context of integrating problem based learning (PBL). So and Kim reported, "participants were able to identify major characteristics of PBL such as authentic tasks, collaborative learning, student centred learning, and teachers as facilitators. Additionally, pre-service teachers perceived that PBL pedagogy provided students with several advantages including independent learning, metacognitive and critical thinking, problem solving skills, collaborative learning skills, and transfer to real life problems" (p. 8).

Following their brief and enjoyable foray into the world of using Logo as an ICT tool in the classroom, the student-teachers, (**A** to **F**)**,** were excited and stated they wanted to use ICT and its tools, in particular Logo, in their own future classrooms.

7.4 Recommendations

As a result of my experience in conducting this study and analyzing its findings, the changes outlined below in the Kuwaiti teacher education programs and the Kuwaiti school system are recommended.

- Train existing college professors in the use of Logo as an ICT tool that supports constructivist learning within the classroom so they may integrate these practises into the mathematics teacher preparation curriculum. This experience will give them an opportunity to reflect on and reevaluate their own beliefs. Furthermore, it will help prepare student-teachers to use these technologies in their future classrooms to enhance the educational process.
- Provide in-service development courses for existing mathematics teachers in Kuwaiti schools in the use of Logo as an ICT tool that supports constructivist learning for mathematics education.

In order for this to be effective we need to:

- Revise existing technology standards to also integrate ICT in the classroom, with particular attention to programs such as Logo that have proven their effectiveness in enriching the teaching and learning of mathematics.
- Redesign the existing ICT courses so the focus is not just on how to use ICT, but rather to see it as an integrated tool for teaching and learning for mathematics education.
- Incorporate ICT in general and Logo in particular, in the mathematics curriculum, and in other subjects (for more details about the impact of using Logo in education, please see section 3.5 How Logo Supports the

Development of Mathematical Knowledge and Understanding of Education of Chapter 3 Literature Review)

- Develop ICT-based teaching modules that incorporate the use of Logo which mathematics teachers can share and re-use to help them integrate ICT and Logo into their curriculums.
- Provide special ICT labs for mathematics instruction in Kuwaiti schools.

7.5 Limitations of This Study

This study was conducted under the following limitations; as a result, it is unknown if these finding would generalize to other populations:

- Only female student teachers enrolled in a mathematics teaching methods course at the College of Basic Education in the State of Kuwait were included in this study.
- No male student-teachers were enrolled in this course since it was discontinued for male students after a new education law changed the teaching system in Kuwait elementary schools.
- All 32 participants were members of the same course (Mathematics Teaching Methods) in the same school (College of Basic Education).
- The researcher, as an external researcher, conducted the intervention.
- The Calculated Chronbach's alpha for some subsections was low, as discussed in Section 6.2.1.
- Some of the questionnaire statements failed to correlate with other statements, as shown in Tables 6 and 8.
- The use of multiple t-tests increases the risk of type one errors.

7.6 Contributions and Recommendations for Further Research

This research has contributed to the field of mathematics education and the use of Logo programming language as an ICT cognitive tool in mathematics instruction by:

- Clarifying Kuwaiti mathematics students-teachers', accepting the sample was all female, beliefs about using Logo as an ICT cognitive tool for mathematics instruction since as of yet no study has been done on this topic in Kuwait.
- Clarifying Kuwaiti mathematics student-teachers' beliefs about the nature of mathematics, teaching mathematics, learning mathematics, the use of Logo for the teaching and learning of mathematics, and the use of ICT in mathematics instruction.
- Shedding light on Kuwaiti student-teachers' beliefs toward integrating Logo in their future classrooms.
- Providing background and underlying data to help the Ministry of Education to develop a scheme to incorporate ICT in general and Logo programming language in particular in the mathematics curriculum.
- Providing background and underlying data to assist the College of Basic Education to develop a strategy for student-teachers to use ICT and its cognitive tools such as Logo to help improve the teaching and learning of mathematics (especially in the schools of Kuwait).
- Helping to build a more complete theory concerning mathematics student-teachers' beliefs about the nature of mathematics, the teaching and learning of mathematics, and the use of Logo and ICT.

- Providing background and underlying data for further research on mathematics student-teachers' beliefs and mathematics teaching methods with the use of ICT.
- Providing background for further research to explore if using Logo in the mathematics classroom helps pupils learn more effectively in Kuwait.

In addition, this study was conducted under some limitations (see section 7.5); however, it is suggested that the study's limitations will be ameliorated by re-executing this study as follows:

- Replicate with a larger and more diverse sample; including male students.
- Follow student-teacher's progress through their teacher-training and beyond into their professional work.
- Use a control group and an experimental group, and compare findings.
- Use ICT and its cognitive tools, such as Logo, across other subject disciplines.
- Reword statements that failed to correlate with other statements in the questionnaire (see Tables 6 an 8).

7.7 Concluding Comments and Reflections on My Experience

In conclusion, this study outcome showed a strong change in student-teachers' beliefs in support of the use ICT in general, and in particular the use of Logo in their future mathematics instruction, as well as using constructivist teaching pedagogies in Kuwait schools. The researcher believes that successful implementation of the reform and the inclusion of ICT and its tools such as Logo in mathematics instruction relies deeply on teachers' beliefs about the usefulness of the approaches and the tools. Therefore, if we are to cause teachers and student-teachers to evaluate and reflect on their beliefs about ICT in general, and in particular Logo, we must incorporate opportunities and create situations to engage them in reflective practises, active mathematics knowledge building where their beliefs are faced and re-evaluated as it was done in this study.

This study, approach and the outcome, provided an opportunity for me to reflect on and practise my own evolving ideas about constructivist teaching and the integration of ICT and its tools in general, and in particular the use of Logo, into the teaching curriculum. Through the years of my graduate studies, I progressed through the same migration in beliefs as demonstrated by the student-teachers in this study. Like the student-teachers who participated in this study, my earlier experience was based in traditional teaching. In this final paragraph of my dissertation, I wish to reflect on statements made in my opening paragraph of Chapter 1. Kuwait's educational system is confronted by the sad reality of Kuwaiti learners' poor performance in mathematics, both nationally and internationally. The Kuwait Ministry of Education has over the years made a substantial commitment toward education reform, including reform in mathematics, but the fact remains that inclusion of ICT and its tools such as Logo that support the constructivist perspective are not yet being accorded the kind of serious attention they deserve. I believe that Kuwait must change its pedagogical underpinnings and embrace these strategies as core components of the Kuwaiti education model.

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APPENDICES

Appendix A

Nottingham Trent University Request Letter and the Researcher's Personal Letter for the Field Study at the College of Basic Education

NOTTINGHAM
TRENT UNIVERSITY

To whom it may concern.

Ms Basia Filipowicz
Research Administrator
Nottingham Trent University Graduate School
Arts, Humanities and Education
Clifton Lane
Nottingham
NG11 8NS

Tel: +44 (0)115 848 6337
Fax: +44 (0)115 848 6339
Email: basia.filipowicz@ntu.ac.uk

04 September 2007

Dear Sir or Madam

Re: Mr Nabeel Sulaiman (DOB 19.05.1966)

This letter is to confirm that Mr Nabeel Sulaiman is registered as a full-time PhD Research Student in the School of Education at Nottingham Trent University. His supervisory team consists of Dr Tony Cotton, Mr Kevin Delaney and Mr Peter Bradshaw from the School of Education. Mr Sulaiman started his studies on 8th January 2007 and is expected to submit a completed thesis no later than 7th January 2011, which is the maximum time of 4 years allowed for full-time study.

As part of his research into Mathematics Education, Mr Sulaiman requires to carry out some fieldwork at the College of Basic Education in Kuwait between the dates of 17th September 2007 and February 2008. Nottingham Trent University would like to express their gratitude and appreciation to the institution for accommodating his research.

If you have any further queries please do not hesitate to contact me.

Yours faithfully

Ms Basia Filipowicz
Research Administrator

السيد العميد المساعد للشؤون الأكاديمية   كلية التربية الأساسية

الدكتور / على اليعقوب   المحترم

تحية طيبة و بعد،،،

أتقدم بكتابي هذا راجياً من حضرتكم التكرم بالموافقة على السماح لي بتطبيق بحث رسالة الدكتوراه الخاصة بي والتي تحمل عنوان

(Exploring Kuwaiti Mathematics Student-teachers' Beliefs toward Using Logo and Mathematics Education)

على طالبات كلية التربية الاساسية قي مقرر طرق تدريس الرياضيات في الفصل الدراسي الحالى 2007 / 2008. حيث أنني سوف أدرب الطالبات عملياً على كيفية استخدام الكمبيوتر، التطبيقات البرمجية (برنامج اللوغو) في تدريس الرياضيات وكذلك سوف أطبق استبانه ومقابلة شخصية للطالبات المشاركات في الدراسة للوقوف على وجهة نظرهم حول استخدام الكمبيوتر، التطبيقات البرمجية (برنامج اللوغو) في تدريس الرياضيات.

وتقبلوا فائق الاحترام و التقدير،،،

الإستاذ نبيل عبدالامام سليمان

طالب دكتوراة جامعة نوتنغهام ترنت

كلية التربية

البريد الإلكتروني N0182005@ntu.ac.uk

المملكة المتحدة

Appendix B

Participation Consent Letter

(English and Arabic Version)

Nottingham Trent University

School of Education

Dear student,

I am a PhD student at School of Education in Nottingham Trent University, United Kingdom. I am conducting a research study to Explore Kuwaitis Mathematics Student-Teachers' Beliefs about the use of Logo and the teaching and learning of mathematics. Therefore, I request your assistance by inviting you to participate in this study. Your participation would help to improve and develop mathematics teaching and learning in schools of Kuwait and the incorporating of Logo programming language.

Your participation is voluntary and will not affect your grades. There are no risks to you or to your privacy if you decide to participate to my study. But if you choose not to participate that is fine. However, your participation is crucial to helping me in my study. I would greatly appreciate your participation.

If you have questions regarding your rights as a research participant, or if a problems arise which you do not feel you can discuss with the researcher, please contact Nottingham Trent University, Graduate Research School tel: (+44) (115) 9418418 or by email Dr. Tony Cotton tony.cotton@ntu.ac.uk.

This section indicates that you are giving your informed consent to participate in the research.

The Participant's consent:

I confirm that I have red this consent and understand the information provided, and do agree to participate in this study. I do understand that my participation in this study is voluntary and that I am able not to participate in the study any time by informing Nabeel Sulaiman personally or by email at n0182005@ntu.ac.uk.

I am 18 years of age or older.

I understand that I will receive a copy of this signed consent form.

Participant's Signature: ______________________ Date: __________________

Thank you for your participation.

Nabeel A. J. Sulaiman

PhD Students, Nottingham Trent University

School of Education

Email: n0182005@ntu.ac.uk

عزيزي الطالب،

انا طالب دكتوراه في كلية التربيه، جامعة نوتنغهام ترنت، المملكة المتحدة.أقوم حالياَ بدراسة لمعرفة فكر طالبات كلية التربية الأساسية- تخصص رياضيات – نحو إستخدام برنامج اللوغو (Logo) وتعليم وتعلم الرياضيات. لذا اطلب مساعدتك من خلال دعوتك للمشاركة في هذه الدراسة. مشاركتك سوف تساعد على تحسين وتطوير تدريس الرياضيات والتعلم فى مدارس الكويت، ودمج برنامج اللوغو(Logo).

مشاركتك في هذه الدراسة طوعيه ولن يكون لها أي تأثير على تحصيلك العلمى. ستتم المحافضة على خصوصيتك اذا قررت المشاركة بالدراسه. ولكن اذا اخترت عدم المشاركة فلا بأس. مشاركتك ذات أهمية لمساعدتي للحصول على إجابات لأسئلة بحثي. شكراَ لتعاونك.

إذا كان لديك أي سؤال حول حقوقك كمشارك في الدراسة او في حال نشوء مشكلة وكنت تشعر انك لا ترغب بمناقشتها مع الباحث، يرجى الاتصال

بجامعة نوتنغهام ترنت، كلية الدراسات العلىا هاتف: 9418418(115)(44+) أو

مراسلة الدكتور Tony Cotton على البريدالألكتروني: tony.cotton@ntu.ac.uk

---

هذا الجزء مخصص لتأكيد موافقتكم على المشاركة في البحث

إقرار المشارك

أقر بقراءتي لهذا الإقرار و بفهمي للمعلومات المتضمنة، وأوافق على المشاركة في هذه الدراسة. وأقر بإدراكي على أن مشاركتي في هذه الدراسة تطوعية وبأنه يمكنني عدم المشاركة في هذه الدراسة في أي وقت بإبلاغ الأستاذ نبيل سليمان برغبتي فى عدم المشاركة إما شخصياً أو عن طريق البريد الإلكتروني على العنوان التالى: n0182005@ntu.ac.uk .

عمري 18 سنة أو أكثر.

أعلم أنني سوف أتسلم صورة موقعة عن هذه الموافقة.

توقيع المشارك:______________ التاريخ:______________

شكراً على مشاركتك

نبيل سليمان

طالب دكتوراه، جامعة نوتنغهام ترنت، كلية التربيه

البريد الالكتروني : n0182005@ntu.ac.uk

Appendix C

Questionnaire Consent Letter

(English and Arabic Version)

Nottingham Trent University

School of Education

Dear Student,

I am a PhD student at School of Education in Nottingham Trent University, United Kingdom. I am conducting a research study to Explore Kuwaitis Mathematics Student-Teachers' Beliefs about the use of Logo and the teaching and learning of mathematics. Therefore, I request your assistance by inviting you to participate in questionnaires. The insights gained from this questionnaire will provide helpful information, clarify mathematics student-teachers' beliefs and help me to accomplish my research. The results would help to improve and develop mathematics teaching and learning in schools of Kuwait and the incorporating of Logo. The completion of this questionnaire will take about 50 minute.

Your participation is voluntary and you are free to discontinue at any time. As a participant you have the right to ask for clarification and deny answers to questions. All information you provide will be kept strictly confidential and the researcher and the researcher's supervisors would be the only one who could access this information, your name will never be used or associated with the study.

There are no risks to you or to your privacy if you decide to participate to my study. But if you choose not to participate that is fine. However, your participation and your opinions are crucial to helping me obtain answers to my research questions. I would greatly appreciate your taking the time.

If you have questions regarding your rights as a research participant, or if a problems arise which you do not feel you can discuss with the researcher, please contact Nottingham Trent University, Graduate Research School tel: (+44) (115) 9418418 or email Dr Tony Cotton tony.cotton@ntu.ac.uk

This section indicates that you are giving your informed consent to participate in the research.

The Participant's consent:

I confirm that I have red this consent and understand the information provided, and do agree to participate in this questionnaire. I do understand that my participation in this questionnaire is voluntary and that I am able not to participate in this questionnaire any time by informing Nabeel Sulaiman personally or by email at n0182005@ntu.ac.uk.

I am 18 years of age or older.

I understand that I will receive a copy of this signed consent form.

Participant's Signature: ______________________ Date: __________________

Thank you for your participation.

Nabeel A. J. Sulaiman

PhD Students, Nottingham Trent University

School of Education

Email: n0182005@ntu.ac.uk

عزيزي الطالب،

انا طالب دكتوراه في كلية التربيه، جامعة نوتنغهام ترنت، المملكة المتحدة. أقوم حالياَ بدراسة لمعرفة فكر طالبات كلية التربية الأساسية- تخصص رياضيات – تجاه إستخدام برنامج اللوغو (Logo)وتعليم وتعلم الرياضيات. لذا اطلب مساعدتك من خلال دعوتك للمشاركة في هذاالإستبيان. نتائج هذه الإستبانة سوف توفر المعلومات المفيدة لتوضيح معتقدات الطلاب المعلمين وتساعدني على إنجاز بحثي. بالإضافة النتائج سوف تساعد على تحسين وتطوير تدريس الرياضيات والتعلم فى مدارس الكويت، ودمج برنامج اللوغو(Logo).

إتمام هذه الإستبانة سيستغرق حوالى 50 دقيقة.

مشاركتك في هذاالإستبيان طوعيه ويمكنك التوقف عن المشاركة في أي وقت. كمشارك لديك الحق في طلب الاستيضاح والإمتناع عن الإجابة على الاسئله. جميع المعلومات التي تذكرها ستظل سرية وسوف أكون مع المشرف على الدراسة الوحيدين المطلعين على هذه المعلومات، ولن يتم ذكر اسمك في الدراسه.

ستتم المحافضة على خصوصيتك اذا قررت المشاركة في هذاالإستبيان. ولكن اذا اخترت عدم المشاركة فلا بأس. مشاركتك ذات أهمية لمساعدتي للحصول على إجابات لأسئلة بحثي. شكراَ لتعاونك.

إذا كان لديك أي سؤال حول حقوقك كمشارك في هذاالإستبيان او في حال نشوء مشكلة وكنت تشعر انك لا ترغب بمناقشتها مع الباحث، يرجى الاتصال

بجامعة نوتنغهام ترنت، كلية الدراسات العلىا هاتف: 9418418(115) (44+) أو

مراسلة الدكتور Tony Cotton على البريدالألكتروني: tony.cotton@ntu.ac.uk

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هذا الجزء مخصص لتأكيد موافقتكم على المشاركة في البحث

إقرار المشارك

أقر بقراءتي لهذا الإقرار و بفهمي للمعلومات المتضمنة، وأوافق على المشاركة في هذا الإستبيان. وأقر بإدراكي على أن مشاركتي في هذا الإستبيان تطوعية وبأنه يمكنني عدم المشاركة في هذا الإستبيان في أي وقت بإبلاغ الأستاذ نبيل سليمان برغبتي فى عدم المشاركة إما شخصياً أو عن طريق البريد الإلكتروني على العنوان التالى: n0182005@ntu.ac.uk .

عمري 18 سنة أو أكثر.

أعلم أنني سوف أتسلم صورة موقعة عن هذه الموافقة.

توقيع المشارك:________________ التاريخ:________________

شكراً على مشاركتك.

نبيل سليمان

طالب دكتوراه، جامعة نوتنغهام ترنت، كلية التربيه

البريد الالكتروني : n0182005@ntu.ac.uk

Appendix D

Interview Consent Letter

(English and Arabic Version)

Nottingham Trent University

School of Education

Dear Student,

I am a PhD student at School of Education, Nottingham Trent University, United Kingdom. I am conducting a research study to Explore Kuwaiti Mathematics Student-Teachers' Beliefs about the use of Logo, and the teaching and learning of mathematics. Therefore, I request your assistance by inviting you to participate in a semi-structured interview. The insights gained from this interview will provide helpful information, clarify mathematics student-teachers' beliefs and help me to accomplish my research. The results would help to improve and develop mathematics teaching and learning in schools of Kuwait through the incorporating of Logo. The completion of this interview will take about one (1) hour.

Your participation is voluntary and you are free to discontinue at any time. As a participant you have the right to ask for clarification and deny answers to questions. The interview will be audio recorded, all information you provide will be kept strictly confidential and the researcher and the researcher's supervisors would be the only one who could access this information, your name will never be used or associated with the study.

There are no risks to you or to your privacy if you decide to participate to my interview. But if you choose not to participate that is fine. However, your participation is crucial to helping me obtain answers to my research questions. I would greatly appreciate your taking the time.

If you have questions regarding your rights as a participant in this interview, or if a problems arise which you do not feel you can discuss with the researcher, please contact Nottingham Trent University, Graduate Research School tel: (+44) (115) 9418418 or email Dr Tony Cotton tony.cotton@ntu.ac.uk

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This section indicates that you are giving your informed consent to participate in the research.

The Participant's consent:

I confirm that I have red this consent and understand the information provided, and do agree to participate in this interview. I do understand that my participation in this interview is voluntary and that I am able not to participate in this interview any time by informing Nabeel Sulaiman personally or by email at n0182005@ntu.ac.uk.

I am 18 years of age or older.

I understand that I will receive a copy of this signed consent form.

Participant's Signature: ______________________ Date: __________________

Thank you for your participation.

Nabeel A. J. Sulaiman

PhD Students, Nottingham Trent University

School of Education

Email: n0182005@ntu.ac.uk

عزيزي الطالب،

انا طالب دكتوراه في كلية التربيه، جامعة نوتنغهام ترنت، المملكة المتحدة.أقوم حالياَبدراسة لمعرفة فكر طالبات كلية التربية الأساسية- تخصص رياضيات – تجاه إستخدام برنامج اللوغو (Logo)وتعليم وتعلم الرياضيات. لذا اطلب مساعدتك من خلال دعوتك للمشاركة في هذه المقابلة الشخصية. نتائج هذه المقابلة الشخصية سوف توفر المعلومات المفيدة لتوضيح معتقدات الطلاب المعلمين وتساعدني على إنجاز بحثي. النتائج سوف تساعد على تحسين وتطوير تدريس الرياضيات والتعلم فى مدارس الكويت، ودمج برنامج اللوغو(Logo). إتمام هذه المقابلة الشخصية سيستغرق حوالى ساعة (1) واحدة.

مشاركتك في هذه المقابلة الشخصية طوعيه ويمكنك التوقف عن المشاركة في أي وقت. كمشارك لديك الحق في طلب الاستيضاح والإمتناع عن الإجابة على الاسئله. سيتم تسجيل المقابلة صوتيا. جميع المعلومات التي تذكرها ستظل سرية وسوف أكون مع المشرف على الدراسة الوحيدين المطلعين على هذه المعلومات، ولن يتم ذكر اسمك في الدراسه.

ستتم المحافضة على خصوصيتك اذا قررت المشاركة في هذاالإستبيان. ولكن اذا اخترت عدم المشاركة فلا بأس. مشاركتك ذات أهمية لمساعدتي للحصول على إجابات لأسئلة بحثي. شكراَ لتعاونك.

إذا كان لديك أي سؤال حول حقوقك كمشارك في هذه المقابلة الشخصية او في حال نشوء مشكلة وكنت تشعر انك لا ترغب بمناقشتها مع الباحث، يرجى الاتصال

بجامعة نوتنغهام ترنت، كلية الدراسات العلىا هاتف: 9418418(115) (44+) أو

مراسلة الدكتور Tony Cotton على البريدالألكتروني: tony.cotton@ntu.ac.uk

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هذا الجزء مخصص لتأكيد موافقتكم على المشاركة في البحث

إقرار المشارك

أقر بقراءتي لهذا الإقرار و بفهمي للمعلومات المتضمنة، وأوافق على المشاركة في هذه المقابلة الشخصية. وأقر بإدراكي على أن مشاركتي في هذه المقابلة الشخصية تطوعية وبأنه يمكنني عدم المشاركة في هذه المقابلة الشخصية في أي وقت بإبلاغ الأستاذ نبيل سليمان برغبتي فى عدم المشاركة إما شخصياً أو عن طريق البريد الإلكتروني على العنوان التالى: n0182005@ntu.ac.uk .

عمري 18 سنة أو أكثر.

أعلم أنني سوف أتسلم صورة موقعة عن هذه الموافقة.

توقيع المشارك:________________ التاريخ: ________________

شكراً على مشاركتك

نبيل سليمان

طالب دكتوراه، جامعة نوتنغهام ترنت، كلية التربيه

البريد الالكتروني : n0182005@ntu.ac.uk

Appendix E

Beliefs Questionnaire

(English and Arabic Version)

Student-teachers' Beliefs Questionnaire

Background Information

Instructions: Please fill in the blank or circle the choice that best answer the following questions

1- Your Name: ______________________

2- Male Female

3- Age: ________

4- Year in College – (e.g. 1= First year) 1 2 3 4 5

5- Where did your first experience with ICT take place? (circle all that apply)

Elementary school Intermediate school Secondary school College

University Other (specify) ______________

6- On the average, how many hours a day do you spend using ICT? _______

7- Have you ever used ICT to do the following?

a.	Word processing	a lot	a little	never
b.	Data presentation	a lot	a little	Never
c.	Information analysis	a lot	a little	Never
d.	Database management	a lot	a little	Never
e.	E-mail	a lot	a little	Never
f.	Developing a web site	a lot	a little	Never

8- Have you ever experienced the use of ICT in your college mathematics courses?

No Yes

if yes, please indicate the following:

Year (e.g. 1= First year…)	Course (e.g. CS135…)	ICT Application (e.g. Geometer's sketchpad, Logo, Excel...)

Belief Questionnaire

Instructions: For each item, please circle one number that indicates how you feel about the statement as indicated below.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
SA	A	U	D	SD

Part I. Nature of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Mathematics is an evolving, creative human endeavor in which there is much yet to be known.	5	4	3	2	1
2.	Mathematicians are hired mainly to make precise measurement and calculations for scientist and other people.	5	4	3	2	1
3.	There are often many approaches to solve a mathematics problem.	5	4	3	2	1
4.	In mathematics something is either right or it is wrong.	5	4	3	2	1
5.	Mathematics involves relating many different ideas and topics.	5	4	3	2	1
6.	Mathematics problems can be solved in only one approach.	5	4	3	2	1
7.	The mathematical ideas can be explained in everyday words that anyone can understand.	5	4	3	2	1
8.	Mathematics consists of unrelated ideas and topics.	5	4	3	2	1
9.	In different cultures around the world there are different models of mathematics.	5	4	3	2	1
10.	In mathematics, perhaps more than other areas, one can find set routines and procedure.	5	4	3	2	1
11.	Everything important about mathematics is already known by mathematicians.	5	4	3	2	1
12.	Solving a mathematics problem usually involves finding a rule or formula that applies.	5	4	3	2	1
13.	Many of the important functions of mathematician are being taken to provide a foundation for information and communication technology.	5	4	3	2	1
14.	Doing mathematics frequently involves exploration.	5	4	3	2	1
15.	Mathematics is a rigid discipline which functions strictly according to inescapable rules.	5	4	3	2	1

No.	Statement	SA	A	U	D	SD
16.	Mathematics has so many applications because its models can be interpreted in so many ways.	5	4	3	2	1
17.	In mathematics, perhaps more than in other fields, one can display originality and ingenuity.	5	4	3	2	1
18.	Mathematics is essentially the same all over the world.	5	4	3	2	1
19.	Doing mathematics involves creativity, thinking, and trial-and-error.	5	4	3	2	1
20.	The mathematical ideas can be explained only by technical mathematical language and special terms.	5	4	3	2	1

Part II. Teaching of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Teacher should show students the exact approach to answerer the mathematics question.	5	4	3	2	1
2.	The teacher must always present the content in a highly structured manner or follows the lesson plan as closely as possible.	5	4	3	2	1
3.	Good mathematics teaching involves class discussion in which students share thoughts and discuss meaning.	5	4	3	2	1
4.	Good mathematics teachers always plan for students to work individually to practise mathematics.	5	4	3	2	1
5.	The teacher should consistently provide students the opportunity to discover concepts and procedures for themselves.	5	4	3	2	1
6.	Information and communication technology is an essential aspect of good mathematics teaching.	5	4	3	2	1
7.	Mathematics teacher should consistently give assignments which require research and original thinking.	5	4	3	2	1
8.	Teachers should provide examples of problem solutions and help students learn to replicate them when doing problems.	5	4	3	2	1
9.	The teacher should always devote time to allow students to find their own methods for solving problems.	5	4	3	2	1
10.	Good mathematics teachers often consider the student preferences when planning lessons.	5	4	3	2	1

No.	Statement	SA	A	U	D	SD
11.	Teachers should show students lots of different approaches to look at the same questions.	5	4	3	2	1
12.	Good mathematics teachers only teach what is essential for mathematics exams.	5	4	3	2	1
13.	Good mathematics instructions progress in planed step-by-step sequence towards the lesson objectives.	5	4	3	2	1
14.	Good mathematics teachers always work sample problems for students before making an assignment.	5	4	3	2	1
15.	Mathematics teachers' role is to provide student with activities that encourage them to wonder about and explore mathematics.	5	4	3	2	1
16.	Good mathematics teachers always show students the quickest way of solving a mathematics problem.	5	4	3	2	1
17.	Mathematics teacher must make assignments on just that which has been thoroughly discussed in classroom.	5	4	3	2	1
18.	Good mathematics teachers frequently give student assignments which require creative or investigative work.	5	4	3	2	1
19.	Class discussions, collaborative and cooperative group work are important aspects of good mathematics teaching.	5	4	3	2	1
20.	Good mathematics teachers plans so that students regularly spend time working without information and communication technology to practice doing mathematics.	5	4	3	2	1

Part III. Learning of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Students who have access to information and communication technology learn to depend on them and do not learn mathematics properly.	5	4	3	2	1
2.	Information and communication technology is essential tool for investigation, examination, construction and consolidation of ideas when students learning mathematics.	5	4	3	2	1
3.	Students must be encouraged to develop and build their own mathematical ideas and procedures, even if their attempts contain much trail and error.	5	4	3	2	1

No.	Statement	SA	A	U	D	SD
4.	Learning mathematics is a process in which students absorb information, storing it in easily retrievable fragment as a result of repeated practice and reinforcement.	5	4	3	2	1
5.	Use of physical tools and real life examples to introduce mathematics ideas is an important component of learning mathematics.	5	4	3	2	1
6.	Teachers must value times of uncertainty, conflict and surprise when students are learning mathematics.	5	4	3	2	1
7.	Understanding mathematical ideas and procedures is important in mathematics learning.	5	4	3	2	1
8.	Mathematics learning is improved if students are encouraged to use their own interpretation of ideas and their own procedures.	5	4	3	2	1
9.	Teachers centered and students' individual work is essential in mathematics learning.	5	4	3	2	1
10.	Students can learn mathematics out of school while participating in ordinary everyday activities.	5	4	3	2	1
11.	Students' mathematics mistakes always reflect their current understandings of ideas or procedures.	5	4	3	2	1
12.	Mathematics learning is all about learning to get the right answer.	5	4	3	2	1
13.	Student best learn mathematics by being shown the correct ways to interpret mathematical symbols, situations and procedures.	5	4	3	2	1
14.	Students' mathematics errors are usually resulting of lack of practice.	5	4	3	2	1
15.	Mathematics is learnt in schools only.	5	4	3	2	1
16.	Students learn mathematics best if they are shown clear, precise step-by-step procedures for doing mathematics.	5	4	3	2	1
17.	Learning mathematics should be an active process.	5	4	3	2	1
18.	A memory of mathematical facts and procedures is essential for mathematics learning.	5	4	3	2	1
19.	A quiet classroom is generally needed for effective mathematics learning.	5	4	3	2	1
20.	Argumentation, proving, problem solving, and collaboration among students and between students and teachers is essential in mathematics learning.	5	4	3	2	1

No.	Statement	SA	A	U	D	SD
21.	Practicing many problems is the best way for students to learn mathematics.	5	4	3	2	1

Part IV. Logo Programming language

No.	Statement	SA	A	U	D	SD
1.	Mathematics is more interested and motivated with Logo.	5	4	3	2	1
2.	Using Logo to solve mathematics problems makes the problems easier to understand.	5	4	3	2	1
3.	Doing mathematics with Logo is enjoyable.	5	4	3	2	1
4.	Mathematics is more understandable with Logo.	5	4	3	2	1
5.	Logo is essentials for construct mathematical models and ideas.	5	4	3	2	1
6.	Sophisticated mathematical concepts are made accessible by Logo.	5	4	3	2	1
7.	Logo is important for mathematical exploration.	5	4	3	2	1
8.	Mathematics is easier if Logo is used to do mathematics.	5	4	3	2	1
9.	Logo can help students to learn the process of mathematics (e.g. the general strategies of problem-solving).	5	4	3	2	1
10.	Logo promotes personal skills (e.g. collaboration and cooperation).	5	4	3	2	1
11.	Interest in mathematics creativity is aroused with Logo mathematical activities.	5	4	3	2	1
12.	Logo can support the way learners construct their own learning.	5	4	3	2	1
13.	Logo stimulates mathematics thinking and reasoning.	5	4	3	2	1
14.	Logo is significant to improve quality of mathematics teaching.	5	4	3	2	1
15.	Logo will help me with my teaching profession.	5	4	3	2	1
16.	The use of Logo will give me the opportunity to be learning facilitator instead of information provider.	5	4	3	2	1
17.	Logo encourages new teaching and learning styles (e.g. investigations discussion and cooperative group work).	5	4	3	2	1
18.	Teaching mathematics with Logo makes me more competent and confident.	5	4	3	2	1
19.	Using Logo enable me to be creative teacher.	5	4	3	2	1
20.	Logo will dramatically improve my method of teaching.	5	4	3	2	1

No.	Statement	SA	A	U	D	SD
21.	Logo would enrich my instruction with creative activities.	5	4	3	2	1
22.	The use of Logo in schools is generally needed for learning mathematics better.	5	4	3	2	1
23.	Learning more about Logo is worthwhile.	5	4	3	2	1
24.	I look forward to using Logo in mathematics instruction.	5	4	3	2	1
25.	Mathematics instruction would be very interesting with Logo.	5	4	3	2	1
26.	Logo will make my instruction difficult to manage.	5	4	3	2	1

Part V. Information and Communication Technology (ICT)

No.	Statement	SA	A	U	D	SD
1.	ICT would motivate students to explore learning.	5	4	3	2	1
2.	ICT will improve the overall quality of education.	5	4	3	2	1
3.	Teacher training programs should incorporate ICT instructional applications.	5	4	3	2	1
4.	ICT can be useful instructional aid in almost all subject areas.	5	4	3	2	1
5.	The use of ICT reduces interaction and collaboration between learners.	5	4	3	2	1
6.	ICT can not enhance remedial education.	5	4	3	2	1
7.	Using ICT would change the teachers' role from information provider to learner facilitator.	5	4	3	2	1
8.	ICT is not an affective instructional tool for students of all abilities.	5	4	3	2	1
9.	Using ICT will improve students' attitudes towards schooling.	5	4	3	2	1
10.	ICT helps teachers organize, control and save time in schools' responsibility.	5	4	3	2	1
11.	ICT stifle creativity among learners.	5	4	3	2	1
12.	Using ICT offers teachers and learners new ways to approach mathematics (e.g. the introduction of more problem-solving, investigation and mathematical discussion).	5	4	3	2	1
13.	ICT can support the variety of ways learners construct their own knowledge and skills.	5	4	3	2	1
14.	The frustrations created by ICT are more trouble than they are worth.	5	4	3	2	1
15.	Colleges' educators need to know how to use and incorporate ICT as instructional tools.	5	4	3	2	1
16.	Learning about how to use ICT is boring to me.	5	4	3	2	1

No.	Statement	SA	A	U	D	SD
17.	I feel comfortable utilizing ICT.	5	4	3	2	1
18.	Using ICT makes me feel tense and uncomfortable.	5	4	3	2	1
19.	The use of ICT will negative affect my instruction proficiencies.	5	4	3	2	1
20.	I believe I could teach using ICT.	5	4	3	2	1
21.	I would like to learn to use ICT in my instruction.	5	4	3	2	1
22.	Learning more about incorporating ICT in teaching is worthwhile.	5	4	3	2	1
23.	All teachers should use ICT.	5	4	3	2	1
24.	The use of ICT in schools will affect negative students' attitudes toward learning.	5	4	3	2	1

Thank you again for your participation. ☺

أخي الطالب/ أختي الطالبة

مع فائق الشكر والتقدير،،،

الرجاء ملأ الفراغ أو إحاطة الإجابة المناسبة للإجابة عن الأسئلة التالية

8- الإسم: ______________________

9- ذكر أنثى

10- العمر: __________

11- السنة الدراسية في الكلية (مثال 1= السنة الأولي) 1 2 3 4 5

12- أين كانت أول تجربة لك عند إستخدام تكنولوجيا المعلومات والإتصالات (أحط كل ما يشمل ذلك)

المرحلة الإبتدائية المرحلة المتوسطة المرحلة الثانوية الكلية الجامعة

غير ذلك الرجاء (وضح) ________

13- على نحو تقديرك، كم ساعه في اليوم تقضيها في استخدام تكنولوجيا المعلومات والإتصالات؟

____

14- هل سبق لك أن قمت بإستخدام تكنولوجيا المعلومات والإتصالات (حدد إستخدامك فيما يلى):

أ-	معالجة النصوص (مايكروسوفت وورد، وورد باد، الخ).	كثيراً	قليلاً	أبداً
ب-	العروض التقديمية (مايكروسوفت باوربوينت، الخ)	كثيراً	قليلاً	أبداً
ج-	تحليل البيانات (مايكروسوفت اكسل، لوتوس، الخ).	كثيراً	قليلاً	أبداً
د-	إدارة قواعد البيانات (مايكروسوفت داتابيس، الخ)	كثيراً	قليلاً	أبداً
هـ-	المراسلات الإلكترونية (مايكروسوفت أوت لووك، ياهو ميل، هوت ميل، الخ)	كثيراً	قليلاً	أبداً
و-	تصميم موقع الكتروني (مايكروسوفت فرونت بيج، الخ)	كثيراً	قليلاً	أبداً

8- هل قمت بإستخدام تطبيقات تكنولوجيا المعلومات والإتصالات في أي مقرر رياضيات بالكلية؟ نعم لا

إذا كانت الإجابة (نعم)، الرجاء إكمال البيانات التالية:

السنة الدراسية (1= السنة الأولي)	**المقرر الدراسي (أس 132، الخ)**	**التطبيق (رسوم الهندسية، اللوجو، أكسل، الخ)**

التعليمات: لكل من الأجزاء الخمسة التالية، الرجاء قراءة كل عبارة ومن ثم إحاطة الرقم في الخانة الدالة على ما تشعر به نحو العبارة.

أولاً: طبيعة الرياضيات

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
-1	الرياضيات هي إبداع إنساني يتميز بالتطور ولا يزال به الكثير مما نحتاج لمعرفته.	5	4	3	2	1
-2	الرياضيات تستخدم بصورة أساسيه لإجراء مقاييس وحسابات دقيقة محددة للعلماء وبعض الأشخاص.	5	4	3	2	1
-3	هناك دائماً العديد من الطرق لحل المسألة الرياضية.	5	4	3	2	1
-4	أي شئ في الرياضيات إما صواب أو خطأ.	5	4	3	2	1
-5	الرياضيات تتضمن ربط العديد من الموضوعات و الأفكار المختلفة.	5	4	3	2	1
-6	المسائل الرياضية يمكن حلها بإسلوب واحد فقط.	5	4	3	2	1
-7	الأفكار الرياضية يمكن شرحها (تفسيرها) بإستخدام كلمات دارجة من الحياة اليومية يمكن لأي شخص فهمها.	5	4	3	2	1
-8	الرياضيات تتكون من أفكار وموضوعات غير مترابطة.	5	4	3	2	1
-9	في الثقافات المختلفة عبر العالم يوجد نماذج مختلفة من الرياضيات.	5	4	3	2	1
-10	في الرياضيات يجد الفرد روتين وإجراءات (خطوات) محددة أكثر من مجال آخر.	5	4	3	2	1
-11	كل الأشياء المهمة عن الرياضيات هي معروفة بالفعل من قبل علماء الرياضيات.	5	4	3	2	1
-12	حل المسألة الرياضية يتضمن غالباً إيجاد قاعدة أو معادلة يمكن تطبيقها.	5	4	3	2	1
-13	العديد من الوظائف الهامة (لعالم الرياضيات) يمكن الإستعانة بها لتوفير أساس لتكنولوجيا المعلومات والإتصالات.	5	4	3	2	1
-14	ممارسة الرياضيات كثيراً ما تتضمن الإستكشاف.	5	4	3	2	1
-15	الرياضيات هي مادة جامدة تعمل بصورة صارمة طبقاً لقواعد محددة لا مفر منها.	5	4	3	2	1

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
16-	الرياضيات لها العديد من التطبيقات لأن نماذجها يمكن تفسيرها بعدة طرق.	5	4	3	2	1
17-	في الرياضيات ربما أكثر من أي مجال آخر يمكن للفرد إظهار الأصالة والإبداع.	5	4	3	2	1
18-	الرياضيات هي نفسها من حيث الجوهر في جميع أنحاء العالم.	5	4	3	2	1
19-	ممارسة الرياضيات تتضمن الإبداع والتفكير والمحاولة والخطأ.	5	4	3	2	1
20-	الأفكار الرياضية يمكن تفسيرها فقط عن طريق لغة رياضية فنية ومصطلحات خاصة.	5	4	3	2	1

ثانياً: تدريس الرياضيات

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
1-	يجب على معلم الرياضيات أن يعرض على طلابه الطريقة الدقيقة (المحددة) لإجابة سؤال الرياضيات.	5	4	3	2	1
2-	يجب على معلم الرياضيات دائماً أن يقدم المحتوى الدراسي بطريقة فائقة الإحكام (روتينية) وأن يقوم بإتباع خطة الدرس بقدر الإمكان.	5	4	3	2	1
3-	التدريس الجيد للرياضيات يتضمن إجراء مناقشات داخل الفصل يقوم فيها الطلاب بتبادل الأفكار ومناقشة المعنى.	5	4	3	2	1
4-	معلم الرياضيات الجيد يخطط دائماً للطلاب للعمل بصورة فردية على تطبيق الرياضيات.	5	4	3	2	1
5-	يجب على معلم الرياضيات أن يعطي الطلاب بصورة منتظمة الفرصة لإكتشاف المفاهيم والإجراءات (الخطوات) بأنفسهم.	5	4	3	2	1
6-	تعتبر تكنولوجيا المعلومات و الإتصالات إتجاه مهم للتدريس الجيد للرياضيات.	5	4	3	2	1
7-	يجب على معلم الرياضبات أن يعطي بصورة منتظمة واجبات تتطلب البحث والتفكير المتميز بالأصالة.	5	4	3	2	1

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
-8	يجب على معلم الرياضيات أن يعطى للطلاب طرق لحل المسائل الرياضية ويساعد الطلاب على تعلمها وتكرارها أثناء الحل.	5	4	3	2	1
-9	يجب على معلم الرياضيات أن يخصص وقتاً يسمح فيه للطلاب أن يجدوا طرقهم الخاصة لحل المسائل الرياضية.	5	4	3	2	1
-10	عندما يقوم معلم الرياضيات بتحضير الدرس يجب أن يضع ما يفضله الطالب بعين الإعتبار.	5	4	3	2	1
-11	يجب على معلم الرياضيات أن يقدم للطلاب طرق مختلفة لتناول السؤال نفسه.	5	4	3	2	1
-12	معلم الرياضيات الجيد يدرس فقط ما هو أساسي لإختبارات الرياضيات.	5	4	3	2	1
-13	التدريس الجيد للرياضيات يسير بصورة مخططة ومتسلسلة خطوة بخطوة (روتينية) في إتجاه أهداف الدرس.	5	4	3	2	1
-14	معلم الرياضيات الجيد دائماً يقوم بعرض مسائل نموذجية للطلاب قبل إعطائهم الواجب.	5	4	3	2	1
-15	دور معلم الرياضيات هو إعطاء الطلاب أنشطة تشجعهم على التفكير وإستكشاف الرياضيات.	5	4	3	2	1
-16	معلم الرياضيات الجيد دائماً ما يعرض على الطلاب أسرع الطرق لحل المسألة الرياضية.	5	4	3	2	1
-17	معلم الرياضيات بجب أن يعطى واجبات فقط على ما تم مناقشته بصورة وافية في الفصل.	5	4	3	2	1
-18	معلم الرياضيات الجيد يعطى بصورة دائمة للطلاب واجبات تتطلب عملاً إبداعياً وبحثياً.	5	4	3	2	1
-19	المناقشات بالفصل والعمل الجماعي التعاوني والتفاعلى تعتبر جوانب هامة من التدريس الجيد للرياضيات.	5	4	3	2	1
-20	معلم الرياضيات الجيد يخطط حتى يتمكن الطلاب بصورة منتظمة من قضاء الوقت في العمل بدون الإستعانة (إستخدام) بتكنولوجيا المعلومات والإتصالات لممارسة الرياضيات.	5	4	3	2	1

ثالثاً: تعلم الرياضيات

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
-1	الطلاب الذين لديهم وسيلة وصول لتكنولوجيا المعلومات والإتصالات يتعلمون الإعتماد علىها ولا يتعلمون الرياضيات بصورة صحيحة.	5	4	3	2	1
-2	تكنولولجيا المعلومات والإتصالات هي أداة هامة لبحث وفحص، وتكوين وتدعيم الأفكار أثناء تعلم الطلاب للرياضيات.	5	4	3	2	1
-3	يجب تشجيع الطلاب على تطوير وبناء أفكارهم وطرق الحل الرياضيه حتى لو كانت محاولاتهم تحتوي على الكثير من المحاولة والخطأ.	5	4	3	2	1
-4	تعلم الرياضيات هي عملية يقوم فيها الطلاب بتلقي(إمتصاص) المعلومات وتخزينها بصورة أجزاء قابلة للإسترجاع بسهولة نتيجة للممارسة المستمرة والتعزيز.	5	4	3	2	1
-5	إستخدام الأدوات المادية والأمثلة المستقاة من الحياة (الأمثلة الحية) لتقديم الأفكار الرياضيه هي عنصر هام لتعلم الرياضيات.	5	4	3	2	1
-6	يجب على المعلمين تقدير (الأخذ بعين الإعتبار) أوقات الشك والتضارب والدهشة عندما يقوم الطلاب بتعلم الرياضيات.	5	4	3	2	1
-7	فهم الأفكار والإجراءات (الخطوات) الرياضيه شيء هام في تعلم الرياضيات.	5	4	3	2	1
-8	يتحسن تعلم الرياضيات لدى الطلاب إذا تم تشجيعهم على إستخدام تفسيرهم الخاص لأفكارهم وإجراءاتهم (خطواتهم) في الحل.	5	4	3	2	1
-9	العمل المركزي للمعلم والفردي للطلاب شيء هام في تعلم الرياضيات.	5	4	3	2	1
-10	يمكن للطلاب تعلم الرياضيات خارج المدرسة أثناء مشاركتهم في الأنشطة الإعتيادية للحياة اليومية.	5	4	3	2	1
-11	أخطاء الطلاب الرياضيه دائماً تعكس فهمهم الحالى للأفكار والإجراءات.	5	4	3	2	1
-12	تعلم الرياضيات هو في مجمله تعلم لكيفية الوصول الى الإجابة الصحيحة.	5	4	3	2	1
-13	يتعلم الطلاب الرياضيات بالشكل الأمثل من خلال عرض الطرق الصحيحة لترجمة الرموز الرياضيه والمواقف والإجراءات (الخطوات).	5	4	3	2	1
-14	أخطاء الطلاب الرياضيه هي دائماً ما تنتج عن نقص في الممارسة.	5	4	3	2	1

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
15-	الرياضيات يتم تعلمها في المدارس فقط.	5	4	3	2	1
16-	يتعلم الطلاب الرياضيات بالشكل الأمثل إذا تم عرض الخطوات بصورة واضحة ودقيقة وخطوة بخطوة.	5	4	3	2	1
17-	تعلم الرياضيات يجب أن يكون عملية نشطة.	5	4	3	2	1
18-	تذكر الحقائق والخطوات الرياضيه هى شىء جوهري (أساسي) لتعلم الرياضيات.	5	4	3	2	1
19-	الفصل الهادىء مطلوب بشكل عام للتعلم الناجح للرياضيات.	5	4	3	2	1
20-	المناقشة والإثبات وحل المشكلات والتعاون بين الطلاب ومع المعلم هي أشياء جوهرية في تعلم الرياضيات.	5	4	3	2	1
21-	ممارسة الكثير من المسائل الرياضية (النموذجية) هي أفضل الطرق لتعلم الرياضيات بالنسبة للطلاب.	5	4	3	2	1

رابعاً: اللوجو

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
1-	الرياضيات تصبح أكثر تشويقاً وتحفيزاً مع اللوجو.	5	4	3	2	1
2-	إستخدام اللوجو لحل مسائل الرياضيات يجعل المسائل أكثر سهولة من حيث الفهم.	5	4	3	2	1
3-	ممارسة الرياضيات مع اللوجو شىء ممتع.	5	4	3	2	1
4-	الرياضيات تصبح أكثر فهماً مع اللوجو.	5	4	3	2	1
5-	اللوجو مهم لتكوين نماذج و أفكار رياضيه.	5	4	3	2	1
6-	المفاهيم الرياضيه المعقدة تصبح أكثر تطبيقاً بإستخدام اللوجو.	5	4	3	2	1
7-	اللوجو مهم لإكتشاف الرياضيات.	5	4	3	2	1
8-	االرياضيات تصبح أكثر سهولة إذا تم إستخدام اللوجو لممارسة الرياضيات.	5	4	3	2	1
9-	اللوجو يمكن أن يساعد الطلاب على تعلم الخطوات الرياضيه مثل الإستراتيجيات والطرق العامة لحل المشكلات.	5	4	3	2	1
10-	اللوجو يشجع المهارات الشخصية مثل التفاعل والتعاون مع الآخرين.	5	4	3	2	1

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
-11	الإهتمام بالإبداع الرياضى يمكن إستثارته من خلال الأنشطة الرياضيه للوجو.	5	4	3	2	1
-12	اللوجو يمكن أن يدعم الطريقة التى من خلالها يقوم الطلاب ببناء تعلمهم.	5	4	3	2	1
-13	اللوجو يحفز التفكير والإستنتاج الرياضى.	5	4	3	2	1
-14	اللوجو مهم لتحسين نوعية تدريس الرياضيات.	5	4	3	2	1
-15	اللوجو سوف يساعدني في التدريس.	5	4	3	2	1
-16	إستخدام اللوجو سوف يعطيني الفرصة لكي أكون ميسر لعملية التعلم بدلاً من مصدر للمعلومات.	5	4	3	2	1
-17	اللوجو يشجع أسالب التدريس والتعلم الجديدة مثل البحث والمناقشة والعمل الجماعي التعاوني.	5	4	3	2	1
-18	تدريس الرياضيات بإستخدام اللوجو يجعلنى أكثر كفاءة وثقة.	5	4	3	2	1
-19	إستخدام اللوجو يساعدنى على أن أكون معلم مبدع.	5	4	3	2	1
-20	اللوجو سوف يحسن طريقتي في التدريس بصورة ملحوظة.	5	4	3	2	1
-21	اللوجو سوف يثري تدريسى بنشاطات إبداعية.	5	4	3	2	1
-22	إستخدام اللوجو في المدارس مطلوب بشكل عام لتعلم الرياضيات بشكل أفضل.	5	4	3	2	1
-23	التعلم أكثر عن اللوجوجدير بالإهتمام.	5	4	3	2	1
-24	أنا أتطلع لإستخدام اللوجو في تدريس الرياضيات.	5	4	3	2	1
-25	تدريس الرياضيات يمكن أن يكون أكثر تشويقاً مع اللوجو.	5	4	3	2	1
-26	اللوجو سوف يجعل تدريسي صعب السيطرة.	5	4	3	2	1

خامساً: استخدام تكنولوجيا المعلومات والإتصالات

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
-1	تكنولوجيا المعلومات والإتصالات سوف تحفز الطلاب على إستكشاف التعلم.	5	4	3	2	1
-2	تكنولوجيا المعلومات والإتصالات سوف تحسن من الكفاءة الكلية للتعليم.	5	4	3	2	1

معارض بشدة	معارض	متردد	موافق	موافق بشدة	العبارة	الرقم
1	2	3	4	5	برامج تدريب المعلمين يجب أن تحوي على تطبيقات تكنولوجيا المعلومات والإتصالات الخاصة بالتدريس.	-3
1	2	3	4	5	تكنولوجيا المعلومات والإتصالات يمكن أن تكون وسيلة تعلمية مفيدة لجميع المواد الدراسية.	-4
1	2	3	4	5	إستخدام تكنولوجيا المعلومات والإتصالات يقلل من التفاعل والتعاون بين المتعلمين.	-5
1	2	3	4	5	تكنولوجيا المعلومات والإتصالات لا يعزز التدريس العلاجي.	-6
1	2	3	4	5	إستخدام تكنولوجيا المعلومات والإتصالات سوف يغير دور المعلم من ملقن للمعلومات إلى ميسر لعملية التعلم.	-7
1	2	3	4	5	تكنولوجيا المعلومات والإتصالات ليست وسيلة تعلمية فعالة للطلاب من ذوي قدرات مختلفة.	-8
1	2	3	4	5	إستخدام تكنولوجيا المعلومات والإتصالات سوف يحسن من إتجاهات الطلاب نحو المدرسة.	-9
1	2	3	4	5	تكنولوجيا المعلومات والإتصالات يساعد المعلمين على التنظيم والتحكم وتوفير وقت المسئوليات المدرسية.	-10
1	2	3	4	5	تكنولوجيا المعلومات والإتصالات يخنق الإبداع بين الطلاب.	-11
1	2	3	4	5	إستخدام تكنولوجيا المعلومات والإتصالات يوفر للمعلمين والطلاب طرق جديدة لتعلم الرياضيات مثل تقديم حلول عديدة لحل المسائل والبحث والمناقشة الرياضيه.	-12
1	2	3	4	5	تكنولوجيا المعلومات والإتصالات يمكن أن يدعم تنوع الطرق التى يكون الطلاب من خلالها معارفهم ومهاراتهم.	-13
1	2	3	4	5	االإحباطات الناتجة عن إستخدام تكنولوجيا المعلومات والإتصالات تتسبب في متاعب أكثر مما تستحق.	-14
1	2	3	4	5	يحتاج معلمي الكليات إلى معرفة كيفية أستخدام وتوظيف(دمج) تكنولوجيا المعلومات والإتصالات كوسائل تعلمية.	-15
1	2	3	4	5	تعلم كيفية إستخدام تكنولوجيا المعلومات والإتصالات ممل بالنبسة لي.	-16
1	2	3	4	5	أشعر بالراحة لإستخدام تكنولوجيا المعلومات والإتصالات.	-17
1	2	3	4	5	إستخدام تكنولوجيا المعلومات والإتصالات يجعلني أشعر بالتوتر وعدم الراحه.	-18

الرقم	العبارة	موافق بشدة	موافق	متردد	معارض	معارض بشدة
-19	إستخدام تكنولوجيا المعلومات والإتصالات سوف يؤثر بصورة سلبية على مهارتي التدريسية.	5	4	3	2	1
-20	أعتقد بأنني قادر على التدريس بإستخدام تكنولوجيا المعلومات والإتصالات.	5	4	3	2	1
-21	أود أن أتعلم إستخدام تكنولوجيا المعلومات والإتصالات في تدريسي.	5	4	3	2	1
-22	التعلم أكثر عن كيفية توظيف(دمج) تكنولوجيا المعلومات والإتصالات في التدريس شيء جدير بالإهتمام.	5	4	3	2	1
-23	كل المعلمين يجب أن يستخدموا تكنولوجيا المعلومات والإتصالات.	5	4	3	2	1
-24	إستخدام تكنولوجيا المعلومات والإتصالات في المدارس سوف يؤثر على الإتجاهات السلبية للطلاب نحو التعلم.	5	4	3	2	1

مرة أخري شكرا لمشاركتك ☺

Appendix F

Beliefs Interview Questions

(English and Arabic Version)

1- How would you describe mathematics?
2- In your opinion, how mathematical concepts (e.g. computation, geometry, algebra, etc.) are best learned?
3- How do you think mathematics should be taught?
4- What do you think about the use of logo as an ICT tool for the teaching and learning of mathematics?
5- In your opinion, what do you consider to be the advantage / disadvantage of the use of Logo in teaching and learning mathematics?
6- What do you think about the use of ICT for teaching and learning mathematics?
7- You may still recall some memories about one or more mathematics teachers, what was so special about him / her?
8- Is there anything you would like to talk about that we have not covered?

1- كيف تصف الرياضيات؟

2- في رأيك، كيف يمكن تعلم مفاهيم الرياضيات (مثل الحساب، الهندسة، الجبر الخ) بصورة أفضل؟

3- في رأيك، كيف يجب تعليم الرياضيات؟

4- ما هو رأيك في استخدام اللوجو كإحدى أدوات تكنولوجيا المعلومات والإتصالات في تعليم وتعلم الرياضيات؟

5- في رأيك، ما هي مميزات وعيوب استخدام اللوجو في تعليم وتعلم الرياضيات؟

6- ما هو رأيك في استخدام تكنولوجيا المعلومات والإتصالات في تعليم وتعلم الرياضيات؟

7- ربما تستطيع استدعاء بعض الذكريات عن واحد أو أكثر من معلمي الرياضيات، بماذا كان يتميز/ تتميز؟

8- هل هناك ما تود أن تضيفه ولم يتم التطرق إليه اثناء المقابلة؟

Appendix G

The Logo Module
(English and Arabic Version)

The Logo Module Sessions

<u>First session</u>: Welcome Meeting and Administration of the pre-test Beliefs Questionnaire

Objectives of this session are to

Introduce the researcher to student-teachers.

1- Inform student-teachers that during their participation in this research study they will do mathematical Logo-based activities and the researcher is not here to assess them and there will be no affect on their course grades.
2- Answer the pre-test questionnaire.

Activities and procedures

1- Welcome student-teachers and introduce the researcher.
2- Ask students to introduce themselves.
3- Explain to the student-teachers the purpose for the researcher being with them and for how long.
4- Inform the student-teachers that any mathematical activities they will practise during the study will not be considered as an assessment for their knowledge or for the course grades but it is for the purpose of the research.
5- Ask student-teachers to feel free to ask questions for any clarification they would be concern about.
6- Administer the consent form and ask the student-teachers to read it clearly then sign it.
7- Administer the pre-test questionnaire, ask student-teachers to answer the questions and to feel free to ask questions for clarification.
8- Collect the questionnaires.
9- Discuss with the student-teachers about the next session's topic.

10- End the session, thanking the student-teachers.

Introduction to Logo programming Language

<u>Second Session:</u> Starting MSLogo and Getting Comfortable

Objectives of this session are to

1- Identify the Logo program interface.

2- Learn the main Logo commands and its use.

3- Depict and draw simple shapes using Logo commands.

Materials

1- Computer lab.

2- Logo programming language software.

3- Logo hands-on practice instruction worksheet.

Logo hands-on practice instruction worksheet activities

1- Turn on your PC.

2- To start the program, double-click on logo shortcut icon on desktop.

3- You are in logo program window.

4- Viewing and identifying the Logo window components.

Entering Logo Commands

A Commands is word or its abbreviation you type (enter) in the **Input Box** as a request for the turtle to perform an action.

- Enter the following commands in the **Input Box**. After each command press the **Enter key.**

fd 100

Right 90

Forward 40

Bk 80

Fd 40

LT 270

rt 360

fd 100

Ht

- What have you drawn on the screen?
- What do the commands FD, rt, Bk, LT and Ht symbolize for?
    - Enter the following command CS to clear the screen and to start over.
    - Enter the following command st to show the turtle. Now draw a letter you like.
    - Enter CS.
    - Look at the next commands and guess what it will draw.

fd 50 rt 90 fd 100 rt 90 fd 50 rt 90 fd 100 rt 90

- Enter the commands in the **Input Box** to check your guess.
    - Look at the next commands and guess what it will draw.

CS

fd 50 rt 90

fd 50 rt 90

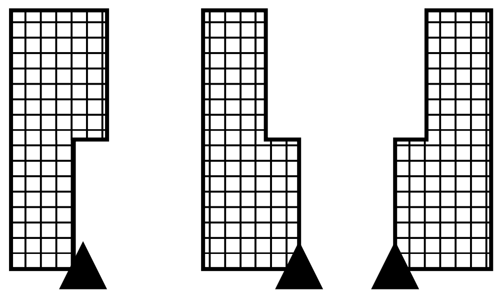
fd 50 rt 90

fd 50 rt 90

- Enter the commands in the **Input Box** to check your guess.

➢ Look at the shapes below; write the commands that draw each shape.

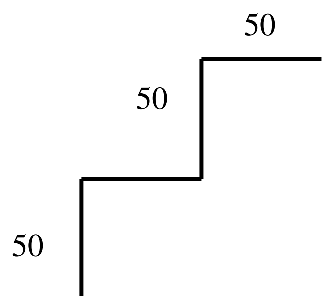
(Note the dark triangle is the starting point and the grid unit is 20*20).



A B C

- Shape A:
- Shape B:
- Shape C:
- Enter the commands in the **Input Box** to check your answers.

➢ Enter cs, then write the commands to draw the following shape.



➢ Enter the following commands in the **Input Box.**

lt 30 fd 100 lt 120 fd 100 lt 120 fd 100 lt 90

➢ Enter the following commands in the **Input Box.**

lt 30 fd 200 lt 120 fd 200 lt 120 fd 200 lt 90

- Compare the second commands with the first one.
- What change commands one have on the first shape?
- What this mean to you in relation to the shape size and angle size?

Home command

- Home is a logo command that sends the turtle to home position but leaves the drawing as it is.
- Enter Cs; then enter the following commands in the **Input Box.** After each command press the **Enter key.**

rt 30

fd 100 rt 120

fd 100 rt 120

Home

Close the Logo program and shut down your computer

Introduction to Logo programming Language

<u>Third Session:</u> Continue Starting MSLogo and Getting Comfortable

Objectives of this session are to

1- Learn how to change the screen background colour and turtle pen colour.

2- Control the turtle pen (lift up and put down the turtle pen).

3- Learn how to fill-in an enclosed space with the preferred colour.

Materials

1- Computer lab.

2- Logo programming language software.

3- Logo hands-on practice instruction worksheet.

Logo hands-on practice instruction worksheet activities

1- Turn on your PC.

2- To start the program, double-click on logo shortcut icon  on desktop.

3- You are in logo program window.

Changing screen background colour and pen colour.

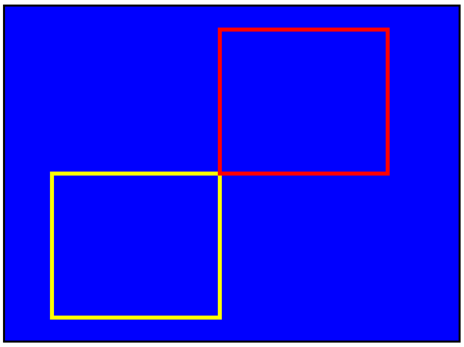
- Use **setscreencolour** or its abbreviation **setsc** followed by the colour code (e.g. setsc 1 to change the background colour to Blue).
- Use **setpencolour** or its abbreviation **setpc** followed by the colour code (e.g. **setpc** 6 to change the pen colour to Yellow).

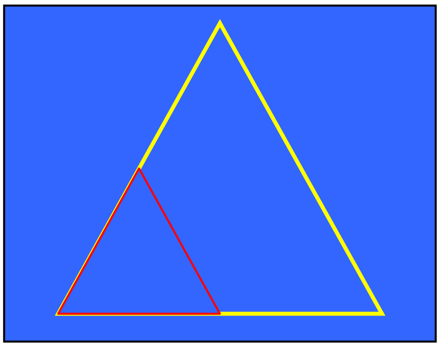
Colours codes

Colour	Code
Black	0
Blue	1
Green	2
Cyan	3
Red	4
Magenta	5

Colour	Code
Yellow	6
White	7
Brown	8
Light brown	9
Mid- green	10
Blue-green	11
Salmon	12
Blue-ish	13
Orange	14
Silver	15

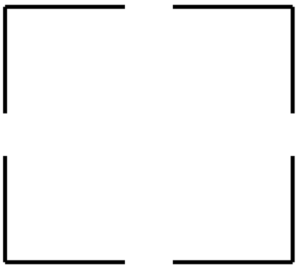
- Enter cs, then write the commands to draw the following shapes





Control the turtle pen

- **Penup** or its abbreviation **pu** lifts the turtle's pen so it will not draw when moving.
- **Pendown** or its abbreviation **pd** puts the turtle's pen down so it will draw when moving.
- Enter cs, then write the commands to draw the following shapes



Filling an enclosed space with colour

- Use **setfloodcolor** or its abbreviation **setfc** to set the flood colour and **fill** to fill-in the shape with flood colour.

- Now use the following commands.

Setfc 1	to set the flood colour to blue
Fd 100 rt 120 fd 100 rt 120 fd 100	to draw the shape
Pu rt 150 fd 40	to lift the pen and move the turtle part-way inside the shape
Fill	to fill the shape with flood colour.

Command	Abbreviation	Action
Forward	Fd	Moves the turtle forward.
Backward	Bk	Moves the turtle backward.
Right	Rt	Makes the turtle turn to the right.
Left	Lt	Makes the turtle turn to the left.
Clearscreen	Cs	Clears the screen of all constructions; as well as, repositions the turtle in the center of the screen.
Hideturtle	Ht	Hides the turtle.
Showturtle	St	Shows the turtle.
Setscreencolour	Setsc	Sets screen background colour.
Setspencolour	Setpc	Sets pen colour.
Penup	Pu	Lifts the turtle's pen so it will not draw when moving.
Pendown	Pd	Puts the turtle's pen down so it will draw when moving.
Penerase	Pe	Puts the turtle's down and mode to erase so it erases any line it crosses.
Penreverse	Px	Puts the turtle's down and mode to reverse to restore the pen to normal use.
Home	Home	Sends the turtle to home position but leaves the drawing as it is.

- Logo also knows mathematical operations so that instead of entering an integer value, mathematical operations can be used (eg. fd 10 + 6/2 * 3 or bk sqrt 25).
- Logo is not case sensitive (You can type in uppercase or lowercase letters).

Close the Logo program and shut down your computer.

Introduction to Logo programming Language

<u>Fourth Session:</u> Exploring Logo REPEAT Command

Objectives of this session are to

1- Learn how to use the REPEAT command.

2- Learn how to draw a shape with REPEAT command.

3- Learn how to read and depict a shape from REPEAT command.

Materials

1- Computer lab.

2- Logo programming language software.

3- Logo hands-on practice instruction worksheet.

Logo hands-on practice instruction worksheet activities

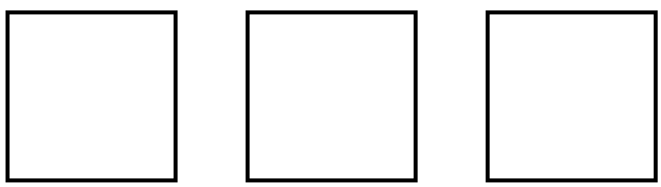
1- Turn on your PC.

2- To start the program, double-click on logo shortcut icon on desktop.

3- You are in logo program window.

REPEAT command

- Enter Cs; then write the commands to draw the following shape (start with shape A then B and C).



A B C

- Enter the following commands in the **Input Box** three times.

  fd 30 rt 90 fd 30 rt 90 fd 30 lt 90 fd 30 lt 90

  - Because you have entered the same command three times you have had three bumps.

- You can reduce this sequence to a single line by using the REPEAT command.

Repeat is a logo command that makes the turtle repeats the command in brackets several times. It takes two inputs: number of repetitions **N** and the **commands** in brackets. Repeat **N** [**commands**].

- Enter the following command and see what happen.

  Repeat 3 [fd 30 rt 90 fd 30 rt 90 fd 30 lt 90 fd 30 lt 90]
- Change number of repetition to 5 and see what will happen.
- Enter the following command and see what will happen.

  Repeat 4 [fd 100 rt 90]
- Since the turtles makes N number of repeated turns for N-sides, the size of each turn in 360/N degree (e.g. Repeat N [fd 100 rt 360/N]).
- Enter cs and try this Repeat 4 [fd 100 rt 360/4]

Look at the next commands and guess what it will draw.

Repeat 8 [fd 100 rt 45]

Enter the commands in the **Input Box** to check your guess.

Close the Logo program and shut down your computer.

Introduction to Logo programming Language

<u>Fifth Session:</u> Writing Logo PROCEDURE Saving and Opening a Predefined Procedure.

Objectives of this session are to

1- Define the Logo PROCEDURE and it components.
2- Learn writing Logo PROCEDURE.
3- Learn saving Logo PROCEDURE.
4- Learn opening predefined Logo PROCEDURE

Materials

1- Computer lab.
2- Logo programming language software.
3- Logo hands-on practice instruction worksheet.

Logo hands-on practice instruction worksheet activities

Logo procedures

- Procedures are Logo's features that allow you to execute multiple commands as a single command. It also allows you to teach logo new words by assigning a name to the procedure you define.
- A procedure has three parts:
  1- It begins with word **to** and is followed by the name you give to the procedure (try to choose names that are descriptive and do not use the same name two times).
  2- The main body where you write the commands; and
  3- It ends with up with the word end.
- To write a procedure you need to access the Editor Window.

➢ Enter edit "Triangle in the **Input Box** and press the enter key**.**

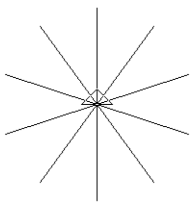
- You are in Editor Window.
- Now you can type in a new procedure (The **to,** procedure name **Triangle** and **end** are already entered for you).

  to Triangle

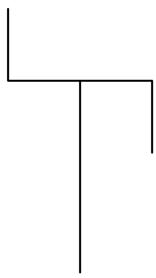
  repeat 3 [fd 100 rt 120]   (the main body to be typed)

  end
- Select Save and Exit from file menu to save the procedure and exit the editor window.
- Now logo knows how to draw a Triangle when ever you want, all you need to do is typing the word Triangle in the **Input Box**. Try it.

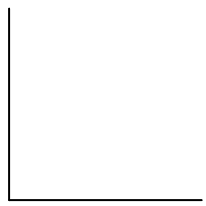
➢ Now write a procedure to draw the following shapes:



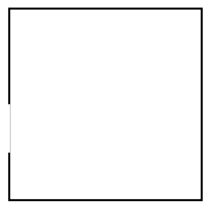
Spokes



Swing



Angle



Square

Saving procedure

- Select **Save** from file menu on the Logo program window.
- Select the Disk or Directory where the file to be saved from the Dialog Box.
- Write the file name and click on save.
- Now save the Square procedure on the desktop.

Opening procedure

- Select Load from file menu on the Logo program window.

- Select the Disk or Directory from which the files need to be loaded from the Dialog Box and click on Open.
- Try to open the Square file.
- Now write a procedure to draw a square with size 200 i.e. fd 200.

Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.

Introduction to Logo programming Language

<u>Sixth Session:</u> Exploring using Variables

Objectives of this session are to:

1- Learn about variables.

2- Define and use single variable.

3- Define and use more than one variable.

Materials:

1. Computer lab.
2. Logo programming language software.
3. Logo hands-on practice instruction worksheet.

Logo hands-on practice instruction worksheet activities

1- Turn on your PC.

2- To start the program, double-click on logo shortcut icon  on desktop.

3- You are in logo program window.

Defining and using Variables

- Open the Square file.
- Write a procedure to draw a square with size 200 i.e. fd 200.

You just wrote two Square procedures with different values for the length of the sides. Instead of rewriting new procedure commands each time, you can do it easily using variables so that different values can be substituted into the procedure commands.

- Now access the Editor window (use ed “Square command).
- Change the procedure commands to:

  to Square :Size (The colon **:** denotes the variable named Size).

  repeat 4 [fd :Size rt 90]

end

- Save the procedure and type the word Square 100 in the **Input Box** and see what will happen.
- Since Size is a variable, you can change its value any time you like.
- Try to use different values and see what will happen (do not use Cs).
- Open the Angle file.
- Change the procedure command, include a variable to draw an angle with different size as following:

  To Angle :degree

  Cs fd 100 home rt :degree fd 100 home

  End

  Or

  To Angle :degree

  cs rt 90 fd 100 bk 100 lt :degree fd 100 home

  End
- Use the procedure to explore the shape of the following angles: 30, 235 and 360.
- Now explore other angles shape.

Defining and using more than one variable

Logo allows you to use more than one variable in a procedure. For example, in a rectangle you have two numbers to change length and width therefore you need to define and use two variables.

- ➢ Write the following procedure to draw a rectangle

  to Rectangle :Width :Length

  repeat 2 [fd :Width rt 90 :Length fd rt 90]

end

- Use variables to write a procedure to draw polygon as following:

  to Polygon :length :sides

  repeat :sides [fd :length rt 360/:sides]

  end

  - Type the following command polygon 4 100 Input **Box** and see what will happen.
  - Now explore different polygons.

Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.

Introduction to Logo programming Language

<u>Seventh Session:</u> Superprocedure and subprocedure

Objectives of this session are to

1- Learn about Superprocedure and subprocedure

2- Define and use Superprocedure and subprocedure

Materials

1- Computer lab.

2- Logo programming language software.

3- Logo hands-on practice instruction worksheet.

Logo hands-on practice instruction worksheet activities

1- Turn on your PC.

2- To start the program, double-click on logo shortcut icon  on desktop.

3- You are in logo program window.

Superprocedure

A procedure that was never called by any other procedure.

Subprocedure

A procedure that has been called by another procedure.

- Now you can use the **Square** procedure as a sub-procedure within the super-procedure **Bricks** as following:

  to **Bricks** :size

  repeat 4 [**Square** :size rt 90 fd :size lt 90]

  end

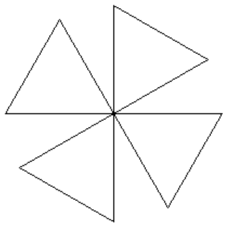
- Write the following procedure to draw a triangle

  to **Triangle**

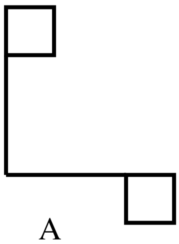
  repeat 3 [fd 100 rt 120]

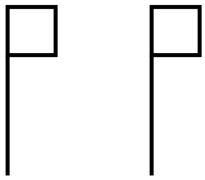
end

➢ Write a super-procedure **Rotate** that uses **Triangle** as sub-procedure to draw the following shape:



Write a super-procedures to draw the following shapes:





A B

Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.

Introduction to Logo programming Language

<u>Eighth Session:</u> Using Coordinate notation and drawing a Circle

Objectives of this session are to

1- Learn about coordinate notation.

2- Use the coordinate notation commands

3- Write procedure to draw a circle.

4- Use “circle” command.

Materials

1- Computer lab.

2- Logo programming language software.

3- Logo hands-on practice instruction worksheet.

Logo hands-on practice instruction worksheet activities

1- Turn on your PC.

2- To start the program, double-click on logo shortcut icon  on desktop.

3- You are in logo program window.

Using Coordinate notation

Logo allows you to move the turtle to an absolute X and Y coordinate location on the screen by using the **SETXY or SETPOS** commands. The absolute move is related to the cartesian geometry and allows you to draw shapes using the X and Y coordinate notation.

- Type the following commands **Input Box** and see what will happen

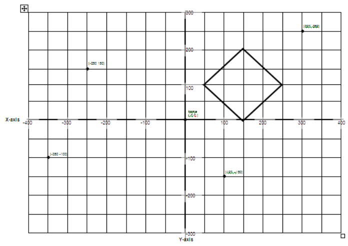
  Setxy 0   100   (You can also use Setpos [0   100])

  Setxy 200   100

  Setxy 200   0

  Setxy 0 0

➢ Write a command to draw the following (Note: the grid unit is 50*50).



Drawing a Circle

You can draw a circle using repeat command or circle commands.

➢ Write the following procedure

To Circle

repeat 360 [fd 1 rt 1]

end

- Type the following command Circle Input **Box** and see what will happen.

➢ You also can use **circle** or **circle2** commands to draw a circle with a size based on the radius.

➢ Type the following command and see what will happen (do not use cs).

Circle 100

Circle2 100

Command	Abbreviation	Action
Setxy *xcor ycor* or Setxy [*xcor ycor*]	-	Moves the turtle to an absolute X and Y coordinate.
Setpos [*xcor ycor*]		Moves the turtle to an absolute X and Y coordinate.
Setx *xcor*	-	Moves the turtle to an absolute X coordinate.
Sety *ycor*	-	Moves the turtle to an absolute Y coordinate.
Setheading	Seth	Sets the turtle's heading in degrees (0 is up).

Command	Abbreviation	Action
Setxyz *xcor ycor zcor*	-	Moves the turtle to an absolute 3D position.
Pos or Getxy	-	Outputs the turtle's current X and Y position.
Xcor	-	Outputs the turtle's current X position.
Ycor	-	Outputs the turtle's current Y position.
Zcor	-	Outputs the turtle's current Y position.
Circle *radius*	-	Draws a circle based on the turtle's position, the current turtle position will be at the **center** of the circle. The circle size is based on the radius
Circle2 *radius*	-	Draws a circle based on the turtle's position, the current turtle position will be at the **edge** of the circle. The circle size is based on the radius
Stampoval *radius* r*adius* *(horizontal radius and vertical radius)*	-	Draws an oval or circle based on the turtle's position, the current turtle position will be at the **center** of the oval. It draws circle if the two inputs are equal.

Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.

Introduction to Logo programming Language

Ninth Session: Exploring Recursion

Objectives of this session are to

1- Learn about recursion technique.

2- Use recursion technique.

3- Print images and procedures.

Materials

1- Computer lab.

2- Logo programming language software.

3- Logo hands-on practice instruction worksheet.

Logo hands-on practice instruction worksheet activities

1- Turn on your PC.

2- To start the program, double-click on logo shortcut icon  on desktop.

3- You are in logo program window.

Recursion

Recursion is one of logo's powerful method in which a procedure calls itself to obtain a repeated event. It is an efficient technique to use when the amount of repetition is uncertain, yet it is vital that a recursion has a STOP condition to detect when the required outcome is reached otherwise it will run on forever.

- You can write the square procedure by using recursion as following

```
to Square :Size
repeat 4 [ fd :Size rt 90]
Square :size             (The procedure Square calling itself)
end
```

- Type the following command Square 100 Input **Box** and see what will happen. (use Halt and Reset to stop the procedure and restore the turtle position)

➢ Now you can use the **stop** command within the Square procedure to draw different sizes of squares as the following:

to Square :size

if :size > 100 [stop]

repeat 4 [fd :size rt 90]

Square :size + 10

end

➢ Write the Spiral procedure as following.

to Spiral :size

if :size > 30 [stop]

fd :size rt 15

Spiral :size + 0.1

end

- Type Spiral 0.5 and see what will happen.
- Type Spiral 40 and see what will happen.

Printing images and procedures

➢ Choose **Print** from the Bitmap menu in Logo program window to print the images you have created on the drawing area.

➢ Choose **Print** from the File menu in the Editor window to print the procedures you have defined.

In PC Logo for windows do the following

➢ Choose Print from the file menu or click on Print button.

- Select from the dialogue the following
    - Select Graphics to Print the images you have created on the drawing area; or

Open the Editor window, choose Print, and select Editor to print the procedures you have defined.

Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.

مقرر اللوجو

<u>المحاضرة الأولى:</u> اللقاء والترحيب بالطلبة و توزيع الإستبيان القبلي

الأهداف

1- تعريف الطلبة بالباحث.

2- تعريف الطلبة ببرنامج البحث.

3- الإجابة على أسئلة الإستبانة قبل بداية البحث.

الأنشطة و الإجراءات

1- الترحيب بالطلبة المشاركين في البحث وتعريفهم بالباحث.

2- تعرف الباحث على الطلبة المشاركين (الطب من المشاركين تقديم أنفسهم للباحث).

3- التويضح للطلبة الهدف من وجود الباحث معهم ومدة البحث.

4- التوضيح للطلبة بأن التدريبات الرياضية التي سوف يتم تنفيذها خلال مدة البحث لا تعتبر كتقييم لمستوى المعرفة ولا تحسب من درجات مقرر طرق تدريس الرياضيات وإنما هي خاصه بالبحث.

5- توزيع نموذج الموافقة على المشاركة في البحث على الطلبة، ومن ثم الطلب منهم قراءة النموذج بتمعن والتوقيع علىة في حال الرغبة في المشاركة.

6- توزيع الإستيبان القبليه على الطلبة للإجابة عليها وتشجيعهم علىعدم التردد في الإستفسار عن أي سؤال غير واضح.

7- جمع الإستبانة.

8- التوضيح للطلبة محتوي المحاضرة القادمة.

9- تقديم الشكر للطلبة على مشاركتهم في البحث.

مقدمة في برنامج اللوجو

<u>المحاضرة الثانية:</u> إستخدام برنامج اللوجو

الأهداف

1- التعرف على مناطق نافذة البرنامج.

2- التعرف على الأوامر الأساسية للبرنامج وإستخداماتها.

3- تمثيل ورسم الأشكال بإستخدام الأوامر.

الأدوات

1- مختبر الحاسوب.

2- برنامج اللوجو.

3- ورقة عمل.

تطبيقات ورقة العمل

1- قم بتشغيل جهاز الكمبيوتر.

2- اضغط مرتين على أيقونة الإختصار  الخاصة ببرنامج اللوجو الموجودة على سطح المكتب لتشغيل برنامج اللوجو.

3- أمامك نافذة برنامج اللوجو.

4- تعرف على مكونات نافذة البرنامج.

استخدام أوامر برنامج اللوجو

الأوامر عبارة عن كلمة أو إختصارها يتم كتابتها في منطقة كتابة الأوامر "Input Box" حيث من خلالها يطلب من السلحف تنفيذ عمل محدد.

أكتب الأوامر التالية في منطقة كتابة الأوامر "Input Box" اضغط مفتاح الإدخال "Enter" بعد الإنتهاء من كتابة الأمر.

fd 100

Right 90

Forward 40

Bk 80

Fd 40

LT 270

rt 360

fd 100

Ht

- ما هو الشكل الذي قمت برسمه؟
- ما الذي تعبر عنه كل من الأوامر التالية FD ، rt ، BK ، LT ، و Ht ؟

أكتب الأمر التالى CS لمسح منطقة الرسومات وتهيئة البرنامج للبدء من جديد.

أكتب الأمر التالى st لإظهار السلحف. ارسم الآن الحرف الذي تفضله.

أنظر الى الأوامر التالية ومن ثم خمن الشكل الذي تمثله.

fd 50 rt 90 fd 100 rt 90 fd 50 rt 90 fd 100 rt 90

- أكتب الأوامر في منطقة كتابة الأوامر "Input Box" للتحقق من تخمينك.

أنظر الى الأوامر التالية ومن ثم خمن الشكل الذي تمثله.

CS

fd 50 rt 90

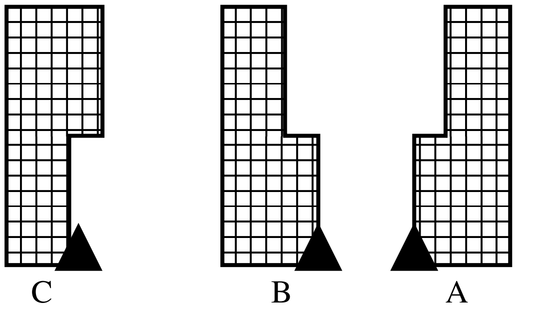
fd 50 rt 90

fd 50 rt 90

fd 50 rt 90

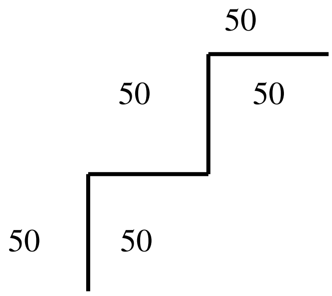
- أكتب الأوامر في منطقة كتابة الأوامر "Input Box" للتحقق من تخمينك.

أنظر الى الأشكال التالية، أكتب الأوامر المناسبة لرسم كل شكل (الشكل المثلث يمثل نقطة البداية، ابعاد الرسم هي 20*20).



- الشكل A:
- الشكل B:
- الشكل C:
- أكتب الأوامر في منطقة كتابة الأوامر "Input Box" للتحقق من إجابتك.

أكتب الأمر cs، ومن ثم أكتب الأوامر لرسم الشكل التالي:



أكتب الأوامر في منطقة كتابة الأوامر "Input Box".

lt 30 fd 100 lt 120 fd 100 lt 120 fd 100 lt 90

أكتب الأوامر في منطقة كتابة الأوامر "Input Box".

lt 30 fd 200 lt 120 fd 200 lt 120 fd 200 lt 90

- قارن بين الأوامر في كل من الخطوتين.
- ما التغيير الذي أحدثه الأوامر الثانية على الشكل الأول.

الأمر Home

الأمر Home يقوم بإعادة السلحف الى موقعه الأصلي مع الإبقاء على الرسم.

أكتب الأمر cs ومن ثم أكتب الأوامر التالية في منطقة كتابة الأوامر "Input Box". اضغط مفتاح الإدخال "Enter" بعد كل أمر.

```
rt 30
fd 100 rt  120
fd 100 rt 120
Home
```

أغلق نافذة البرنامج، ومن ثم قم بإغلاق جهاز الكمبيوتر.

مقدمة في برنامج اللوجو

المحاضرة الثالثة: تابع إستخدام برنامج اللوجو

الأهداف

1- تعلم كيفية تغيير خلفية نافذة البرنامج وقلم الرسم

2- التحكم في قلم السلحف (رفع و إنزال قلم السلحف).

3- تعلم كيفية ملء الأشكال المغلقة باللون المفضل.

الأدوات

1- مختبر الحاسوب.

2- برنامج اللوجو.

3- ورقة عمل.

تطبيقات ورقة العمل

1- قم بتشغيل جهاز الكمبيوتر.

2- اضغط مرتين على أيقونة الإختصار  الخاصة ببرنامج اللوجو الموجودة على سطح المكتب لتشغيل برنامج اللوجو.

3- أمامك نافذة برنامج اللوجو.

تغيير لون منطقة الرسم و قلم الرسم

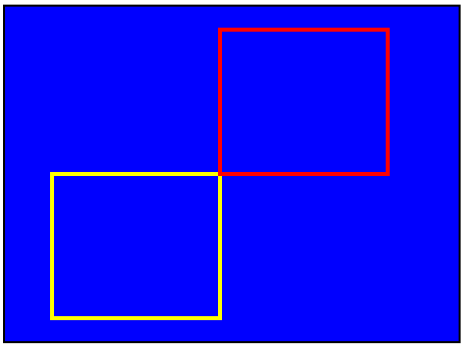
- إستخدم الأمر **setscreencolour** أو اختصار الأمر **setsc** متبوع بالرمز الدال على اللون المطلوب (مثال : setsc 1 لتغيير لون منطقة الرسم الى اللون الأزرق).
- إستخدم الأمر **setpencolour** أو اختصار الأمر **setpc** متبوع بالرمز الدال على اللون المطلوب (مثال : **setpc** 6 لتغيير لون قلم الرسم الى اللون الأصفر).

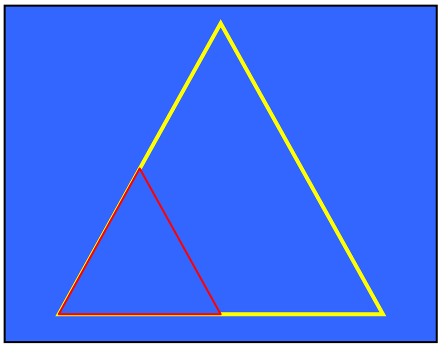
للتعرف على رموز الألون، استخدم الجدول التالي:

Colour	Code
Black	0
Blue	1
Green	2
Cyan	3
Red	4
Magenta	5
Yellow	6
White	7

Colour	Code
Brown	8
Light brown	9
Mid- green	10
Blue-green	11
Salmon	12
Blue-ish	13
Orange	14
Silver	15

إستخدم الأمر **CS** ومن ثم أكتب الأوامر المناسبة لرسم الشكل التالي:

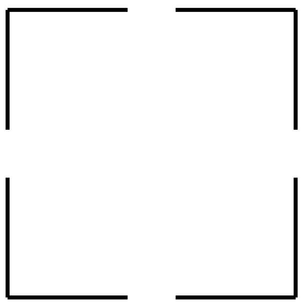




التحكم في قلم السلحف للرسم

- إستخدم الأمر **penup** أو اختصار الأمر **pu** لرفع قلم السلحف لإيقاف رسم الأشكال عند تحريك السلحف.
- إستخدم الأمر **pendown** أو اختصار الأمر **pd** لإنزال قلم السلحف ورسم الأشكال عند تحريك السلحف.

إستخدم الأمر CS، ومن ثم أكتب الأوامر اللا زمة لرسم الشكل التالي:



ملء الأشكال (الرسوم) المغلقة بالألوان

- إستخدم الأمر **setfloodcolour** أو اختصار الأمر **setfc** لتفعيل أمر ملء اللون ومن ثم إستخدم الأمر **fill** لملء الشكل المغلق باللون المرغوب.

- أكتب الأوامر التالية في منطقة كتابة الأوامر:

Setfc 1	لتفعيل أمر ملء اللون الى اللون الأزرق.
Fd 100 rt 120 fd 100 rt 120 fd 100	لرسم الشكل المطلوب.
Pu rt 150 fd 40	لرفع قلم الرسم وتحريك السلحف الى داخل الشكل.
Fill	لملء الشكل المغلق باللون المرغوب.

الوظيفة	الإختصار	الأمر
تحريك السلحف إلى الأمام.	Fd	Forward
تحريك السلحف إلى الخلف.	Bk	Backward
تغيير إتجاه السلحف إلى جهة اليمين.	Rt	Right
تغيير إتجاه السلحف إلى جهة اليسار.	Lt	Left
مسح الأشكال المرسومة مع إعادة السلحفاة الى موضعه الأصلي.	Cs	Clearscreen
لإخفاء السلحف.	Ht	Hideturtle
لإظهار السلحف.	St	Showturtle
تفعيل أمر تغيير لون منطقة الرسم.	Setsc	Setscreencolour
تفعيل أمر تغيير لون قلم الرسم.	Setpc	Setspencolour
رفع قلم السلحف لإيقاف رسم الأشكال عند تحريك السلحف.	Pu	Penup
إنزال قلم السلحف لرسم الأشكال عند تحريك السلحف.	Pd	Pendown
تفعيل قلم السلحف وتحويله الى ممحاه.	Pe	Penerase
إستعادة السلحف للوضع ما قبل المسح.	Px	Penreverse
إعادة السلحف إلى الموقع موضعه الأصلي راسما خط العودة دون مسح الرسم.	Home	Home

- يتوفر في برنامج اللوجو خاصية إستخدام العمليات الحسابية كأوامر بديلة للأرقام

(مثال: fd 10 + 6/2 * 3 أو bk sqrt 25).

- يتيح برنامج اللوجو خاصية كتابة الأوامر بإستخدام الأحرف الكبيرة أو الأحرف الصغيرة دون تمييز بينها.

أغلق نافذة البرنامج، ومن ثم قم بإغلاق جهاز الكمبيوتر.

مقدمة في برنامج اللوجو

المحاضرة الرابعة: استخدام الأمر REPEAT

الأهداف

1- تعلم استخدام الأمر REPEAT.

2- تعلم رسم الأشكال بإستخدام الأمر REPEAT.

3- تعلم كيفية ورسم الأشكال بعد قراءة الأمر REPEAT.

الأدوات

مختبر الحاسوب.

برنامج اللوجو.

ورقة عمل.

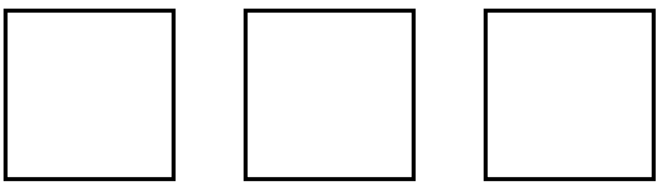
تطبيقات ورقة العمل

قم بتشغيل جهاز الكمبيوتر.

اضغط مرتين على أيقونة الإختصار الخاصة ببرنامج اللوجو الموجودة على سطح المكتب لتشغيل برنامج اللوجو.

استخدام الأمر REPEAT

- استخدم الأمر CS، أكتب الأوامر المناسبة لرسم الأشكال التالية (إبدأ بالشكل أ ثم ب ثم ج)



أ   ب   ج

- أكتب الأوامر التالية في منطقة كتابة الأوامر "Input Box" ثلاث مرات.

fd 30 rt 90 fd 30 rt 90 fd 30 lt 90 fd 30 lt 90

- نظراً لكتابة نفس الأمر ثلاث مرات تم تكرار رسم الشكل ثلاث مرات.
- يمكن إختصار تكرار كتابة نفس الأمر وذلك بإستخدام الأمر **REPEAT** .

- الأمر **REPEAT** هو أحد الأوامر المستخدمة في برنامج اللوجو لتكرار الأوامر بين الأقواس المربعة عدة مرات. يستخدم الأمر **REPEAT** المعطيات التالية: عدد مرات التكرار **N** والأوامر ما بين الأقواس المربعة المطلوب تكرارها. Repeat **N** [**commands**].

أكتب الأمر التالى في منطقة كتابة الأوامر ومن ثم لاحظ ماذا يحدث.

Repeat 3 [fd 30 rt 90 fd 30 rt 90 fd 30 lt 90 fd 30 lt 90]

قم بتغيير عدد مرات التكرار الى 5، ومن ثم لاحظ ما يحدث.

أكتب الأمر التالى في منطقة كتابة الأوامر ومن ثم لاحظ ما يحدث.

Repeat 4 [fd 100 rt 90]

بما أن عدد مرات التكرار **N**، فإنه يمكن قياس زاوية الدوران الداخلية لأي شكل مغلق بإجراء العملية الحسابية التالية 360/N (مثال: Repeat N [fd 100 rt 360/N]).

- أكتب الأمر CS، ومن ثم أكتب الأمر التالى:

Repeat 4 [fd 100 rt 360/4]

أنظر الى الأمر التالى ومن ثم خمن الشكل الذي يمثله.

Repeat 8 [fd 100 rt 45]

- قم بكتابة الأمر في منطقة كتابة الأوامر ”Input Box“ للتحقق من تخمينك.

أغلق نافذة البرنامج، ومن ثم قم بإغلاق جهاز الكمبيوتر.

مقدمة في برنامج اللوجو

<u>المحاضرة الخامسة:</u> كتابة البرامج (الإجراءات) Procedures وحفظ و فتح برنامج سبق حفظه

الأهداف

1- تعريف البرامج (الإجراءات) Procedures ومكوناته.

2- تعلم كيفية كتابة (الإجراءات) Procedures لبرنامج اللوجو.

3- تعلم كيفية حفظ (الإجراءات) Procedures لبرنامج اللوجو.

4- تعلم كيفية فتح (الإجراءات) Procedures التي سبق حفظها لبرنامج اللوجو.

الأدوات

1- مختبر الحاسوب.

2- برنامج اللوجو.

3- ورقة عمل.

تطبيقات ورقة العمل

1- قم بتشغيل جهاز الكمبيوتر.

2- اضغط مرتين على أيقونة الإختصار  الخاصة ببرنامج اللوجو الموجودة على سطح المكتب لتشغيل برنامج اللوجو.

كتابة البرامج (الإجراءات) اللوجو Writing Logo procedure

أحد مميزات برنامج اللوجو هو كتابة البرامج التي تتيح للمستخدم تنفيذ مجموعة من الأوامر بإستخدام أمر واحد يمثل إسم البرنامج.

- يتكون البرنامج من ثلاث اجزاء:

  1- يبدأ البرنامج بكلمة To متبوع باسم البرنامج (يفضل إختيار أسم يصف ما يقوم البرنامج بتنفيذه).

  2- الجزء الخاص بكتابة الأوامر.

  3- ينتهي البرنامج بكلمة End.

- تستخدم نافذة Editor لكتابة البرنامج.

اكتب Edit "Triangle في منطقة كتابة الأوامر، ثم اضغط على مفتاح إدخال "Enter" أو اضغط على الأمر Edall من نافذة الأوامر Commander .

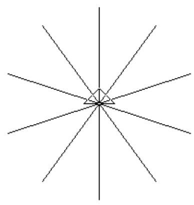
- أنت الآن في نافذة Editor.
- يمكنك الآن كتابة برنامج بإسم Triangle كما هو مبين من إسم البرنامج كالتالى.

```
to Triangle
repeat 3 [ fd 100 rt 120 ]
end
```

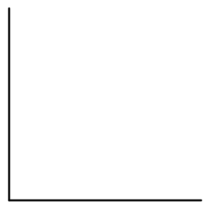
(الجزء الخاص بكتابة الأوامر)

- اختر الأمر "Save and Exit" من قائمة File لحفظ البرنامج واغلاق نافذة Editor.
- يمكن لبرنامج اللوجو رسم مثلث Triangle متى شئت، فقط أكتب كلمة Triangle في منطقة كتابة الأوامر. جرب ذلك.

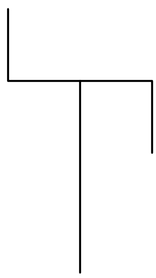
أكتب برامج لرسم كل من الأشكال التالية:



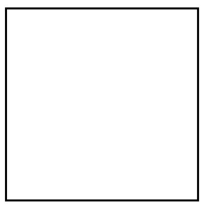
Spokes



Angle



Swing



Square

حفظ البرنامج

- أختر الأمر "Save" من قائمة File.
- من صندوق المحاورة اختر محرك الأقراص الذي تريد لحفظ الملف.
- أكتب أسم الملف ثم اضغط على الأمر حفظ "Save" لحفظ الملف.
- قم الأن بحفظ برنامج Square على القرص الخاص بك.

فتح برنامج سبق حفظه

- اختر الأمر "Load" من قائمة ملف.
- من صندوق المحاورة، اختر محرك الأقراص المحفوظ عليه ملف البرنامج، ومن ثم اضغط الأمر Open لفتح الملف.

- أفتح الملف الخاص ببرنامج Square.
- أكتب الأن برنامج لرسم مربع Square قياس طول اضلاعة 200.

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

مقدمة في برنامج اللوجو

<u>المحاضرة السادسة:</u> إستخدام المتغيرات Using Variables

الأهداف

1- التعرف على المتغيرات Variables.

2- تعريف واستخدام متغيرVariable واحد فقط.

3- تعريف واستخدام أكثر من متغير Variables.

الأدوات

1- مختبر الحاسوب.

2- برنامج اللوجو.

3- ورقة عمل.

تطبيقات ورقة العمل

1- قم بتشغيل جهاز الكمبيوتر.

2- اضغط مرتين على أيقونة الإختصار  الخاصة ببرنامج اللوجو الموجودة على سطح المكتب لتشغيل برنامج اللوجو.

تعريف واستخدام المتغيرات Variables

أفتح ملف Shapes.

- **أكتب برنامج لرسم مربع قياس طول ضلعه 200**

لقد قمت بكتابة برنامجين يحتويان على قيمتين مختلفتين تمثلان طول ضلع المربع. بدلا من كتابة برنامج جديد في كل مرة، يمكنك استخدام المتغيرات Variables وتعيين قيم مختلفة كمدخلات للبرنامج متى شئت.

- إفتح نافذة Editor (إستخدم الأمر ed “Shapes).
- قم بتغيير برنامج Square كالتالى:

(يستخدم الرمز : لتعريف إسم المتغيرSize)

```
To Square :Size
 repeat 4 [ fd :Size rt 90]
 End
```

- اختر الأمر ”Save and Exit“ من قائمة File لحفظ البرنامج واغلاق نافذة Editor.

- أكتب كلمة Square 100 في منطقة كتابة الأوامر ثم لاحظ ما يحدث.
- بما أن البرنامج يحتوي على المتغير Size: إذا يمكنك تغيير قيمة المتغيرSize: متى شئت.
- اللآن استخدم قيم مختلفة، ولاحظ ما يحدث (لا تستخدم الأمر CS).
- إفتح برنامج Angle.
- قم بتغيير البرنامج كالتالى:

```
To Angle :dgree
Cs rt 90 fd 100 bk 100 lt :dgree fd 100 home ht
end
```

- إستخدم البرنامج لرسم زاويتان قياس كل منهما 30 و 270 درجة على التوالى.
- إستخدم البرنامج لرسم والتعرف على أشكال الزوايا مختلفة القياس.

إستخدام اكثر من متغير في البرنامج

يتيح برنامج اللوجو ميزة إستخدام اكثر من متغير عند كتابة البرنامج. فمثلاً عند كتابة برنامج لرسم مستطيل تحتاج الى قيمتين الأولى لتغيير طول المستطيل والثانية لتغيير عرض المستطيل، لذلك تحتاج الى تعريف واستخدام متغيرين.

- أكتب البرنامج التالى لرسم مستطيل

```
To Rectangle :Width  :Length
repeat 2 [ fd :Width rt 90 :Length  fd rt 90]
end
```

- إستخدم المتغيرات في كتابة برنامج لرسم شكل رباعي كالتالى:

```
To Polygon :length :sides
repeat :sides [fd :length rt 360/:sides]
end
```

- أكتب كلمة Polygon 4 100 في منطقة كتابة الأوامر ثم لاحظ ما يحدث.
- الآن استخدم البرنامج Polygon لإكتشاف والتعرف على الأشكال الرباعية المختلفة.

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

مقدمة في برنامج اللوجو

المحاضرة السابعة: كتابة برنامج رئيسى Super-procedure وبرنامج ثانوي (فرعي) Sub-procedure

الأهداف

1- التعرف على مفهوم البرنامج الرئيسي Super-procedure و البرنامج ثانوي (فرعي) Sub-procedure.

2- تعريف واستخدام البرنامج الرئيسي Super-procedure و البرنامج ثانوي (فرعي) Sub-procedure.

الأدوات

1- مختبر الحاسوب.

2- برنامج اللوجو.

3- ورقة عمل.

تطبيقات ورقة العمل

1- قم بتشغيل جهاز الكمبيوتر.

2- اضغط مرتين على أيقونة الإختصار  الخاصة ببرنامج اللوجو الموجودة على سطح المكتب لتشغيل برنامج اللوجو.

البرنامج الرئيسى Super-procedure

هو البرنامج الذي لا يتم إستدعاءه من قبل برنامج اخر.

البرنامج الثانوي (فرعي) Sub-procedure

هو البرنامج الذي يتم إستدعاءه من قبل برنامج اخر.

- الآن يمكنك إستخدام برنامج Square كبرنامج فرعي عند كتابة البرنامج الرئيسى Bricks كالتالى:

To **Bricks** :size

repeat 4 [**Square** :size rt 90 fd :size lt 90]

end

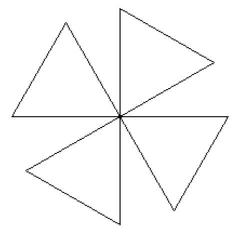
- أكتب البرنامج التالى لرسم مثلث

To **Triangle**

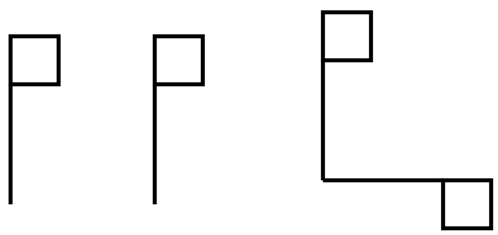
repeat 3 [fd 100 rt 120]

end

- أكتب برنامج رئيسى **Super-procedure** بإسم Rotate الذي يستخدم برنامج Triangle كبرنامج ثانوى (فرعى) لرسم الشكل التالى:



- أكتب برنامج رئيسى **Super-procedure** لرسم الأشكال التالية:



ب أ

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

مقدمة في برنامج اللوجو

<u>المحاضرة الثامنة:</u> الإحداثيات Coordinate notation والدائرة Circle

الأهاف

1- التعرف على مفهوم الإحداثيات Coordinate notation .
2- استخدام أوامر الإحداثيات Using Coordinate notation.
3- كتابة أمر إجراء Procedure لرسم دائرة.
4- إستخدام الأمر دائرة Circle.

الأدوات

1- مختبر الحاسوب.
2- برنامج اللوجو.
3- ورقة عمل.

تطبيقات ورقة العمل

1- قم بتشغيل جهاز الكمبيوتر.
2- اضغط مرتين على أيقونة الإختصار  الخاصة ببرنامج اللوجو الموجودة على سطح المكتب لتشغيل برنامج اللوجو.

استخدام الإحداثيات Using Coordinate notation

يتيح برنامج اللوجو خاصية تحريك السلحف الى نقطة محددة للنظام الإحداثي السيني (X) والصادي (Y) للمحاور المتعامدة في منطقة الرسوم وذلك بإستخدام الأمر SETXY، أو الأمر SETPOS. هذا ويتيح التحرك المحدد رسم الأشكال الهندسية بإستخدام الإحداثيات (X ،Y) للمحورين السيني والصادي.

ملاحظة : يعتبر موضع السلحف الأصلي وسط منطقة الرسوم هو نقطة الأصل (0،0).

أكتب الأوامر التالية في منطقة كتابة الأوامر ثم لاحظ ما يحدث

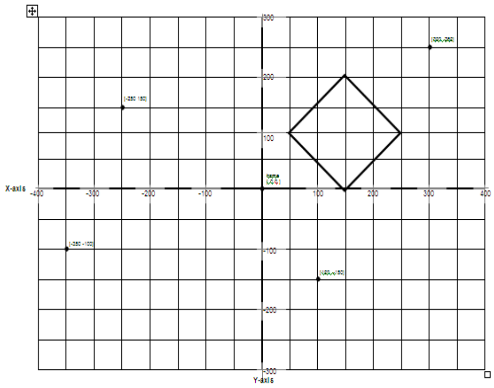
Setxy 0 100 (يمكنك ايضا استخدام الأمر [0 100] Setpos).

Setxy 200 100

Setxy 200 0

Setxy 0 0

أكتب الأوامر اللازمة لرسم الشكل التالى (ملاحظة: قياس الوحدة المربعة 50*50).



رسم الدائرة Drawing a Circle

يمكنك رسم الدائرة بإستخدام الأمر REPEAT أو الأمر Circle.

اكتب البرنامج التالى

```
To Circle
Repeat 360 [fd 1 rt 1]
End
```

- أكتب كلمة Circle في منطقة كتابة الأوامر ثم لاحظ ما يحدث.

يمكن استخدام الأمر circle أو circle2 لرسم دائرة باستخدام طول نصف القطر.

اكتب الأوامر التالية في منطقة كتابة الأوامر ثم لاحظ ما يحدث.

```
Circle 100
Circle2 100
```

الأمر	الإختصار	الوظيفة
Setxy *xcor ycor* or Setxy [*xcor ycor*]	-	تحريك السلحف الى نقطة محددة للنظام الإحداثي السيني X والإحداثي الصادي Y
Setpos [*xcor ycor*]	-	تحريك السلحف الى نقطة محددة للنظام الإحداثي السيني X والإحداثي الصادي Y
Setx *xcor*	-	تحريك السلحف الى نقطة محددة للنظام الإحداثي السيني X
Sety *ycor*	-	تحريك السلحف الى نقطة محددة للنظام الإحداثي الصادي Y
Setheading	Seth	توجيه السلحف بمقدار درجة محددة (مثال 0 درجة الى الأعلى).
Setxyz *xcor ycor zcor*	-	تحريك السلحف الى نقطة محددة في النظام ثلاثي الأبعاد.
Pos or Getxy	-	عرض الإحداثى السيني X والصادي Y للسلحف.

الوظيفة	الإختصار	الأمر
عرض الإحداثي السيني X للسلحف.	-	Xcor
عرض الإحداثي الصادي Y للسلحف.	-	Ycor
لرسم دائرة بإستخدام طول نصف القطر، وضع السلحف يكون في مركز الدائرة.	-	Circle *radius*
لرسم دائرة بإستخدام طول نصف القطر، وضع السلحف يكون على محيط الدائرة.	-	Circle2 *radius*

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

مقدمة في برنامج اللوجو

<u>المحاضرة التاسعة:</u> المعاودة Recursion

الأهداف

1- التعرف على مفهوم المعاودة Recursion.

2- استخدام المعاودة Recursion.

3- طباعة الأشكال و الإجراءات Procedures.

الأدوات

1- مختبر الحاسوب.

2- برنامج اللوجو.

3- ورقة عمل.

تطبيقات ورقة العمل

1- قم بتشغيل جهاز الكمبيوتر.

2- اضغط مرتين على أيقونة الإختصار  الخاصة ببرنامج اللوجو الموجودة على سطح المكتب لتشغيل برنامج اللوجو.

مفهوم المعاودة Recursion

تعتبر خاصية المعاودة إحدى المميزات الفعالة لبرنامج اللوجو والتي يقوم من خلالها البرنامج بإستدعاء نفسه عند التنفيذ. على الرغم من أن خاصية المعاودة عملية وفعالة عندما يكون عدد مرات التكرار غير معروفة، إلاّ انه من المهم أن تحتوى عملية المعاودة على الأمر STOP لوقف تنفيذ البرنامج. في حال عدم وجود الأمر STOP فإن تنفيذ البرنامج يستمر إلى مالا نهاية.

يمكن كتابة برنامج Square باستخدام المعاودة **Recursion** كالتالى.

to Square :Size

repeat 4 [fd :Size rt 90]

Square(إستدعاء البرنامج Square :siz لنفسه)

end

- أكتب الأمر التالى Square 100 في منطقة كتابة الأوامر ثم لاحظ ما يحدث. (استخدم الأمر Halt ثم الأمر Reset لإيقاف تنفيذ البرنامج وإعادة السلحف إلى موقعه الأصلي).

يمكنك الآن استخدام الأمر Stop ضمن برنامج Square لرسم مربعات مختلفة كالتالى

```
to Square :size
if :size > 100 [stop]
repeat 4 [fd :size rt 90]
Square :size + 10
end
```

أكتب برنامج Spiral كالتالى

```
to Spiral :size
if :size > 30 [ stop ]
fd :size rt 15
Spiral :size + 0.1
end
```

- أكتب الأمر التالى Spiral 0.5 في منطقة كتابة الأوامر ثم لاحظ ما يحدث.
- أكتب الأمر التالى Spiral 40 في منطقة كتابة الأوامر ثم لاحظ ما يحدث.

طباعة الأشكال والبرامج

- اختر الأمر Print من قائمة Bitmap لطباعة الشكل المرسوم من منطقة الرسوم.
- اختر الأمر Print من قائمة File في نافذة Editor لطباعة البرنامج أو البرامج التى تم كتابتها.

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

Appendix H

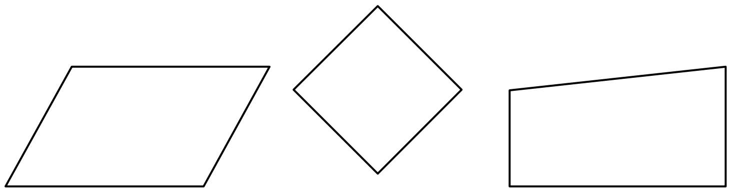
The Mathematical Logo-based Activities
(English and Arabic Version)

Mathematical Logo-based activities

First: Geometry

<u>Tenth session:</u> Parallelogram

Introduction



- What would you name these shapes?
- Discuss in your group the properties of each shape.
- Identify the common properties between the shapes.

1- Turn on your PC.

2- Start the Logo program

3- Do the following practice:

1- Complete the following sequence commands to draw a parallelogram with 50º angle.

Rt ___ Fd 100 Rt ___ Fd 150 Rt ___ Fd 100 Rt ___ Fd 150 Rt ___

Enter the commands in the Input Box to see if you get a parallelogram, then discuss in your group the parallelogram and complete the following statements:

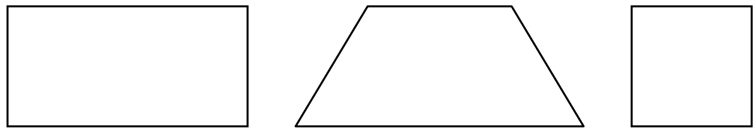
- The __________ sides of the parallelogram are equal and ________.
- The __________ angles of the parallelogram are equal.
- The obtuse angles of the parallelogram are both equal to _______.
- The acute angles of the parallelogram are both equal to _______.
- The sum of the angles of the parallelogram is ______ degrees.

- **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

Mathematical Logo-based activities

<u>Eleventh session:</u> Rectangle and Square

Introduction



- What would you name these shapes?
- Discuss in your group the properties of each shape.
- Identify the common properties between the shapes.

1- Turn on your PC.

2- Start the Logo program

3- Do the following practice:

Write the procedure Poly below.

```
To Poly :Length :Angle1 :Width :Angle2
repeat 2 [ fd : Length  rt :Angle1  fd : Width  rt :Angle2]
end
```

- Use the procedure Poly to draw
    A. A rectangle
    B. A square.
- Discuss in your group the properties of each shape.
- Identify the common properties between the shapes.

- Complete the following table:

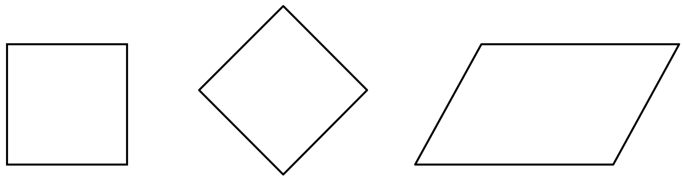
Number of sides (N)	Name	Turning angle (A)	A * N	Exterior angle	Interior angle
	Rectangle				
	Square				

➢ **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

Mathematical Logo-based activities

<u>Twelfth session:</u> Parallelogram and Rhombus.

Introduction



- What would you name these shapes?
- Discuss in your group the properties of each shape.
- Identify the common properties between the shapes.

1- Turn on your PC.

2- Start the Logo program

3- Do the following practice:

Write the procedure Poly below.

```
To Poly :Length :Angle1 :Width :Angle2
repeat 2 [ fd : Length  rt :Angle1  fd : Width  rt :Angle2]
end
```

- Use the procedure Poly to draw
  - A. A parallelogram.
  - B. A rhombus.
- Discuss in your group the properties of each shape.
- Identify the common properties between the shapes.

- Complete the following table:

Number of sides (N)	Name	Turning angle (A)	A * N	Exterior angle	Interior angle
	Parallelogram				
	Rhombus				

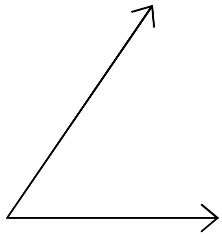
3- Can you write a procedure to draw a regular triangle?

➢ **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

Mathematical Logo-based activities

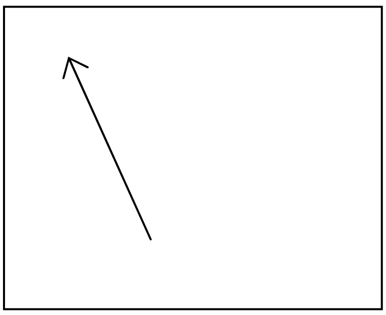
<u>Thirteenth session:</u> Angle

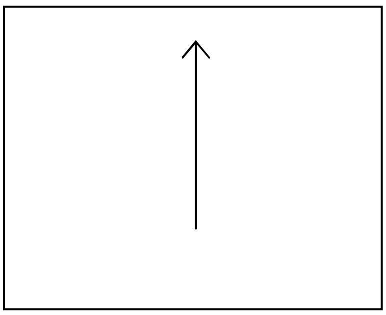
Introduction:



A B

1- Discuses each of the above shape with your group.
2- What do you think shape A represent?
3- How do you think shape B was constructed? What do you think it represents?
4- For each of the following rays, use a pen to depict an angle.





1- Turn on your PC.

2-Start the Logo program

3- Do the following practice:

Write the procedure Poly below.

A- Complete the procedure **Ray** that draws an arrow like the one shown here.

TO **RAY**

FD _____

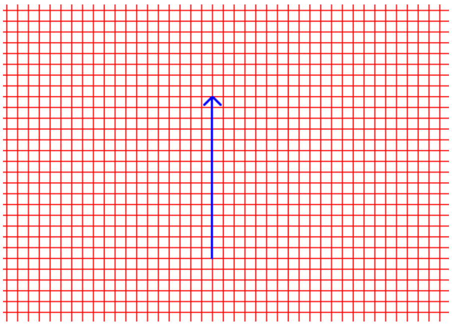
RT 45 BK 12 FD ______

LT ___ BK ____ FD 12

RT 45

BK _____

END



B- Use procedure **ANGLE** to investigate angle concept and complete the table for each angle. This procedure has one input for angle size and uses **RAY** procedure.

TO **ANGLE** __________

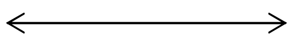
RT 90

RAY

LT ______

RAY

END

Angle Size	Angle Name	Sketch
30º		
	Right Angle	
135		
		

- **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

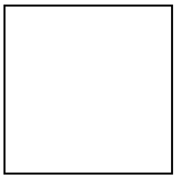
Mathematical Logo-based activities

Second: Algebra

<u>Fourteenth session:</u> Variables

Introduction:

50



Look at the above shape and answer the following statements:

- The perimeter of the Square is equal to ___________.
- The area of the Square is equal to _____________.
- How big can you make your Square?
- How small can you make your Square?
- What would allow you to change your Square size? Why?

1- Turn on your PC.

2- Start the Logo program

3- Do the following practice:

1- Complete the following sequence commands to draw the above Square.

To Square

fd _____ rt 90

fd _____ rt 90

fd _____ rt 90

fd _____ rt 90

End

- Type the word Square in the Input Box to see if you get Square.

2- Now edit your procedure; include **Scale** input to multiply all the sides by a **Scale** input. (Note: Start your procedure with: To Square **:Scale**) Write your procedure below:

- Type the commands below in the **Input Box** and see what will happen to the size of your square. (Use Cs to clear the screen after each command).

Square 2

Square 5.1

Square 0.7

Square -2.1

- How big can you make your Square?
- How small can you make your Square?
- What allow you to change your Square size? Why?

3- Edit your procedure so it will draw many different sized squares. Write your procedure below:

- Use your general procedure to draw different size squares.

4- What is the perimeter of the Square with **L** side length is equal to?

5- What is the area of the Square with **L** side length is equal to?

6- What are the perimeter and the area of rectangle with **W** side width and **L** side?

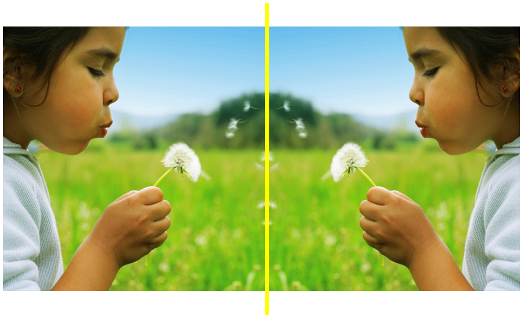
➢ **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

Mathematical Logo-based activities

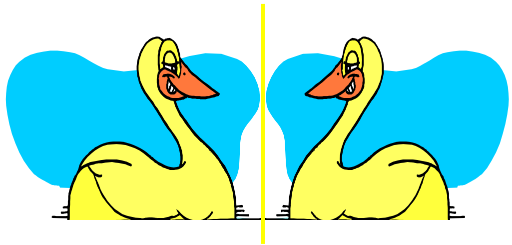
Third: Transformation Geometry

<u>Fifteenth session:</u> Reflection

Introduction



Reflecting line (Mirror)



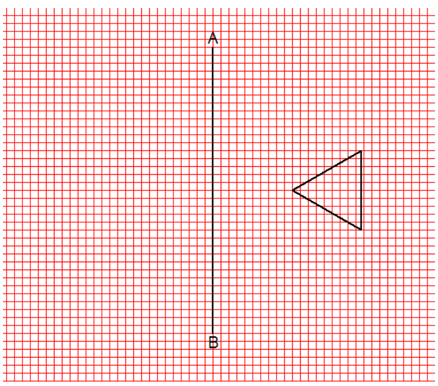
Reflecting line (Mirror)

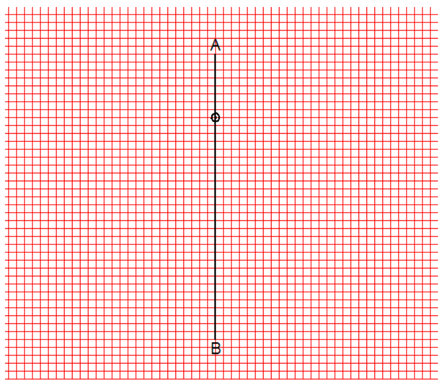
1- Investigate the above picture; what do you notice about it? Share your ideas with your group.

2- Investigate the effect of the Reflecting Line (Mirror) on the image and describe it to you group.

3- For each of the following shapes, use a pen to draw its reflection image.

(Note: the grid unit is 10 * 10).





1- Turn on your PC.

2- Start the Logo program

3- Do the following practice:

Use the following predefines logo procedures: **Axis**, **Reflect**, **Triangle** and **Point** to reflect the above shapes as following:

A- To Reflect the Triangle:

- Type the word **Axis** in the **Input Box** to draw the A B axis.
    - Type the word **Triangle** in the **Input Box** to draw the triangle.
    - To reflect the Triangle type **Reflect Triangle** in the **Input Box** and see what will happen.
    - Investigate the mirror image with your group and compare its properties with the original image. Write your conclusion below.

B- To reflect the Point:

- Type the word **Axis** in the **Input Box** to draw the A B axis.
    - Type the word **Point** in the **Input Box** to draw the Point.
    - To reflect the Point type **Reflect Point** in the **Input Box** and see what will happen.
    - Investigate the mirror image with your group and compare its properties with the original image. Write your conclusion below.

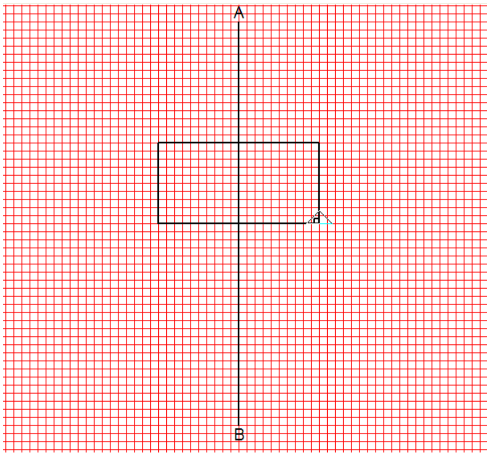
➢ **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

Mathematical Logo-based activities

<u>Sixteenth session:</u> Reflection

4- For the following shape, use a pen to draw its reflection image.

(Note: the grid unit is 10 * 10).



1- Turn on your PC.

2- Start the Logo program

3- Do the following practice:

- Use Reflect procedure to reflect the Rectangle as following:
- Type the word **Axis** in the **Input Box** to draw the A B axis.
  - Type the word **Rectangle** in the **Input Box** to draw the Rectangle.
  - Type the word **Reflect Rectangle** in the **Input Box** and see what will happen.
  - Investigate the mirror image with your group and compare its properties with the original image. Write your conclusion below.

2- Investigate Reflection:

- Use **Axis1** procedure that has two inputs in the **Input Box** to draw the A B axis and moves the turtle to any absolute X and Y coordinate you like. For example **Axis1 100 50** will draw the A B axis and moves the turtle to x=100 and y=50.
- Use the following procedures: **Square**, **Pentagon, R.Triangle and line.**
- Use Reflect procedure to reflect each shape.

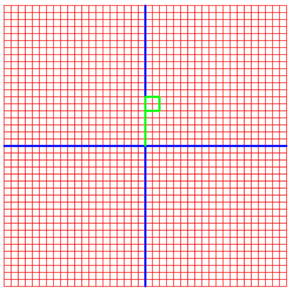
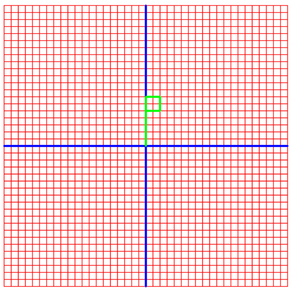
➢ **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

Mathematical Logo-based activities

<u>Seventeenth session</u>: Rotation

Introduction

1- Use a pen to draw the final image for the flag following:

A- Rotate the flag 90º degree clockwise clockwise around its bottom (base).

B- Rotate the flag 270º degree around its bottom (base).

1- Turn on your PC.

2- Start the Logo program

3- Do the following practice:

2- Use logo to investigate rotation concept as following:

- Complete the procedure **FLAG** that draws a flag like the one shown above.

  TO **FLAG**

  FD _____

  Repeat ____ [FD 20 RT ____]

  END

- Complete the procedure **ROTATE** that rotates the flag. This procedure uses the procedure **FLAG** and accepts two variables :DEGREE and : DIRECTION

  TO **ROTATE** : __________ :DIRECTION

  IFELSE :DIRECTION = “CLOCKWISE [RT :________] [LT :__________]

  FLAG

END

- Use the procedure ROTATE to rotate the flag, in a clockwise direction, through an angle of 45º, 90º, 135, 180º. Investigate other angles. (Note use quotation mark (")with direction input, that is, "Clockwise.
- Use the procedure ROTATE to rotate the flag, in an "anticlockwise direction.

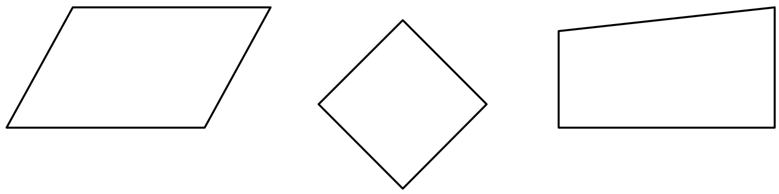
➢ **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

المسائل الرياضية بإستخدام برنامج اللوجو

أولا: الهندسة

<u>المحاضرة العاشرة:</u> متوازي الأضلاع Parallelogram

مقدمة



- ماذا تسمى هذه الأشكال؟
- ناقش مع زملائك في المجموعة خصائص كل شكل من الأشكال السابقة.
- أذكر الخصائص المشتركة بين هذه الأشكال.

1- شغل جهاز الكمبيوتر.

2- شغل برنامج اللوجو.

3- أجر التدريبات التالية:

اكمل الأوامر التالية لرسم متوازي اضلاع فيه زاوية قياسها 50 درجة.

Rt ___ Fd 100 Rt ___ Fd 150 Rt ___ Fd 100 Rt ___ Fd 150 Rt __

اكتب الأوامر في منطقة كتابة الأوامر مع ملاحظة هل تم الحصول على شكل متوازي الأضلاع ام لا.

ناقش مع زملائك في المجموعة مفهوم متوازي الأضلاع ومن ثم اكمل العبارات التالية:

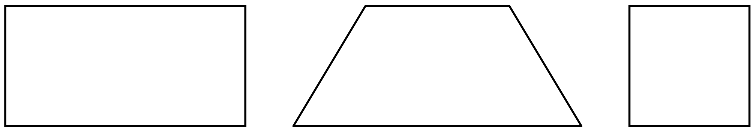
- في متوازي الأضلاع الأضلاع ______________ متساوية و ______________.
- في متوازي الأضلاع الزوايا ______________ متساوية في القياس.
- قياس الزوايا المنفرجة لمتوازي الأضلاع المرسوم يساوي ____________ درجة.
- قياس الزوايا الحادة لمتوازي الأضلاع المرسوم يساوي ____________ درجة.
- مجموع قياس الزوايا الداخلية في متوازي الأضلاع المرسوم يساوي ____________ درجة.

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

المسائل الرياضية بإستخدام برنامج اللوجو

<u>المحاضرة الأحدي عشر:</u> المستطيل Rectangle والمربع Square

مقدمة



- ماذا تسمى هذه الأشكال؟
- ناقش مع زملائك في المجموعة خصائص كل شكل من الأشكال السابقة.
- أذكر الخصائص المشتركة بين هذه الأشكال.

1- شغل جهاز الكمبيوتر.

2- شغل برنامج اللوجو.

3- أجر التدريبات التالية:

أكتب برنامج Poly التالى:

```
To Poly :Length :Angle1 :Width :Angle2
repeat 2 [ fd : Length  rt :Angle1  fd : Width  rt :Angle2]
end
```

- إستخدم برنامج Poly لرسم كل مما يلي:
  A. مستطيل.
  B. مربع.
- ناقش مع زملائك في المجموعة خصائص المستطيل.
- ناقش مع زملائك في المجموعة خصائص المربع.
- أذكر الخصائص المشتركة بين المستطيل والمربع.

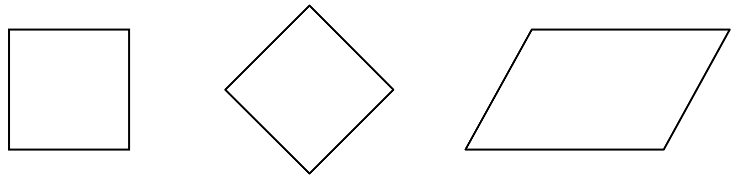
- أكمل الجدول التالى:

عدد الأضلاع (N)	أسم الشكل	قياس زاوية الدوران (A)	A * N	قياس الزاوية الخارجية	قياس الزاوية الداخلية
	مستطيل				
	مربع				

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

<u>المحاضرة الإثنى عشر:</u> متوازي الأضلاع Parallelogram والمعين Rhombus

مقدمة



- ماذا تسمى هذه الأشكال؟
- ناقش مع زملائك في المجموعة خصائص كل شكل من الأشكال السابقة.
- أذكر الخصائص المشتركة بين هذه الأشكال.

1- شغل جهاز الكمبيوتر.

2- شغل برنامج اللوجو.

3- أجر التدريبات التالية:

أكتب برنامج Poly التالى:

```
To Poly :Length :Angle1 :Width :Angle2
repeat 2 [ fd : Length  rt :Angle1  fd : Width  rt :Angle2]
end
```

- إستخدم برنامج Poly لرسم كل مما يلي:
  A. متوازي اضلاع.
  B. معين.
- ناقش مع زملائك في المجموعة خصائص كل شكل.
- أذكر الخصائص المشتركة بين متوازي الأضلاع والمعين.

- أكمل الجدول التالى:

عدد الأضلاع (N)	أسم الشكل	قياس زاوية الدوران (A)	A * N	قياس الزاوية الخارجية	قياس الزاوية الداخلية
	متوازي الأضلاغ				
	معين				

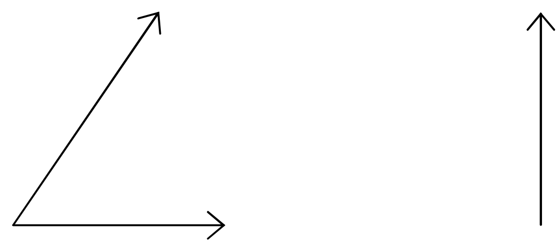
أكتب برنامج لرسم مثلث، ثم أذكر خصائصه.

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

المسائل الرياضية بإستخدام برنامج اللوجو

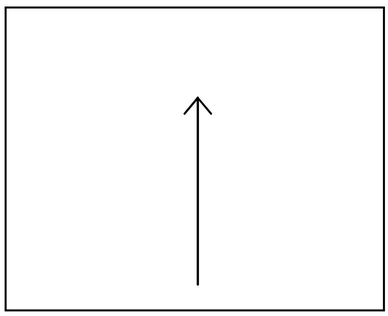
<u>المحاضرة الثالثة عشر:</u> الزاوية Angle.

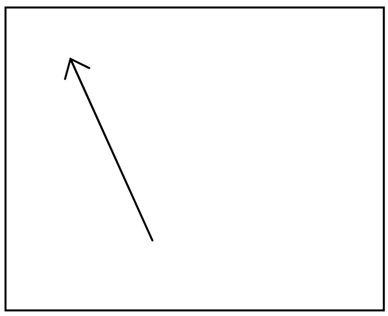
مقدمة



ب أ

- ناقش مع زملائك في المجموعة كل من الأشكال السابقة.
- ماذا يمثل الشكل أ ؟
- أذكر كيف تم تكوين الشكل ب ؟ وماذا يمثل هذا الشكل ؟
- لكل من الأشكال التالية، استخدم القلم لرسم زاوية.





1- شغل جهاز الكمبيوتر.

2- شغل برنامج اللوجو.

3- أجر التدريبات التالية:

أكمل أوامر البرنامج **Ray** لرسم الشكل الموضح باللون الأزرق في الأسفل. (ملاحظة: وحدة قياس الرسم تساوى 10 * 10).

TO **Ray**

FD _____

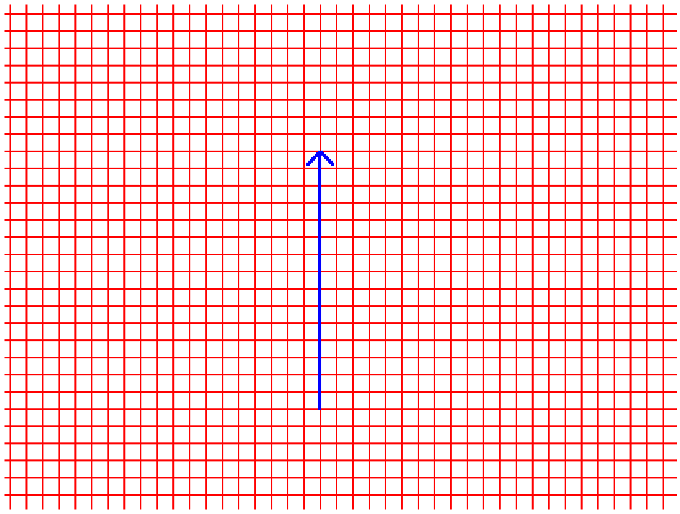
RT 45 BK 12 FD ______

LT ___ BK ____ FD 12

RT 45

BK _____

END



استخدم البرنامج **Angle** لبحث مفهوم الزاوية ومن ثم أكمل الجدول التالى. (ملاحظة: البرنامج **Angle** فيه متغير واحد **Size** ويستخدم البرنامج **Ray**).

TO **Angle** ___________

Cs

RT 90

Ray

LT ______

Ray

End

شكل الزاوية	أسم الزاوية	قياس الزاوية
		30º
	زاوية قائمة	
		135

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

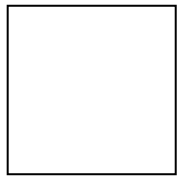
المسائل الرياضية بإستخدام برنامج اللوجو

ثانيا: الجبر Algebra

<u>المحاضرة الرابعة عشر:</u> المتغيرات Variables

مقدمة

50



أنظر الى الشكل السابق ثم اجب عن العبارات التالية:

- محيط المربع يساوي ______________.
- مساحة المربع تساوى _____________.
  - ما هو أكبر حجم لرسم المربع؟
  - ما هو أصغر حجم لرسم المربع؟
- ما الذي اجاز لك تغيير حجم المربع؟ لماذا؟

1- شغل جهاز الكمبيوتر.

2- شغل برنامج اللوجو.

3- أجر التدريبات التالية:

1. أكمل الأوامر التالية لرسم المربع السابق

To Squar

fd _____ rt 90

fd _____ rt 90

fd _____ rt 90

fd _____ rt 90

End

- أكتب كلمة Square في منطقة كتابة الأوامر، ثم لاحظ هل تم رسم شكل مربع.

2. قم بتغيير برنامج Square ، استخدم المتغير Scale لمضاعفة أضلاع المربع. (ملاحظة: ابدأ البرنامج بـ To Square :Scale). أكتب البرنامج في الأسفل.

- أكتب الأوامر التالية في منطقة كتابة الأوامر ثم لاحظ ما يحدث لحجم المربع. (استخدم الأمر Cs بعد كتابة كل أمر).

Square 2

Square 5.1

Square 0.7

Square -2.1

- ما هو أكبر حجم لرسم المربع؟
- ما هو أصغر حجم لرسم المربع؟
- ما الذي اجاز لك تغيير حجم المربع؟ لماذا؟

3. قم بتغيير برنامج Square لرسم مربع ذو احجام مختلفة. اكتب البرنامج في الأسفل.

- استخدم البرنامج لرسم مربع ذو احجام مختلفة.

4- ما هو محيط مربع فيه طول احد اضلاعه يساوي L؟

5- ما هي مساحة مربع فيه طول احد اضلاعه يساوي L؟

6- ما هو محيط ومساحة مستطيل طوله L وعرضه W؟

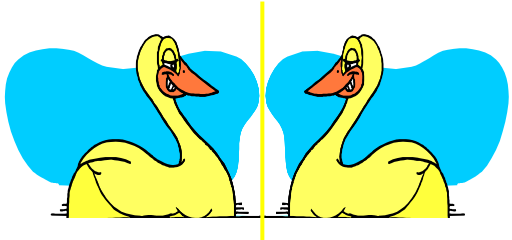
أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

المسائل الرياضية بإستخدام برنـامج اللوجو

ثالثا: التحويلات الهندسية Transformation Geometry

المحاضرة الخامسة عشر: الإنعكاس Reflection

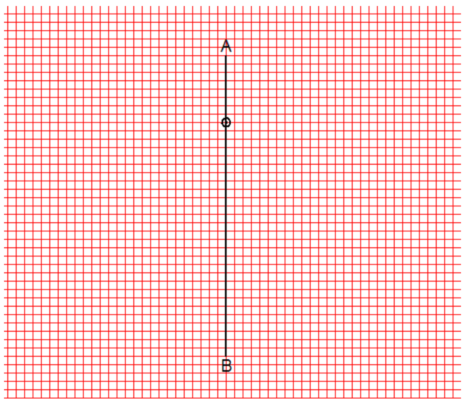
مقدمة

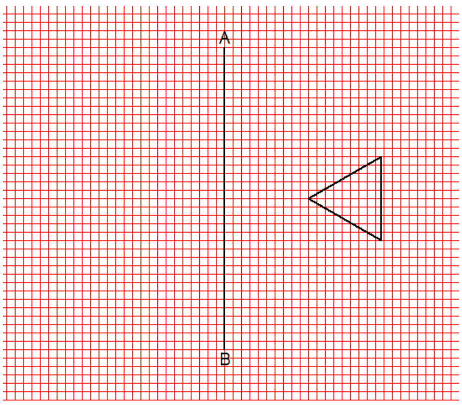


محور الإنعكاس (مرآة)

محور الإنعكاس (مرآة)

1. إبحث في الأشكال السابقة، ماذا تلاحظ ؟ تبادل وزملائك في المجموعة الرأي.
2. إبحث في تأثير محور الإنعكاس (المرآة) على الشكل ثم اوصفه لزملائك في المجموعة.
3. استخدم القلم لرسم صورة إنعكاس كل من الأشكال التالية في محور الإنعكاس **A B**. (ملاحظة: وحدة قياس الرسم تساوى 10*10).





1- شغل جهاز الكمبيوتر.

2- شغل برنـامج اللوجو.

3- أجر التدريبات التالية:

استخدم كل من البرامج التالية: **Axis**، **Reflect**، **Triangle**، و **Point** لرسم (تمثيل) صور إنعكاس كل من الأشكال السابقة في محور الإنعكاس **A B** كما يلي:

أ- إنعكاس المثلث Triangle

- أكتب كلمة **Axis** في منطقة كتابة الأوامر لرسم محور الإنعكاس **A B**.
- أكتب كلمة **Triangle** في منطقة كتابة الأوامر لرسم المثلث.
- لإنعكاس المثلث، أكتب العبارة Reflect Triangle في منطقة كتابة الأوامر ثم لاحظ ما يحدث.
- إبحث في الصورة الناتجة عن إنعكاس المثلث في محور الإنعكاس A B مع زملائك في المجموعة، ثم قارن بين خصائص الشكل الأصلي وصورته. اكتب الإستنتاج في الأسفل.

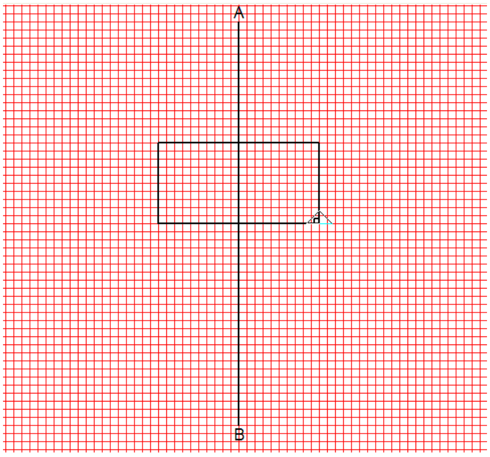
ب- إنعاكس النقطة Point

- أكتب كلمة **Axis** في منطقة كتابة الأوامر لرسم محور الإنعكاس **A B**.
- أكتب كلمة Point في منطقة كتابة الأوامر لرسم نقطة.
- لإنعكاس النقطة، أكتب العبارة **Reflect Point** في منطقة كتابة الأوامر ثم لاحظ ما يحدث.
- إبحث في الصورة الناتجة عن إنعكاس النقطة في محور الإنعكاس A B مع زملائك في المجموعة، ثم قارن بين خصائص الشكل الأصلي وصورته. اكتب الإستنتاج في الأسفل.

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

<u>المحاضرة السادسة عشر:</u> الإنعكاس Reflection

4- استخدم القلم لرسم صورة إنعكاس الشكل التالى في محور الإنعكاس **A B**. (ملاحظة: وحدة قياس الرسم تساوى 10*10).



1- شغل جهاز الكمبيوتر.

2- شغل برنامج اللوجو.

3- أجر التدريبات التالية:

ب- أستخدم برنامج Reflect لإنعاكس المستطيل كما يلي:

- أكتب كلمة **Axis** في منطقة كتابة الأوامر لرسم محور الإنعكاس **A B**.
- أكتب كلمة **Rectangle** في منطقة كتابة الأوامر لرسم مستطيل.
- أكتب العبارة **Reflect Rectangle** في منطقة كتابة الأوامر ثم لاحظ ما يحدث.
- إبحث في الصورة الناتجة عن إنعكاس المستطيل في محور الإنعكاس A B مع زملائك في المجموعة، ثم قارن بين خصائص الشكل الأصلي وصورته. اكتب الإستنتاج في الأسفل.

البحث في مفهوم الإنعكاس

- اكتب اسم البرنامج **Axis1** والذي يحتوي على متغيرين في منطقة كتابة الأوامر لرسم المحور A B وتحريك السلحف الى نقطة محددة للنظام الإحداثي السيني X والإحداثي الصادي Y الذي ترغب فيه.

  مثلا: عند كتابة الأمر Axis1 100 50 في منطقة كتابة الأوامر سوف يتم رسم المحور A B وتحرك السلحف الى النقطة x= 100 و y=50 .
- استخدم البرامج التالية: **Square**، **Pentagon**، **R.Triangle** و **Line**.
- استخدم برنامج Reflect لرسم صورة إنعكاس كل شكل.

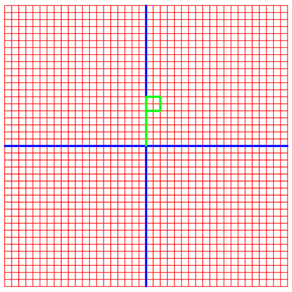
أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

المسائل الرياضية بإستخدام برنامج اللوجو

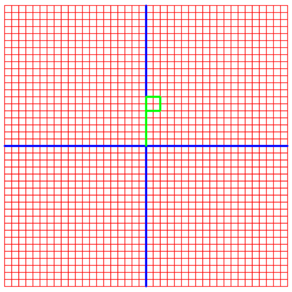
<u>المحاضرة السابعة عشر:</u> الدوران Rotation

مقدمة

1. استخدم القلم لرسم صورة الشكل Flag في الأسفل بعد كل مما يلي:



أ- دوران الشكل Flag بزاية قياسها 90 درجة حول قاعدته التي تمثل نقطة الأصل في إتجاه عقارب الساعة.



ب- دوران الشكل Flag بزاية قياسها 270 درجة حول قاعدته التي تمثل نقطة الأصل في إتجاه عقارب الساعة.

1- شغل جهاز الكمبيوتر.

2- شغل برنامج اللوجو.

3- أجر التدريبات التالية:

استخدم برنامج اللوجو لدراسة مفهوم الدوران كما يلي:

- أكمل البرنامج **Flag** لرسم علم كما هو ممثل في الأعلى

TO **FLAG**

FD _____

Repeat ____ [FD 20 RT ____]

END

- أكمل البرنامج **Rotate** لدوران العلم. يحتوى البرنامج Rotate على المتغيرين Degree: و Direction: بالإضافة الى استخدامه للبرنامج Flag.

TO **Rotate** : __________ :Direction

IFELSE :Direction = “Clockwise [RT :________] [LT :__________]

FLAG

END

- الآن، استخدم البرنامج Rotate لإستدارة العلم في إتجاه عقارب الساعة لزوايا قياسها التالى:

أ- 45º   ب- 90º

ج- 135º   د- 180º

- ابحث في قياس الزوايا الأخرى. (ملاحظة: استخدم رمز (") قبل كتابة الإتجاه. مثال: "Clockwise

- استخدم برنامج Rotate في إستدارة Flag العلم في الإتجاه عكس عقارب الساعة "anticlockwise

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

Preparation of Lesson Plan

<u>Eighteenth Session:</u> Preparation of Mathematical Logo-based lesson plan

Objectives of this session are to:

1- Identify the elements of lesson plan.

2- Practice the preparation of a Mathematics lesson plan that incorporates Logo programming language.

Materials:

1- Methods of Teaching Mathematics textbook. (the course textbook)

2- Mathematical Logo-based activities

3- Computer lab.

4- Logo programming language software.

Activities:

1- Review and discuss the lesson plan elements – Title, Objectives, Teaching aids, Introduction, Activities, and Assessment. (These elements were taught by the formal professor of the course).

2- Discuss with the student-teachers the Logo-based activates used and its relation to the topics taught in Mathematics curriculum.

3- Ask student-teachers either to work in groups of two or work individual.

4- Ask student-teachers to chose a mathematical topic and practice preparation of a lesson plan that incorporates the use of Logo programming language to teach that topic.

5- Supervise student-teachers work.

6- At the end of the session student-teachers were asked to bring their work for the next session.

Preparation of Lesson Plan

<u>Nineteenth Session:</u> Continue Preparation of Mathematical Logo-based lesson plan

Objective of this session is to:

1- Continue to practice the preparation of a Mathematics lesson plan that incorporates Logo programming language to develop student-teachers knowledge.

Materials:

1- Student-teachers lesson plan.
2- Methods of Teaching Mathematics textbook.
3- Mathematical Logo-based activities.
4- Computer lab.
5- Logo programming language software.

Activities:

1- Ask student-teachers to continue work in preparing the Mathematics lesson plan.
2- Supervise student-teachers work.
3- At the end of the session student-teachers lesson plans will be collected.

Preparation of Lesson Plan

<u>Twentieth Session:</u> Continue Preparation of Mathematical Logo-based lesson plan

Objectives of this session are to:

1- Review and discuss with student-teachers their lesson plans.

2- Practice the preparation of a Mathematics lesson plan that incorporates Logo programming language to develop student-teachers knowledge.

Materials:

1. Student-teachers lesson plan.

Activities:

1- A Discussion of four (4) student-teachers lesson plans will be conducted to identify and view the lesson plan structure and how Logo is incorporated.

2- At the end of this session student-teachers will be asked to prepare an individual lesson plan for the next session where they will practice teaching Mathematics.

Practice Teaching with the use of Logo

Twenty first, twenty second and twenty third sessions:

Practice teaching Mathematics with the use of Logo programming language

Objective of this session is to:

1- Provide student-teachers the role of formal teachers, in a context where they practice teaching mathematic lesson with the use of Logo programming Language.

Materials:

1- Student-teachers individual lesson plan.

2- Computer lab.

3- Logo programming language software.

Activities:

1- Six (6) student-teachers, two (2) in each session will practice teaching their colleagues the Mathematical topic with the use of Logo programming Language.

- **Save your work on the computer and on your rewritable CD or floppy, close the Logo program and shut down your computer.**

<u>Twenty-forth session:</u> Thanking Meeting and Administration of post-test Beliefs Questionnaire

Objectives of this session are to:

1- Thank student-teachers.

2- Administer the post-test Beliefs Questionnaire.

إعداد نموذج درس

<u>المحاضرة الثامنة عشر:</u> إعداد نموذج درس يتضمن برنامج اللوجو

الأهداف

1- التعرف على عناصر خطة الدرس.

2- التدرب على إعداد نموذج خطة درس يتضمن برنامج اللوجو.

الأدوات

1- كتاب طرق تدريس الرياضيات (كتاب المقرر).

2- تدريبات الرياضيات.

3- مختبر الكمبيوتر.

4- برنامج اللوجو.

الأنشطة

1- مراجعة ومناقشة عناصر الدرس: العنوان، الأهداف، الوسائل التعليمية، المقدمة، عرض الدرس، التقييم (هذه العناصر تم تدريسها من قبل أستاذ المقرر).

2- مناقشة الطلاب بخصوص التدريبات الرياضية التي تم تطبيقها بإستخدام برنامج اللوجو وإرتباطها في مواضيع الرياضيات التي يتضمنها مقرر الرياضيات.

3- الطلب من الطلاب العمل إما بصورة منفردة أو في صورة مجموعات.

4- الطلب من الطلاب إختيار أحدى مواضيع مادة الرياضيات التي يتم تدريسها والتدرب على إعداد نموذج درس يتضمن برنامج اللوجو لتدريس الموضوع المختار.

5- الإشراف على عمل الطلاب.

6- تسليم نموذج الدرس المحاضرة القادمة.

إعداد نموذج درس

<u>**المحاضرة التاسعة عشر:**</u> متابعة إعداد نموذج درس يتضمن برنامج اللوجو

الأهداف

1- إستكمال تدريب وتطوير أداء الطلاب على إعداد نموذج خطة درس رياضيات يتضمن برنامج اللوجو كوسيلة تعليمية لتطوير معرفة الطالب - المعلم.

الأدوات

1- نماذج الدروس المعدة من قبل الطلاب.
2- كتاب طرق تدريس الرياضيات (كتاب المقرر).
3- تدريبات الرياضيات.
4- مختبر الكمبيوتر.
5- برنامج اللوجو.

الأنشطة

1- الطلب من الطلاب إستكمال العمل في إعداد نموذج الدرس.
2- الإشراف على عمل الطلاب.
3- جمع نماذج الدروس التي تم إعدادها من قبل الطلاب في نهاية المحاضرة.

إعداد نموذج درس

<u>المحاضرة العشرون:</u> متابعة إعداد نموذج درس يتضمن برنامج اللوجو

الأهداف

1- مراجعة ومناقشة نماذج خطة الدروس المعدة من قبل الطلاب.

2- إستكمال تدريب وتطوير أداء الطلاب على إعداد نموذج خطة درس رياضيات يتضمن برنامج اللوجو كوسيلة تعليمية لتطوير معرفة الطالب - المعلم.

الأدوات

1- نماذج الدروس المعدة من قبل الطلاب.

الأنشطة

1- مراجعة ومناقشة عدد اربع نماذج دروس تم إعدادها من قبل الطلاب للتعرف عن كثب على كيفية تضمين برنامج اللوجو لتدريس موضوع الرياضيات.

2- الطلب من التلاميذ العمل بصورة منفردة لإعداد نموذج درس للمحاضرة القادمة حيث سيتم التدريب على تدريس موضوع رياضيات.

التدرب على التدريس بإستخدام برنامج اللوجو

<u>المحاضرة إحدى وعشرون، إثنى وعشرون، ثلاث وعشرون:</u> التدريب على تدريس الرياضيات بإستخدام برنامج اللوجو

الأهداف

1- منح الطلاب الفرصه للقيام بدور المعلم حيث يتم تدريس درس الرياضيات بإستخدام برنامج اللوجو.

الأدوات:

1- نماذج الدروس المعدة من قبل الطلاب بصورة منفردة.

2- مختبر الكمبيوتر.

3- برنامج اللوجو.

الأنشطة

1- قيام ستة (6) طلاب، إثنان (2) في كل محاضرة بالتدرب على تدريس زملائهم الطلاب موضوع الرياضيات الذي قاما بإعداده مستخدما برنامج اللوجو.

أحفظ العمل الذي قمت به في جهاز الكمبيوتر أو على وسيط الحفظ الخاص بك، ومن ثم أغلق نافذة البرنامج وجهاز الكمبيوتر.

تطبيق الإستبانة البعدية

<u>المحاضرة أربع وعشرون:</u> شكر الطلاب وتوزيع الإستبانة البعدية

الأهداف

1- شكر الطلاب على مشاركتهم في الدراسة.

2- تطبيق الإستبانة البعدية.

Appendix I

The SPSS Analysis output

Pre-test Questionnaire Data Analysis output

The Paired-Samples t-test Results For

1- **Pre-test Mean Score For Part1 Nature of Mathematics Constructivist View WITH Pre-test Mean Score For Part1 Nature Of Mathematics Traditional View**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsConstructivistView	3.5875	32	.51728	.09144
	PreTestMeanScoreForPart1NatureOfMathematicsTraditionalView	3.8813	32	.39221	.06933

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsConstructivistView & PreTestMeanScoreForPart1NatureOfMathematicsTraditionalView	32	-.686	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsConstructivistView - PreTestMeanScoreForPart1NatureOfMathematicsTraditionalView	-.29375	.83664	.14790	-.59539	.00789	-1.986	31	.056

2- **Pre-test Mean Score For Part2 Teaching Of Mathematics Constructivist View WITH Pre-test Mean Score For Part2 Teaching Of Mathematics Traditional View**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsConstructivistView	3.6969	32	.76009	.13437
	PreTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	4.0750	32	.55474	.09807

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsConstructivistView & PreTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	32	-.603	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsConstructivistView - PreTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	-.37812	1.18069	.20872	-.80381	.04756	-1.812	31	.080

3- **Pre-test Mean Score For Part3 Learning Of Mathematics Constructivist View WITH Pre-test Mean Score For Part3 Learning Of Mathematics Traditional View.**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsConstructivistView	3.8344	32	.67662	.11961
	PreTestMeanScoreForPart3LearningOfMathematicsTraditionalView	4.1222	32	.36627	.06475

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsConstructivistView & PreTestMeanScoreForPart3LearningOfMathematicsTraditionalView	32	-.229	.207

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsConstructivistView - PreTestMeanScoreForPart3LearningOfMathematicsTraditionalView	-.28778	.84001	.14849	-.59064	.01507	-1.938	31	.062

4- **Pre-test Total Mean Score Of Constructivist View For PARTS 1,2 and 3 WITH Pre-test Total Mean Score Of Traditional View For PARTS 1,2 and 3**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestTotalMeanScoreOfConstructivistViewForPARTS123	11.1188	32	1.79200	.31678
	PreTestTotalMeanScoreOfTraditionalViewForPARTS123	12.0784	32	1.13909	.20136

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestTotalMeanScoreOfConstructivistViewForPARTS123 & PreTestTotalMeanScoreOfTraditionalViewForPARTS123	32	-.641	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestTotalMeanScoreOfConstructivistViewForPARTS123 - PreTestTotalMeanScoreOfTraditionalViewForPARTS123	-.95966	2.66941	.47189	-1.92209	.00277	-2.034	31	.051

The Descriptive Statistics Frequencies Results For

1- **Pre-test Mean Score and Std. Deviation For Part4 The Use Of Logo Programming Language.**

Frequencies

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Statistics

PreTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage

N	Valid	32
	Missing	0
Mean		3.4844
Std. Deviation		.65205

PreTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.92	1	3.1	3.1	3.1
	3.00	10	31.3	31.3	34.4
	3.04	3	9.4	9.4	43.8
	3.08	1	3.1	3.1	46.9
	3.12	1	3.1	3.1	50.0
	3.15	2	6.3	6.3	56.3
	3.23	1	3.1	3.1	59.4
	3.42	1	3.1	3.1	62.5
	3.54	1	3.1	3.1	65.6
	3.62	1	3.1	3.1	68.8
	3.65	1	3.1	3.1	71.9
	3.69	1	3.1	3.1	75.0
	3.88	1	3.1	3.1	78.1
	4.00	1	3.1	3.1	81.3
	4.23	1	3.1	3.1	84.4
	4.31	1	3.1	3.1	87.5
	4.50	1	3.1	3.1	90.6
	4.92	1	3.1	3.1	93.8
	4.96	1	3.1	3.1	96.9
	5.00	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

2- **Pre-test Mean Score and Std. Deviation For Part5 The Use Of ICT**

Frequencies

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Statistics

PreTestMeanScoreForPart5TheUseOfICT

N	Valid	32
	Missing	0
Mean		3.4531
Std. Deviation		.52723

PreTestMeanScoreForPart5TheUseOfICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.75	2	6.3	6.3	6.3
	2.83	1	3.1	3.1	9.4
	2.88	1	3.1	3.1	12.5
	2.96	1	3.1	3.1	15.6
	3.00	3	9.4	9.4	25.0
	3.04	1	3.1	3.1	28.1
	3.08	3	9.4	9.4	37.5
	3.17	1	3.1	3.1	40.6
	3.21	1	3.1	3.1	43.8
	3.25	2	6.3	6.3	50.0
	3.29	1	3.1	3.1	53.1
	3.38	1	3.1	3.1	56.3
	3.50	1	3.1	3.1	59.4
	3.63	2	6.3	6.3	65.6
	3.71	1	3.1	3.1	68.8
	3.75	1	3.1	3.1	71.9
	3.79	2	6.3	6.3	78.1
	3.96	1	3.1	3.1	81.3
	4.00	1	3.1	3.1	84.4
	4.13	1	3.1	3.1	87.5
	4.25	1	3.1	3.1	90.6
	4.29	1	3.1	3.1	93.8
	4.38	1	3.1	3.1	96.9
	4.71	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Post-test Questionnaire Data Analysis output

The Paired-Samples t-test Results For

1- **Post-test Mean Score For Part1 Nature of Mathematics Constructivist View WITH Post-test Mean Score For Part1 Nature Of Mathematics Traditional View**

T-Test

```
[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PostTestMeanScoreForPart1NatureOfMathematicsConstructivistView	4.1531	32	.35466	.06270
	PostTestMeanScoreForPart1NatureOfMathematicsTraditionalView	3.1625	32	.41251	.07292

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PostTestMeanScoreForPart1NatureOfMathematicsConstructivistView & PostTestMeanScoreForPart1NatureOfMathematicsTraditionalView	32	-.297	.099

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PostTestMeanScoreForPart1NatureOfMathematicsConstructivistView - PostTestMeanScoreForPart1NatureOfMathematicsTraditionalView	.99063	.61872	.10938	.76755	1.21370	9.057	31	.000

2- **Post-test Mean Score For Part2 Teaching Of Mathematics Constructivist View WITH Post-test Mean Score For Part2 Teaching Of Mathematics Traditional View**

T-Test

```
[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PostTestMeanScoreForPart2TeachingOfMathematicsConstructivistView	4.1781	32	.31799	.05621
	PostTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	3.1156	32	.57029	.10081

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PostTestMeanScoreForPart2TeachingOfMathematicsConstructivistView & PostTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	32	-.163	.371

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PostTestMeanScoreForPart2TeachingOfMathematicsConstructivistView - PostTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	1.06250	.69688	.12319	.81125	1.31375	8.625	31	.000

3- **Post-test Mean Score For Part3 Learning Of Mathematics Constructivist View WITH Post-test Mean Score For Part3 Learning Of Mathematics Traditional View.**

T-Test

```
[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PostTestMeanScoreForPart3LearningOfMathematicsConstructivistView	4.2281	32	.30079	.05317
	PostTestMeanScoreForPart3LearningOfMathematicsTraditionalView	3.3636	32	.48215	.08523

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PostTestMeanScoreForPart3LearningOfMathematicsConstructivistView & PostTestMeanScoreForPart3LearningOfMathematicsTraditionalView	32	-.117	.523

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PostTestMeanScoreForPart3LearningOfMathematicsConstructivistView - PostTestMeanScoreForPart3LearningOfMathematicsTraditionalView	.86449	.59746	.10562	.64908	1.07990	8.185	31	.000

4- **Post-test Total Mean Score Of Constructivist View For PARTS 1,2 and 3 WITH Post-test Total Mean Score Of Traditional View For PARTS 1,2 and 3**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PostTestTotalScoreMeanOfConstructivistViewForPARTS123	12.5594	32	.78980	.13962
	PostTestTotalMeanScoreOfTraditionalViewForPARTS123	9.6418	32	1.15978	.20502

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PostTestTotalScoreMeanOfConstructivistViewForPARTS123 & PostTestTotalMeanScoreOfTraditionalViewForPARTS123	32	-.272	.132

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PostTestTotalScoreMeanOfConstructivistViewForPARTS123 - PostTestTotalMeanScoreOfTraditionalViewForPARTS123	2.91761	1.57060	.27764	2.35135	3.48387	10.508	31	.000

The Descriptive Statistics Frequencies Results For

1- **Post-test Mean Score and Std. Deviation For Part4 The Use Of Logo Programming Language.**

Frequencies

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Statistics

PostTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage

N	Valid	32
	Missing	0
Mean		4.1178
Std. Deviation		.55260

PostTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	1	3.1	3.1	3.1
	3.08	1	3.1	3.1	6.3
	3.12	1	3.1	3.1	9.4
	3.35	1	3.1	3.1	12.5
	3.50	1	3.1	3.1	15.6
	3.54	1	3.1	3.1	18.8
	3.62	1	3.1	3.1	21.9
	3.73	1	3.1	3.1	25.0
	3.85	1	3.1	3.1	28.1
	3.92	3	9.4	9.4	37.5
	3.96	2	6.3	6.3	43.8
	4.04	1	3.1	3.1	46.9
	4.15	1	3.1	3.1	50.0
	4.19	1	3.1	3.1	53.1
	4.23	1	3.1	3.1	56.3
	4.27	1	3.1	3.1	59.4
	4.35	1	3.1	3.1	62.5
	4.38	1	3.1	3.1	65.6
	4.46	2	6.3	6.3	71.9
	4.62	2	6.3	6.3	78.1
	4.65	1	3.1	3.1	81.3
	4.69	2	6.3	6.3	87.5
	4.73	1	3.1	3.1	90.6
	4.85	1	3.1	3.1	93.8
	4.92	1	3.1	3.1	96.9
	5.00	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

2- Post-test Mean Score and Std. Deviation For Part5 The Use Of ICT

Frequencies

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Statistics

PostTestMeanScoreForPart5TheUseOfICT

N	Valid	32
	Missing	0
Mean		3.9388
Std. Deviation		.51315

PostTestMeanScoreForPart5TheUseOfICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.92	1	3.1	3.1	3.1
	3.17	2	6.3	6.3	9.4
	3.21	1	3.1	3.1	12.5
	3.29	2	6.3	6.3	18.8
	3.46	1	3.1	3.1	21.9
	3.50	1	3.1	3.1	25.0
	3.58	1	3.1	3.1	28.1
	3.75	4	12.5	12.5	40.6
	3.83	1	3.1	3.1	43.8
	3.92	3	9.4	9.4	53.1
	4.00	1	3.1	3.1	56.3
	4.08	1	3.1	3.1	59.4
	4.17	1	3.1	3.1	62.5
	4.21	1	3.1	3.1	65.6
	4.25	1	3.1	3.1	68.8
	4.29	1	3.1	3.1	71.9
	4.38	2	6.3	6.3	78.1
	4.42	2	6.3	6.3	84.4
	4.54	2	6.3	6.3	90.6
	4.67	1	3.1	3.1	93.8
	4.75	1	3.1	3.1	96.9
	4.79	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Pre-test and Post-test Questionnaire Data Analysis output

The Paired-Samples t-test Results For

1- **Pre-test Mean Score For Part1 Nature Of Mathematics Constructivist View WITH Post-test Mean Score For Part1 Nature Of Mathematics Constructivist View**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsConstructivistView	3.5875	32	.51726	.09144
	PostTestMeanScoreForPart1NatureOfMathematicsConstructivistView	4.1531	32	.35468	.06270

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsConstructivistView & PostTestMeanScoreForPart1NatureOfMathematicsConstructivistView	32	.331	.064

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsConstructivistView - PostTestMeanScoreForPart1NatureOfMathematicsConstructivistView	-.56562	.52154	.09220	-.75366	-.37759	-6.135	31	.000

2- **Pre-test Mean Score For Part1 Nature Of Mathematics Traditional View WITH Post-test Mean Score For Part1 Nature Of Mathematics Traditional View.**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsTraditionalView	3.8813	32	.39221	.06933
	PostTestMeanScoreForPart1NatureOfMathematicsTraditionalView	3.1625	32	.41251	.07292

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsTraditionalView & PostTestMeanScoreForPart1NatureOfMathematicsTraditionalView	32	.065	.723

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart1NatureOfMathematicsTraditionalView - PostTestMeanScoreForPart1NatureOfMathematicsTraditionalView	.71875	.55033	.09729	.52033	.91717	7.388	31	.000

3- **Pre-test Mean Score For Part2 Teaching Of Mathematics Constructivist View WITH Post-test Mean Score For Part2 Teaching Of Mathematics Constructivist View**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsConstructivistView	3.6969	32	.76009	.13437
	PostTestMeanScoreForPart2TeachingOfMathematicsConstructivistView	4.1781	32	.31799	.05621

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsConstructivistView & PostTestMeanScoreForPart2TeachingOfMathematicsConstructivistView	32	.253	.162

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsConstructivistView - PostTestMeanScoreForPart2TeachingOfMathematicsConstructivistView	-.48125	.74593	.13186	-.75019	-.21231	-3.650	31	.001

4- **Pre-test Mean Score For Part2 Teaching Of Mathematics Traditional View WITH Post Test Mean Score For Part2 Teaching Of Mathematics Traditional View**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	4.0750	32	.55474	.09807
	PostTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	3.1156	32	.57029	.10081

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsTraditionalView & PostTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	32	.658	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart2TeachingOfMathematicsTraditionalView - PostTestMeanScoreForPart2TeachingOfMathematicsTraditionalView	.95937	.46549	.08229	.79155	1.12720	11.659	31	.000

5- **Pre-test Mean Score For Part3 Learning Of Mathematics Constructivist View WITH Post-test Mean Score For Part3 Learning Of Mathematics Constructivist View**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsConstructivistView	3.8344	32	.67662	.11961
	PostTestMeanScoreForPart3LearningOfMathematicsConstructivistView	4.2281	32	.30079	.05317

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsConstructivistView & PostTestMeanScoreForPart3LearningOfMathematicsConstructivistView	32	.353	.047

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsConstructivistView - PostTestMeanScoreForPart3LearningOfMathematicsConstructivistView	-.39375	.63598	.11243	-.62305	-.16445	-3.502	31	.001

6- **Pre-test Mean Score For Part3 Learning Of Mathematics Traditional View WITH Post-test Mean Score For Part3 Learning Of Mathematics Traditional View**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsTraditionalView	4.1222	32	.36627	.06475
	PostTestMeanScoreForPart3LearningOfMathematicsTraditionalView	3.3636	32	.48215	.08523

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsTraditionalView & PostTestMeanScoreForPart3LearningOfMathematicsTraditionalView	32	.243	.180

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart3LearningOfMathematicsTraditionalView - PostTestMeanScoreForPart3LearningOfMathematicsTraditionalView	.75852	.52989	.09367	.56748	.94957	8.098	31	.000

7- **Pre-test Mean Score For Part4 The Use Of Logo Programming Language WITH Post-test Mean Score For Part4 The Use Of Logo Programming Language**

T-Test

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[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav
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Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage	3.4844	32	.65205	.11527
	PostTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage	4.1178	32	.55280	.09772

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage & PostTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage	32	.404	.022

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage - PostTestMeanScoreForPart4TheUseOfLogoProgrammingLanguage	-.63341	.66316	.11723	-.87251	-.39432	-5.403	31	.000

8- Pre-test Mean Score For Part5 The Use Of ICT WITH Post-test Mean Score For Part5 The Use Of ICT

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestMeanScoreForPart5TheUseOfICT	3.4531	32	.52723	.09320
	PostTestMeanScoreForPart5TheUseOfICT	3.9388	32	.51315	.09071

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestMeanScoreForPart5TheUseOfICT & PostTestMeanScoreForPart5TheUseOfICT	32	.385	.029

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestMeanScoreForPart5TheUseOfICT - PostTestMeanScoreForPart5TheUseOfICT	-.48568	.57683	.10197	-.69365	-.27771	-4.763	31	.000

9- **Pre-test Total Mean Score Of Constructivist View For PARTS 1,2 and 3 WITH Post-test Total Mean Score Of Constructivist View For PARTS 1,2 and 3**

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestTotalMeanScoreOfConstructivistViewForPARTS123	11.1188	32	1.79200	.31678
	PostTestTotalMeanScoreOfConstructivistViewForPARTS123	12.5594	32	.78980	.13962

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestTotalMeanScoreOfConstructivistViewForPARTS123 & PostTestTotalMeanScoreOfConstructivistViewForPARTS123	32	.385	.029

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestTotalMeanScoreOfConstructivistViewForPARTS123 - PostTestTotalMeanScoreOfConstructivistViewForPARTS123	-1.44063	1.65663	.29285	-2.03790	-.84335	-4.919	31	.000

10- Pre-test Total Mean Score Of Traditional View For PARTS 1, 2 and 3 WITH Post-test Total Mean Score Of Traditional View For PARTS 1, 2 and 3

T-Test

[DataSet1] C:\Documents and Settings\n0182005\Desktop\PRE AND POST QUESTIONNARE DATA ANALYSIS.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTestTotalMeanScoreOfTraditionalViewForPARTS123	12.0784	32	1.13909	.20136
	PostTestTotalMeanScoreOfTraditionalViewForPARTS123	9.6418	32	1.15978	.20502

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTestTotalMeanScoreOfTraditionalViewForPARTS123 & PostTestTotalMeanScoreOfTraditionalViewForPARTS123	32	.506	.003

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PreTestTotalMeanScoreOfTraditionalViewForPARTS123 - PostTestTotalMeanScoreOfTraditionalViewForPARTS123	2.43665	1.14307	.20207	2.02453	2.84877	12.059	31	.000

Appendix J

The Raw Frequencies for Pre-test Questionnaire Statements

Belief Questionnaire

Instructions: For each item, please circle one number that indicates how you feel about the statement as indicated below.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
SA	A	U	D	SD

Part I. Nature of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Mathematics is an evolving, creative human endeavor in which there is much yet to be known.	3	7	15	7	0
2.	Mathematicians are hired mainly to make precise measurement and calculations for scientist and other people.	20	10	1	0	1
3.	There are often many approaches to solve a mathematics problem.	11	15	5	1	0
4.	In mathematics something is either right or it is wrong.	16	13	3	0	0
5.	Mathematics involves relating many different ideas and topics.	8	12	9	3	0
6.	Mathematics problems can be solved in only one approach.	0	4	8	10	10
7.	The mathematical ideas can be explained in everyday words that anyone can understand.	3	10	15	3	1
8.	Mathematics consists of unrelated ideas and topics.	3	9	4	11	5
9.	In different cultures around the world there are different models of mathematics.	6	6	14	5	1
10.	In mathematics, perhaps more than other areas, one can find set routines and procedure.	12	16	3	1	0
11.	Everything important about mathematics is already known by mathematicians.	15	11	4	2	0
12.	Solving a mathematics problem usually involves finding a rule or formula that applies.	15	15	2	0	0
13.	Many of the important functions of mathematician are being taken to provide a foundation for information and communication technology.	2	11	13	6	0
14.	Doing mathematics frequently involves exploration.	4	15	10	3	0

No.	Statement	SA	A	U	D	SD
15.	Mathematics is a rigid discipline which functions strictly according to inescapable rules.	11	11	3	6	1
16.	Mathematics has so many applications because its models can be interpreted in so many ways.	7	13	6	6	0
17.	In mathematics, perhaps more than in other fields, one can display originality and ingenuity.	5	11	14	2	0
18.	Mathematics is essentially the same all over the world.	13	17	2	0	0
19.	Doing mathematics involves creativity, thinking, and trial-and-error.	11	10	9	2	0
20.	The mathematical ideas can be explained only by technical mathematical language and special terms.	10	15	3	3	1

Part II. Teaching of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Teacher should show students the exact approach to answerer the mathematics question.	17	12	1	1	1
2.	The teacher must always present the content in a highly structured manner or follows the lesson plan as closely as possible.	21	7	3	1	0
3.	Good mathematics teaching involves class discussion in which students share thoughts and discuss meaning.	9	15	4	4	0
4.	Good mathematics teachers always plan for students to work individually to practise mathematics.	13	8	6	5	0
5.	The teacher should consistently provide students the opportunity to discover concepts and procedures for themselves.	8	13	6	4	1
6.	Information and communication technology is an essential aspect of good mathematics teaching.	7	6	17	2	0
7.	Mathematics teacher should consistently give assignments which require research and original thinking.	4	16	7	5	0
8.	Teachers should provide examples of problem solutions and help students learn to replicate them when doing problems.	28	4	0	0	0
9.	The teacher should always devote time to allow students to find their own methods for solving problems.	8	11	9	4	0

No.	Statement	SA	A	U	D	SD
10.	Good mathematics teachers often consider the student preferences when planning lessons.	9	7	7	8	1
11.	Teachers should show students lots of different approaches to look at the same questions.	13	9	8	2	0
12.	Good mathematics teachers only teach what is essential for mathematics exams.	6	7	6	5	8
13.	Good mathematics instructions progress in planed step-by-step sequence towards the lesson objectives.	18	7	4	3	0
14.	Good mathematics teachers always work sample problems for students before making an assignment.	20	12	0	0	0
15.	Mathematics teachers' role is to provide student with activities that encourage them to wonder about and explore mathematics.	14	8	6	4	0
16.	Good mathematics teachers always show students the quickest way of solving a mathematics problem.	10	13	5	4	0
17.	Mathematics teacher must make assignments on just that which has been thoroughly discussed in classroom.	14	8	6	2	2
18.	Good mathematics teachers frequently give student assignments which require creative or investigative work.	4	8	11	8	1
19.	Class discussions, collaborative and cooperative group work are important aspects of good mathematics teaching.	11	8	8	5	0
20.	Good mathematics teachers plans so that students regularly spend time working without information and communication technology to practice doing mathematics.	9	4	13	5	1

Part III. Learning of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Students who have access to information and communication technology learn to depend on them and do not learn mathematics properly.	11	8	7	4	2
2.	Information and communication technology is essential tool for investigation, examination, construction and consolidation of ideas when students learning mathematics.	2	13	14	3	0

No.	Statement	SA	A	U	D	SD
3.	Students must be encouraged to develop and build their own mathematical ideas and procedures, even if their attempts contain much trail and error.	10	11	10	1	0
4.	Learning mathematics is a process in which students absorb information, storing it in easily retrievable fragment as a result of repeated practice and reinforcement.	23	8	0	1	0
5.	Use of physical tools and real life examples to introduce mathematics ideas is an important component of learning mathematics.	15	10	5	2	0
6.	Teachers must value times of uncertainty, conflict and surprise when students are learning mathematics.	9	9	11	3	0
7.	Understanding mathematical ideas and procedures is important in mathematics learning.	11	10	3	8	0
8.	Mathematics learning is improved if students are encouraged to use their own interpretation of ideas and their own procedures.	7	15	7	3	0
9.	Teachers centered and students' individual work is essential in mathematics learning.	14	12	6	0	0
10.	Students can learn mathematics out of school while participating in ordinary everyday activities.	6	17	6	3	0
11.	Students' mathematics mistakes always reflect their current understandings of ideas or procedures.	7	8	12	5	0
12.	Mathematics learning is all about learning to get the right answer.	15	16	1	0	0
13.	Student best learn mathematics by being shown the correct ways to interpret mathematical symbols, situations and procedures.	13	19	0	0	0
14.	Students' mathematics errors are usually resulting of lack of practice.	14	13	5	0	0
15.	Mathematics is learnt in schools only.	2	2	6	12	10
16.	Students learn mathematics best if they are shown clear, precise step-by-step procedures for doing mathematics.	19	11	1	1	0
17.	Learning mathematics should be an active process.	14	11	5	2	0
18.	A memory of mathematical facts and procedures is essential for mathematics learning.	14	17	1	0	0

No.	Statement	SA	A	U	D	SD
19.	A quiet classroom is generally needed for effective mathematics learning.	12	13	5	2	0
20.	Argumentation, proving, problem solving, and collaboration among students and between students and teachers is essential in mathematics learning.	14	9	3	6	0
21.	Practicing many problems is the best way for students to learn mathematics.	18	11	2	1	0

Part IV. Logo Programming language

No.	Statement	SA	A	U	D	SD
1.	Mathematics is more interested and motivated with Logo.	6	8	18	0	0
2.	Using Logo to solve mathematics problems makes the problems easier to understand.	3	10	19	0	0
3.	Doing mathematics with Logo is enjoyable.	4	8	20	0	0
4.	Mathematics is more understandable with Logo.	5	5	22	0	0
5.	Logo is essentials for construct mathematical models and ideas.	3	7	22	0	0
6.	Sophisticated mathematical concepts are made accessible by Logo.	3	6	23	0	0
7.	Logo is important for mathematical exploration.	3	5	23	1	0
8.	Mathematics is easier if Logo is used to do mathematics.	3	10	19	0	0
9.	Logo can help students to learn the process of mathematics (e.g. the general strategies of problem-solving).	4	10	18	0	0
10.	Logo promotes personal skills (e.g. collaboration and cooperation).	5	6	21	0	0
11.	Interest in mathematics creativity is aroused with Logo mathematical activities.	4	6	22	0	0
12.	Logo can support the way learners construct their own learning.	5	5	21	1	0
13.	Logo stimulates mathematics thinking and reasoning.	3	7	22	0	0
14.	Logo is significant to improve quality of mathematics teaching.	4	4	22	2	0
15.	Logo will help me with my teaching profession.	6	6	19	1	0
16.	The use of Logo will give me the opportunity to be learning facilitator instead of information provider.	5	3	24	0	0

No.	Statement	SA	A	U	D	SD
17.	Logo encourages new teaching and learning styles (e.g. investigations discussion and cooperative group work).	4	7	21	0	0
18.	Teaching mathematics with Logo makes me more competent and confident.	5	5	22	0	0
19.	Using Logo enable me to be creative teacher.	5	7	20	0	0
20.	Logo will dramatically improve my method of teaching.	4	6	21	1	0
21.	Logo would enrich my instruction with creative activities.	6	6	20	0	0
22.	The use of Logo in schools is generally needed for learning mathematics better.	6	4	21	1	0
23.	Learning more about Logo is worthwhile.	8	6	18	0	0
24.	I look forward to using Logo in mathematics instruction.	9	7	15	1	0
25.	Mathematics instruction would be very interesting with Logo.	7	6	18	1	0
26.	Logo will make my instruction difficult to manage.	3	7	21	1	0

Part V. Information and Communication Technology (ICT)

No.	Statement	SA	A	U	D	SD
1.	ICT would motivate students to explore learning.	4	9	12	5	2
2.	ICT will improve the overall quality of education.	6	6	16	4	0
3.	Teacher training programs should incorporate ICT instructional applications.	6	10	15	1	0
4.	ICT can be useful instructional aid in almost all subject areas.	5	11	9	6	1
5.	The use of ICT reduces interaction and collaboration between learners.	0	13	15	2	2
6.	ICT can not enhance remedial education.	2	8	19	3	0
7.	Using ICT would change the teachers' role from information provider to learner facilitator.	5	5	18	4	0
8.	ICT is not an affective instructional tool for students of all abilities.	0	11	14	5	2
9.	Using ICT will improve students' attitudes towards schooling.	5	10	15	2	0
10.	ICT helps teachers organize, control and save time in schools' responsibility.	3	13	9	7	0
11.	ICT stifle creativity among learners.	3	9	15	4	1

No.	Statement	SA	A	U	D	SD
12.	Using ICT offers teachers and learners new ways to approach mathematics (e.g. the introduction of more problem-solving, investigation and mathematical discussion).	5	9	15	3	0
13.	ICT can support the variety of ways learners construct their own knowledge and skills.	1	15	9	7	0
14.	The frustrations created by ICT are more trouble than they are worth.	2	6	18	4	2
15.	Colleges' educators need to know how to use and incorporate ICT as instructional tools.	7	11	14	0	0
16.	Learning about how to use ICT is boring to me.	8	12	6	2	4
17.	I feel comfortable utilizing ICT.	7	14	6	5	0
18.	Using ICT makes me feel tense and uncomfortable.	10	11	7	4	0
19.	The use of ICT will negative affect my instruction proficiencies.	9	9	10	3	1
20.	I believe I could teach using ICT.	5	5	20	2	0
21.	I would like to learn to use ICT in my instruction.	9	16	6	1	0
22.	Learning more about incorporating ICT in teaching is worthwhile.	9	16	7	0	0
23.	All teachers should use ICT.	5	4	13	10	0
24.	The use of ICT in schools will affect negative students' attitudes toward learning.	1	6	16	7	2

Thank you again for your participation. ☺

Appendix K

The Raw Frequencies for Post-test Questionnaire Statements

Belief Questionnaire

Instructions: For each item, please circle one number that indicates how you feel about the statement as indicated below.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
SA	A	U	D	SD

Part I. Nature of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Mathematics is an evolving, creative human endeavor in which there is much yet to be known.	12	18	2	0	0
2.	Mathematicians are hired mainly to make precise measurement and calculations for scientist and other people.	8	7	6	10	1
3.	There are often many approaches to solve a mathematics problem.	13	16	3	0	0
4.	In mathematics something is either right or it is wrong.	15	7	7	2	1
5.	Mathematics involves relating many different ideas and topics.	14	17	1	0	0
6.	Mathematics problems can be solved in only one approach.	1	2	1	20	8
7.	The mathematical ideas can be explained in everyday words that anyone can understand.	3	21	6	2	0
8.	Mathematics consists of unrelated ideas and topics.	0	0	3	20	9
9.	In different cultures around the world there are different models of mathematics.	4	14	8	5	1
10.	In mathematics, perhaps more than other areas, one can find set routines and procedure.	5	12	7	7	1
11.	Everything important about mathematics is already known by mathematicians.	9	12	8	2	1
12.	Solving a mathematics problem usually involves finding a rule or formula that applies.	12	17	1	2	0
13.	Many of the important functions of mathematician are being taken to provide a foundation for information and communication technology.	10	16	6	0	0
14.	Doing mathematics frequently involves exploration.	10	18	2	1	1

No.	Statement	SA	A	U	D	SD
15.	Mathematics is a rigid discipline which functions strictly according to inescapable rules.	2	2	7	14	7
16.	Mathematics has so many applications because its models can be interpreted in so many ways.	12	19	1	0	0
17.	In mathematics, perhaps more than in other fields, one can display originality and ingenuity.	11	17	4	0	0
18.	Mathematics is essentially the same all over the world.	17	10	4	1	0
19.	Doing mathematics involves creativity, thinking, and trial-and-error.	15	17	0	0	0
20.	The mathematical ideas can be explained only by technical mathematical language and special terms.	0	5	6	16	5

Part II. Teaching of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Teacher should show students the exact approach to answerer the mathematics question.	5	9	4	12	2
2.	The teacher must always present the content in a highly structured manner or follows the lesson plan as closely as possible.	7	3	6	15	1
3.	Good mathematics teaching involves class discussion in which students share thoughts and discuss meaning.	14	18	0	0	0
4.	Good mathematics teachers always plan for students to work individually to practise mathematics.	6	12	6	8	0
5.	The teacher should consistently provide students the opportunity to discover concepts and procedures for themselves.	10	21	1	0	0
6.	Information and communication technology is an essential aspect of good mathematics teaching.	9	18	5	0	0
7.	Mathematics teacher should consistently give assignments which require research and original thinking.	9	20	2	1	0
8.	Teachers should provide examples of problem solutions and help students learn to replicate them when doing problems.	14	9	4	5	0
9.	The teacher should always devote time to allow students to find their own methods for solving problems.	12	20	0	0	0

No.	Statement	SA	A	U	D	SD
10.	Good mathematics teachers often consider the student preferences when planning lessons.	6	21	2	3	0
11.	Teachers should show students lots of different approaches to look at the same questions.	9	21	2	0	0
12.	Good mathematics teachers only teach what is essential for mathematics exams.	1	1	4	22	4
13.	Good mathematics instructions progress in planed step-by-step sequence towards the lesson objectives.	9	8	6	7	2
14.	Good mathematics teachers always work sample problems for students before making an assignment.	9	12	4	6	1
15.	Mathematics teachers' role is to provide student with activities that encourage them to wonder about and explore mathematics.	12	19	1	0	0
16.	Good mathematics teachers always show students the quickest way of solving a mathematics problem.	6	5	4	13	4
17.	Mathematics teacher must make assignments on just that which has been thoroughly discussed in classroom.	5	4	7	14	2
18.	Good mathematics teachers frequently give student assignments which require creative or investigative work.	5	15	9	3	0
19.	Class discussions, collaborative and cooperative group work are important aspects of good mathematics teaching.	11	18	2	1	0
20.	Good mathematics teachers plans so that students regularly spend time working without information and communication technology to practice doing mathematics.	3	1	8	17	3

Part III. Learning of Mathematics

No.	Statement	SA	A	U	D	SD
1.	Students who have access to information and communication technology learn to depend on them and do not learn mathematics properly.	1	3	8	16	4
2.	Information and communication technology is essential tool for investigation, examination, construction and consolidation of ideas when students learning mathematics.	5	21	6	0	0

No.	Statement	SA	A	U	D	SD
3.	Students must be encouraged to develop and build their own mathematical ideas and procedures, even if their attempts contain much trail and error.	19	12	1	0	0
4.	Learning mathematics is a process in which students absorb information, storing it in easily retrievable fragment as a result of repeated practice and reinforcement.	5	9	5	12	1
5.	Use of physical tools and real life examples to introduce mathematics ideas is an important component of learning mathematics.	15	15	2	0	0
6.	Teachers must value times of uncertainty, conflict and surprise when students are learning mathematics.	12	16	4	0	0
7.	Understanding mathematical ideas and procedures is important in mathematics learning.	9	22	1	0	0
8.	Mathematics learning is improved if students are encouraged to use their own interpretation of ideas and their own procedures.	15	12	5	0	0
9.	Teachers centered and students' individual work is essential in mathematics learning.	2	11	6	10	3
10.	Students can learn mathematics out of school while participating in ordinary everyday activities.	6	26	0	0	0
11.	Students' mathematics mistakes always reflect their current understandings of ideas or procedures.	2	19	9	2	0
12.	Mathematics learning is all about learning to get the right answer.	8	18	4	2	0
13.	Student best learn mathematics by being shown the correct ways to interpret mathematical symbols, situations and procedures.	9	16	4	3	0
14.	Students' mathematics errors are usually resulting of lack of practice.	8	15	5	4	0
15.	Mathematics is learnt in schools only.	1	1	2	15	13
16.	Students learn mathematics best if they are shown clear, precise step-by-step procedures for doing mathematics.	6	14	4	5	3
17.	Learning mathematics should be an active process.	10	20	2	0	0
18.	A memory of mathematical facts and procedures is essential for mathematics learning.	7	20	2	2	1

No.	Statement	SA	A	U	D	SD
19.	A quiet classroom is generally needed for effective mathematics learning.	13	7	5	3	4
20.	Argumentation, proving, problem solving, and collaboration among students and between students and teachers is essential in mathematics learning.	16	14	2	0	0
21.	Practicing many problems is the best way for students to learn mathematics.	8	14	4	6	0

Part IV. Logo Programming language

No.	Statement	SA	A	U	D	SD
1.	Mathematics is more interested and motivated with Logo.	9	20	3	0	0
2.	Using Logo to solve mathematics problems makes the problems easier to understand.	7	18	6	1	0
3.	Doing mathematics with Logo is enjoyable.	10	19	2	1	0
4.	Mathematics is more understandable with Logo.	8	18	5	1	0
5.	Logo is essentials for construct mathematical models and ideas.	9	15	7	1	0
6.	Sophisticated mathematical concepts are made accessible by Logo.	11	15	5	1	0
7.	Logo is important for mathematical exploration.	7	19	5	1	0
8.	Mathematics is easier if Logo is used to do mathematics.	10	15	6	1	0
9.	Logo can help students to learn the process of mathematics (e.g. the general strategies of problem-solving).	9	20	2	1	0
10.	Logo promotes personal skills (e.g. collaboration and cooperation).	15	15	2	0	0
11.	Interest in mathematics creativity is aroused with Logo mathematical activities.	9	18	4	1	0
12.	Logo can support the way learners construct their own learning.	11	13	8	0	0
13.	Logo stimulates mathematics thinking and reasoning.	13	18	1	0	0
14.	Logo is significant to improve quality of mathematics teaching.	10	17	3	1	0
15.	Logo will help me with my teaching profession.	10	17	4	1	0
16.	The use of Logo will give me the opportunity to be learning facilitator instead of information provider.	11	16	5	0	0

No.	Statement	SA	A	U	D	SD
17.	Logo encourages new teaching and learning styles (e.g. investigations discussion and cooperative group work).	16	12	4	0	0
18.	Teaching mathematics with Logo makes me more competent and confident.	10	14	6	2	0
19.	Using Logo enable me to be creative teacher.	15	9	6	2	0
20.	Logo will dramatically improve my method of teaching.	9	16	6	1	0
21.	Logo would enrich my instruction with creative activities.	14	15	3	0	0
22.	The use of Logo in schools is generally needed for learning mathematics better.	11	15	5	1	0
23.	Learning more about Logo is worthwhile.	15	13	4	0	0
24.	I look forward to using Logo in mathematics instruction.	9	16	3	4	0
25.	Mathematics instruction would be very interesting with Logo.	10	18	4	0	0
26.	Logo will make my instruction difficult to manage.	6	10	9	4	3

Part V. Information and Communication Technology (ICT)

No.	Statement	SA	A	U	D	SD
1.	ICT would motivate students to explore learning.	10	18	4	0	0
2.	ICT will improve the overall quality of education.	9	19	4	0	0
3.	Teacher training programs should incorporate ICT instructional applications.	11	18	3	0	0
4.	ICT can be useful instructional aid in almost all subject areas.	13	16	3	0	0
5.	The use of ICT reduces interaction and collaboration between learners.	3	18	6	3	2
6.	ICT can not enhance remedial education.	3	15	10	3	1
7.	Using ICT would change the teachers' role from information provider to learner facilitator.	12	16	3	1	0
8.	ICT is not an affective instructional tool for students of all abilities.	2	10	13	6	1
9.	Using ICT will improve students' attitudes towards schooling.	9	18	5	0	0
10.	ICT helps teachers organize, control and save time in schools' responsibility.	8	19	4	1	0
11.	ICT stifle creativity among learners.	5	13	7	4	3

No.	Statement	SA	A	U	D	SD
12.	Using ICT offers teachers and learners new ways to approach mathematics (e.g. the introduction of more problem-solving, investigation and mathematical discussion).	11	16	4	1	0
13.	ICT can support the variety of ways learners construct their own knowledge and skills.	12	19	1	0	0
14.	The frustrations created by ICT are more trouble than they are worth.	4	10	9	6	3
15.	Colleges' educators need to know how to use and incorporate ICT as instructional tools.	20	11	1	0	0
16.	Learning about how to use ICT is boring to me.	10	12	5	3	2
17.	I feel comfortable utilizing ICT.	14	13	2	2	1
18.	Using ICT makes me feel tense and uncomfortable.	5	18	5	4	0
19.	The use of ICT will negative affect my instruction proficiencies.	4	17	7	3	1
20.	I believe I could teach using ICT.	13	9	7	3	0
21.	I would like to learn to use ICT in my instruction.	14	12	4	2	0
22.	Learning more about incorporating ICT in teaching is worthwhile.	17	11	4	0	0
23.	All teachers should use ICT.	13	5	8	6	0
24.	The use of ICT in schools will affect negative students' attitudes toward learning.	10	8	7	6	1

Thank you again for your participation. ☺

Appendix L

Sample Transcript of Interview

(English and Arabic Version)

Day: Sunday

Date: 30 – 09- 2007

Subject: Pre- interview

Researcher: In the beginning, I would like to welcome and thank you for participating in the interview and the study. Before starting, please read this letter about your participation in the interview and then sign it.

Researcher: Thank you, shall we start?

Student D: Yes.

Researcher: How would you describe mathematics?

Student D: I consider mathematics rules and procedures; it is an active subject for the brain and broadens thinking. As when the brain works with this subject it does not think in one point but thinks on other points to reach a solution for the point he thinks about. That is when I solve a mathematical problem I recall previous things so that I can solve this problem.

Researcher: In your opinion, how mathematical concepts (e.g. computation, geometry, algebra, etc.) are best learned?

Student D: To learn mathematics we should learn by rote learning but not always. We should also learn through discussion. As well as use of models like shapes and cubes to understand the rule in a better way.

Researcher: How do you think mathematics should be taught?

Student D: I think learning mathematics can be done by explains the topic slowly step by step, with the use of visual aides, making sure the students understand and ask students to use pencil and papers to solve the problems.

Researcher: Rote learning, do you see another way?

Student D: learning through discussion, Discuses with the students, explain though the use of visual aids, and asks students not to follow only the approach the teacher provided to solve the problem; on the contrary he will accept any approach as long as the answer is correct.

Researcher: What do you think about the use of Logo as an ICT tool for the teaching and learning of mathematics?

Student D: I do not know.

Researcher: Haven't you used it before?

Student D: No I did not use it before.

Researcher: In your opinion, what do you consider to be the advantage / disadvantage of the use of Logo in teaching and learning mathematics?

Student D: I do not know.

Researcher: What do you think about the use of ICT for teaching and learning mathematics?

Student D: It is useful.

Researcher: How?

Student D: The teacher prepares for the lesson using an aids such as Power presentation, and uses it when teaching. This attracts students' attention and makes them interact with the lesson.

Researcher: So you see it positively.

Student D: Yes.

Researcher: You may still recall some memories about one or more mathematics teachers, what was so special about him / her?

Student D: I remember one of my teachers in grade seven used to demonstrate a problem using PowerPoint, and solved the problem slowly step by step making sure that we understood. After that she would demonstrate another problem and would uses discussion to arrive at the answer.

Researcher: What about the way of solution?

Student D: She did not hold on to one way for solving a problem, my teacher used to ask and encourage students to use different approaches as long as the answer is correct.

Researcher: So what she was concerned about was the steps and the final correct answer, do you like this procedure and would like to use it while teaching?

Student D: Yes, I like it and I like to apply it for all stages.

Researcher: Do you see it an acceptable way?

Student D: Yes, as it is attracts student's attention and creates interaction within the class.

Researcher: Is there anything you would like to talk about that we have not covered?

Student D: I wish they would use the computer during the teaching process as the students love computers, and they are a useful tool.

Researcher: would you like to add anything else?

Student D: No thanks.

Researcher: Thank you for your participation in the interview and the study, wishing you a good luck in your study and practical life.

Student D: Thank you.

اليوم: الأحد

التاريخ: 30- 09 - 2007

الموضوع: المقابلة القبلية

الباحث: في البداية أحب أن أرحب بك وأشكرك علي المشاركة في المقابلة والدراسة، قبل البدء أرجو قراءة هذا الخطاب الخاص في المشاركة في المقابلة ومن ثم التوقيع.

الباحث: شكرا، هل نبدأ؟

الطالبة D: نعم.

الباحث: كيف تصفين مادة الرياضيات؟

الطالبة D: أنا اعتبر الرياضيات عبارة عن قوانين وخطوات وهي مادة حركة للمخ وتوسع التفكير حيث أن المخ عندما يشتغل بهذه المادة لا يفكر بنقطه واحده ولكنه يفكر في نقاط أخرى لكي يصل إلى حل للنقطة التي يفكر فيها. حيث أنني عندما احل مسالة رياضيات فإنني استدعى أشياء سابقة لكي استطيع حل هذه المسألة.

الباحث: في رأيك لو سألنا كيف يمكن تعلم مفاهيم الرياضيات (مثل الحساب، الهندسة، الجبر الخ) بصورة أفضل؟

الطالبة D: لكي نتعلم الرياضيات يجب أن نتعلم بطريقة التلقين ولكن ليس دائما يجب أيضا أن نتعلم عن طريق المناقشة. كذلك يمكن استخدام المجسمات كالإشكال والمكعبات حتى استطيع فهم الفانون بطريقة أفضل.

الباحث: في رأيك، كيف يجب تعليم الرياضيات؟

الطالبة D: أنا أعتبر تعليم الرياضيات من الممكن أن يكون بشرح الموضوع ببطء خطوة بخطوة مع استخدام الأدوات التوضيحية، مع الحرص علي فهم الطلاب وأسال الطلاب أن يستخدموا القلم والورقة لحل المسائل.

الباحث: طريقة التلقين، هل ترين طريقة أخري؟

الطالبة D: هناك التعليم بطريق المناقشة مناقشة الطلبة، الشرح من خلال استخدام الأدوات التوضيحية وسؤال الطلاب عدم إتباع فقط طريقة المعلم المعطاة لحل المشكلة علي العكس سوف يقبل أي طريقة طالما كان الحل صحيح.

الباحث: ما هو رأيك في استخدام اللوجو كإحدى أدوات تكنولوجيا المعلومات والاتصالات في تعليم وتعلم الرياضيات؟

الطالبة D: لا أدرى.

الباحث: الم تقومي باستخدامه من قبل؟

الطالبة D: كلا لم استخدمه من قبل.

الباحث: في رأيك، ما هي مميزات وعيوب استخدام اللوجو في تعليم وتعلم الرياضيات؟

الطالبة D: لا أدرى.

الباحث: ما هو رأيك في استخدام تكنولوجيا المعلومات والاتصالات في تعليم وتعلم الرياضيات؟

الطالبة D: انه مفيد.

الباحث: كيف؟

الطالبة D: المعلم يعد للدرس مستخدما الوسائل مثل عروض الباوربوينت ويستخدمها عندما يدرس هذا يجذب انتباه الطلاب ويجعلهم يتفاعلون مع الدرس.

الباحث: إذن أنت تنظرين له نظرة ايجابية.

الطالبة D: نعم.

الباحث: ربما تستطيع استدعاء بعض الذكريات عن واحد أو أكثر من معلمي الرياضيات، بماذا كان يتميز/ تتميز؟

الطالبة D: أتذكر أن إحدى مدرساتي في الصف السابع كانت دائما ما تشرح المسألة مستخدمة البوربوينت وتحل المسألة ببطء خطوة بخطوة تتأكد إننا فهمنا. وبعد ذلك تشرح مسألة أخري وتناقشنا لنصل للحل مع بعضنا.

الباحث: ماذا عن طريقة الحل؟

الطالبة D: لم تكن تتقيد بوجود طريقة واحدة للحل كانت مدرستي تطلب وتشجع الطلاب علي استخدام طرق مختلفة ما دامت الإجابة كانت صحيحة.

الباحث: إذن ما تهتم به هو الخطوات الصحيحة والناتج النهائي الصحيح. هل يعجبك هذا الأسلوب وتودين استخدامه في التدريس ؟

الطالبة D: نعم يعجبني وأحب أن أطبقه على كل المراحل.

الباحث: هل ترين انه أسلوب مناسب؟

الطالبة D: نعم حيث انه يجذب انتباه الطالب ويخلق تفاعل في الصف.

الباحث: هناك ما تود أن تضيفه ولم يتم التطرق إليه أثناء المقابلة؟

الطالبة D: أتمنى أن يستخدمون الكمبيوتر أثناء العملية التعليمية حيث أن الطلاب يحبون الكمبيوتر وهم أدوات مفيدة.

الباحث: هل تحبين إضافة شيء آخر؟

الطالبة D: لا شكرا.

الباحث: شكرا علي المقابلة والمشاركة في الدراسة مع تمنياتي لك بالتوفيق في حياتك العلمية والعملية.

الطالبة D: شكرا.

Day: Thursday

Date: 03-01-2008

Subject: Post-interview

Researcher: In the beginning I would like to welcome and thank you for participating in the interview and the study. Shall we start?

Student D: Yes.

Researcher: How would you describe mathematics?

Student D: Mathematics is active subject I mean it makes the brain active when studying mathematics it means continuing something without interruption. It is an active subject and a thinking subject**.**

Researcher: In your opinion, how mathematical concepts (e.g. computation, geometry, algebra, etc.) are best learned?

Student D: If I want to learn, I prefer working or moving that is through discussion, problem solving and Logo because it has discussion and gives fixed information for the student.

Researcher: How do you think mathematics should be taught?

Student D: employ students' discussion and use the Logo program or any other programs for mathematics education that allows students to think and be creative, to answer the problems and comprehend the mathematical topic.

Researcher: What do you think about the use of logo as an ICT tool for the teaching and learning of mathematics?

Student D: Logo is a useful ICT tool but to understand it better we must follow up its use.

Researcher: You said your opinion about the use of the program for education, why did you say it is useful? Or in your opinion, what do you consider to be the advantage / disadvantage of the use of Logo in teaching and learning mathematics?

Student D: About the advantages, Logo reduces students' time and effort expended in manual drawing since it allows students to draw difficult shapes. It supports students' discussion and motivation, and also develops students' thinking, imagination and creativity.

Researcher: what about the fast and instant visual display?

Student D: the fast and instant visual display of students' answers allows students to check and explore and correct their wrong answers and learn.

Researcher: what about the disadvantages?

Student D: Based on the way I used the program, I do not see any disadvantages maybe there is someone who sees that the program has disadvantages but for me I do not see it has disadvantages.

Researcher: There aren't any disadvantages about the program?

Student D: No.

Researcher: Why?

Student D: Because everything I learn was useful.

Researcher: that was about the Logo program, but what do you think about the use of ICT for teaching and learning of mathematics?

Student D: Using ICT is useful for mathematics and other subjects because it has characteristics for education.

Researcher: How?

Student D: Everybody can use it and help to enhance students' thinking and creativity. It saves students' efforts and promotes discussion context, and saves teachers' time.

Researcher: Why does it save teacher's time?

Student D: Because he supervises students' learning when teaching.

Researcher: Are you going to use the computer in teaching?

Student D: Yes.

Researcher: You may still recall some memories about one or more mathematics teachers, what was so special about him / her?

Student D: I remember one of my teachers in grade seven; her style was nice in explaining the question using PowerPoint with solving the problem slowly, step by step, so that we understand the lesson after that she gives another question and discuses during solving and encourages us to solve using more than one way.

Researcher: What about the Logo sessions?

Students D: The lectures showed me how mathematics teaching and learning could be with educational aids like the Logo program.

Researcher: What would you like to add?

Student D: I believe what I learned about Logo and everything I did either on drawing shapes or mathematics operations was useful and important for me.

Researcher: Is there anything you would like to talk about that we have not covered?

Student D: I want to say that when I start my job as a teacher and, also for other teachers, I would like that we would be provided with a computer lab to enable us to teach mathematics with the use of computer.

Researcher: Is it a computer lab for mathematics only?

Student D: Yes.

Researcher: Do you have anything to add?

Student D: No thanks.

Researcher: Thank you for your participation in the interview and the study, wishing you a good luck in your study and practical life.

Student D: Thank you.

اليوم: الخميس

التاريخ: 2008-01-03

الموضوع: المقابلة البعدية

في البداية أحب أن أرحب بك وأشكرك علي المشاركة في المقابلة والدراسة. هل نبدأ؟

الطالبة D: نعم.

الباحث: كيف تصفين مادة الرياضيات؟

الطالبة D: الرياضيات مادة حركة، اعني إنها تجعل المخ يتحرك أثناء دراسة مادة الرياضيات ويعني الاستمرار بالشيء دون مقاطعة إنها مادة حركة ومادة تفكير.

الباحث: في رأيك لو سألنا كيف يمكن تعلم مفاهيم الرياضيات (مثل الحساب، الهندسة، الجبر الخ) بصورة أفضل؟

الطالبة D: إذا أردت التعلم أفضل العمل أو الحركة ذلك من خلال طريقة المناقشة وحل المشكلات وبرنامج اللوجو حيث فيها حوار وتثبت المعلومة لدي الطالب.

الباحث: في رأيك، كيف يجب تعليم الرياضيات؟

الطالبة D: نوظف المناقشة بين الطلبة واستخدام برنامج اللوجو أو أي برامج أخرى لتعليم الرياضيات التي تجعل الطلاب يفكرون ويبدعون لحل المسائل واستيعاب موضوع درس الرياضيات.

الباحث: ما هو رأيك في استخدام اللوجو كإحدى أدوات تكنولوجيا المعلومات والإتصالات في تعليم وتعلم الرياضيات؟

الطالبة D: اللوجو أداة تكنولوجيا معلومات واتصالات مفيدة ولكن لكي نفهمه أكثر لابد من المتابعة في استخدامه.

الباحث: قلتي رأيك في استخدام البرنامج بالنسبة للتعليم، لماذا قلت انه مفيد؟ أو في رأيك، ما هي مميزات وعيوب استخدام اللوجو في تعليم وتعلم الرياضيات؟

الطالبة D: بالنسبة للمميزات، اللوجو يقلل من وقت وجهد الطلاب المبذول في الرسم اليدوي لأنه يتيح للطلاب رسم الأشكال الصعبة انه يدعم المناقشة وتحفيز الطلاب، وأيضا يطور تفكير وخيال وإبداع الطلاب.

الباحث: ماذا عن العرض المباشرة والسريع؟

الطالبة D: العرض المباشر والسريع لإجابات الطلاب تمكن الطلاب من فحص واكتشاف وتصحيح إجاباتهم الخاطئة والتعلم.

الباحث: ماذا عن العيوب الموجودة في البرنامج؟

الطالبة D: بناء علي الطريقة التي استخدمت فيها البرنامج لا أري أن هناك عيوب ربما هناك من يري أن للبرنامج عيوب ولكن أنا لا أرى أن له عيوب.

الباحث: لا يوجد أي عيب بخصوص البرنامج؟

الطالبة D: لا.

الباحث: لماذا؟

الطالبة D: لان كل شيء تعلمته مفيد.

الباحث: هذا بالنسبة لبرنامج اللوجو، لكن ما هو رأيك في استخدام تكنولوجيا المعلومات والاتصالات في تعليم وتعلم الرياضيات؟

الطالبة D: استخدام تكنولوجيا المعلومات والاتصالات مفيد للرياضيات وغيره من المواد لان فيه ميزات للتعليم.

الباحث: كيف؟

الطالبة D: الجميع يستطيع أن يستخدمه ويساعد في تعزيز التفكير والإبداع عند الطلاب يوفر جهد الطلبة ويدعم جو المناقشة وأيضا يختصر وقت المعلم.

الباحث: لماذا يختصر وقت المعلم؟

الطالبة D: لأنه يشرف علي تعلم الطلاب أثناء التدريس.

الباحث: هل ستستخدمين الكمبيوتر في التدريس؟

الطالبة D: نعم.

الباحث: ربما تستطيع استدعاء بعض الذكريات عن واحد أو أكثر من معلمي الرياضيات، بماذا كان يتميز/ تتميز؟

الطالبة D: أتذكر أن إحدى مدرساتي في الصف السابع كان أسلوبها جميل تشرح المسألة مستخدمة البوربوينت مع الحل خطوة خطوة وببطء حتى نفهم الدرس وبعد ذلك تعطي مسألة أخري ونتناقش أثناء الحل وتشجعنا نحل بأكثر من طريقة.

الباحث: ماذا عن محاضرات اللوجو؟

الطالبة D: المحاضرات بينت لي كيف من الممكن أن يكون تدريس وتعلم الرياضيات مع الوسائل التعليمية مثل برنامج اللوجو.

الباحث: ماذا تودين أن تضيفين؟

الطالبة D: أعتقد أن ما تعلمته عن الوجو وكل شيء قمت فيه سواء في رسم الأشكال أو العمليات الحسابية كان لي مفيد ومهم.

الباحث: هل هناك ما تود أن تضيفه ولم يتم التطرق إليه أثناء المقابلة؟

الطالبة D: ما أريد أن أقول هو انه عندما أبدأ مجال العمل كمدرسة وأيضا بالنسبة للمدرسات أحب أن يوفر لنا مختبرات كمبيوتر تمكنا من تدريس الرياضيات باستخدام الكمبيوتر وتعليم الأطفال أشياء إضافية يبدع بها علي أساس إذا كان لديه تخيل أو فكر يقوم بتطويره.

الباحث: هل هو مختبر كمبيوتر خاص لمادة الرياضيات ؟

الطالبة D: نعم.

الباحث: هل لديك ما تضيفنه.

الطالبة D: لا شكرا.

الباحث: شكرا علي المقابلة والمشاركة في الدراسة مع تمنياتي لك بالتوفيق في حياتك العلمية والعملية.

الطالبة D: شكرا.