THE RELATIONSHIP BETWEEN STUDENT TEACHERS' BELIEFS ABOUT THE NATURE OF MATHEMATICS AND THEIR ATTITUDES TOWARD MATHEMATICS AND TEACHING MATHEMATICS

A thesis submitted to

The University of Manchester for the degree of

Doctor of Philosophy

In the Faculty in Education

2000

Noha R. Alrwaished

Centre of Mathematics Education

Faculty of Education

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

This study investigates the relationship between student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics and teaching mathematics. The primary focus of this study is beliefs held about the nature of mathematics by primary mathematics student teachers in the State of Kuwait. Another purpose of this study is to explore the relationships among beliefs about the nature of mathematics held by these student teachers and their attitudes toward mathematics and teaching mathematics.

The design of the study is both descriptive and correlational. The subjects were 418 mathematics student teachers enrolled in the College of Education at Kuwait University and the College of Basic Education at the Public Authority for Applied Education and Training (PAAET), also in Kuwait. The beliefs about the nature of mathematics scale (BNMS) was developed by the researcher to measure the student teachers' beliefs about three views, namely the Platonist view, the instrumentalist view, and the problem-solving view. In addition, two existing scales were used: Mathematics Attitude Scales (MAS) and Teaching Mathematics Attitude Scales (TMAS). The interviews with 16 Kuwaiti mathematics student teachers and 4 instructors who teach in one or the other college provided explanatory data.

The findings of the research were that the Arabic translation of the American mathematics attitudes scale (MAS) and the Australian teaching mathematics attitudes scale (TMAS) were valid for the Arab sample. The reliability and validity of the MAS and TMAS were established using interpretation of Arab experts' opinions, factor analysis testing, and Cronbach (alpha) reliability coefficients. A significant finding was that there is a relationship between the student teachers' attitudes toward mathematics and their attitudes toward mathematics teaching. On the other hand, no correlation was found between the MAS and the TMAS in the one part and the BNMS for the other part, that is, there seemed be no relationship between their beliefs about the nature of mathematics and their attitudes toward mathematics and teaching mathematics. The MAS and the TMAS scales have correlations with the background variables. The gender variable, measured against the findings relating to Kuwaiti student teachers' attitudes toward mathematics, indicated that males were more confident and less anxious in learning and teaching mathematics and mathematics than were females. As for the findings on the BNMS, when related to the gender variable, we found that for the females the highest scores were for the instrumentalist view, while for the males the highest scores were for the problem-solving view.

DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning

NOTES ON COPYRIGHT

ACKNOWLEDGEMENTS

The author of the present study wishes to acknowledge the benefit she has obtained from the generosity, and helpful advice of several people, as well as the contributions of many experts.

First, I would like to express my deep gratitude for the patient support and guidance of my supervisor, Professor. Julian Williams, whose expertise, advice and, not least, his private library were always available to me while conducting this research, making a significant contribution to the successful completion of this study.

I am most grateful to my husband and my lovely children Abdullah, Lolwa, and Abdulaziz, who also in many ways supported me throughout the period of my study.

Last, but not least in importance, I wish to extend my humble appreciation to my parents and all the friends and members of my family for their individual support and encouragement.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

Mathematics educators play a crucial educational role in preparing future teachers. Essentially, this is because mathematics is one of the most important fields of human activity. It is, in fact, a comprehensive subject impinging on most aspects of human life. Mathematics educators at the university level face a major problem in that the majority of primary student teachers come to their classes having experienced only traditional methods of mathematics teaching. These future primary mathematics teachers enter mathematics education classes with well-established attitudes toward mathematics as a subject and the teaching of the subject, and similarly well-established beliefs about the nature of mathematics and their ability to perform mathematical work.

One of the motivations for this study is the suggestion by Thompson (1984) and Ernest (1989a) that teachers' attitudes toward the subject matter and its teaching play an important role in their approach to mathematics teaching. It is also clear that teachers' beliefs about the nature of mathematics will have a relationship with their attitudes toward mathematics and its practice. Ernest (1989a, p.20) mentioned how the importance of such views regarding subject matter has been noted both across a range of subjects (referring to Clark and Peterson, 1986; Feinman-Nemser and Floden, 1986) and for mathematics in particular (referring to Kuhs and Ball, 1986; Ernest, 1987, 1988b; Brown, 1988; Cooney, 1988). Thompson (1992) noted that the nature of teachers' beliefs about the subject matter and about its teaching and learning, as well as the influence of those beliefs on teachers' instructional practice, are relatively new topics of study.

In addition, all mathematics primary teachers have their own methods and styles of teaching, as has been demonstrated in the studies undertaken by Bennett (1976) and McLeod and others (1976). Also, some researchers have suggested that these may depend on their beliefs about the nature of mathematics and their attitudes toward mathematics teaching. Knowledge about mathematics is very significant, but alone does not explain differences among mathematics teachers. The interest in these topics led the researcher to study them in relation to student teachers in the State of Kuwait. Section 1.1 will state the problem approached by the present study and section 1.3 will explain the significance of this study.

A review of research on these three dimensions-namely, beliefs about the nature of mathematics, attitudes toward mathematics, and attitudes towards teaching mathematics-will help us to choose or develop the instruments appropriate for the present research. Three scales were used to arrange the data collected from the questionnaire used in this study, besides the information gained from interviews and classroom observations. One of these scales was developed using the insights of many preceding studies and was validated in an organised framework. These instruments were designed to measure the student teachers' beliefs and attitudes in the two education colleges of the State of Kuwait, with the main focus on the second-, third-, and fourth-year student teachers.

There were two stages in this study. The pilot stage was used to validate the instruments and develop the new scale. 97 student teachers in the College of Education at Kuwait University participated in the pilot stage. In the main stage, 418 student teachers completed these instruments, as also did four instructors from the two education colleges in Kuwait. Three major background variables were investigated in this study in an attempt to understand their effect on the student teachers' attitudes and beliefs, namely class level, age, and gender.

The next sections of this chapter will explain the research problem, the research questions, the significance of the study, and the limitations of the study. We will review the development of education in Kuwait in the second chapter. The third chapter reviews relevant literature, focusing on conceptions of the nature of mathematics, teachers' attitudes toward mathematics and teaching, and definitions of terms used in the study. A review of research methodology will be presented in Chapter Four, which includes a description of the instruments used in this study, the hypotheses, and data collection. Chapter Five will introduce the development of the nature of mathematics scale. Chapter Six describes the validation and reliability of the two other instruments used in this study. Chapter Seven assembles the main study results. The last chapter, concluding this research and discussing the findings, also suggests possible areas of further research.

1.1 Statement of the Problem

Student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics and its teaching are important topics to study in the mathematics education field. There is strong evidence to suggest that beliefs about and attitudes toward the subject matter and its teaching play an important role in teachers' approaches to mathematics teaching and actual practice in teaching mathematics (Ball, 1988; Thompson, 1984; and Ernest 1989), but unfortunately there has been a lack of reports or studies carried out in this respect for mathematics student teachers, examining the relationship between their beliefs about the nature of mathematics and their attitudes toward mathematics and its teaching. Also, in view of developments in the Kuwaiti educational system, especially with the entry of modern mathematics and new movements in this field, as well as changes in modern educational practice, it would, it seems, be useful to explore the different attitudes and beliefs regarding this subject held by the females and males who study in these two colleges. Therefore, the main object of this study is to describe the beliefs about the nature of mathematics held by primary mathematics student teachers in the College of Education at Kuwait University and the College of Basic Education at the Public Authority for Applied Education and their attitudes towards mathematics and its teaching. Another object of this study is to explore the relationships among beliefs about the nature of mathematics held by these student teachers and their attitudes toward mathematics and the teaching of mathematics.

1.2 Research Questions

This section presents the research questions, bringing into focus the research problem. Relevant research questions were divided into four parts, as follows:

1.2.1 Research Questions concerning the Student Teachers' Attitudes towards Mathematics

1. What are student teachers attitudes toward mathematics?
2. Is there a relationship between mathematics attitude scales (mathematics anxiety, confidence in learning mathematics, and the other sub-scales in the MAS)?
3. To what extent will class level and age influence student teachers' attitudes toward mathematics?
4. To what extent will gender influence student teachers' attitudes toward mathematics?
5. Does one class level or gender score higher in mathematics anxiety, confidence in learning mathematics, or other areas measured in the MAS?

1.2.2 Research Questions concerning the Student Teachers' Attitudes towards Mathematics Teaching

1. What are student teachers' attitudes toward mathematics teaching?
2. Is there a relationship between, on the one hand, either the anxiety or confidence and enjoyment in teaching mathematics scales and, on the other hand, either the desire for recognition or the pressure to conform scales?
3. To what extent will gender, age, and class level influence student teachers' attitudes toward the teaching of mathematics?
4. Is there a certain class level, gender, or age group that experiences more anxiety or confidence and enjoyment in teaching mathematics than the other class levels, gender, or age groups?

1.2.3 Research Questions concerning the Student Teachers' Beliefs about the Nature of Mathematics

1. What are student teachers' beliefs about the nature of mathematics?
2. What is the most accepted view about the nature of mathematics appearing among this sample?
3. Is there a certain class level or gender of student teacher who is more affected by one of the beliefs about the nature of mathematics?

1.2.4 Research Questions concerning the Relationship between the MAS, the TMAS, and the BNMS

1. What are the relationships between student teachers' attitudes toward mathematics and attitudes toward teaching mathematics and their beliefs about the nature of mathematics?
2. Is there a relationship between the student teachers' attitudes toward mathematics and their attitudes toward mathematics teaching?
3. Which of the sub-scales in the MAS have a strong relationship with the other sub-scales in the TMAS?
4. Do student teachers' beliefs about the nature of mathematics have a significant relation with their attitudes toward mathematics teaching?
5. Do the student teachers' beliefs about the nature of mathematics have a significant relation with their attitudes toward mathematics?
6. Is the student teachers' confidence and enjoyment in teaching mathematics affected by their confidence in learning mathematics or by one of the three views about the nature of mathematics?

1.3 Significance of the Study

In order to answer the research questions and to prepare good future primary mathematics teachers, it is essential to learn their beliefs about the nature of mathematics and the relation of these beliefs to their attitudes toward this subject, and their attitudes toward the teaching of mathematics. As educators we should know what these are before we can change or improve these beliefs and attitudes.

This study is important for the College of Education in Kuwait University and the College of Basic Education for a number of reasons.

First of all, it is the first piece of educational research specific to this area since the College of Education was established at Kuwait University in September 1980 and the College of Basic Education was established in 1987.

Second, the most important reason is that the findings of this study may provide decision-makers at Kuwait University and the College of Basic Education with more information about the beliefs and attitudes of the primary mathematics student teachers enrolled in these two colleges. The study will show the student teachers' attitudes and beliefs toward their subject and its teaching, and how these may depend on their gender and class level. An understanding of the particular needs of each gender and class level will enable educationists in these two colleges to design a more suitable curriculum for this major.

The third reason for this study's importance is that any insights generated by it may, if practically considered, have a beneficial effect on a large number of people in the State of Kuwait (children, student teachers, etc.) and may also be used to improve the undergraduate mathematics major in these two education colleges.

1.4 Delimitations of the Study

The following is a list of the delimitations pertinent to this study:

1. The study is delimited to student teachers in the Education College at Kuwait University and the College of Basic Education.
2. The study investigates only the beliefs about the nature of mathematics held by student teachers in the primary mathematics major at the College of Education at Kuwait University and the College of Basic Education.
3. The study investigates only the student teachers' attitudes towards mathematics and the teaching of mathematics, and should not be taken to represent their teaching styles.
4. The study is delimited to reporting the variable of beliefs and attitudes. No attempt is made to discover the reasons for these beliefs and attitudes.
5. The study uses a stratified sampling method rather than a random method.
6. The interviews with the student teachers are organised in groups instead of individually.

1.5 Summary

From the above sections much will have been learned about this study. These sections have stated the problem and explained what questions the study tries to answer. We have also explained the significance of this study and defined its parameters.

CHAPTER TWO

EDUCATIONAL DEVELOPMENT IN KUWAIT

2.0 Introduction

In the previous chapter, we briefly introduced the study, stating the problem to be investigated, the research questions, the significance of the research, and the limitations of the study. In the present chapter, divided into eight sections, some information is offered about the place of the study and the sample involved in it. The historical review covers the different steps that the education system in Kuwait has passed through.

2.1 The Beginnings of Education in Kuwait

As the educational system in Kuwait is under the control of the Kuwaiti government, the Ministry of Education carries the overall responsibility for the educational objectives and all educational decisions. As the National Report on the Development of Education (1996) noted, the Ministry of Education is aware of its responsibility in facing the challenges of the future, in staying abreast of the rapidly developing contemporary revolution in the field of science and technology, and is developing the concept of education and the agreed curricula.

In order to accomplish the general objectives of education, schooling was categorised in a series of stages in 1983 and the functions of each stage were defined. In this paper we are concerned only with the primary stage.

2.2 Historical Background to the Educational System in Kuwait

In the last quarter of nineteenth century, some religious men pioneered education in Kuwait. Since that time, Kuwait has experienced remarkable progresses in areas such as economics, culture, society, and education. One of the most important aspects has been educational development. Since those early days, the education system in Kuwait has developed across the country. The education system in any country tends to pass through different stages, changing from non-formal education to formal education. So, in Kuwait, we may see two stages of educational development:

1. Non-formal education, 1887 – 1935; and
2. Formal education, 1936 - present.

2.2.1 Non-Formal Education, 1887-1935

Education started in very early days in mosques. The *Mullah,* or religious man (who led the people in prayer), taught the people about the rule of Islam and some lessons from the holy *Qur'an* (the holy book of Islam), the *Sunnah* (the biography of the Prophet Muhammad), and Islamic history. In 1887, the first class started in a mosque as a non-formal type of education. That meant there were no specially built classrooms for students, no organised class periods, no specialist teachers for different subjects, no organised school administration, and no well-defined curricula or textbooks.

There were a few men who offered basic instruction about the *Qur'an* to the people. The *Mullah,* as a teacher, taught the people several Islamic values, those which were most important for faithful Muslims. He would also teach them *Tafsir* (Qur'anic exegesis), *Sunnah* (prophetic traditions), *Fiqh* (jurisprudence), and *Tajwid* (Qur'anic recitation). The *Mullahs* had authority in their *Kuttab*, (Qur'an schools) over such matters as the curriculum, the place of instruction, and time to begin and finish lessons. Nobody had any right to interfere in their work, not even the government. *Mullahs* could be very strict with boys. According to al-Abdul Ghafur (1978), several religious scholars emerged in Kuwaiti society, including a group of learned and religious people who acquired their education from neighbouring lands: Najd, al-Ihsa', Bahrain, and elsewhere. These people endeavoured to teach the common people of Kuwait the fundamental aspects of their religion, Islam, in the mosques. In this form, teaching started in Kuwait from that time on. It was first in the form of religious education and sermons delivered in the mosques where people used to come wishing to learn about the basis of their Islamic religion from the mouth of a *Mullah*.

The *Kuttab* system of education for boys started in 1887 and lasted until 1912. The word '*Kuttab*' is derived from the Arabic word '*Kitab*' (meaning a book), indicating how this form of learning centred around reading. The *Kuttab* would be attached to the mosque or the *Mullah's* home, where children were taught to recite the holy Qur'an and learn the elements of reading, writing, and simple arithmetic, as well as some useful activities in trade and business. However, girls did not have the same opportunity for education enjoyed by boys until the *Kuttab* system for girls started in 1916, when the first *Kuttab* was establish by a women teacher (*Muttawa')*. As she taught girls only the Qur'an, this meant that girls left the *Kuttab* without knowing how read and write Arabic very well. In 1926, as al-Abdul Ghafur (1978) mentions, the first *Kuttab* for girls began to teach reading and writing Arabic, arithmetic, and the elements of home economics.

The *Kuttab* remained in non-formal education until 1912, when al-Mubarakiya Primary School was opened in Kuwait. This was the first primary school and was set up and supported by some wealthy citizens and Sheikh Mubarak al-Sabah, the ruler of Kuwait at that time. With the opening of al-Mubarakiya Primary School, education entered a new phase in Kuwait.

In 1921, Sheikh Ahmad al-Jabir opened al-Ahmadiya Primary School. There were now a lot of children registered in each school (Quantitative Development in Kuwait, 1995). Teachers in both schools were Kuwaitis and non-Kuwaitis from other Islamic and Arab countries such as Egypt, Jordan, Iraq, and Palestine (al-Abdul Ghafur, 1978). Until 1936, there were just four primary schools in Kuwait. At the end of this period, pupils who finished their education in the al-Mubarakiya or al-Ahmadiya schools were usually sent to Iraq to finish their secondary school education. Some wealthy people and organisations supported these pupils. There was no governmental support for them as scholarships only started in 1924 (al-Abdul Qader, 1986).

Thus, informal education began with the teaching of boys, before girls were taught separately. The teaching style was very strict and traditional in methodology and in some ways this influenced formal education, as the next section will explain.

2.2.2 Formal Education, 1936 - Present

A new era of education commenced in October 1936, when the government established the Council of Education to manage education in the state. Sheikh Abdullah al-Jabir was the first head of this Council, which was responsible for planning, designing the curriculum, and school management.

Among the many reasons the establishing this Council were the following:

1. The discovery of oil in that year;
2. The growing importance of education for a community where illiterates still constituted the majority of the population in Kuwait;
3. The increasing number of students wishing to benefit from education, so that the two existing schools proved insufficient; and
4. The desire of the government to control the education system under a new, modern organisation.

Most societies started to educate boys before girls. In Kuwait, as early as 1937, the government provided formal education for girls by establishing the first primary school for girls. In addition, in the same year, the first secondary school for boys was established. In the meantime, the Department of Education in Kuwait requested the Ministry of Education in Egypt to help organise the curriculum for schools in Kuwait. In the academic year 1945-1946, Kuwaiti schools increased to a total of seventeen: one secondary school, twelve primary schools for boys, and four primary schools for girls. In addition, the total number of students enrolled increased to 3,635 boys and

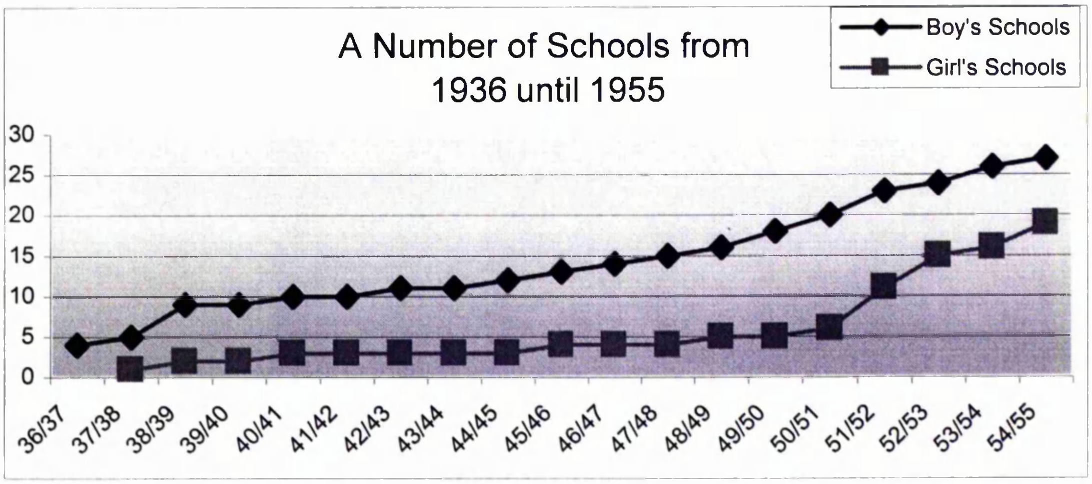
820 girls, being taught by 142 male teachers and 34 female teachers. In 1949, some secondary classes for girls were opened in the school. Table 2.1 and Figure 2.1 show the increasing number of schools, teachers, and pupils (Ministry of Education, 1995).

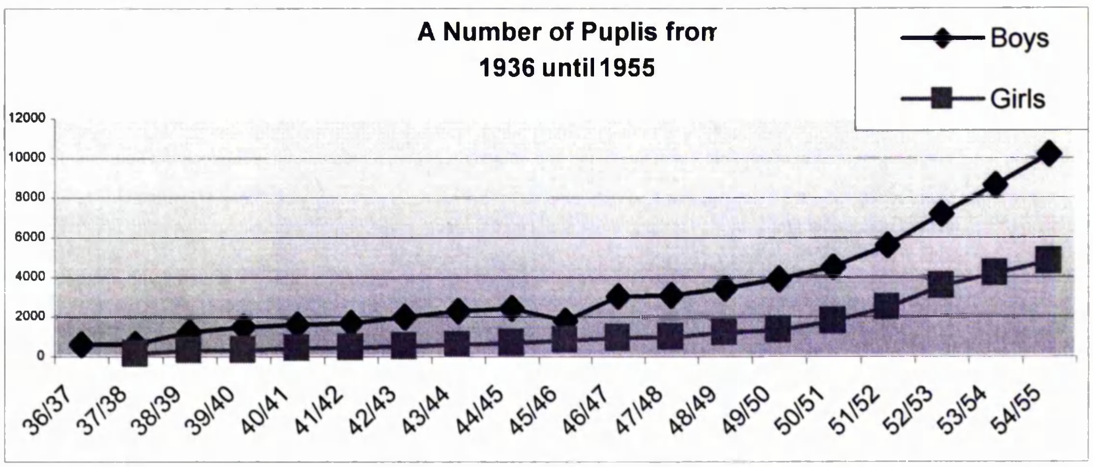
Table 2.1: Numbers of Schools, Pupils, and Teachers from 1936 until 1955

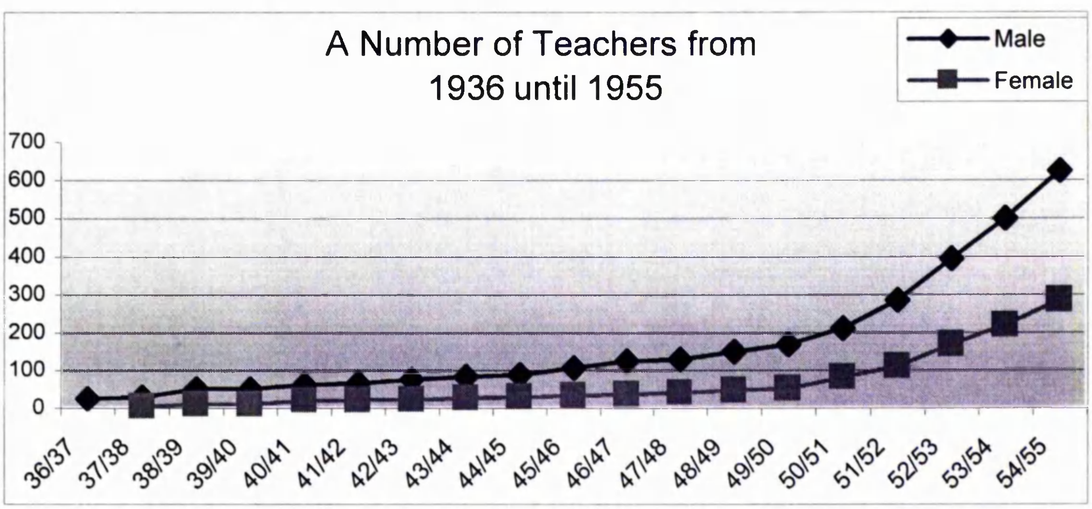
Year	Schools				Pupils				Teachers			
	*B	G	T	I	*B	G	T	I	**M	F	T	I
36/37	4	-	4	-	600	-	600	-	26	-	26	-
37/38	5	1	6	2	620	140	760	160	30	5	35	9
38/39	9	2	11	5	1220	300	1520	760	52	11	63	28
39/40	9	2	11	-	1500	330	1830	310	52	11	63	-
40/41	10	3	13	2	1621	400	2012	182	64	20	84	21
41/42	10	3	13	-	1700	460	2160	148	67	22	89	5
42/43	11	3	14	1	2000	520	2520	360	77	24	101	12
43/44	11	3	14	-	2300	590	2890	370	84	27	111	10
44/45	12	3	15	1	2420	670	3090	200	89	30	119	8
45/46	13	4	17	2	1815	820	3635	545	108	34	142	23
46/47	14	4	18	1	3027	935	3962	327	126	37	163	21
47/48	15	4	19	1	3100	980	4080	118	130	41	171	8
48/49	16	5	21	2	3450	1215	4665	585	150	48	198	27
49/50	18	5	23	2	3906	1334	5340	675	170	52	222	24
50/51	20	6	26	3	4520	1772	6292	952	212	82	294	72
51/52	23	11	34	8	5595	2447	8042	1750	287	111	398	104
52/53	24	15	39	5	7188	3550	10738	2696	394	170	564	166
53/54	26	16	42	3	8642	4182	12824	2086	500	221	721	157
54/55	27	19	48	6	10186	4794	14980	2156	624	286	910	189

* B = Boy G = Girl T = Total I = Increase
** M= Male F = Female T = Total I = Increase
Source: The Ministry of Education, 1998.

Figure 2.1: Numbers of Schools, Pupils, and Teachers from 1936 until 1955







There were many different institutions established in this period. The first, an Institute for Religious Education, was established in 1947 as a secondary school. This institute taught religious subjects. Most of the teachers in it came from Egypt, particularly graduates from al-Azhar University. In addition, A Commercial Studies Institution came into being in 1950. At the same time, the Teachers' Institution was opened to prepare teachers to meet the needs of schools. In 1954, an Institute for Female Teachers was established. All teachers who graduate this institution are able to teach in primary schools. Also, an Industrial College was founded to meet the demand for technicians and professionals in the country (al-Abdul Ghafur, 1978).

The important changes accruing in Kuwait in 1956 as a result of an increase in oil production, labour coming from other countries, and a growing population, led to an increase in the number of the children who needed education, which meant that the number of schools had to be increased. At independence in 1961, Kuwait became a member of the Arab League. In the same year, the Council of Education became the Ministry of Education. Many post-secondary institutes were established and began to provide two-year post-secondary courses in technical and commercial education. Similarity, instruction in teacher training colleges replaced the old four-year post-intermediate courses.

In 1963, Kuwait joined UNESCO and the development of education increased with the co-operation of advanced countries. These countries supported Kuwait in developing many ones, education being one of the most important areas. First of all, they submitted many syllabuses, for example from Iraq, Palestine, and Egypt, to the

Education Council. Second, they sent teachers to teach in Kuwait, enabling Kuwaiti teachers to benefit from their teaching experience. Finally, they designed the curriculum for the all school stages existing at that time. The government increased the budget for education and found support in the studies prepared by some educational experts. A proposal submitted by al-Kabbani and al-Krawi had effect in changing the educational system in Kuwait, as it became divided into four stages (al-Abdul Ghafur, 1978), each consisting of four further class levels. These educational stages are as follows:

- Kindergarten stage: from age four to five.
- Primary stage: from age six to nine.
- Intermediate stage: from age ten to thirteen.
- Secondary stage: from age fourteen to seventeen.

Table 2.2 shows the increase in the number of children, teachers, and schools in all stages from 1956 until 1997, while figure 2.2 plots the increases from 1970 until 1994.

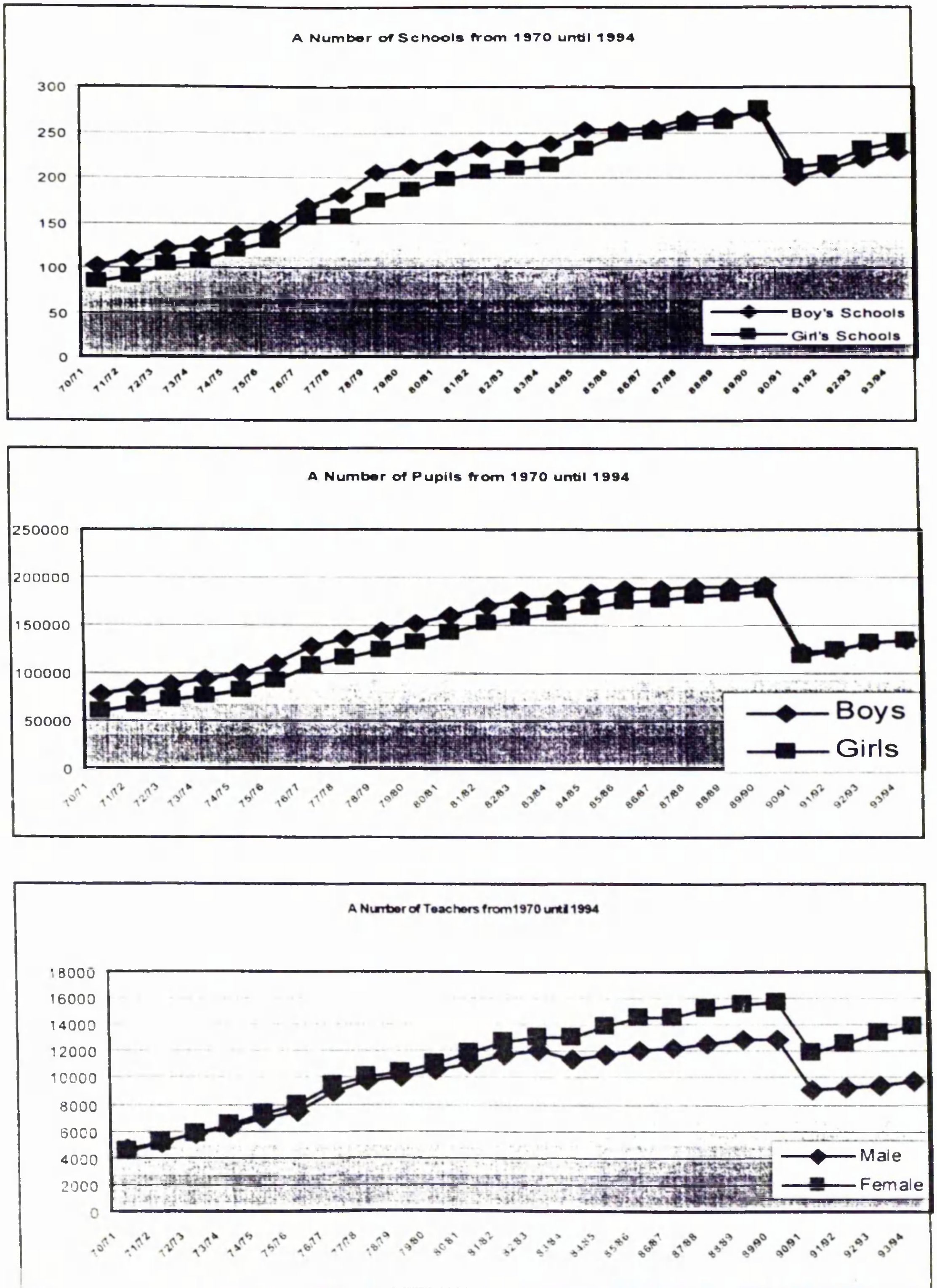
Table 2.2: Numbers of Schools, Pupils, and Teachers from 1956 until 1994

Year	Schools				Pupils				Teachers			
	*B	G	T	I	*B	G	T	I	**M	F	T	I
55/56	28	20	52	4	12994	6657	19651	4671	715	380	1095	185
56/57	43	40	87	35	15185	8481	23666	4015	870	536	1406	311
57/58	46	40	92	5	18777	10655	29433	5766	1023	676	1699	293
58/59	49	45	103	11	21728	12686	34414	4982	1085	745	1830	131
59/60	50	48	113	10	24978	15324	40302	5888	1134	877	2011	181
60/61	60	54	134	21	27698	17459	45157	4855	1248	1007	2255	244
61/62	62	56	142	8	30860	20230	51090	5933	1371	1180	2551	296
62/63	61	55	140	2-	35651	23833	59484	8394	1561	1401	2962	411
63/64	67	60	157	17	41511	28597	70108	10624	1890	1699	3589	627
64/65	73	63	166	9	46613	32509	79122	9014	2241	1974	4215	626
65/66	77	63	176	10	53550	38238	91788	12666	2680	2356	5036	821
66/67	76	66	178	2	58702	43026	101728	9940	2957	2701	5668	632
67/68	88	66	195	17	64366	47655	112021	10293	3342	3053	6395	727
68/69	96	73	212	17	68877	51673	120550	8529	3811	3506	7317	922
69/70	99	82	224	12	73262	55783	129045	8495	4235	3984	8219	902
70/71	101	85	230	6	78363	60384	138747	9702	4548	4446	8994	775
71/72	109	90	245	15	84460	66219	150679	11932	5174	5138	10312	1318
72/73	121	103	273	28	88897	71334	160231	9552	5734	5771	11505	1193
73/74	126	108	287	14	93371	76046	169417	9186	6199	6408	12607	1102
74/75	138	119	309	22	100061	82717	182778	13361	6990	7223	14213	1606
75/76	144	130	325	16	109873	92034	201907	19129	7481	7991	15472	1259
76/77	168	154	378	53	127380	107823	235203	33296	8862	9365	18227	2755
77/78	181	157	394	16	136714	116498	253212	18009	9667	10107	19774	1547
78/79	205	175	437	43	143586	123932	267518	14306	10151	10473	20624	850
79/80	211	186	457	20	152656	132677	285333	17815	10558	10996	21554	930
80/81	221	199	481	24	160987	141623	302610	17277	11034	11851	22885	1331
81/82	232	205	510	29	170804	151670	322474	19864	11722	12645	24367	1482
82/83	231	209	519	9	176605	158591	335196	12722	12048	13089	25137	770
83/84	237	213	527	8	178388	161513	339901	4705	11325	13125	24450	687-
84/85	253	231	562	35	183138	167466	350504	10703	11794	13858	25652	1202
85/86	252	247	593	31	187204	173291	360495	9891	11973	14592	26565	913
86/87	254	250	606	13	188452	176098	364550	4055	12224	14532	26756	191
87/88	265	259	636	30	190428	180027	370455	5905	12519	15154	27673	917
88/89	269	260	642	2	190615	182063	372678	2223	12895	15536	28431	758
89/90	271	277	668	26	191664	185176	376840	4162	12856	15748	28604	173
90/91	200	211	528	140-	121143	118390	239533	137307-	9136	11916	21052	7552-
91/92	210	216	544	16	123117	124629	247746	8213	9307	12475	21782	730
92/93	219	232	572	28	131327	132323	263650	15904	9405	13344	22749	967
93/94	228	240	594	22	133848	134249	268097	4447	9678	13824	23502	753

* B = Boys G = Girls T = Total I = Increase
** M= Males F = Females T = Total I = Increase

Source: The Ministry of Education, 1998.

Figure 2.2: A Number of Schools, Pupils, and Teachers from 1970 until 1994



From the above table and figure we notice that the number of schools, pupils, and teachers actually decreased in 1990, which was, of course, an account of the Iraqi invasion of the State of Kuwait. Since political crises change the whole position in a particular society, not only socially, but also politically, economically, educationally, and culturally, they have a real impact on the curriculum. They change the whole of society in all aspects. In fact, crisis situations cause people to rethink their situation and position, and may cause them to reject their previous assumptions and redirect their subsequent behavior in better ways. Before the Iraqi invasion there was in Kuwait a large number of students and teachers from different Arab countries. Because the Kuwaiti government was very disappointed by some Arab countries during the invasion, a large number of teachers and their families from those countries left Kuwait and the Ministry of Education stopped hiring any teacher from them (al-Ghunaim and others, 1996).

2.3 Objectives for the Primary School Stage

The primary stage is the first stage and a compulsory one in the education system of Kuwait. According to the National Report on the Development of Education (1996), the objectives of the primary stage are the following:

- To strengthen the child's spirit and mind in order to build his personality in keeping with the principles and concepts enshrined in the Muslim religion.
- To provide the child with basic knowledge in three skills: reading-writing, and arithmetic.
- To encourage the child to participate in artistic and handicraft activities.

- To help the child develop social awareness and concepts of co-operation and responsibility.
- To cultivate children's awareness of their national identify through the teaching of their national history (p.8).

2.4 Objectives for Mathematics Teaching in the Primary School

In May 1983, the Arab Gulf States Educational Research Centre held a conference in Kuwait. The objective of this conference was to unify the goals of education and to develop mathematics education and other areas in all stages. According to Al-Nimir (1989, p. 67) mentioned that

> the Ministry of Education in Kuwait claimed that it was responsible for preparing the country's students to live in the twenty-first century, when mathematical concepts and skills will be used to solve day-to-day problems of living.

They should, the Ministry asserted, be well prepared to use easily and successfully technological tools such as calculators and computers. In the mathematics workshop at this conference all the supervisors of mathematics and curriculum designers were represented. They agreed that there must be a reform of the mathematics curricula for all school-stages. The main aims, they felt, were to identify new developments in the mathematics curriculum in the Arab Gulf States to transfer experiences about the mathematics curriculum between them, and to suggest outlines for the next workshop based on new movements in advanced countries.

The Ministry of Education stated that mathematics teaching in the primary stage should help students to understand their environment and society. There are certain objectives for the mathematics curriculum at this stage. Al-Nimir (1989, 31) noted that the following are the objectives for teaching mathematics in the primary stage:

1. Recognising that mathematical concepts and that mathematical knowledge that are appropriate to students' abilities in the primary stage.
2. Acquiring mathematical skills.
3. Acquiring some thinking techniques in solving everyday mathematical problems.
4. Development of the affective domain, such as self-confidence in solving mathematical problems, and enjoyment of mathematical notations, terms, and patterns.

2.5 The Development of Teacher Training

The first serious steps in a series of teacher training attempts in Kuwait were taken between 1962 and 1973. They began with the establishment of an institute for the training of male primary school teachers and another for female teachers in primary schools and kindergartens. Both institutions offered four-year courses following the school diploma. The programme for teacher training included both pedagogical and subject-specific instruction.

This was the starting point in the process of training teachers for the primary stage of education. It was, however, a far from adequate programme for the training of primary school teachers in Kuwait. The international conference on education convened in 1953 stressed the importance of university education for primary school teachers. Similarly, the report on new horizons of the teaching profession issued in the USA in 1961 underlined the importance of a five-year university programme for the training of teachers. In the light of such trends in education, the Ministry of Education set up a committee in 1969 to establish the necessary policies for teacher training. As far as the training of teachers for the intermediate and secondary stages was concerned, the committee recommended university training. The purpose of that stage was to raise the standard of teachers, hence the fact that the teaching staff in this institute had to have Ph.D. or MA degrees. A "credit hours" system was applied as from the academic year 1977-1978. Teachers of primary and kindergarten stages would receive training for two years following their secondary school certificate. These were considered temporary decisions until the state could train primary teachers at the university level. For the academic year 1986-1987, both institutes were upgraded to the College of Basic education, offering a four-year programme.

The development of teacher training in the State of Kuwait confirms the continuous efforts that have gone into raising the value and standard of teacher training in general and that of primary school teachers in particular. All these efforts are continuously directed toward improved training in keeping with the world pedagogical trends in this field.

2.6 Mathematics and Science Teacher Preparation

There are two colleges preparing teachers in the State of Kuwait. The first is the College of Education at Kuwait University, and the second is the College of Basic Education. The following two sections will explain their various:

2.6.1 The College of Education at Kuwait University

Kuwait University was founded in October 1966, five years after the State of Kuwait obtained her independence, with Colleges of Science, Arts, and Education and the Girls' College, with 418 students and 31 teaching staff (Ministry of Information 1986, p. 8). At present, the university consists of nine colleges: the College of Arts; the College of Commerce, Economics, and Political Sciences; the College of Engineering and Petroleum; the College of Law; the College of Shari'a and Islamic Studies, the College of Medicine; the College of Allied Health Sciences and Nursing; the College of Science; and the College of Education. There is also the College of Higher Studies, founded in 1979, which offers two-year masters degrees in a limited number of specialisations, such as the natural sciences, medicine, and engineering. Currently, the college offers some additional subjects, amongst which are: Masters in Education, Masters in Law, Masters in shari'a and Islamic Studies, and Masters in Arts.

The objectives for the College of Education were outlined by the Ministry of Planning in 1979 as follows:

1. The preparation of male and female teachers in all subjects (mathematics, Islamic studies, science, and other) for all stages.
2. The conducting and applying of educational research studies.
3. The introduction of graduate students in the education field.
4. The preparation of education administrating, planning, supervisory, curriculum development, evaluation and testing, and counselling and guidance personnel.

The main objective of the College of Education is to offer undergraduate and post-graduate programmes to prepare teachers for teaching at the various school stages. These programmes aim at developing new methods and techniques to provide quality education in all subjects. One of these areas is student teaching. The Centre for Training Student Teachers assumes the responsibility of administering and developing this programme through many functions, including the following:

1. To plan student teacher activities according to the needs of society and the students' own abilities.
2. To set up the objectives and programmes of student teaching, and follow up their implementation and development to achieve these objectives.
3. To co-operate with the Department of Curricula and Instruction and other departments in the college regarding student teaching.
4. To co-operate with other centres in the college and with the Ministry of Education to improve the quality of student teaching.

The College of Education offers a program that leads to the Bachelor of Arts degree in education. Two teacher-training programmes have been introduced in this college, designed respectively to prepare teachers for the kindergarten and primary stages or for the intermediate and secondary school stages. The mathematics and science teacher preparation programme is one of the primary programmes in the College of Education at Kuwait University. Providing Kuwaiti schools with qualified mathematics and science teachers is the major goal of this programme. Teacher preparation was offered under a new system, the elective-course system. This is a four-year programme (eight semesters) and requires completion of 132 credits for graduation. There are three types of course in the programme:

1. University- required courses (27 credits).
2. Specialisation required courses (57 credits).
3. Professional required courses (48 credits).

The students of this programme are required to take their courses mainly in two colleges: the College of Science and the College of Education. In addition, the university-required courses are obtained from various university colleges.

With regard to specialisation courses, the student teachers are required to study fifteen courses. Seven of these courses in mathematics: calculus A and B, linear algebra, concept of modern mathematics, introduction to the mathematics foundation and two mathematics courses they choose from those given in the Mathematics Department. In addition, they study eight courses in science including biology, geology, and chemistry. In their first and second years the student teachers must study the required courses, because admission to some of these courses may depend on their first completing other courses.

The third part of students' training consists of professional courses and these are the most important steps designed to prepare teachers competent in their profession. This part include 16 courses, their values is 48 credits, 2 courses of them for teaching method (one in mathematics teaching method and one in science teaching method). These courses include lecture discussion, preparing a whole lesson, and focus.

Teaching practice lasts for one whole semester (three months). Student teachers spend a full semester in primary schools, practising the daily professional responsibilities undertaken by primary school teachers with special emphasis on teaching mathematics and science. The student teacher also study courses about the mathematics teaching (e.g. teaching methods 1&2 and audio-visual aids). Training is given under the supervision of a co-operating mathematics teacher (the mathematics head teacher) at the school, the school principal, and a faculty member from the College of Education.

2.6.2 The College of Basic Education

In 1982, the Public Authority for Applied Education and Training (PAAET) was established, and all technical and vocational institutes were combined under the responsibility and administration of PAAET.

The goal of PAAET, according to its establishment law, is to develop the national technical manpower and to meet the development requirements in the country through its two sectors: education and training. PAAET carries on its activities through three main fields. The main activity is to offer applied and training programmes with different inputs and outputs. Duration of study or training is based on purpose and aim, and is divided into two main sections:

1. Applied education programmes, provided in four colleges: the College of Basic Education, the College of Business Studies, the College of Health Sciences and Technological Studies.

2. Different training programmes offered by training institutes and centres: the Water and Electricity Training Institute, the Telecommunication and Navigation Institute.

2.6.2.1 The Aims of the Mathematics Department in the College of Basic Education

The mathematics curriculum at the College of Basic Education aims to prepare the teacher culturally, academically, and professionally to teach mathematics at the primary stage. This extends to teaching science if necessity demands. The mathematics programme aims to achieve the following objectives:

1. Promoting the general cultural background so as to enable the trainee teacher to handle the questions raised by the primary school child.
2. Strengthening the mathematical concepts and skills integrated in the primary school curricula.
3. Instructing in the mathematical skills and concepts, which help the trainee teacher, entrusted to carry out the task to him/her efficiently.

4. Helping to acquire a reasonable amount of fundamental scientific skills which enable the trainee teacher to teach science in the primary stage if need arises.
5. Giving extra dimensions in mathematics, which could constitute basics for more learning in execution of the principle of the ongoing learning.
6. Acquainted with the computer and the language used therein, besides imparting ability for using it in teaching mathematics in primary schools.
7. Teaching the contents of the primary mathematics and science curricula and approaches to demonstrating them in the schoolbooks.
8. Teaching about the role played by Arabs and Muslims in the history of mathematics and appreciating their efforts in developing this science now and in the past.
9. Promoting the tendencies towards mathematics, besides developing positive attitudes towards it and promoting good functional values and habits.
10. Promoting methods of second thinking based on mathematical reasoning and analogy.
11. Providing information about the various educational audio-visuals aids for teaching mathematics and explaining how to select and using them.
12. Informing about important current theories in education and psychology, explaining their relevance for methods and approaches and their role in improving the teaching-learning process.
13. Promoting the various teaching skills through actual practice.
14. Promoting the skill of participating in various scholarly activities (PAAET 1996, p. 12).

2.7 Important Factors in Primary Education in Kuwait

In the Kuwaiti education system, students are generally grouped into grades according to age. This means that all children born in the same calendar year are placed in the same grade. Primary schools cover the range from 6-9 years. The size of primary school classes depends on the district in which the school is located. The State of Kuwait is divided into five districts, namely Alahmidi, Alfarwanya, Hawali, Aljahrah, and the Capital. For example, Aljahrah is a large district and the classes are large in schools, which are themselves very big with student populations ranging between 400 and 1,000. Each school contains at least 4 classes for each year. All the government schools are single-sex except for some of the private schools. There is no tracking in Kuwaiti schools, and there are no special classes for children with handicapping conditions. Children with physical or mental handicaps may, however, attend special schools, such as those for the deaf. Depending on their achievement in final examinations the children pass to the next grade.

Kuwaiti teachers typically hold a Bachelor in Education degree with a specialist major in education. As previously noted, there are two specific institutions graduating primary mathematics teachers: the College of Education at Kuwait University and the College of Basic Education. The sample of this study is drawn from student teachers in both these colleges. Individuals cannot be employed as teachers if they have not majored in education. Each teacher must teach a special subject. In the primary school these subjects include Arabic, English, Islamic Studies, Mathematics, Science, Social Science, Music, and Art, which means that one class can be taught by more than four teachers. The teachers must follow the curriculum that the Ministry of Education lays down. The teacher typically begins each lesson with a description of its purpose and ends it with a summary of what has been accomplished. There is frequent use of teaching aids, such as group work and with items to be manipulated. Teachers rely on homework exercises to strengthen what has been accomplished during the daily lessons.

Unlike most other countries, the qualifications of teachers vary in different sections of the country. In the UK primary education covers the age range 5-11 in two departments: infant (5-7) and junior (8-11 years). As Bennett and Desforges (1991) mention separate infant schools and junior schools are also available, as are first schools covering either the age ranges 5-8, or 5-9, or even 5-10, and middle schools (8-12 or 9-13 years). The big difference between educational provision in Kuwait and the UK is that UK schools provide education for children with special educational needs. The average class size is about 25 pupils, but this does vary. Most schools are small in its size in UK. Bennett and Desforges (1991) mention that 40% of all schools take between 100 and 200 children. The teacher is responsible to teach a certain class for the whole academic year for all subjects.

2.8 Summary

This chapter has reviewed and outlined the most important information about the educational system in the State of Kuwait. In the above sections we have surveyed the beginnings of the educational system, and its history in the State of Kuwait, and the objectives of primary schools and of teaching mathematics in the primary stage in Kuwaiti schools. We also reported on the beginnings of the teacher-training programme in Kuwait, reviewing the two education colleges in Kuwait, describing their development and the two types of programmes they offer.

We have described how in the past a simple form of education for boys, and later girls, was in vogue in Kuwait, followed by very rapid expansion in educational provision at all stages following the discovery of oil, although hampered for a while by the Iraqi invasion. As a result of major changes in Kuwaiti society generally, there have also been many changes in the educational system. The preparation of student teachers is now a part of this educational system. Therefore, their attitudes toward education, not least mathematics education, have also been affected. In addition, the gender issue has come to the fore, so that women now try to take their position in many areas of Kuwaiti society from which they were previously excluded. It will be interesting to understand the female and male student teachers attitudes toward mathematics and its teaching.

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

The objective of this chapter is to review the previous studies in this field. The review covers literature concerning the different conceptions that are held by student teachers and others concerning the nature of mathematics, attitudes toward mathematics, and attitudes toward the teaching of mathematics. We then provide a theoretical background for the study, the operational definitions of the major concepts involved in this study, and explain how researcher developed the items of the new scale used in this study. The first section, 3.1, answers the following questions: What is the nature of mathematics? How have scholars defined the nature of mathematics? What views are held concerning the nature of mathematics? How are these views related to the teacher's conceptions of mathematics?

Section 3.2 is concerned with attitudes towards mathematics. Here we try to investigate how these attitudes toward mathematics affect both students and teachers, and whether attitudes are transferred from teachers to students. We will look at some previous studies which measure such attitudes.

Moving into section 3.3, our concern is with students' attitudes toward the teaching of mathematics. We will ask why these attitudes should be measured and consider how other studies have measured student teachers' attitudes towards the teaching of mathematics. This leads us in the next section 3.4 to a consideration of teachers' preparation programmes and how the issues discussed in this chapter affect the educators in the way they prepare future teachers. Finally, the last section will explain the definitions of terms used in the study.

Student teachers at most universities come from a variety of backgrounds and social environments, and their prior experience in schooling will have shaped their present beliefs about the nature of mathematics, their attitudes about mathematics as a subject of the curriculum, and their attitudes toward the teaching of mathematics. Therefore, it is useful if we first define the beliefs that are held about the nature of mathematics.

3.1 Definition of the Nature of Mathematics

Mathematics is an important subject in all societies in the world. Views concerning the nature of mathematics have an effective impact on research in mathematics, which has a long history. In order to understand the different conceptions of mathematics, it will be useful to remind ourselves briefly of the history of this discussion.

3.1.1 A Historical Review of the Philosophy of Mathematics

Dossey (1992) divides the discussion of the history of the nature of mathematics into three periods. The first of these periods goes back to the fourth century BC, when the first major contributors to the dialogue were made by Plato and his student, Aristotle. Plato asserted that the objects of mathematics had an existence of their own, beyond the mind, in the external world. He drew clear distinctions between the ideas of the mind and their representations perceived in the world by the senses. From this basic precept we understand that Plato drew a distinction between arithmetic and logic. He believed that arithmetic is the theory of numbers while, on the other hand, logistics deals with the methods of calculation required by businessmen. On the other hand, his student Aristotle conceived of mathematics as one of three classifications into which knowledge could be divided: the physical, the mathematical, and the theological. In addition, Dossey (1992) remarked that Aristotle explained that

> mathematics is the one which shows up quality with respect to forms and local motions, seeking figure, number, and magnitude, and also place, time, and similar things (p. 40).

Aristotle believed that the senses play the main role in abstracting ideas in mathematics. His view was based on experienced reality, where knowledge is obtained from experimentation, observation, and abstraction. This view supports the conception that one constructs the relations inherent in a given mathematical situation. He attempted to understand mathematical relationships through the collection and classification of empirical results derived from experiments and observation and then by deduction of a system to explain the inherent relationships in the data. Thus, the works and ideas of Plato and Aristotle moulded two of the major contrasting themes concerning the nature of mathematics. For example, Aristotle offered a solid foundation for the use of logic in substantiating scientific claims in the Middle Ages. Also, as Dossey (1992) mentions, the difference between Plato and his students concerning the nature of mathematics was used as evidence in the early 1500s by Francis Bacon for the need to separate pure mathematics from applied mathematics.

It seems clear that the concept of mathematics held by the Platonic school is closely linked to the concepts held by the next three views of mathematics. In fact, although different views of mathematics have been offered at different times and by different cultures, they have all been influenced by the Platonic school.

The second period, as Dossey mentions, was the late nineteenth and early twentieth centuries, when new investigations were made into the nature of mathematics. Three views of mathematics emerged to deal with contemporary problems, namely: logicism, intuitionism, and formalism. The German mathematician Gottlob Frege founded the first of these, the school of logicism, in 1884. He believed that the ideas of mathematics could be viewed as a subset of the ideas of logic. This was similar to the Platonic school of thought.

> The proponents of logicism set out to show that mathematical propositions could be expressed as completely general propositions whose truth followed from their form rather than from their interpretation in a specific contextual setting (Dossey, 1992, p.41).

Another view, quite different from that of the logicists, is the intuitionists' view, initiated by the Dutch mathematician, L. E. J. Brouwer. The intuitionists were concerned with the appearance of paradoxes in set theory and their possible ramifications for all of classical mathematics. In contrast, the logicists accepted the contents of classical mathematics.

> The intuitionists accepted only the mathematics that could be developed from the natural numbers forward through the mental activities of constructive proof (Dossey, 1992, p. 41).

The German mathematician David Hilbert moulded the third view, which he propounded near the beginning of the twentieth century. This school, called formalism, supported the Aristotelian tradition more than Platonism. Dossey (1992) noted that Hilbert saw mathematics as "arising from intuition based on objects that could at least be considered as having concrete representations in the mind" (p.41).

Dossey (1992) summarised these three views by observing that they all tended to view the content of mathematics as products. For logicism the contents were the elements of the body of classical mathematics, for the intuitionist school the contents were the theorems that had been constructed from first principles via 'valid' patterns of reasoning, but in formalism mathematics was made up of the formal axiomatic structures developed to rid classical mathematics of its shortcomings.

The consideration of mathematics from a philosophical point of view has attracted many writers who have treated it in different ways. As we have seen, the above views focused on the content of mathematics as products. The third period in this history is the modern view. Dossey (1992) particularly mentioned the work of Tymoczko and Hersh in developing the way people look at mathematics. For example, Dossey (1992) mentions that

> Hersh (1986) argues that the search for the foundations of mathematics is misguided. He suggests that the focus be shifted to the study of the contemporary practice of mathematics, with the notion that current practice is inherently fallible and, at the same time, a very public activity (p. 42).

The above view reflects the need for a new philosophy of mathematics linking both the academic mathematician and mathematics education, and indicates a perceived need to accept the idea that mathematics is a human activity. This allowance for human activity, as Hersh argues, will make an important change in mathematics. It means that this activity ceases to be strictly governed by any philosophical schools like logicism or formalism, but should deal with daily experiences. It seems this is a social view, which emphasises the doing of and using of mathematics, rather than the notion of mathematics as object.

Sfard (1991) has suggested that abstract mathematical notions can be conceived in two fundamentally different ways: structurally as objects or operationally as processes. She claims that the operational conception is, for most people, the first step in the acquisition of new mathematical notions. The transition from a 'process' conception to an 'object' conception is accomplished neither quickly nor without great difficulty. After they are fully developed, both conceptions are said to play important roles in mathematical activity.

In conclusion, the review of the history of the nature of mathematics reveals many different perspectives. Views can be divided into different categories and as emphasising different dimensions. In one way or another these views about the nature of mathematics affect teachers' conceptions of mathematics. It will be helpful to start the next section by reviewing the different conceptions that are held by teachers about mathematics.

3.1.2 Culture and Mathematics

The purpose of this section is to look at some studies about culture and mathematics learning. Nunes (1992) noted that there are two views about culture and mathematics. With regard to the first view, espoused by Stigler and Baranes in 1988, Nunes noted that the definition of mathematical knowledge in this view 'is implicit and appears to be based on the content of knowledge. Activities that involve number, geometrical patterns, are treated as applications of mathematical knowledge (p. 558). On the other hand, the second view, apparent in the work of Gal'perin and Georgiey in 1969 and again in the work of D'Ambrosio in 1986, suggested that the analysis of cultural influences on mathematical knowledge could demonstrate both differences and invariance in mathematical knowledge across culture. The first view emphasises differences rather than similarities across cultures, while the second view, 'mathematizing' reality, represents reality in such a way that knowledge can be generated through inferences using mental representations and there is no need to manipulate reality further in order to verity this new knowledge regardless of whether the mathematical knowledge is developed in or out of school.

In addition, Bishop (1988) noted that there are six fundamental activities, which, he argued, are both universal in their appearance in every cultural group and necessary and sufficient for the development of mathematical knowledge. They are counting, locating, measuring, designing, playing, and explaining. He argued that if these six activities are universal, then a curriculum which is structured around these activities would allow the mathematical ideas from different cultural groups to be introduced sensibly in a curriculum which would allow all cultural group to present their own mathematical ideas.

Nunes (1992) noted that there are different methods of counting and measuring in use from culture to culture. On the other hand, we should take into account the impact of the new technology as this facilitates speedy exchange of information and transfer of knowledge from one country to another. In this connection D'Ambrosio (1990) has commented,

> Throughout the history of mankind every culture has recorded, in different ways, reports of travellers who have seen or heard about ways of coping with reality and explaining facts and phenomena which are different from their own. The encounters of cultures are, evidently, responsible for the dynamics of cultural changes (p. 121).

3.1.3 Teachers' Conceptions of Mathematics

Teachers have a variety of conceptions of mathematics, as has been indicated by a great deal of research into the subject, e.g. that of Ernest, 1989a; Hersh, 1986; Lerman, 1983; and Thompson, 1984. In this section we will try to examine these conceptions, reviewing the literature from Skemp (1978) until the latest classification by Ernest (1989a).

Lerman's (1983) categorisation of views about the nature of mathematics has two extreme poles: the absolutist and fallibilist views. He argued that, as a consequence, these two views might lead to two different teaching perspective: knowledge-centred and problem-solving. As Lerman (1983) noted, from an absolutist view, all of mathematics is based on perfect foundations, while, from a fallibilist view, mathematics develops through conjectures, proofs, and refutations, and uncertainty is accepted as inherent in the discipline.

In fact, different schemes of classification have been offered at different times. In a later study Ernest (1989a) mentioned another category for the classification of this issue. He added a third view, the instrumentalist view, in his classification of views about the nature of mathematics. This third view may be appropriate for the instructor type of person who likes to use mathematics as a tool involving rules and skills, as the next paragraph will explain. It is noticeable that Lerman's absolutist views is parallel with Ernest's Platonist view, and Lerman's fallibilist view is parallel with Ernest's problem-solving view,

Ernest (1989a) defined a teacher's conception of the nature of mathematics teaching as a whole. Such views form the basis of the philosophy of mathematics, although some of the views likely to be held by teachers may not have been elaborated into fully articulated philosophies. Ernest (1989a) defined them as follows:

> First of all, there is a dynamic, problem-driven view of mathematics as a continually expanding field of human inquiry. Mathematics is not a finished product, and its results remain open to revision (the problem-solving view). Secondly, there is the view of mathematics as a static but unified body of knowledge, consisting of interconnecting structures and truths. Mathematics is a monolith, a static immutable product, which is discovered, not created (the Platonist view). Thirdly, there is the view that mathematics is a useful but unrelated collection of facts, rules and skills (the instrumentalist view) (Ernest, p.21).

In earlier studies, Skemp (1978) presented a discussion about the nature of mathematics in a psychological rather than a philosophical way. Thompson (1992) described this important classification. He noted that Skemp categorised the nature of mathematics depending on the instructional approaches. Skemp credited Mellin Olsen with drawing his attention to a distinction between two different meanings generally associated with 'understanding' as it relates to mathematics: 'relational understanding' and 'instrumental understanding'.

Based on the type of knowledge each reflects Skemp tried to draw a distinction between 'instrumental mathematics' and 'relational mathematics'. Instrumental knowledge of mathematics is knowledge of a set of 'fixed plans' for performing mathematical tasks. The characteristic of these plans is that they follow a step-by-step process in performing a certain task. Executing many fixed plans is the type of learning that leads to instrumental mathematics, by which pupils can find their ways from particular starting points. On the other hand, relational mathematics is characterised by the possession of conceptual structures that enable the possessor to construct several plans to perform a certain task.

Another broad categorisation, more detailed than the above classifications mentioned by Thompson (1984), is Perry's scheme. This scheme was adapted for the study of conceptions of mathematical knowledge by Copes (1979). Copes proposed four types of conceptions: absolutism, multiplism, relativism, and dynamism. He described each type as corresponding to a conception of mathematical knowledge prevailing at different periods of it historical development.

> Absolutism prevailed from the time of the Egyptians and Babylonians until the middle of the 19th century. From an absolutist perspective, mathematics was viewed as a collection of facts whose truth is verifiable in the physical world. Multiplism, according to Copes, emerged with the advent of non-Euclidean geometries. Mathematical facts no longer needed to be verified by observable physical phenomena. Multiplism was characterised by the coexistence of different mathematical systems that might contradict each other. Relativism was marked by the abandonment of efforts to prove the logical consistency of the different systems and the concomitant acceptance of their coexistence as equally valid systems. Dynamism is characterised by a commitment to a particular system or approach within the context of relativism (Thompson, 1992, p. 133).

It is thought that these several classifications have their influence on teachers and the way they teach their students. The next section looks at these classifications and their relationship with teaching.

3.1.4 The Nature of Mathematics and Practice

In this section we will review some studies that argue that there is a relationship between beliefs about mathematics and the practice of mathematics teachers. Some of these studies have been of assistance to the researcher in the present study in developing a new scale for the purpose of this study.

Many researchers have indicated that teachers' beliefs about mathematics and its teaching play a significant role in shaping the teachers' characteristic patterns of instructional behaviour. The NCTM notes that "teachers are key figures in changing the ways in which mathematics is taught and learned in schools" (NCTM, 1991, p. 2).

Thompson (1992) noted that Copes in 1979 had suggested ways in which different teaching styles can communicate different conceptions. For example, a teaching style that emphasises the transmission of mathematical facts, right versus wrong answers and procedures, and single approaches to the solutions of problems may communicate an absolutist or dualist view of mathematics. That is similar to the findings of Thompson's 1984 study.

Using a case study Thompson (1984) investigated the relationship between three junior high school teachers' beliefs about mathematics and mathematics teaching, and their instructional practice. Thompson's analysis also looked at the formal properties of conceptual systems that could explain the differences among the teachers' conceptions. Teachers were observed daily for four weeks, with daily interviews after the observations during the last two weeks in this study. In addition, the teachers performed six tasks over the period of the study. Thompson (1984) noted that Kay, one of the teachers, held a problem-solving view, Jeanne held a Platonist view, and Lynn held an instrumentalist view. He found that Jeanne saw mathematics as a coherent subject of logically interrelated topics, Kay emphasised discovery and verification because she regarded mathematics as a challenging subject, while Lynn viewed mathematics as prescriptive and deterministic. This meant that the teachers' ideas of what constituted mathematical understanding reflected their views of mathematics.

Ernest (1989a) noted that each of the three views described above have their own outcomes. The problem-solving view leads to greater acceptance of children's methods and approaches to tasks. On the other hand, the static Platonist or instrumentalist view can lead to the teacher's insistence on there being a single 'correct' method for solving each problem. He identified the impact of beliefs on teaching as represented and summarised in the following table:

Table 3.1: Views of Mathematics

View of Mathematics	Model of Teacher	Intended Outcome
Instrumentalist	Transmission	Child's compliant behaviour and skills mastery.
Platonist	Explainer	Learning as the reception of knowledge.
Problem-solving	Facilitator	Learning as autonomous problem posing and solving, and as the active construction of understanding.

Ernest (1989a) noted that there are three key causes for the mismatch between beliefs and practices, viz: (1) the depth of the espoused beliefs and the extent to which they are integrated with other knowledge and beliefs; (2) the teachers' level of consciousness of their own beliefs and the extent to which these reflect on their practice of teaching mathematics; (3) the social context.

He also noted that the different views concerning the nature of mathematics have their roots in the main curriculum reform movements in mathematics. For example, the 'modern maths' movement of the early 1960s can be linked to the Platonist view through its stress on structure, the laws of number, and central and unifying concepts of mathematics, such as sets and functions. Similarly, the 'back-to-basics' movement can be linked with the instrumentalist view, which emphasises basic numeracy as knowledge of facts, rules, and skills, without regard for meaningful connections within this knowledge. Again, as Ernest (1989a) noted, the third view has parallels with the recommendations of official bodes such as the standards of the USA's NCTM in the 1980, the HMI in 1985, and the National Curriculum Mathematics Working Group in 1987. However, this is a matter of emphasis, and one can point to elements of the three views in each of these curriculum reform movements.

Similarly, as Thomson (1992) noted, teachers' conceptions of mathematics might include more than one of the above views. "The clustering quality of belief systems may help explain the occurrence of conflicting beliefs" (Thompson, p.132). In the next section we will attempt to explain belief systems and their effects.

3.1.5 Beliefs Systems

In this section we will try to explore more about beliefs. We should first consider the difference between the two words 'beliefs' and 'knowledge', a difference previously noted by Abelson (1979). One of these differences is that beliefs can be held with varying degrees of conviction. Another distinguishing feature is that not everyone holds the same beliefs and believers are aware that others may believe differently than they do.

Thompson (1992) noted that Green (1971) and Rokeach (1960) agreed that "the notion of a belief system is a metaphor for examining and describing how an individual's beliefs are organised." Green (1971) identified three dimensions of belief systems. As a first dimension, he observed that beliefs are never held in total independence of all other beliefs, and that some beliefs are related to others in the way that reasons are related to conclusions. Thus, a beliefs system has a quasi-logical structure, with some primary beliefs and some derivative beliefs. The second dimension of belief systems is that they are characterised by the degree of conviction with which they are held, in other words they have a psychological strength that can be viewed as either central or peripheral, the central ones being the most strongly held beliefs and the peripheral ones those most susceptible to change or examination. This entails a teacher's derivative belief in the importance of being prepared to answer students' questions, as this may be more important or psychologically central to the teacher for reasons of maintaining authority and credibility than for clarifying the subject to the students. The third dimension has to do with the claim that beliefs are held in clusters and protected from any relationship with other sets of beliefs. Thompson (1992) suggested that this clustering property might be a reason for some of the different beliefs admitted by teachers in several studies.

3.1.6 Some Studies of Teachers' Beliefs about Mathematics

Clark and Peterson (1986) noted in their review of literature on teachers' thought processes the importance of understanding teachers' and student teachers' implicit theories and beliefs about education. Researchers in mathematics education suggest that teachers' beliefs about what mathematics is and what it means to know, do, and teach mathematics may be driving forces in the construction of mathematical ideas (Cooney, 1985; and Kloosterman and Stage, 1992).

The National Council of Teachers of Mathematics (NCTM, 1989) promoted a new conception of what it means to know, learn, and teach mathematics. They focused on the learners' personal construction of mathematical knowledge. This is the problem-solving view, as described by Ernest (1989a). The NRC (1989) also underlined the need for schools to consider the role of teachers' beliefs in students' motivation, performance, and achievement in mathematics. In this section we will try to review several studies about teachers' beliefs about the nature of mathematics.

Wood, Cobb, and Yackel (1991) found from their case study that changes had occurred in second-grade teachers' beliefs. Their perceptions had resulted in changes in:

> the nature of (a) mathematics from rules and procedure to meaningful activity, (b) learning from passivity to interacting and communicating, and (c) teaching from transmitting information to initiating and guiding students' development of knowledge (p. 587).

Raymond and Santos (1995) studied the extent to which future teachers are aware of the many facets of what it means to be a teacher of mathematics. They developed a unique mathematics content course, entitled T104, specially designed for primary student teachers and incorporating the new vision of teaching mathematics through problem-solving (NCTM, 1989; NCR, 1989) by challenging students to construct and/or reconstruct their understanding through their experiences and what they are learning throughout the process. T104 was an ideal setting for the study of prospective teachers' beliefs systems because it was designed to challenge student teachers to question their beliefs about themselves as mathematics learners and to contemplate the ups and downs involved in continuous reflections about knowing, doing, learning, and teaching mathematics. The course challenged their views of what mathematics is. Journals kept by student teachers reflected the struggles they faced when the course content and methodology challenged their prior views of mathematics and mathematics teaching. They also mentioned that student teachers redefined their beliefs about knowing, learning, and teaching mathematics. While it was acknowledged that just eight volunteer student teachers may not have been representative of the entire group of T104 student teachers, Raymond and Santos felt that the material they contributed did help to demonstrate how some T104 students were affected and to illustrate beliefs and moments of uncertainty expressed by some numbers of the T104 community.

In an interesting discussion, Thompson (1992) mentioned the two studies of Collier (1972) and Shirk (1973). He noted that Collier used Likert scales to measure primary student teachers' beliefs about mathematics and mathematics teaching along a formal-informal dimension. While the formal dimension dealt with mathematics as an exact science free of ambiguity and consisting of rules, in contrast, the informal dimension dealt with mathematics as an aesthetic, creative, and investigative observation of nature offering a multiplicity of approaches to the solution of problems. Collier concluded that, allowing for the cross-sectional nature of the samples, the results indicated some slight progression in the beliefs of the teachers toward an informal view of mathematics and mathematics instruction as they went through the programme. In the study of Shirk (1973), he observed four primary student teachers during a mathematics methods course. His results were unlike those of Collier in that he found no discernible change in the teachers' conceptions. Shirk observed some changes in instructional behaviour, but noted that these were consistent with the teachers' conceptions. Reviewing these two studies, Thomson (1992) concluded,

> Taken together, the results of Collier (1972) and Shirk (1973) suggest that prospective teachers' conceptions are not easily altered, and that one should not expect noteworthy changes to come about over the period of a single training course. Still, one might wonder if it would be possible to obtain more encouraging results than those reported by either Collier or Shirk through intervention of comparable duration, but specifically designed to induce change in the teachers' conceptions (p. 139).

A more recent study, by Becker and Pence (1996), concerning secondary school teachers, examines the critical aspects of staff development, which translate into changes in teachers' beliefs and classroom practices consistent with U S reform efforts. This study was made with the co-operation of high school teachers involved in two staff development projects: 'Building Bridges to Mathematics for All' and the 'San Jose Mathematics Leadership Project'.

Becker & Pence (1996) pointed out that the model of Ernest (1989a), which relates teachers' views of mathematics with intended classroom outcomes, informed their work as they tried to relate teachers' beliefs (and changes in them), not only about mathematics but also about mathematics teaching and learning, to classroom practice.

Becker & Pence also noted that beliefs may be influenced by other factors in the context of the school and the classroom. Cooney's (1993) view of beliefs also informed their work as they tried to ascertain not only what works to stimulate teacher change, but also what impedes it in the school setting. As previously noted, their study made use of the staff development project 'Building Bridges to Mathematics for All', which has been in operation since Autumn of 1992. This includes several facets: a 13-days intensive summer institute, five days of the academic year spent in full-day workshops, and classroom coaching. They noted that the main aims of the staff development were that:

> teachers will learn new ideas about how students learn mathematics, changing their instrumentation to a student-centred one using a variety of instructional modes to serve a diverse population; teachers will learn how their expectations of student achievement can make a critical difference on student achievement and what their role is in achieving educational equity for all students;
> teachers will learn new content and learn to extend content across topics and stands as needed for implementation of integrated courses (Becker & Pence, 1996, p. 106).

The San Jose Mathematics Leadership Project planned for a long involvement of participants. Becker & Pence mentioned that considerable time was needed for teachers' if conceptions of mathematics teaching and learning were to change. In this project teachers committed themselves to either a three-year or two-year programme of staff development.

> The main goal of the Leadership project was to develop teacher Leaders who could go back to their schools and school districts and lead the continuing reform in mathematics education curriculum and instruction (Becker & Pence, 1996, p. 107).

Becker & Pence (1996) found that involving groups of teachers from the same school rather than lone individuals helped provide the support system for change back at the school site. They also found that changes in teachers' beliefs came slowly with in-depth involvement over a long period of time, but did accompany changes in classroom practice.

The above studies point to the importance of teachers' beliefs about the nature of mathematics. Even if there are slight changes in students' or teachers' beliefs about the nature of mathematics, teachers and educators must consider and test this issue and its effect on teachers and student teachers. Student teachers should be helped to understand the pedagogical relevance of their beliefs about the nature of mathematics.

Reviewing the above three sections, we notice that in some way there is a link and relationship between beliefs about the nature of mathematics and in the classroom. The next section will explore attitudes towards mathematics, because this study tries to examine the relationship between beliefs about the nature of mathematics and attitudes towards mathematics.

3.2 Students' Attitudes toward Mathematics

A large number of studies of students' attitudes toward mathematics have been produced over the years. Some of these also consider the effects of student's attitudes on teachers and student teachers. The attitudes we are particularly considering include mathematics anxiety, confidence in learning mathematics, the usefulness of mathematics, and enjoyment in mathematics. Educators have adopted the general belief that it is beneficial for a student to have a positive attitude toward a subject being studied, such as mathematics. This accords with the obvious fact that a student learns better when he or she likes what is being taught and teachers taught better if confident about their knowledge. If future teachers could themselves be exposed to a good educational background and support system and could build on a background of solid experience, it is possible that more teachers would elect to teach mathematics at the primary level. Primary student teachers come from a variety of backgrounds and social environments, and their prior experiences in schooling will shape their present attitudes about teachers, teaching, and the subject matter that is taught (Van Voorhis and Anglin, 1994).

As McLeod (1992) noted, there are two different ways in which attitudes toward mathematics are acquired. An attitude may first result from the automatizing of a repeated emotional reaction to mathematics. For example, if a student has repeated negative experiences with algebra exercises, the emotional impact will usually lessen in intensity over time. Eventually, the emotional reaction to algebra exercises will become more automatic. In a second way, an already existing attitude can be transferred to a new but related task. For example, if a student has a negative attitude toward algebra exercises, he/she may attach that same attitude to exercises in another subject in mathematics.

In the following sections we will explore mathematics anxiety, confidence in learning mathematics, and other types of attitudes toward mathematics. The many studies that have investigated attitudes toward mathematics have explored the influence of a range of possible attitudes including, for example, maths anxiety, confidence in learning mathematics, views concerning the usefulness of mathematics, and enjoyment in learning mathematics. The one of these attitudes which has received proportionally much more attention than others is mathematics anxiety and so we will make this our first consideration.

3.2.1 Mathematics Anxiety

There are various ways of defining mathematics anxiety. Some researchers have defined it as an emotional and cognitive dread of mathematics (Hodges, 1983; Reyes, 1984), which, as some researchers have noted, may have a far-reaching effect on the lives of students. Richardson and Suinn (1972) suggested that mathematics anxiety

> involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations (p. 551).

They concluded that mathematics anxiety might prevent a student from completing a fundamental mathematics course or pursuing an advanced course in mathematics. In another study, Fennema and Sherman (1976) stated that their mathematics anxiety scale was

> intended to measure feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics. The dimension ranges from feeling at ease to feeling distinct anxiety. The scale is not intended to measure confidence in, or enjoyment of, mathematics (p. 326).

Hembree (1990) used meta-analysis study to integrate the findings of 151 studies in order to examine the relationship between mathematics anxiety and other variables. The results of this meta-analysis showed that mathematics anxiety is bound directly to avoidance of the subject. In particular, over-anxious students took fewer high school courses and showed little intention in high school and college to take more mathematics courses. In addition, Tobias and Weissbrod (1980) claimed that mathematics anxiety and mathematics avoidance could be mutually supporting. They wrote that mathematics avoidance could lead to erosion of mathematics skills and hence to anxiety when one is later faced with situations involving mathematics. In contrast, Kelly and Tomhave (1985) wrote, "There is insignificant evidence that a causal link exists between anxiety and mathematics avoidance" (p.51). We may conclude that while some researchers have disputed any connection between mathematics anxiety and mathematics avoidance, Hembree's meta-analysis shows that there is indeed a connection.

3.2.1.1 Mathematics Anxiety Transfer from Teachers to Students

There are some studies which agree that mathematics anxiety is conveyed from teachers to students. Lazarus (1974) coined the term 'mathophobia' to refer to maths anxiety. He mentioned that the attitudes of teacher and their feelings about mathematics were far more important than their actual knowledge. As Lazarus noted, "These will surely be important to the student whether the teacher intends it or not" (p.22). Explaining this further, he asserts,

> The teacher who takes no joy in mathematics, to whom mathematics is only a set of units to be "covered" by a certain date, is unlikely to be effective in the ways that matter the most. When material is drudgery to the teacher, we can hardly expect it to excite the students. Those students who do develop or maintain an interest must then do so in spite of the teacher—and occasionally against his active opposition, as when the teacher discourages speculation, probing questions, and exploration of new techniques, insisting instead that everything be done by the book. Most students will simply take their cue from the teacher, sharing his view that mathematics must be a dull, pointless task. Sadly, almost every student comes to adopt this perspective sooner or later. Mathophobia is a highly communicable condition, to which the young are especially liable (p.22).

In their study of mathematics anxiety and mathematics avoidance in primary student teachers, Kelly and Tomhave (1985) point out that a high proportion of them were mathematics-anxious, the majority of them women, who may be perpetuating maths anxiety with young girls in their classrooms. The gender issue will discussed more deeply in section 3.2.3. It is conjectured that students who are surrounded by confident teachers who are excited and positive about their role in the students' learning process will exhibit fewer symptoms of maths anxiety than students whose teachers are themselves anxious or uncomfortable.

On the other hand, in a study by Bush (1989) of primary teachers' mathematics anxiety and its effect on their students, the author found no significant relationship between teachers' maths anxiety and changes in mathematics students' anxiety.

Similarly, Chavez and Widmer (1982) agreed that teachers who experienced maths anxiety and yet seemed determined to make mathematics an enjoyable experience for their students were able to break the cycle of mathematics anxiety.

There are therefore a number of studies agreeing that there is a relationship between teachers' and the students' anxiety in mathematics. The next section will review some studies about mathematics anxiety and student teachers

3.2.1.2 Mathematics Anxiety and Primary Student Teachers

Many studies have discussed student teachers' maths anxiety, including those of Bulmahn and Young (1982), Battista (1986), Becker (1986), Sovchik, Meconi, and Steiner (1981), and Hembree (1990).

In a study about primary student teachers, Battista (1986) tried to explore their mathematics anxiety in relation to the mathematics methods course, which included lecture-discussion, small group activities, and five weeks' teaching practice in schools. The finding was that student teachers' maths anxiety could be reduced by the mathematics methods course. There may have been two possible reasons for this. First, the methods course, especially the teaching practice, illustrated to the student teachers the usefulness of mathematics in their future teaching careers. Second, as maths anxiety seems to be related to lack of self-confidence in dealing with mathematics, the methods course and in particular the teaching practice convinced them that mathematics is not something to be feared.

The preparation programme for student teachers in Kuwait includes these types of courses and activities, as we mentioned in Chapter Two. So, for instance, the College of Basic Education states its aim to be to prepare teachers culturally, academically, and professionally to teach mathematics at the primary stage. Specifically, the college programme aims to achieve the following objectives through its preparation courses: to promote an interest in mathematics, besides developing positive attitudes towards it and promoting good functional values and habits; further, to promote the various teaching skills appropriate to mathematics education through actual practice and various activities.

Hembree (1990) examined by meta-analysis the levels of mathematics anxiety in student teachers undergoing various college courses and majors. He concluded that high levels appeared in remedial mathematics and declined with more advanced study. Mathematics and science majors were predictably low in the construct. The highest levels occurred for students preparing to teach in primary schools.

Bulmahn and Young (1982) studied approximately 100 primary education students. In questionnaire responses and essays the students wrote about their attitudes toward mathematics. Bulmahn and Young classified the students as either 'humanities types' or 'mathematics–science types'. Primary education majors in the study were found to be predominantly 'humanities types'. They found that a large portion of primary school teachers have a much greater interest in language and social studies than in mathematics and science. Another finding was that many beginning student teachers felt that they did not need anything more than skill with basic computations and the teachers' manual to teach primary school mathematics. They hypothesised, on the basis of these results, that the abilities and personality types that draw people to primary education and to mathematics are inconsistent and unlikely to be possessed by the same person. Nevertheless, they pointed to a concern that mathematics anxiety may be a "communicable disease that is being carried by elementary teachers to generations of the student population" (p. 56).

In a later study, Becker (1986) commenced by referring to the work of Bulmahn and Young and stating her disagreement with their conclusion. In her own work she used the mathematics anxiety scale, one of the mathematics attitudes scales developed by Fennema and Sherman (1976). Becker's sample was 81 students in the primary education major and 71 students from general astronomy. The findings were that significantly more primary education students showed symptoms of mathematics anxiety than did the students in the astronomy classes. She concluded that it would be good to be very positive about mathematics, but we may be expecting too much if we want education students to be more positive about mathematics than college students in general.

In the above study both of the astronomy and primary majors recognise the importance of mathematics in their specialist. For example, students in the astronomy major will certainly understand the usefulness of mathematics and be positive about the value of mathematics is their further studies and their future work. Primary education major students will also need to be positive about this subject since they must teach into primary school pupils at a very fundamental stage.

3.2.1.3 Maths Anxiety and Beliefs about Mathematics

Austin and Wadlington (1992) studied the effect of beliefs about mathematics on maths anxiety and the maths self-concept in primary teachers. 50 student teachers and 15 in-service teachers participated in the study. All participants were rated on the Mathematics Anxiety Rating Scale (MARS), which is a 98-item self-report inventory with a Likert format. In addition, they were subjected to the Kulm Mathematics Self-Concept Test (KMSCT), which is a 27-item, Likert scale, self-report inventory, and to the Math Belief Survey Instrument (MBSI), which was developed for this study and consisted of 12 maths beliefs statements first identified by Kogelman and Warren (1978) and later used in a study of the beliefs of student teachers conducted by Frank (1990). Austin and Wadlington found that those who disagreed with the belief that 'Math is not creative' scored high in the KMSCT, while those who agreed that 'Math is not creative' scored low in the KMSCT.

Also, no significant differences were found in student teachers' and in-service teachers' levels of maths anxiety according to their agreement or disagreement with any particular mathematics belief. With the exception of belief 11, 'Math is not creative', there was no evidence of a significant effect of maths beliefs on maths self-concept. They mentioned that less-anxious individuals perceived themselves as doing well in mathematics in spite of these beliefs. They found that those who believed that mathematics is not creative had a low math self-concept.

They also found that the in-service group were slightly less certain regarding some of their beliefs. They suggested this was because the in-service teachers had more real classroom experience than the pre-service teachers did and, consequently, they had become more flexible in their thinking.

After reviewing the above studies, we have arrived at a clearer understanding of mathematics anxiety. The major features of this section are, first, the identification of the intrinsic links between students' mathematics anxiety and their avoidance of studying mathematics in their later life. Second, we have seen how mathematics anxiety might adversely affect both teachers' practice and students' attitudes in general and most especially on mathematics, as this anxiety tends to transfer to the students. Our study seeks to examine the anxiety of student teachers who will be the future teachers of an important subject. The review has also indicated that certain changes that can be made to mathematics teaching methods and the preparation programme might will improve future teachers' attitudes toward mathematics, therefore we will examine the relationship between the class levels and the level of mathematics anxiety for the sample of this study.

3.2.2 Confidence in Learning Mathematics

Confidence in learning mathematics is an interesting topic that researchers have tried to investigate. Reyes (1984) mentioned that confidence correlates positively with achievement in mathematics in secondary school examination levels. A similar result was found by Fenemma and Tartre (1995) about students in grade 6^{th} to 12^{th}. In addition, a lot of studies found that confidence related to elective enrolment in mathematics courses, and used this in studying, for example, gender difference (Fennema, 1989 and Linn & Hyde, 1989).

There are different ways of measuring confidence in learning mathematics. McLeod (1992) noted that the National Assessment system of compiling data on students simply asked if they were good at mathematics. On the other hand, Fennema and Sherman (1976) developed a scale to assess student confidence.

In Mura's (1987) investigation of student teachers' levels of confidence, career plans, and gender, the sample of 1,270 students was selected from five Canadian universities. The findings of this study were that women tended to be less confident than men and fewer women planned to take advanced mathematics courses in their college than did men.

The Fennema and Sherman (1976) mathematics attitude scales are among the popular measures used in studies of attitudes toward mathematics. Fennema and Sherman's study investigated the secondary school level. One of the nine scales was for confidence in learning mathematics. The main purpose of this study was to gain more information concerning females' learning of mathematics as well as information concerning variables related to the election of mathematics courses. They stated that the confidence in learning mathematics scale was

> intended to measure confidence in one's ability to learn and to perform well on mathematics tasks. The dimension ranges from distinct lack of confidence to definite confidence. The scale is not intended to measure anxiety or mental confusion, interest, enjoyment, or zest in problem solving (p.326).

They found that female students in grades 6-12 showed less confidence than male students in their ability to learn and do mathematics.

3.2.3 Gender and Mathematics Attitudes

Many researchers have discussed the gender issue in mathematics learning. Various areas of concern have been examined in these studies. For example, Swafford (1980) looked at the gender difference and algebra learning; Fennema and Tartre (1985) and Battista (1990) considered differences of spatial visualisation in mathematics between girls and boys; Leder (1982) and Elliott (1990) focused on the relationship between selected affective variables and mathematics achievement; and Hembree (1990) focused on mathematics anxiety. There have, in addition, been a number of other studies that have developed or used certain scales to measure this issue, for example, the study of Smith and Walker (1988), and that of Fennema and Sherman (1978), who constructed a mathematics male domain scale, which was

> intended to measure the degree to which students see mathematics as a male, neutral, or female domain in the following ways: (a) the relative ability of the sexes to perform in mathematics; (b) the masculinity of those who achieve well in mathematics; (c) the appropriateness of this line of study for the two sexes (p. 325).

These studies have arrived at different results. For example, Smith and Walker (1988) present an analysis of data from three mathematics examination and revealed that females performed slightly better than males on the ninth and eleventh grad papers wile males did better on the tenth grade paper. That indicates that there is no essential differences were found in these examinations. They found that males and females appear to perform as well on curriculum-specific tests, provided the two groups have a similar history of previous courses taking in mathematics.

The sample for the study of Ethington (1990) was drawn from 8 of the 24 countries which participated in the Second International Study of Mathematics. The performances of eighth-grade students in the different countries were compared for the content areas of fractions, ratio/proportion/percent, algebra, geometry, and measurement. Ethington found no sign of gender effects for any of the areas that were tested. The very small differences observed favoured females more frequently than males. Ethington concluded that the performance patterns observed were consistent with the hypothesis that cultural factors affect observed gender differences in mathematics performance.

On the other hand, many studies have discovered gender differences in learning mathematics. For example, Olson and Kansky (1981) found that the number of mathematics courses taken at the pre-college stage, as well as the highest level of mathematics achieved, varied with the gender of the student. While males generally took more mathematics courses and reached higher levels of achievement than did females, the differences were most pronounced in the largest school.

Another study arrived at similar results concerning gender differences and mathematics anxiety. In this study Hembree (1990) used meta-analysis to synthesise the findings of 151 studies. From this study the author found that females displayed higher mathematics anxiety levels than males. However, mathematics anxiety appeared to be more strongly linked with poor performance and avoidance of mathematics in pre-college males rather than females.

There are different explanations for this gender difference in learning mathematics. Leder (1992) reviewed several theoretical models relating to this issue, first mentioning that of Eccles et al. (1985), which attempted to explain students' decisions to enrol in mathematics courses. Leder (1992) listed several points that affected this issue, as Eccles et al. wrote,

> The cultural milieu, the behaviours, attitudes and expectations, the individual's goals and general self-schemata or self-image, the perceptions of the value of the task, achievement behaviour, expectancies, task-specific beliefs, past events as well as their interpretations, and the differential aptitudes of the child are all included as integral and interacting components of the model (p. 609).

The next model mentioned by Leder was that of Deaux and Major in 1987, who also focused on gender and social interaction. They considered the individual's goals and self-schemata, the expectancies and goals of others with whom the individual interacts, and the context in which the interactions occur, and they argued that the importance of different components is not fixed but will rather depend on the characteristics of the expectancy-its perceived social desirability, certainty, and situational context-and on the individual's concern with self-presentation or selfverification. In a recent study Leder (1990) investigated interaction differences in the classroom experiences of 289 males and 292 females in grade levels 3, 6, 7, and 10 from 14 different Australian schools. In the majority of teacher-initiated contacts, boys were found to have interacted more with their teacher and consistently sought and caught the teacher's attention more frequently than had girls.

Leder also noted the Reyes and Stanic model of group difference in mathematics achievement. Reyes and Stanic particularly focused on mathematics teachers and the classroom. The key components of their model, concerned not only with gender but also with race and socio-economic status, related differences in mathematics learning to social influences, teachers' attitudes, school mathematics curricula, the classroom processes, students' attitudes, and achievement-related behaviour.

Leder felt that all the above models agreed on a number of components, <u>viz:</u>

> The emphasis on the social environment, the influence of other significant people in that environment, students' reactions to the cultural and more immediate context in which learning takes place, the cultural and personal values placed on that learning, and the inclusion of learner-related affective, as well as cognitive, variables (p.609).

In addition, Fennema, Peterson, Carpenter, and Lubinski (1990) investigate teachers' beliefs in relation to gender and mathematics. For this study there were 38 first-grade female teachers in 24 schools in USA. They ask them to identify their two most and leads successful male and female students in mathematics, to attribute causation of these students' successes and failures, and to describe their characteristics. Teachers' choices of most and least successful students were compared to mathematics test scores of their students. From their analyses they found that teacher beliefs about male and female students in mathematics were different. Teachers noticed male students as being their best students and teachers thought their best male students, when compered to their best female students, were more competitive, more logical and volunteered answer, more independent in mathematics. The researchers pointed out differences in teachers' expectation of female and male students, which lead the teachers to overrate the males' mathematical capability and to underrate the females.

This review of literature has made it evident that there are many variables that affect students' attitudes in learning mathematics. Some educators might agree while others might disagree with results from the above studies. As Leder summarised, even if there is a small difference related to gender in mathematics learning, the above studies' samples of behaviour and beliefs still represent the wider society. She noted,

> There is some evidence that on average females are somewhat less confident about their ability to do mathematics, less certain that mathematics is an appropriate and needed area of study for them, more ambivalent about the value to them of success in mathematics; also they may be less functional than males in their attributions of success and failure and less likely to persist on the more challenging tasks (p. 616).

The advantage of the reviewed work is to show the significant and continuing focus on the gender differences in mathematics learning. These studies served to highlight these issues from different angles. Even there are different results but these studies have not only been used to specify a certain problem but help us as educators to change and try to find the solution to these issues. In Kuwait, there are large numbers of females are now have shown themselves capable of achieving well in different fields and in mathematics, even they educationally started after the males. Thus, in this study the need to investigate the gender differences in the student teachers and to understand the difference in the College of Education at Kuwait.

3.2.4 Teachers' Views concerning the Usefulness of Mathematics

Fennema (1990) observed those teachers' beliefs influence the way that they teach and talk about mathematics to their students. She commented,

> If teachers believe that mathematics is useful… it seems reasonable to assume that they will work harder to ensure that their students learn mathematics (p. 174).

In an earlier study by Fennema and Sherman (1976), proposing mathematics attitude scales, they said that their mathematics usefulness scale was

> designed to measure students' beliefs about the usefulness of mathematics currently, and in relationship to the future education, vocation, or other activities (Fennema and Sherman, 1976, p.326).

They developed this particular scale based on Hilton and Borglund's conclusion in 1971 about the sex-related differences in perception of the usefulness of mathematics.

The preceding review of literature has made frequent reference to the mathematics attitudes scales developed by Fennema and Sherman in 1976. These cover four important attitudes that the present study seeks to investigate, namely, mathematics anxiety, confidence in mathematics, the male-domain, and the usefulness of mathematics. The wording of the items in these scales does not seem to be obviously culture specific and has been used by many researcher to measure college students' attitudes (Butler and Austin-Martin, 1981; Heher 1988; Elliot, 1990). More details about these scales will be found in Chapter Six.

The reviews in the next section, together with those in this section, provide the literature support for the theoretical framework and methodology of this study.

3.3 Mathematics Teaching Attitudes

This section reports one of the important aspects of student teachers' attitudes, that is their attitudes toward teaching mathematics. It is in recent years that researchers have begun to recognise the importance of this particular issue.

Our own fieldwork confirmed that some student teachers have a fear of teaching mathematics, which suggests the importance of correcting their attitude toward teaching mathematics through appropriate training programmes. It could be said that the attitudes of primary student teachers toward mathematics teaching are most important because they teach at a fundamental level in the children's life, when they are particularly susceptible to adult influence. As Ernest (1989a) has commented, "The teacher's attitudes to mathematics itself may affect the teacher's attitudes to the teaching of mathematics, which in turn have a powerful impact on the atmosphere and ethos of the mathematics classroom" (p.28).

In a recent study Nisbet (1991) mentioned that "Discipline Review of Teacher Education in Mathematics and Science" and "Mathematics Counts" highlighted a complex problem in the area of attitudes in the teaching and learning of mathematics and, in particular, the attitudes associated with mathematics held by student teachers. He noted that the same problems where were discovered in studies conducted by Sullivan (1987) and Watson (1987). Therefore, depending on these studies, Nisbet developed an instrument for measuring pre-service teachers' attitudes to the teaching of mathematics. He suggested that in order to analyse the attitudes of student teachers to teaching mathematics, scales parallel to the Fennema-Sherman scales measuring attitude toward mathematics should be devised. Nisbet's sample consisted of 155 student teachers. After testing for validity, he arrived at four sub-scales for this instrument. These are the mathematics teaching anxiety scale, the confidence and enjoyment in teaching mathematics scale, the desire for recognition scale, and the pressure to conform scale. The main object of this instrument is to enable educationists to know the attitudes of student teachers toward the teaching of mathematics and to monitor such attitudes during a teacher education programme.

One of the aims of his study is to investigate the student teachers mathematics teaching anxiety for the primary major because of the important of their feeling while they learn to become teachers. The 'mathematics teaching anxiety' scale involves feelings of pressure and worry about teaching mathematics. In the mathematics teaching anxiety scale Nisbet found a weak but significant negative correlation between level of anxiety and year of programme. Thus, third-year students scored lower in the scale than did second- and first-year students.

However, the 'confidence and enjoyment in teaching mathematics' scale were designed to measure the student teachers' confidence and enjoyment in their ability to perform well in teaching mathematics. In the confidence and enjoyment in teaching mathematics scale the result in his study showed that student teachers became more confident and enjoyed teaching mathematics more as they progressed through the programme. Nisbet suggested that mathematics education course designers and lecturers should offer opportunities for their students to have experiences which can boost their confidence and provide enjoyment in the context of teaching mathematics to children.

The next two scales are important for the student teachers in this major. As Nisbet noted that the last two scales offered encouragement for the personal emotional needs of student teachers with regard to other people in their lives, because the social pressures on student teachers affect human behaviour. The desire for recognition scale designed to measure the student teachers' desire to be recognised and known by other people in future as good teachers. With regard to the third scale, 'the desire for recognition scale', Nisbet mentioned that this scale was similar to the attitude toward success in mathematics scale of the Fennema-Sherman scales. The findings showed that this scale correlated weakly but positively with the numbers of years of school mathematics taken by the student teachers.

Finally, The pressure to conform scale designed to measure the student teachers' feeling of distaste at being noticed or observed by other people for any individual characteristics he/she may show in the way he/she teaches mathematics. In the pressure to conform scale there were three general variables that correlated significantly in these scales' scores. The type of mathematics variable correlated positively, while the class level and age variables correlated negatively. In other words, with regard to the last-mentioned variable, student teachers felt less pressure to conform later in their course and mature students felt such a pressure even less.

In another study, Ludlow and Bell (1996) tried to investigate the attitudes and anxieties that future primary teachers may have toward teaching mathematics. College students were asked to respond to attitudes towards mathematics and its teaching (ATMAT) scales at the beginning, mid-term, and end of one semester. One important aspect of this attitude scale was that it was used to elicit responses concerning prior experiences related to mathematics.

The study was conducted on two sections of primary mathematics methods courses taught in spring 1994 at a private New England institution. The same instructor taught both sections. There were a total of 50 students, primarily women in their early 20s at the junior level in their studies. A 29-item, 6-point Likert scale questionnaire was created to measure attitudes and experiences associated with mathematics and its teaching. The questionnaire was distributed three times in the beginning of the term, the midterm and the end of the term. The higher the score the more positive the attitude toward teaching mathematics.

The authors noted that items were selected from published tests of mathematics attitudes and self-concepts along with generated items that focused upon attitudes toward teaching mathematics. In addition to items selected from the published tests, there were those relating to the doing or performing of mathematics, because teaching mathematics requires a significant amount of doing mathematics. The published tests included the math attitude scale revised by Aiken in 1963 and the mathematics self-concept scale devised by Holly in 1971. Face validity tests were conducted by college instructors, who reviewed the survey and agreed that the statements should measure attitudes toward mathematics and its teaching.

Ludlow and Bell (1996) mentioned that the scores would increase from the beginning to the end of the semester. They found that the average attitude estimate at the beginning of the semester was .26, at the mid term it was .54, and at the end of the semester it was .73. This meant that the attitudes of the students improved. They noted the reason for this change in the attitude of the students. At the beginning of the semester the students came to the course with a generally negative attitude toward all aspects of mathematics and the teaching of it. Once the course began, the students began to differentiate more clearly between what really made them uncomfortable and those aspects of mathematics with which they could feel more confident, particularly in the teaching of mathematics. The purpose of this study was to describe the development and attendant psychometric characteristics of attitudes towards mathematics and its teaching. The authors recognised that even the statistical results provided excellent evidence that attitudes towards mathematics and its teaching scales

(ATMAT) is a useful measure, although the small sample threatened the internal validity of factor-analytic solutions.

In this section we have considered the mathematics teaching attitudes of student teachers as a preliminary to understanding this issue and introducing different instruments designed to measure these attitudes. As we have seen, the ATMAT instrument has been used to measure attitudes toward the teaching of mathematics ranging from positive to negative, but without any sub-scales, while Nisbet's (1990) instrument consisted of four sub-scales designed to investigate specific attitudes toward the teaching of mathematics. The present study seeks to investigate certain dimensions of student teachers' attitudes towards the teaching of mathematics by addressing a number of particular questions.

3.4 Mathematics Teachers' Preparation Programmes

Teachers' preparation is an important issue, since it has a real effect on the way that mathematics is taught in schools. The National Research Council (NRC) and the National Council of Teachers of Mathematics (NCTM) have both suggested that education programmes should prepare students in the development of thinking skills and learning processes, and direct them toward the cultivation of positive attitudes which are necessary for lifelong learning (Raymond and Santos, 1995). In 1989, the NCTM proposed a new conception of what it means to know, learn, and teach mathematics. The council's proposal was so radical that, in effect, it amounted to a call for mathematics education reform, and the council specifically advocated a rethinking of mathematics teachers' preparation.

In general, Casey and Howson (1993) argued that teacher educators must make obvious basic changes to prepare teachers. The effectiveness of pre-service training programmes to prepare new and practising professionals for the increasingly complicated and distinctive demands of public school teaching is a concern penetrating all areas of education reform (Blanton, 1992; Bradley, 1994).

Swafford (1994) mentioned that there were certain issues in teachers' education programmes, the inclusion of which was essential in order to prepare the best teachers. Student teachers should have developed a certain body of knowledge, certain beliefs, and certain practices so that they, as new teachers, can enter the classroom able to implement and maintain the new and modern view of school mathematics. Swafford noted that a number of critical issues should be included in teachers' preparation if genuine reform was to take place, and particularly cited in this context the NCTM's standards for the teaching of mathematics (1991) and its definition of mathematics teachers' principles, *viz:*

> setting goals and selecting or creating mathematical tasks to help students achieve these goals;
> stimulating and managing classroom discourse so that both the students and the teacher are clear about what is being learned;
> creating a classroom environment to support teaching and learning mathematics;
> analysing student learning, the mathematical tasks, and the environment in order to make ongoing instrumental decisions (NCTM, 1991, p.5).

Depending on the NCTM's professional teaching standards, Swafford emphasised that student teachers should know their students as learners of mathematics, and know mathematical pedagogy. She explained the three aspects of teachers' personal preparation, which she defined as developing teachers' knowledge, developing teachers' beliefs, and developing teachers' classroom practice.

First, teachers' knowledge is undoubtedly the most important influence on their teaching. It will be used by teachers to engage their students in the study of mathematics, helping them to select the mathematical tasks to support classroom discourse and to assess students' understanding of set tasks. Swafford (1994) recognised three dimensions of teachers' knowledge, namely, content knowledge, pedagogical knowledge, and pedagogical content knowledge.

Content knowledge,

The first dimension noted by Swafford (1994), content knowledge, is a critical issue in teacher preparation and Swafford offered many recommendations to improve mathematical content knowledge. She mentioned the NCTM's professional standards for the teaching of mathematics and a report by the MAA, both of which agreed with the same content knowledge. She advised on the number of semester hours and the content that should be covered. The latter she described as follows:

1. number systems and number sense,
2. geometry and measurement,
3. patterns, functions, and algebra, and
4. data analysis, probability, and statistic.

> For the K-4 teachers, the coverage is concrete and focused on understanding the underlying principles, meanings, and connections. For 5-8 teachers, their preparation program should incorporate and expand on the topics covered by the teachers at the K-4 level and additionally include the development of basic concepts of
> 5. Calculus (p.162).

She noted that primary student teachers and middle-grades teachers should cover the content described above in a minimum of nine and fifteen semester hours, respectively, of college mathematics, with three and four years of high school college preparatory mathematics. The learning of this content should be experienced in a good environment. Student teachers need to learn mathematics by doing rather than by being told, also by using technology. They also need to learn mathematics independently, so that they may gain confidence in their own ability. They should be helped to understand the mathematical language from several dimensions, and know the nature of mathematics through a historical and cultural approach.

Pedagogical content knowledge,

Swafford's second dimension of teachers' knowledge is the pedagogical knowledge that student teachers should acquire. She suggested that student teachers should know how to manage a classroom, discipline unruly students, get the day or class going smoothly, keep records, meet with parents, and perform a host of other routine activities. The preparation programmes need to help future teachers develop a repertoire of appropriate scripts that will serve them as a set of survival skills when they begin to teach.

Pedagogical content knowledge

The last dimension of teachers' knowledge is pedagogical content knowledge, that is, the special knowledge about teaching and learning that is specific to the content. This kind of knowledge is concerned with how the subject might be represented in a way that is suitable for the learner. It also involves knowledge of the curriculum and instructional materials and technologies. Swafford commented that this kind of knowledge is not totally separate from mathematics content knowledge. Student teachers should visit schools and observe real-world situations besides learning indirectly about them in college.

Second, Swafford noted that teachers' beliefs about the nature of mathematics and about the nature of mathematics learning and teaching have been shown to be as important as their knowledge of mathematics. The vision of school mathematics presented in the NCTM's curriculum and evaluation standards in 1989 is one that views mathematics as problem-solving and learning as the construction of knowledge through working on worthwhile mathematical tasks. She cited Thompson (1984) as having shown a fairly consistent relationship between teachers' beliefs about the nature of mathematics and their instructional practice.

For example, a teacher who believes that mathematics is a set of facts and procedures is often one who views the teaching of mathematics as the clear presentation of concepts and procedures. On the other hand, a teacher who believes that knowing mathematics is the ability to recite facts and perform computations is often one who views the learning of mathematics as drilled practice. In fact, many factors colour teachers' beliefs about the nature of mathematics, for example, the need to cover the whole syllabus, which might compel teachers to adopt one particular view simply in order to finish the requirements.

Moreover, Swafford (1994) felt that beliefs had been shown to be resistant to change. Beliefs about the nature of mathematics and its teaching are developed over the entire life of students of mathematics. Teacher preparation programmes will be only a small fraction of the prospective teacher's total experience of mathematics.

Swafford suggested that teacher preparation programmes need to address teachers' beliefs as well as teachers' knowledge. Teachers' knowledge of mathematics and pedagogy is translated into practice through the filter of their beliefs about mathematics and the nature of mathematics teaching and learning. This underscores the need for a change in the way undergraduate mathematics courses are taught.

Finally, it is in their classroom experiences that student teachers have the opportunity to begin to develop their practice. There are a number of studies suggesting that student teachers tend to adopt the behaviour and attitudes of their co-operating teachers in their training course. Therefore, Swafford believed that to develop the ability to create and manage engaging learning environments where students are actively involved, it must begin during student teaching. The field experiences must challenge their beliefs about teaching and learning, and provide an opportunity for student teachers to reflect on their practice and analyse their own lessons, rather than simply receive suggestions from their college supervisors and co-operating teachers.

In another study, Anderson and Piazza (1996) stated that student teachers' and teachers' traditional beliefs about the learning and teaching of mathematics must change if their practice is to change. They listed several proposals, drawn from earlier studies, which, in their opinion, were necessary for those changes to take place in student teachers' education:

> (a) Preservice teacher education should be based on the same pedagogical principles as mathematics instruction; (b) if preservice teachers are expected to teach mathematics for understanding they must themselves become mathematics learners; (c) regular classroom experience and consultation provide support, sustaining preservice teachers' learning in the context that matters most; (d) collaboration among preservice and inservice teachers is essential to the process of reform; (e) autonomous preservice and inservice teachers should be the goal of education (Anderson and Piazza, 1996, p. 54).

Moreover, recent efforts by educators to improve the preparation of teachers have attempted to strengthen the knowledge base related to teaching and teacher education. Such efforts have attempted both to clarify the nature of teaching expertise and to identify teacher education practices that facilitate its development (Berlier, 1987).

As we mentioned before, there is a gap between the student teachers' preparation and how that preparation may colour their beliefs about the nature of the subject that they teach. Regan and Hannah (1993) described a project in which they tested student teachers' beliefs about their work, by examining the outcome of their teacher preparation programme. For this purpose, they went into the schools and classrooms of the teachers they had prepared, looked at their work, and discussed it with them over a period of eighteen months. They visited the schools of ten elementary teachers, watched them teach, interviewed them, their colleagues and principals, and re-read archival files containing documents about their progress through their preparation programme. The findings of this study should help teacher educators to understand more clearly the complex interplay between individuals their teacher preparation, and their schools. The educational system will not advance merely as a sequence of changed teacher education programmes in colleges and universities. If teachers are given training which provides them with new knowledge and skills, and are then placed in positions where they are unable to use that knowledge and those skills, then this will simply produce more teacher drop-outs.

The above-mentioned studies indicate that there are many aspects of the teacher preparation programme which have yet to be examined. Indeed, the present researcher came to the view that there are many aspects of teacher preparation programmes in the Arab states in general, and in Kuwait in particular where improvements could be made. Attempts to improve the preparation programmes for mathematics teachers must be continued, supported by evaluation studies designed to assess the extent to which the goals and objectives of such programmes, both in their theoretical and practical aspects, are being met. Evaluation should include the examination of the provision made for the acquisition of teaching methods and skills appropriate to the sector in which the programme's graduates will later work, in primary school. The current study seeks to examine student teachers' beliefs and attitudes while focusing on class level and gender variables. The results of this study should inform educators about the student teachers in this particular major. All of these should help to inform the continued development of teacher education programmes.

3.4.2 Types of Teacher Preparation Programmes

Swafford (1994) reviewed several types of models and schools of teacher preparation. Each school tried to cover certain critical issues in preparing teachers. The Holmes model and the elementary middle school mathematics specialist programme focus on developing teachers' content knowledge. Programmes using hypermedia platforms, i.e. multimedia classrooms, are equipped with video-recorders and computers, and focus on developing pedagogical content knowledge and beliefs. Professional development school induction programmes focus on how teachers are prepared and the environment in which they practise and teach. The following sections will explain some of these programmes.

3.4.2.1 The Holmes Model

In the mid 1980s, the Holmes Group was formed by a number of research universities in the USA. This group call for an undergraduate major in the teaching field, requiring a fifth year for the completion of a teacher preparation programme. One of the members of this group, Ohio State University, use this model for the preparation of secondary mathematics teachers. This major includes a five-quarter programme made up of two summers and the intervening year. In addition to the usual educational foundations and methods course, students take a research design course in the fall quarter, design a research project in the winter quarter, and carry out the research project in the spring quarter during their student teaching.

During the summer capstone seminar, students write up their research projects, which then become their masters' projects. Through the research component, the Ohio State University's programme seeks not only to cultivate teachers as researchers but also to induce an examination of beliefs through action research.

The programme further attempts to develop reflective practitioners, with particular attention being paid during student teaching to planning for instruction and an examination of the relationship of planning to what happens in the classroom. Hence, this Holmes model addresses the need to increase future teachers' content knowledge and the development of their pedagogical content knowledge and beliefs.

3.4.2.2 The Elementary Mathematics Specialist Model

This model was developed by the State of Illinois and requires all the student teachers to take eighteen semester hours in a teaching field as part of their undergraduate general education requirement. Illinois State University developed a programme featuring a sequence of seven mathematics courses specially designed for future teachers of primary and middle school mathematics. For example, this programme builds to calculus instead of beginning with calculus, thereby helping students to understand calculus from its basics. The content covered by this course conforms to the content recommended for the primary level curriculum. Each course attempts to extend students' knowledge and mathematical power and to relate the content learned to the school curriculum.

3.4.2.3 Use of Hypermedia Platforms

Two universities in the USA have introduced this type of programme to teach student teachers. These are Michigan State University and Vanderbilt University, which have introduced hypermedia platforms in primary education in an aim to develop student teachers' pedagogical content knowledge and beliefs. Interactive, multimedia classrooms are equipped with workstations configured with a computer with a CD-ROM drive, videodisc player, video monitor, and audiocassette recorder and headphone amplifier. Using hypermedia platforms with related print information, such as students' work, teachers' journals, and relevant research, provides the opportunity to combine video segments of actual classrooms for future teachers to analyse.

From a recorded situation the student teachers try to explore children's thinking and teachers' behaviour on a particular concept. They look at events more closely by stopping and replaying the tape and trying to figure what is happening in the lesson from teachers' and students' writings about the lesson or from another related video segment, and track their own developing interpretations. This helps the student teachers to see alternatives to traditional approaches to teaching. By engaging in the analysis required, future teachers are forced to examine their own understanding of mathematics and their beliefs about teaching.

3.4.2.4 Professional Development Schools

Defining the professional development school, Swafford (1994) said, "It is a working model of restructured schools developed and operated by local school and university educators working as colleagues" (p. 169).

This type of school tries to provide an environment for future student teachers to observe and practise school mathematics in. For example, Holt High School in Holt, Michigan is a Michigan State University Professional Development School where attempt has been made to improve teaching and learning for understanding. This type of school tries to allow student teachers access to mathematics classrooms and students, and emphasies teaching for understanding with a goal of helping student teachers understand what it means to teach and assess for understanding.

3.4.2.5 Induction Programmes

Swafford (1994) noted that student teachers need an appropriate environment in which they may observe and practise for implementing a new vision of school mathematics. One of the institutions that operate an induction programme for first-year teachers is the University of Northern Colorado. This programme is a collaborative one between the university and the neighbouring school district.

This kind of programme was designed to develop reflective abilities in the novice teacher through activities such as video and audio tape self-analysis, and academic seminars. The particular goal of these programmes is generally not the teaching of mathematics but the providing of help to prepare teachers so that they may gain a new vision of school mathematics during the important first years of teaching.

From the above we can conclude that most of the models agree that student teachers should acquire knowledge of mathematics, a professional education, and field experience, even though they may vary in the degree of emphasis that they place on each of these dimensions.

3.5 Definitions of Terms Used in the Study

After the above review of literature, it will be helpful to provide definitions of terms that are frequently used in this study.

Attitude: the predisposition of an individual to respond in a consistent manner toward an object, idea, concept, or situation.

Attitudes toward mathematics: student teachers' attitudes towards mathematics as a subject. For this study four attitudes were measured: mathematics anxiety, confidence, usefulness, and male domain.

Attitudes toward teaching mathematics: student teachers' attitudes towards teaching mathematics. For this study four attitudes were measured: mathematics teaching anxiety, confidence and enjoyment, the desire for recognition, and the pressure to conform.

Beliefs about the nature of mathematics: convictions involving certain views a bout the nature of mathematics held by students, teachers, or student teachers.

Confidence and enjoyment in teaching mathematics: student teachers' confidence and enjoyment in their ability to perform well in teaching mathematics.

Confidence in learning mathematics: confidence in one's ability to learn and to perform well in mathematical tasks.

Mathematics anxiety: involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations.

Mathematics as a male domain: the degree to which students see mathematics as a male, neutral, or female domain in the following ways: (a) the relative ability of the sexes to perform in mathematics; (b) the masculinity of those who achieve well in mathematics; (c) the appropriateness of this line of study for the two sexes.

Mathematics teaching anxiety: involves feelings of pressure and worry about teaching mathematics.

The desire for recognition: the student teachers' desire to be recognised and known by other people in future as good teachers.

The pressure to conform: the student teachers' feeling of distaste at being noticed or observed by other people for any individual characteristics he/she may show in the way he/she teaches mathematics.

Usefulness of mathematics: the usefulness of mathematics both currently and in relation to students' future education and other activities.

3.6 Summary

While I became aware of the many studies that have been undertaken about beliefs and attitudes in education, I also became aware that most of these have been concerned with issues of classification of mathematics, or of teachers' and students' attitudes analysed in separate studies. What is contained in the literature does not provide a great deal of information about the relation between student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics and its teaching. The key questions I wanted to investigate were, What kind of views about the nature of mathematics should the mathematics primary student teachers be acquiring in their teacher training programmes in Kuwait? And which of these views have a relationship with the student teachers' attitudes in learning and teaching mathematics?

Ernest (1989) mentioned how each belief implies a specific model of teacher and outcomes. Also, many studies have shown that attitudes are important for the teaching of mathematics (e.g. Battista, 1986; and Ernest 1989). The literature does not provide us as educators with information on the relationship between student teachers' beliefs about nature of mathematics and their attitudes toward mathematics and the teaching of this subject. Nevertheless, Ernest's model shows that if a teacher is a problem-solving believer, there will be certain out comes in the classroom, where he or she will be a facilitator, will believe that mathematics is an open and creative subject, and so on. However, we still do not know whether the believer in this particular view of the nature of mathematics will be confident in learning mathematics, or whether perhaps the instrumentalist believer will be more likely to be confident.

Student teachers are important persons in the education system if we want to change or improve teaching, simply because they are the future teachers. In Kuwait, even though new movements in education are sometimes experimented with, traditional ways of learning and teaching still dominate. In this context it would be helpful to know student teachers' views about the nature of mathematics and their attitudes toward the teaching of mathematics, as these people will teach Kuwaiti children in the future. Any improvement that can be made to their training will therefore have a long-reaching effect.

The preceding review of literature has helped to identify the fundamental issues related to the concept and aims of this research. It provides not only conceptual knowledge about the research problem but also helps us to understand the teachers' conceptions of mathematics reviewed in section 3.1.2. I have chosen one of the models of the teachers' conceptions of mathematics to become the theoretical background for this study and an aid in constructing the instrument to assess the student teachers' beliefs about the nature of mathematics. The main source of the items in the second part of the questionnaire is the model of Ernest (1989a). In section 3.1.5 we reviewed some studies of teachers' beliefs about mathematics and these helped us to decide on the appropriate methodology to be used in this particular study.

Our review of studies about attitudes toward mathematics and its teaching indicated how these studies used different methods and instruments to measure these attitudes and how the results were varied. These studies suggest some possible instruments for use in the present study, for example, the Fennema-Sherman mathematics attitude scales (MAS) used to measure students' attitudes towards mathematics, and Nisbet's instrument used to measure student teachers' attitudes towards mathematics teaching (TMAS).

The next chapter will outline and discuss the methodology and procedures considered or used to achieve the aim of the present study. It will include further details about the research methods, the population, the research design, the instrumentation, and the research hypotheses underlying this study. It will also explain the techniques and procedures used in collecting the data, including some brief information about the pilot and main studies.

CHAPTER FOUR

METHODOLOGY

4.0 Introduction

The purpose of this chapter is to survey and discuss the methodology and procedures considered or used to achieve the objectives of this study. The following sections will explain the purpose, the classification of research methods, the population, the research design, the instrumentation, and the research hypotheses underlying this study. In addition, the procedures used in collecting the data, including the pilot study and the main study, and finally, the techniques for data analysis used in the study will be reviewed.

4.1 The Purpose of the Study

The main purpose of this study is to describe the beliefs about the nature of mathematics held by primary mathematics student teachers in the College of Education at Kuwait University and the College of Basic Education and their attitude towards learning mathematics and its teaching. Another purpose of this study is to explore the relationships, if any, between the beliefs about the nature of mathematics held by these student teachers and their attitudes toward mathematics and the teaching of mathematics.

4.2 The Nature of Research

Cohen and Manion (1989) noted that the researchers adopting two types of approaches positivist or objectivist and anti-positivist or subjectivist. They noted that

> Investigators adopting an obectivist (or positivist) approach to the social world and who treat it like the world of natural phenomena as being hard, real and external to the individual will choose from a range of traditional options- surveys, experiments, and the like. Others favouring the more subjectivist (or anti--positivist) approach and who view the social world as being of much softer, personal and man-created kind will select from a comparable range of recent and emerging techniques- accounts, participant observation and personal constructs, for example.

Nowadays, it is often recommended that researchers use more than one method of investigation or perspective and consequently generate more than one type of data in a study (Burgess, 1984; Cohen and Manion, 1989; Verma and Mallick, 1999). This approach is commonly referred to as 'triangulation'. One obvious advantage of using this approach is that the strength of one method may compensate for the weakness of another. The present study uses more than one method to help the researcher to answer the questions raised in it.

Research classified according to method can be subsumed two broad categorise experimental and non-experimental research. With experimental research, the researcher can manipulate one or more independent variables. With non-experimental research, the researcher is not able to manipulate variables, but can only observe relationships between the variables as they exist. There are many types of non-experimental designs, or descriptive research namely, case studies, surveys, developmental studies, follow-up studies, documentary analysis, trend analysis, correlational studies, and causal-comparative studies (Brog and Meredith, 1989)

Wiersma (1995) noted that there are underlying differences in the epistemologies of qualitative and quantitative research. These are based on different paradigms, a paradigm being a model consisting of assumptions, concepts, and propositions. Qualitative research, in its purest sense, follows the naturalist paradigm, that is the belief that research should be conducted in a natural setting and that the meanings derived from research are specific to that setting and its conditions. The ideal approach is a holistic interpretation of the natural setting. However, quantitative research has its roots in positivism and is more closely associated with the scientific method than is qualitative research. Baryman (1993) points out that employing both qualitative and quantitative approaches in a study might strengthen its validity:

> Qualitative and quantitative research may be perceived as different ways of examining the same research problem. By combining the two, the researcher's claims for the validity of his or her conclusions are enhanced if they can be shown to provide mutual confirmation (p. 131).

As a result, the style of research adopted for the current study was to generate both qualitative and quantitative data. As with other types of research, it has its advantages and disadvantages, as the following sections will explain with regard to the present study.

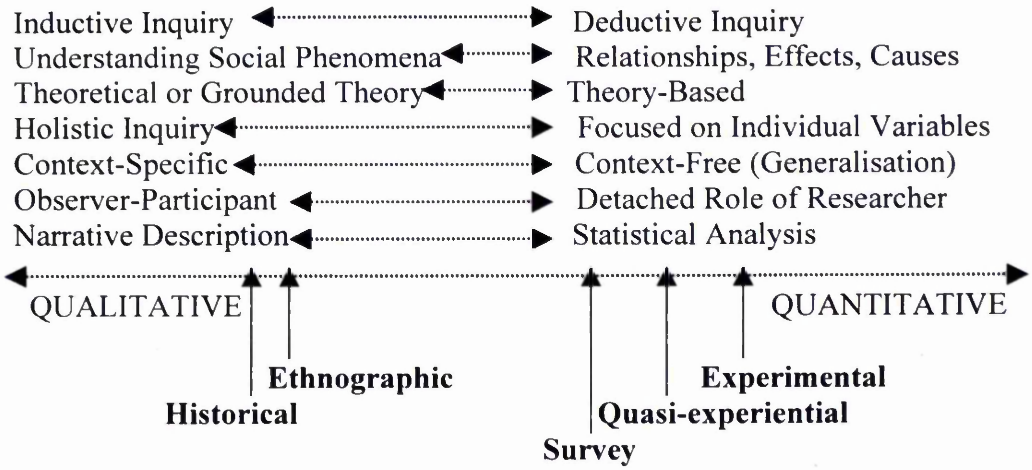
4.3 Classification of Educational Research

Researchers have classified educational research in a number of ways (see, for example, Van Dalen, 1979; Leedy, 1993;. and Wiersma, 1995). There have been classifications according to different disciplines (e.g. philosophical, psychological, sociological), according to methods applied (e.g. historical, descriptive, ethnographic, or experimental), and according to the goals or purpose of the research (e.g. basic and applied).

In yet another systematisation, Wiersma (1995) categorised educational research into two types: first, basic and applied research, and, second, qualitative and quantitative research. Griffin (1985) noted that quantitative studies frequently involve the use of questionnaires, social surveys, experiments, and attitude scales. Such methods allow the researcher to conduct a large-scale comparative analysis and may be generalisable. Qualitative studies frequently involve the use of case studies, open-ended interviews, ethnography (participant observation), and triangulation. These methods are fairly time-consuming and are better suited to small-scale case studies, but they may provide useful insights into particular cases.

Wiersma (1995) noted that qualitative and quantitative researches have their own characteristics, but, as applied to educational research, the distinction is more on a continuum than a dichotomy. Using the following figure, Wiersma tried to present the characteristics of the qualitative and quantitative research continuum, and to conceptualise the differences between the qualitative and quantitative methods.

Figure 4.1: Characteristics of Qualitative-Quantitative Research



Source: Wiersma (1995, p.14)

4.3.1 Types of Educational Research Methods

Brayman (1993) pointed out that applying both quantitative and qualitative approaches in a study may enhance the validity of its findings. This is, in fact, what is sought in the present study. The style of research adopted for the present study is what has already been described as descriptive and it seeks to generate both quantitative and qualitative data. In the following subsections, we will introduce the types of research method used in this study and the reasons for using them.

4.3.1.1 The Descriptive Method

Descriptive research is not confined to data-gathering, but may go beyond this to involve recording, analysis, comparison, and interpretation of the conditions that exist. As Gay (1992) has noted, descriptive research involves collecting data in order to test hypotheses or to answer questions concerning the current status of the subject under study. In this kind of research, it is necessary to develop an appropriate instrument for obtaining the desired information. That is because the researcher asks questions that have not been asked before, or seeks to obtain information that is not already available. As with other types of research, the descriptive approach has its particular advantages and disadvantages. It has a lot of advantages. For example, it can produce rigorous cause and effect evidence. Also, it offers the possibility of unbiased data by selecting random samples, beside suppling the researcher with better data on complex human behaviour (Borg and Gall, 1979). On the other hand, one of the disadvantages in descriptive research, proof of causation, is difficult to establish, and the time at which the study is made is a critical factor in the interpretation of data.

Cohen and Manion (1989) mentioned that most educational research methods are descriptive. For example, surveys development studies, ethnographic studies, evaluation studies, and action research. In the next sections we will review the methods that are used in this current study.

4.3.1.1.1 Surveys

Cohen and Manion (1989), and Verma and Mallick (1999) have all noted that in education and other social sciences, surveys are one of the most commonly used methods of descriptive research. Surveys gather data at a particular time with the intention of

> (a) Describing the nature of existing conditions, or (b) Identifying standards against which existing conditions can be compared, or (c) Determining the relationships that exist between specific events (Cohen and Manion, 1989, p. 97).

The data of surveys can be gathered from the whole population via a census of a selected sample of the whole population. Verma and Mallick (1999) mention that the topics that may be studied using this type of method are population trends or movements, and pupils' or teachers' attitudes or opinions. The collection of information typically involves one or more of the following data-gathering techniques: structured or semi-structured interviews, self-completion or postal questionnaires, standardised tests of attainment or performance, and attitude scales.

In this present study, the researcher develops an instrument to test specific phenomena, such as, beliefs about the nature of mathematics. Using information obtained through a series of steps, a particular scale is developed and named 'the beliefs about the nature of mathematics scale' (BNMS). This device helps the researcher to answer questions concerning student teachers' beliefs about the nature of mathematics. However, as Gay (1995) mentioned that most studies use some sort of data collection instrument, often a published, standardised instrument. For this study it was appropriate to use two previously developed scales, the attitudes toward mathematics scale (MAS) and the attitudes toward teaching mathematics scale (TMAS) (see Chapter Six).

4.3.1.1.2 Case Studies

Wiersma (1995) defined the case study as one in which a single group is studied in depth. As Cohen and Manion (1989) mentioned that case study may probe deeply and to analyse and help to reveal certain relevant information, which is not and cannot be obtained through the survey method. So, in many research programmes, the two methods operate to complement each other. This approach helps the researcher to offer a description of situations from the sample and to observe certain behaviour in individual cases. In case studies, data collection involves observation and interviewing.

As a first means of gathering data for this study, interviews were a very helpful tool. There are different classifications of interviews, for example, structured and unstructured, focused and unfocused, or limited and in-depth interviews. Nisbet and Entwistle (1970) divided interviews into three types: the informal, the structured, and the semi-structured interview. In the informal interview, the interviewer does not follow questions from a detailed interview guide but works to a general plan, asking appropriate questions with a view to leading respondents towards giving the type of information required by the study. In the structured interview, the interviewer asks each respondent a series of questions, which have been carefully constructed to form an interview guide. In the third kind of interview, the semi-structured interview, the interviewer usually poses a series of open-ended questions in order to elicit certain data or to investigate certain opinions or feelings.

On the other hand, Kvale (1996) mentioned that different approaches and forms were used depending on interviews and interview subjects, for example, individual interview and group interviews. The individual interview vary according to content, such as seeking factual information, or opinions an attitudes, or narratives and life histories. Group interviews today are often referred to as focus groups.

The interview has a lot of advantages. Because of its flexibility, it gives the interviewer the opportunity to explore thoroughly certain areas of inquiry, follow up ideas, and investigate motives, attitudes, and feelings. Borg and Gall (1979, p. 313) observed that the

> semi-structured interview is generally most appropriate for interview studies in education. It provides a desirable combination of objectivity and depth and often permits gathering valuable data that could not be successfully obtained by any other approach.

On the other hand, there are some disadvantages attaching to interviews. Interviews are very time consuming, they require a lot of time to make preparatory arrangements, to conduct, and to analyse. There are factors that may influence the responses, because the interview is a human interaction (Ackroyd and Hughes, 1992).

In the current study, just four instructors were interviewed, two from each college, because it took a lot of time to arrange the appointments with the instructors and the time for the main stage for this study was very limited. In addition, a total of five focus groups were made in the pilot stage and four focus groups in the main stage, involving student teachers in the State of Kuwait.

Second, Best (1981) mentioned that observation is a useful tool for descriptive research. It helps the researcher to collect more data about the behaviour of individuals in their natural setting. It requires a good training, including knowing how to control one's personal emotions and the art of good listing and observing (Woods, 1986). In the current study the non-participant observation was used in the main stage in an effort to understand more about the sample in their mathematics teaching methods classes.

Thus, the current study uses both the methods described above. Case study is used in investigating student teachers' opinions and beliefs about the nature of mathematics and their attitudes toward mathematics and the teaching of mathematics, since the information obtained by this approach contains more details than information obtained via surveys.

In this study surveys and observations serve the purpose of gathering basically descriptive data, while interviews provide qualitative data and opportunities to explore individuals' experiences relating to the problems addressed. For example, the three scales used in the main study seek to elicit information that may help to answer some research questions about the student teachers' beliefs and attitudes, while the interviews seek to establish the background of these student teachers in greater detail.

4.3.1.1.3 The Correlational Method

The correlational method involves collecting data in order to determine whether, and to what degree, a relationship exists between two or more quantifiable variables. The degree of relationship is expressed as a correlation coefficient. Correlational research is designed to determine which variables of a list of likely candidates are related, or to test hypotheses regarding expected relationships. It enables researchers to test more than one variable at the same time and eliminate variables that are not clearly related. In the case of variables that are closely related, causal-comparative or experimental studies may be advisable to determine whether the relationships are causal.

This is precisely what is done in the current study in examining, for example, the relationship between student teachers' beliefs about the nature of mathematics on the one hand and their attitudes toward mathematics and again toward the teaching of mathematics on the other hand. The present study makes use of factor analysis and regression analysis to analyse the relationship between factors involved in it, for example, in finding the relationship between the three views about the nature of mathematics in the BNMS and student teachers' confidence in learning mathematics as measured on the MAS

Every method has its particular advantages and disadvantages. Cohen and Manion (1989) have commented that correlational research is useful in investigating the problems of education and the social sciences because its allows for the measurement of a number of variables and their relationships together. It also provides the researcher with insights into the way variables operate that cannot be gained by other means. On the other hand, it does not establish any cause-and-effect relationships.

As previously mentioned, more than one of the above research methods is used in the present study. Because of the nature of the research problem in this study, it was felt necessary to use the survey research method to develop a new scale about views on the nature of mathematics. This helps us to know the beliefs and attitudes of a large number of student teachers in the State of Kuwait. In addition, there was a need to interview student teachers in the pilot stage to gain information to develop the new scale, and interview the instructors and student teachers to obtain more evidence for the findings of the questionnaire for the main stage.

4.4 The Population and Sample of the Study

In any study, sampling is a significant consideration if one is to obtain a good representation of a population. So, it would be useful if we defined the population. Gay (1992) defined the population as the group of interest to the researcher, the group concerning which he or she would like the results of the study to be generalisable. He also observed that the aim in defining the population in the researcher's study is to help other researchers determine how appropriate are his or her findings to their own situations.

Sampling is the process of selecting a number of individuals for a study in such a way that the individuals represent a larger group from which they are selected. The purpose in this is to obtain information about a population. Cohen and Manion (1989), Leedy (1993), and Sirkin (1995) have all mentioned that there are several methods of selecting a sample for research purposes. One may select different methods of sampling, such as random sampling, stratified sampling, cluster sampling, or systematic sampling.

Random sampling is the process of selecting a sample in such a way that all individuals in the defined population have an equal and independent chance of being selected for the sample (Gay, 1992). Stratified sampling is the process of selecting a sample in such a way that identified sub-groups in the population are represented in the sample in the same proportion in which they exist in the population. The steps in stratified sampling are similar to those in random sampling except that selecting is from sub-groups in the population rather than from the population as a whole. As Wiersma (1995) mentioned that the condition of random selection is included by the selection within the subpopulations.

On the other hand, cluster sampling is sampling in which groups, not individuals, are selected randomly. Finally, systematic sampling is sampling in which individuals are selected from a list by taking every *kth* name, where *k* equals the number of individuals on the list divided by the number of subjects desired for the sample. All these types follow the same steps: identification of the population, determination of required sample size, and selecting of the sample.

In this study, the stratified sampling method is used for a specific population. This type of sampling means dividing the population into homogeneous groups, each group containing subjects with similar characteristics (Cohen and Manion, 1989). The reason for using this type of sampling is the need to know the beliefs and attitudes of student teachers enrolled in the primary mathematics and science major at the two colleges in the State of Kuwait.

The study population consists of primary mathematics and science student teachers at the College of Education (Kuwait University) and the College of Basic Education. These are the only two colleges that have primary mathematics and science teacher majors in the State of Kuwait. There are the two colleges preparing teachers in the State of Kuwait. The College of Basic Education is the older of the two and more students are enrolled in it. The sexes are segregated in this college and it specialises in teaching two levels the kindergarten and primary levels. By contrast, the College of Education in Kuwait University is a mixed college and it offers majors in all four levels, namely kindergarten, primary, intermediate, and high school levels. But there is a similarity in their requirement courses the student teachers should study in these two colleges (see Chapter Two). In addition, these student teachers will teach the primary level and this level is like a foundation stage for the other levels. If educators study these particular majors and try to improve the training programmes, a large number of people in the state of Kuwait (children, student teachers, etc.) might benefit.

In the College of Education at Kuwait University there were 260 students enrolled for the academic year 1997-1998. In the College of Basic Education 778 students were enrolled for the academic year 1997-1998 (see Table 4.1).

Table 4.1: Numbers of Student Teachers in the College of Education and the College of Basic Education

Institution	Male	Female	Total
College of Education	56	204	260
College of Basic Education	241	537	778
Total	297	741	1038

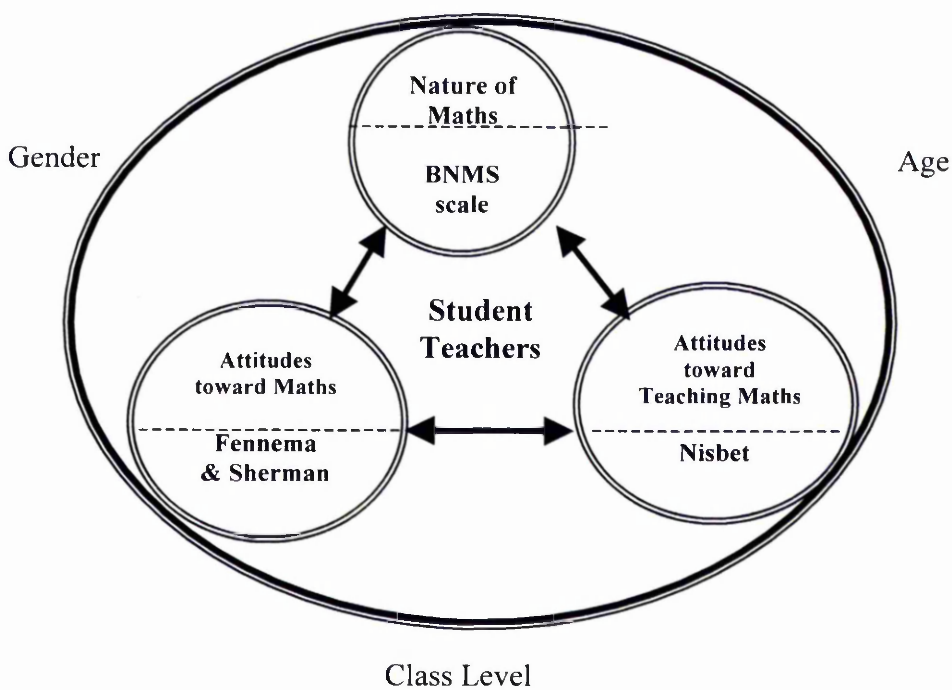
Source: Ministry of Education, 1998.

For the current study, the sample in the pilot stage, totalling 97 student teachers, was selected from the primary mathematics and science major at the College of Education in Kuwait University. However, in the main study the sample ranged more widely, as the student teachers in the College of Basic Education were also involved in this study. For the main stage, a total of 418 student teachers from both colleges participated in this study.

4.5 The Research Design

Wiersma (1995) mentioned that in conducting a survey researchers should follow a series of detailed steps which should be carefully planned. The research framework helps the researcher to focus on his or her research questions. For the present research it was necessary to follow two phases. The next figure depicts in simplified from the research design.

Figure 4.2: The Research Design



The first phase was the pilot study, which is an important step to take in developing a new scale and also in testing and evaluating the two existing scales (the MAS and the TMAS). This stage took place in December 1997 the State of Kuwait. For this study the researcher developed a new scale designed to register the student teachers' beliefs about the nature of mathematics. The pilot study is a very important stage for many reasons. It helps the researcher to see how the scales may be used at the time of the main study. It also gives one a chance to make necessary changes to the scale based on statistical and expert opinion. This phase involved the following steps:

1. The researcher carried out a face-validity survey to discuss with experts and evaluate the two existing scales (the MAS and the TMAS) (see Chapter Six).
2. The researcher interviewed five groups of student teachers as a means of collecting information about their opinions on the nature of mathematics (see Appendix 2 a).
3. The researcher collected the most common responses of students on their beliefs about the nature of mathematics and transformed these into scale items.
4. 97 student teachers answered this first draft scale about the nature of mathematics.
5. Different types of validity test were used, including factor analysis, face-validity, and testing the translation.
6. All the required revision of the beliefs about the nature of mathematics scale was completed before the main study.
7. After making changes in the scale, the researcher decided to make a factor analysis for the new scale as one group, to make sure that the factors did measure the right views.
8. Using the revised scale, scores on the beliefs about the nature of mathematics scale were obtained for 25 primary mathematics teachers (see Appendix 3).

For more details about the steps from 2-8, see Chapter Five.

The second phase was the main study, which took place from April to June 1998. During this stage five more steps were followed, viz:

1. The questionnaire was distributed to the sample in the two colleges (see Appendix 1).
2. Semi-structured interviews were carried out with four instructors in the College of Education and the College of Basic Education (see Appendix 2 c).
3. Observations were made of the mathematics teaching methods course to assess the student teachers' beliefs and attitudes concerning learning and teaching mathematics.
4. Focus groups were held with the student teachers to gain more information about their attitudes and beliefs about mathematics and its teaching (see Appendix 2 b).
5. The results were analysed and discussed in the final chapter.

See Chapter Seven for more details about this main stage of the study.

4.6 The Instrument and Instrumentation for the Main Study

In any research it is necessary, before the data collection step, to identify or develop the instruments to be used. Four instruments were used in gathering data for the main study. All these were conducted in Arabic because they needed to be answered by Arabs. They consisted of:

1. A questionnaire including four parts (see Appendix 1):
   - Part I: personal background information.
   - Part II: a scale eliciting attitudes toward mathematics (MAS).
   - Part III: a scale eliciting student teachers' beliefs about the nature of mathematics (BNMS).
   - Part IV: a scale eliciting attitudes toward mathematics teaching (TMAS).
2. A schedule of interviews with instructors of mathematics education (see Appendix 2 c).
3. Focus groups with the student teachers (see Appendix 2 b).
4. Classroom observations on the mathematics teaching methods course.

4.6.1 The Questionnaire Eliciting Personal Background Information

This questionnaire contained four questions about student teachers' backgrounds. These questions represented the independent variables in this study, which were gender, class level, age, and nationality.

4.6.2 The Scale Eliciting Attitudes toward Mathematics (MAS)

The Fennema-Sherman mathematics attitude scales (1976) were used to measure confidence in learning mathematics, perceptions of mathematics as a male domain, perceptions of the usefulness of mathematics, and mathematics anxiety. This scale contains 48 items. Those questioned were required to indicate their responses on a five-point Likert-type scale.

4.6.3 The Scale Eliciting Student Teachers' Beliefs about the Nature of Mathematics (BNMS)

In order to investigate student teachers' beliefs about the nature of mathematics, it was necessary to create an additional scale. The primary intention was to design a scale to measure the extent to which students' beliefs about the nature of mathematics accorded with established views. The design of this scale was modelled after the Ernest model on the nature of mathematics (1989a). It is a five-point Likert-type scale. The items sought to gather information on student teachers' beliefs concerning three views about the nature of mathematics: the Platonist view, the instrumentalist view, and the problem-solving view. These items were constructed based on information obtained in focus groups, expert opinions, and information contained in literature sources. Certain steps were followed to develop this scale, more details of which will be found in Chapter Five.

In this scale the student teachers were required to indicate their responses on 10 items by ticking their selection of one of five options. These five options ranged from 'strongly agree' to 'strongly disagree'.

4.6.4 The Scale Eliciting Attitudes toward Mathematics Teaching (TMAS)

This is an instrument to measure primary student teachers' attitudes to teaching mathematics. The object of this attitude-measuring instrument is to enable educators to measure the attitudes of student teachers toward the teaching of mathematics and to monitor these attitudes during a teacher education programme. This scale included twenty-two items and student teachers were required to indicate their responses on a seven-point Likert-type scale (Nisbet, 1991).

4.6.4.1 The Validity and Reliability of Scales

This section will highlight the steps takes to verify the validity and reliability of the above three scales used in this study. It is very important for the researcher to find tests that measure the variables that are to be investigated in the research. Gay (1992, p.155) said of validity, "It is the degree to which a test measures what it is supposed to measure." He also argued that a test is valid for a particular purpose and for a particular sample. As validity test depends on the specific purpose of the exercise and the sample tested, there are different types of validity test, referring respectively to content validity, construct validity, concurrent validity, and predictive validity. In addition, Slavin (1984) and Wiersma (1995) agreed that the validation of a questionnaire depends on the nature of the instrument.

For this study a scale was developed to investigate student teachers' beliefs about the nature of mathematics. These were validated by:

1. Face-validating the scale by six Arab teachers who were studying in the U.K.
2. Translating the Arabic version into English and retranslating to ensure that the wording of the scale was the same in Arabic.
3. Using factor analysis to ensure that the items were in the right grouping.

For more details, see Chapter Five. For other instruments validated by face-validation in the pilot study and factor analysis and different statistical tests in the main study, more details will be found in Chapter Six.

4.6.5 Interviews with the Instructors of Mathematics Education

Four of the instructors who teach mathematics teaching methods courses in the College of Education at Kuwait University and the College of Basic Education were interviewed as part of the main study between April to June 1998. These interviews helped the researcher to understand more about the Kuwaiti student teachers' beliefs and attitudes from their instructors' point view, and to look from another perspective at the student teachers' beliefs and attitudes. These interviews probed issues arising out of the refinement of student teachers' data, including:

1. Investigate the instructors' beliefs about the nature of mathematics and their attitudes toward mathematics and mathematics teaching.
2. Their students' attitudes toward mathematics and teaching mathematics.
3. Gender and mathematics and teaching of mathematics.

The interviews were semi-structured and contained many questions, which were prepared in advance. In a semi-structured interview the researcher has a set of questions but, compared with a structured interview, the researcher has a great deal of flexibility. Interviews with instructors were typically conducted in their offices. With the permission of the interviewees, one of the interviews was audio taped to allow more detailed and accurate analysis. Where respondents did not wish to be recorded, the researcher took notes during the meeting. These interviews were analysed and transferred from Arabic into English to be used as qualitative data in writing up the findings in Chapter Seven (for the interview questions, see Appendix 2 c).

4.6.6. Focus Group with the Student Teachers

One of the purposes of the focus groups was to understand more about the Kuwaiti student teachers' opinions on the nature of mathematics, and also their attitudes toward mathematics and the teaching of mathematics. Another purpose was to give the researcher the opportunity to explore thoroughly about the gender issue and mathematics as it affected the Kuwaiti student teachers. For the main study there was a total of 16 student teachers involved in these focus groups, 4 student teachers in each group. The reason to interview them in group is the limitation of time for this study. The researcher divided the questions into three groups, as follows:

Group One: Focusing on their beliefs about the nature of mathematics.

Group Two: Focusing on their attitudes regarding mathematics and their teaching of mathematics.

Group Three: Focusing on gender issues in mathematics and the teaching of mathematics.

In analysing the interview data the researcher used a recording notes for the most important topics dealt with in this study and for particular research questions. These statements were discussed and tried to find the general results depending on the data. Some of these statements of these student teachers were used in Chapter Seven after mentioning the general results, for example, the statement that the majority of student teachers were confident in learning mathematics. Because of similar or repeated statements, the researcher highlighted a particular student teacher's statement as an example supporting the result. The following table is an example of the analytical system used in this study for the following question "Are you confident in doing mathematics, especially the advanced mathematics course?" The student teachers' statements in the interviews were written in diary notes, as the following table shows. See Appendix 5 for more details about the other issues and the distribution of the student teachers' statements used in Chapter Seven.

Table 4.2: Student Teachers' Statements from Interviews about their Confidence in Learning Mathematics

No.	Statement
1*	I like mathematics itself, to solve mathematical problems and so on, but not teaching it to other people. I do not have that ability.
2*	I do believe that in this stage I'm positive in doing mathematics and capable of obtaining good grades in these courses.
3*	I like mathematics, but not other advanced courses and I am very worried about Calculus B. I'm not the type of student who scores well in mathematics.
4*	I think the main reason why I chose this major is my liking for mathematics itself. I have not generally worried about being able to solve mathematics problems or learn mathematics. Even when I was in high school I always had good marks in mathematics courses. I think mathematics has a strong relation with our lives in the trading market especially as we males always work and use mathematics in our families' companies or in our work when I worked in the summer job.
5	You know, if you are confident in practising the basic and fundamental rules, I think you will not worry about difficult and more advanced mathematics courses. Mathematics for me is like plants. They have roots and these roots help the plant to grow, and if you know and understand the rules and the skills, you will not have any problem later on.
6*	In my life I have never been worried about sitting mathematics exams, but I was advised by my friends it would be better to enter this major because it contains less difficult mathematics courses than other majors. I still have the feeling about mathematics courses in the college, that they would be more difficult than high school mathematics.
7	That's right. I never thought of being worried about mathematics. But the way we use exams to evaluate children every month makes children afraid of this subject.
8	Of course I am good in mathematics… simply, choosing this kind of major is strong evidence that I am confident in doing mathematics, any type of mathematics.
9*	I chose this major because I knew there are not too many pure mathematics courses in it. I'm afraid that the courses at the college level are more difficult than at high school.
10	Mathematics is my favourite subject for me when I was in primary schools.
11*	I don't think I have any problem with this…Because I have already done these types of course. I studied calculus A and B and Algebra. The information and the assessment do not vary from the high school mathematics. I believe this should make the students in this major confident in doing mathematics, even the hard and advanced mathematics courses. I like this type of course. It makes me think carefully and try to use new methods.
12	I don't have any problem in mathematics.
13*	You know that we will teach children in the primary level. I enjoy learning the basics and the foundation of mathematics, not the difficult topics in mathematics, I mean the advanced mathematics. I cannot deal with it.
14*	Some things worry me about studying the mathematics course, especially studying it in the English language at this college.
15	I think I could handle the most mathematical problems.
16	Actually speaking about mathematics and me, I always have good grade in mathematics courses.

* Selected statements in the present study.

4.6.7 Observation of the Mathematics Teaching Methods Course

The purpose of this was to obtain more information about the student teachers' beliefs about the nature of mathematics and how they apply these belief and attitudes in the mathematics teaching methods course. Observations can make an important contribution to data collection in descriptive research (Best, 1981). Unfortunately, the limitations of time meant that the researcher could be only a non-participating observer. However, observation did help the researcher to focus on specific behaviour and issues about the student teachers' attitudes toward mathematics and teaching mathematics, and their beliefs about the nature of mathematics. As a result, additional data about the sample could be used as evidence in the finding stage, so that observation became a complementary tool alongside other methods used in this study.

4.7 The Research Hypotheses

It has frequently been recommended that research should proceed on the basis of certain working hypotheses. According to Kerlinger (1986), hypotheses are important and indispensable tools of scientific research and may provide direction upon the research methodology to be adopted. Research hypotheses focus on the expected relationship (or difference) between two variables, in other words, the relationship that the researcher expects to verify through the collection and analysis of data.

Research hypotheses relevant to the present study can be divided into four groups, as follows:

4.7.1 Research Hypotheses about the Student Teachers' Beliefs about the Nature of Mathematics

1. There will be no differences between males' and females' beliefs about the nature of mathematics.
2. There will be no differences between class levels and the student teachers' beliefs about the nature of mathematics.
3. There will be no differences between age groups and the student teachers' beliefs about the nature of mathematics.

4.7.2 Hypotheses about the Student Teachers Attitudes towards Mathematics Teaching

1. Gender will influence student teachers' mathematics teaching anxiety, confidence and enjoyment in mathematics teaching, and their desire for recognition and pressure to conform.
2. The class level of the student teachers will be related to student teachers' mathematics teaching anxiety, confidence and enjoyment in mathematics teaching and their desire for recognition and pressure to conform.

3. The age of student teachers will be an important variable in their mathematics teaching anxiety, confidence and enjoyment in mathematics teaching, and desire for recognition and pressure to conform.
4. There will be no relationship between anxiety and confidence and enjoyment in teaching mathematics or other sub-scales.

4.7.3 Hypotheses about the Student Teachers' Attitudes towards Mathematics

1. There will be no relationship between gender and student teachers' attitudes toward mathematics.
2. There will be relationship between class level and student teachers' attitudes toward mathematics.
3. There will be relationship between age groups and student teachers' attitudes toward mathematics.

4.7.4 Hypotheses about Student Teachers' Scores on the MAS, the TMAS, and the BNMS

1. There will be no relationship between the factors of student teachers' attitudes toward mathematics and their attitudes toward mathematics teaching.
2. There will be no relationship between the factors of student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics teaching.
3. Student teachers' beliefs about the nature of mathematics will be a variable influencing one of the student teachers' attitudes toward mathematics.

4.8 Data Collection

There were two stages for this study, the first of which was the pilot study, which took place in December 1997 in the State of Kuwait. Because of the need for a scale which enable the researcher to understanding the student teachers' beliefs about the nature of mathematics the researcher developed a new scale. In this study the researcher was able to evaluate the existing scales referred to as the MAS and the TMAS. The researcher followed the several steps highlighted in section 4.5. All these stages were conducted in Arabic, the language most suitable for the sample of this study. Chapter five will discuss every step in developing the beliefs about the nature of mathematics scale.

Second, we come to the main stage of the research programme. Before conducting the main study in educational institutions, it was necessary to obtain permission from authorities in Kuwait University. To this end, the researcher had first to obtain permission from her department in the University of Kuwait, supported by a letter from her supervisor in the University of Manchester. On her arrival in Kuwait, the researcher visited her department to obtain an official letter describing the main theme of her study and the instruments she wanted to use.

The main study involved two higher educational institutions in Kuwait. The data collection work lasted three months, from April to June 1998. During this period the researcher distributed questionnaires, conducted interviews, and observed classroom lessons. The work required a well-organised plan and a determined effort to complete the work perfectly and accurately within the given time and resources.

The focus of the study was student teachers of primary mathematics and science major. Mathematics primary teachers usually graduate from one of two educational institutions in Kuwait, Kuwait University and the College of Basic Education, so that the sample which participated in the study was chosen from these institutions. Instructors who teach mathematics teaching methods course in these institutions also took part in the study.

As was mentioned in section 4.4, a total of 450 student teachers' questionnaires was distributed in the main study. The number returned was 418 student teachers. In addition, 4 focus groups were conducted with a total of 16 student teachers. All student teachers were selected on a random and voluntary basis from the mathematics teaching methods classes. Interviews took place in both institutions after classes and were mainly conducted in the Teaching and Curriculum Department at Kuwait University and the College of Basic Education, each lasting some 35-45 minutes.

Four instructors in these institutes were interviewed in semi-structured interviews which lasted around 45 to 55 minutes. Interviews with the instructors took place in their offices.

All interviews and focus groups were carried out in Arabic and were arranged by prior appointment. Some of the interviews and focus groups were audio taped or recorded in notes taken by the researcher. During the interview and focus group sessions, the researcher tried to create an atmosphere of openness to ensure that interviewees felt at ease and to give them the opportunity to convey their feelings, perceptions, and criticism freely without feeling under any pressure (for more details, see sections 4.6.5 and 4.6.6).

Classroom observations were made during the main study. The researcher attended four classes, two at Kuwait University and two in the College of Basic Education. It is essential to note that these observations were planned to be complementary to the questionnaires and interviews. Their objective was to gather more information about the sample and to discover, if possible, the student teachers' beliefs about the nature of mathematics and their attitudes towards mathematics and the teaching of mathematics.

4.9 Design and Techniques for Data Analysis

There are different types of statistical testing. A statistical test should be selected to meet the requirements of the research hypotheses and questions. The data collected in the three scales were used to investigate the student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics and the teaching of mathematics. The design for the analysis of data included t-Tests, Pearson correlation coefficients, analyses of variance (ANOVA), factor analyses, and multiple linear regression analyses.

4.9.1. Pearson Correlation Coefficients

Wiersma (1995) notes that the measure of correlation is called the correlation coefficient, which measures the strength of the relationship between two variables. For example, in this study we wish to know to which degree the student teachers' beliefs relate to their attitudes toward mathematics and the teaching of mathematics. The correlation coefficient can take on values from –1.00 through 0 to +1.00. The greater the absolute value of the coefficient, the stronger the relationship. The sign preceding the coefficient, plus or minus, indicates the direction of the relationship. Zero indicates no relationship. The correlation coefficient does not necessarily indicate a cause-and-effect relationship between the two variables. This measure is used extensively as a statistic to describe the relationship between two variables and factor analysis depends on such measures. There are different correlation coefficients used under varying conditions. The most commonly used is the Pearson correlation coefficient.

The Pearson correlation coefficient tells us the strength and direction of a correlation. This type of test helped to analyse possible relationships affecting group four in the present study (hypotheses about the relationship between student teachers' attitudes towards mathematics and mathematics teaching, and their beliefs about the nature of mathematics).

4.9.2. Analysis of Variance (ANOVA)

Hinton (1995) notes that the analysis of variance is similar to the t-Test but is without some restrictions, so that, for example, the t-Test allows a comparison of only two samples at a time. For this reason the ANOVA is a very popular statistical technique in a range of research fields because it deals with more than two sub-samples. Klugh (1974) mentioned that ANOVA is based on several assumptions. One of these assumptions is that the samples have been drawn from a normally distributed population. Another assumption is that the data in the samples have been randomly obtained. For example, in this study we need to use this kind of test to answer hypothesis two in group one (There will be differences between class levels and the student teachers' beliefs about the nature of mathematics). In this group there are more than two samples to compare, as the class level is divided into three groups.

4.9.3 Factor Analysis

Johnson and Wichern (1992) note that the twentieth-century originators of factor analysis were Karl Pearson, Charles Spearman, and others. They note further the because of its early association with constructs such as intelligence, factor analysis was nurtured and developed primarily by scientists interested in psychometric measurement. The major purpose of factor analysis is to describe, if possible, the covariance relationships among many variables in terms of a few underlying, but unobservable, random quantities called factors. This means that variables can be grouped by their correlations. All variables within a particular group are highly correlated among themselves but have relatively small correlation with variables in a different group. Each group of variables represents a single underlying construct, or factor, that is responsible for the observed correlation. In the present study the researcher chose factor analysis to make sure that the scale represented the three views on the nature of mathematics, namely the problem-solving view, the Platonist view, and the instrumentalist view. For example, the problem-solving view items in this scale should be highly correlated among themselves, compared with their correlation with other items.

4.9.4 Linear Regression

Montgomery and Peck (1992) note that regression analysis is used to investigate and model the relationship between the variables. Regression models are used for different purposes, including data description, parameter estimation, prediction and estimation, and control. In the present study this model is used to understand and describe the relationships between the three scales in the study.

4.10 Summary

This chapter has outlined the method and goals of the research, describing the development of the nature of mathematics scale and other instruments used to investigate the student teachers' attitudes toward mathematics and the teaching of mathematics. Figure 4.1 epitomises the framework for the research. The data collection step has also been described in its two phases, namely the pilot phase and the main study phase. Details concerning the development of the new instrument, the nature of mathematics scale, are contained in the following chapter. The main study results will be available in Chapter Seven. The hypotheses of this study show the variables to be measured. This will help the researcher to select the appropriate test statistics to be used.

CHAPTER FIVE

THE DEVELOPING OF "THE BELIEFS ABOUT THE NATURE OF MATHEMATICS SCALE"

5.0 Introduction

The preceding chapter has discussed the methodology used in this study. It highlighted several themes: the purpose of the study, different types of research methods, the sampling, the research design, the instruments used in this study, and the hypotheses of the study. In this chapter the focus will be on the developing of the beliefs about the nature of mathematics scale. We will consider only part three of the whole questionnaire for this study, which measures the beliefs held about the nature of mathematics by primary mathematics student teachers in the State of Kuwait. Items of the beliefs about the nature of mathematics scale (BNMS) are classified under three types of view (the Platonist view, the instrumentalist view, and the problem-solving view). The data analysis was carried out on the pilot study to confirm the items of the scale, using factor analysis and other kinds of validity measures, including interviews with the student teachers. As we know, the questionnaire is considered as one of the main ways of collecting data. Thus, Borg and Gall (1979) pointed out that "the first step in carrying out a satisfactory questionnaire study is to define your problem and list specific objectives to be achieved or hypotheses to be tested" (p. 431).

5.1 The Theoretical Background

The BNMS was designed to measure the beliefs about the nature of mathematics held by student teachers of the mathematics and science primary major in the State of Kuwait. Items of this scale are structured in accord with Ernest's (1989a) definition of views about the nature of mathematics.

> First of all, there is a dynamic, problem-driven view of mathematics as a continually expanding field of human inquiry. Mathematics is not a finished product, and its results remain open to revision (the problem-solving view). Secondly, there is the view of mathematics as a static but unified body of knowledge, consisting of interconnecting structures and truths. Mathematics is a monolith, a static immutable product, which is discovered, not created (the Platonist view). Thirdly, there is the view that mathematics is a useful but unrelated collection of facts, rules and skills (the instrumentalist view) (p.21).

The scale was devised to cover these three views of the nature of mathematics, namely: the Platonist, the Instrumentalist, and the Problem-solving views. In the next section, we will explore the planning that the researcher followed to develop this scale for this study.

5.2 Planning for Constructing the Nature of Mathematics Scale

The methodology for constructing this scale involves a series of steps. Verma and Mallick (1999) mentioned that reviewing the objective of the study is the first step in constructing the questionnaire. For this study the initial step is to define the research problem and to read and understand any literature that may help to begin developing the scale's design. The scale must include items that can be used to test the research hypotheses and answer the questions raised by the research problem. In section 1.2.3 of Chapter One the research questions about the student teachers' beliefs about the nature of mathematics were presented as follows:

1. What are student teachers' beliefs about the nature of mathematics?

2. What is the most accepted view about the nature of mathematics appearing on this sample?

3. Is there a certain class level, gender, and age of student teacher which is more affected by one of the beliefs about the nature of mathematics?

Accordingly, to answer these questions, it was necessary to develop the BNMS. Then the sample must be selected depending on the research problem.

5.2.1 Training Stage for Items Development and Test Construction in the UK

After searching for the suitable theoretical background, the next step was to try to develop a first draft, as a training stage for the researcher, to be applied to British student teachers at the University of Manchester. The aim of this step was to practise how to develop the items of this scale according to the information and the answers gathered from the student teachers. Many researchers intend to interview the same sample and use their answers to build the items of the scale. First, the researcher interviewed a group of 4 student teachers from the Mathematics Education class at the University of Manchester. With the help of another researcher, the present researcher wrote the interview questions beforehand and constructed guidelines for the expected answers based on Ernest's (1989a) definition of the nature of mathematics. The purpose of this was to make the interview easier to control. Examples are contained in Table 5.1.

Table 5.1: Example of the Guidelines for the Interview

Major Question	Platonist View	Instrumentalist View	Problem-Solving View
In your opinion, what is mathematics?	• Study & understanding of the everlasting truth. • Understanding of numerical sequences and exact relationships and interrelationships. • A study which is of a logical nature. • Facts.	• A tool we may use in our life. • A way of using information and rules in order to help solve problems in later life.	• A useful subject for many life activities as it enables discovery. • A language which is able to describe physical events or predict why 'things' happen in the real world. • Processes /investigation. • Something changeable/dynamic. • Something that is fun and interesting.

Open-ended questions were also distributed to 29 student teachers in the Mathematics Education course. These questions asked the student teachers about mathematics in general and what were their beliefs about the nature of mathematics. The purpose of this step was to ensure that the items in this scale came from the student teachers' responses and comments about these questions. Next, the student teachers' answers were classified into three groups by using keywords based on the Ernest's definition about the nature of mathematics. The student teachers' answers were analysed using descriptors characterising the three views. These descriptors are the keywords used to tell the researcher what to look for and to help categorise the student teachers' answers, so that they can be used to formulate the items of the first draft scale. These keywords are as follows:

1. For the Platonist view: 'exact', 'certain', 'correct', 'fixed', 'truths', 'facts', 'old', 'inherited', and 'relationship'.
2. For the instrumentalist view: 'rules', 'tool', 'memorising', 'skill', and 'steps'.
3. For the problem-solving view: 'discovery', 'many ways', 'creative', 'fun', 'dynamic', 'activity', 'language', 'investigation', 'discussion', 'changeable', and 'simplifying the complex'.

Using this analysis, the student teachers' answers were grouped as shown in Table 5.2.

Table 5.2: Examples of Categorisation of the Student Teachers' Answers

Platonist View	Instrumentalist View	Problem-Solving View
• Maths is the study of everlasting truths.	• Maths is a tool, which allows us to manipulate the world around us.	• Maths is a language needed in society, for example, when buying things from shops.
• Mathematics is old facts that have been used from long ago.	• Maths is the skill of using numbers to apply to real life.	• It is a discussion subject using different kinds of methods to find a solution.
• Maths is the study of numbers and quantifiable information ordered into a systematic framework.	• Mathematics is all about using a set of agreed rules.	• An interesting challenge.
• Maths is certain and exact facts.	• Answering similar questions repeatedly often helps pupils to master a new lesson.	• Aesthetically pleasing intellectual activity, which also has immense practical/ scientific possibilities.
• Strong relationships between old concepts that was found long time ago.	• Solving numerical and geometric problems by using certain steps.	• A changeable subject that helps us deal with different areas in our lives.
• An unchangeable subject that was discovered.	• Applying mathematical skills to reach solutions.	• Mathematics is using your mathematics knowledge in many ways and methods to solve a problem.
• Learning the correct mathematical knowledge is the most important thing.	• Mathematics is referring to basics and rules more than using creative methods.	• Learning mathematics through practical activities and investigation work, not being too abstract.

These responses helped the researcher to write up the scale items in the UK as a preparatory step for the next stage, which is the pilot stage in the State of Kuwait.

5.2.2 Constructing the Scale in Kuwait (the Pilot Study)

The pilot study in investigative research is very important for many reasons. It helps the researcher to see how the scale will be applied at the time of the main study. Also, it gives a chance to make necessary changes to the scale, after checking for ambiguity, confusion, and poorly prepared items.

In this study the same steps used in the practice stage at Manchester were also followed in the State of Kuwait. The pilot phase took place in December 1997. These steps included:

1. Focus groups and transfer of the answers to scale items.
2. Pilot run.
3. Test of validity of the first draft scale.
4. Final draft of the scale.

First of all, the researcher tried to select the sample by using a stratified random selection method. The selection was from among student teachers in the College of Education at Kuwait University studying Primary Mathematics and Science Major. In five focus groups the researcher was able to interview a total of twenty-nine student teachers (see Table 5.3). An attempt was made to collect information from them about their views on the nature of mathematics, using a prepared questions, the purpose being to make the interviews easier to control (see Appendix 2 a).

Table 5.3: Timetable for the Focus Groups

Date	Number in Groups
21 Dec.1997	Group of five student teachers.
22 Dec. 1997	Group of two student teachers.
23 Dec. 1997	Group of seven student teachers.
24 Dec. 1997	Two groups of seven and eight student teachers.

The researcher collected the student teachers' answers with the help of another researcher. Then these answers were categorised according to Ernest's definitions of views about the nature of mathematics and the keywords (descriptors) characterising three views about the nature of mathematics, namely, the Platonist view, the instrumentalist view, and the problem-solving view.

Student teachers' answers in these focus groups provided useful information for constructing the BNMS; this was the main object of these interviews. As mentioned before, particular questions were prepared beforehand in order to ascertain the student teachers' beliefs about the nature of mathematics. It was hoped that their answers might reflect common features of their beliefs about this matter. The following are examples of the questions that were posed in these focus groups:

- In your opinion what is mathematics all about?
- How can you define mathematics?
- Is mathematics similar to other subjects in our life?
- How should we learn mathematics?

The most important question that the focus group was concerned to obtain answers to was: In your opinion, what is mathematics all about? In the following we try to explore one of the focus groups about this question. Most of the keywords were observed in the discussion with the student teachers. As an example, we may refer to a focus group with two student teachers, both of them in the fourth year and both having finished the teaching mathematics methods course. This discussion lasted 35 minutes.

One of the student teachers seemed to hold strong beliefs in support of the Platonist view, as a lot of key words about this particular view emerged, as it was highlighted in the paragraph below shows. But at the same time there was one keyword indicating the instrumentalist view, which is underlined in the following paragraph. When the researcher asked the question, In your opinion what is mathematics all about? the following answer was obtained:

> Student teacher A: In all my life I have never asked or thought about what mathematics is, but from my experience in studying this subject at school I believe mathematics is a subject **found a long time ago** and we have **inherited** this information from generation to the generation. Let me give you an example: my grandfather used the rules (adding, subtracting) to solve money and calculate his money to reach an **exact** solution, and we do that right now.

Another student teacher's response seems closer to the problem-solving view, which the highlighted words show, although she did use a few words which is underlined, which might indicate the instrumentalist view.

> Student teacher B: In some ways I disagree with my friend. Mathematics is an **interesting subject.** It was my favourite subject in my school days. Mathematics is not just about rules but also involves trying to understand the concept, thinking about it, and trying to **improve** these old concepts and mathematical ideas. Mathematics consists of interesting and **different methods** of solving our problems by thinking and **sharing our thoughts** with others in schoolwork or even in our homes.

With the help of another researcher we highlighted the most common answers and tried to categorise them as we did in the preparatory stage in the UK (see section 5.2.1, Table 5.2). These answers were transposed into 24 scale items in the Arabic version. The scale was designed as a self-completion scale. This kind of scale designed to be completed by the student himself or herself with the researcher present. The items were written in closed questions. As Verma and Mallick (1999) mentioned that this type of question is easy to code for subsequent analysis and allow limited number of options to select. In this study the researcher preferred to choose five-point Likert scale.

Table 5.4 shows a first draft of the scale of the Arab student teachers' sample in the English translation. It is divided as follows: 1-9 problem-solving view, 10-17 Platonist view, and 18-24 instrumentalist view and shows the coding for each item as an aid to identifying the items in the statistical tests.

Table 5.4: The First Draft of the Scale of the Arab Student Teachers' Sample in its English Translation

No.	View	Items
1	P.S.	The best way to teach mathematics in an interesting way is through videos and puzzles.
2	P.S.	Children can acquire skills in mathematics through connecting it with the environment or appealing objects, as, for instance, by counting toys.
3	P.S.	A child acquires mathematics by discussing and having the opportunity to think independently away from sheer memorising.
4	P.S.	A teacher should help children to find their own solutions to mathematical problems by themselves.
5	P.S.	Mathematics is a subject whose laws are changeable.
6	P.S.	Mathematics involves a continuous discussion to solve mathematical problems and continuous thinking of alternatives. It is a changeable subject
7	P.S.	Mathematics can be taught to children through experimentation and discovery.
8	P.S.	Mathematics consists of calculations, which give accurate and flexible solutions.
9	P.S.	Mathematics is a wide subject connected with most sciences and applied to the simplest matters of daily life.
10	P.	Mathematics means the basic mathematical knowledge, which must be understood by all.
11	P.	Mathematics means mathematical calculations, figures, and the geometry created by man and it is a perfect truth.
12	P.	Mathematics, for me, means executing mathematical calculations, which demand an intellectual effort.
13	P.	A mathematical calculation is a problem with only one solution arrived at by using old concepts.
14	P.	Mathematics is rules, which are unchangeable.
15	P.	Mathematics means correlated actual relations, which cannot be erroneous.
16	P.	A mathematics teacher should teach the children only the exact mathematical relationships.
17	P.	Mathematics means working out numbers and mathematical calculations already known.
18	I.	A mathematical calculation has one right answer for each problem.
19	I.	Presenting new information to students by asking them to solve similar examples in order to help them memorise this information.

No.	View	Item
20	I.	Mathematics is a group of symbols and figures and limited to solving known mathematical problems.
21	I.	Mathematics means a set of mathematical questions in need of a set of steps to find one correct answer.
22	I.	Mathematics means laws and theories used to solve problems in scientific questions only.
23	I.	Working on similar exercises is the best way to teach mathematics.
24	I.	Teaching mathematics to children through memorising laws and rules is better than teaching it through audio-visual aids.

After these items had been mixed up, a total of 97 student teachers at the College of Education of Kuwait University answered this scale as a pilot run. The next step was to test the validity of this scale. There are different types of validity test used in this study.

First, factor analysis was carried out on the data using the SPSS. As each view has its own items, they were divided into three groups. Each group has its own factor analysis test and is tested separately. (See Tables 5.5, 5.6, and 5.7 and Figures 5.1, 5.2, and 5.3)

Table 5.5: Factor Analysis of the Problem-Solving View

Item No.	Component	
	1	2
6	.854	-.234
7	.762	
4	.737	
3	.731	-.224
2	.711	-.455
9	.642	-.361
5	.534	.383
8	.494	.739
1	.561	.715

Figure 5.1: Scree Plot for Factor Analysis of the Problem-Solving View

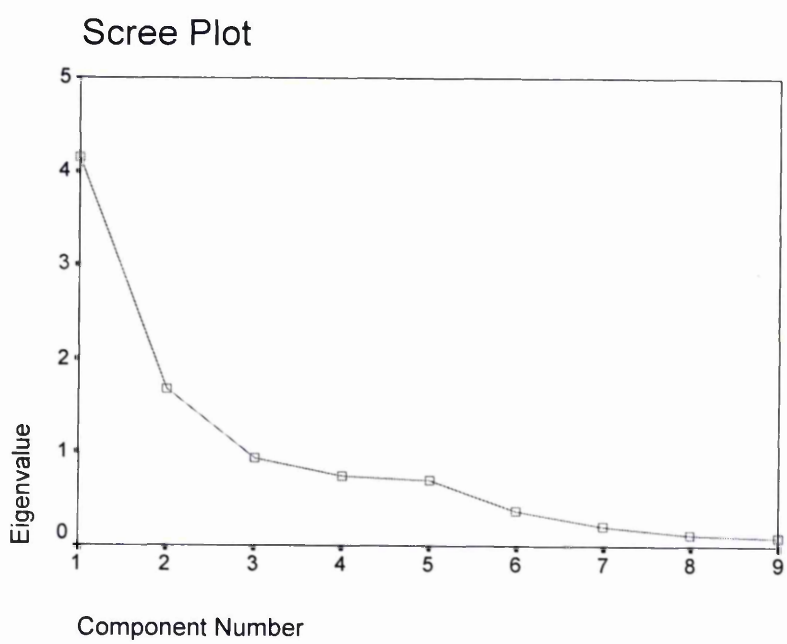


Table 5.6: Factor Analysis of the Platonist View

Item No.	Component		
	1	2	3
12	.819	-.260	
11	.752	-.461	
13	.671	.354	-.520
15	.658	-.653	
17	.301	.691	.403
14	.568	.600	
16	.390	.530	
10	.578		.704

Figure 5.2: Scree Plot for Factor Analysis of the Platonist View

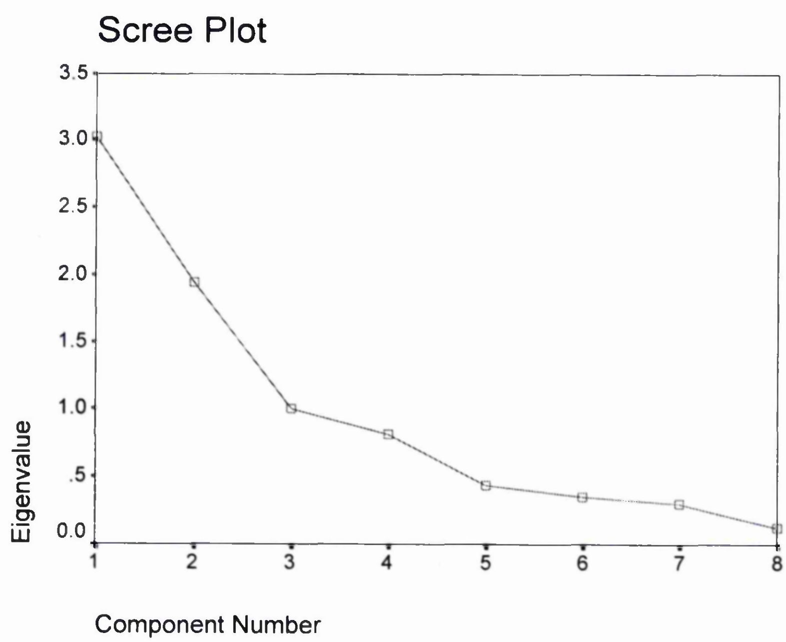
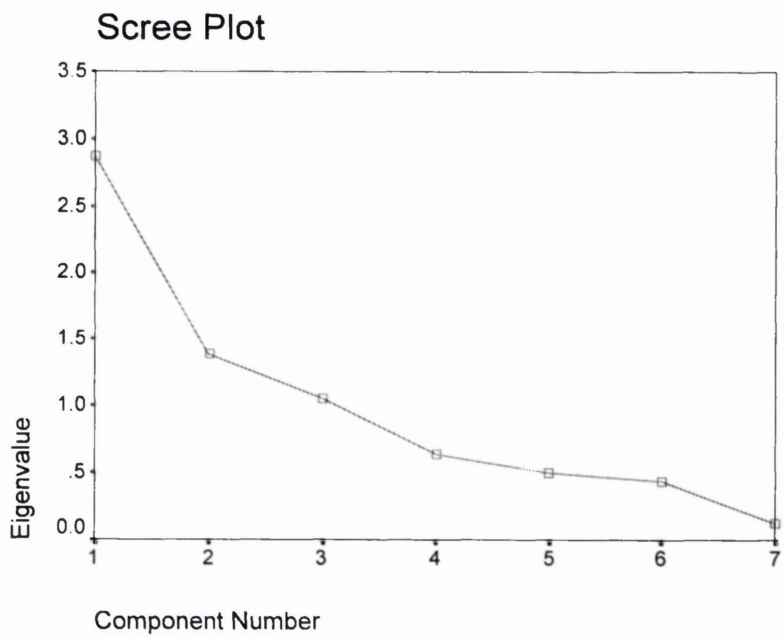


Table 5.7: Factor Analysis of the Instrumentalist View

Item No.	Component		
	1	2	3
19	.808	.389	-.207
22	.741	.276	
20	.673		-.372
23	.632	-.463	-.359
24	.311	.720	.435
21	.578	-.621	.358
18	.621		.637

Figure 5.3: Scree Plot for Factor Analysis of the Instrumentalist View



The above tables show that most of the items fall within component number 1. The purpose is to know what items have a low loading, so that we can cancel them. 9 out of 24 items were cancelled because of low loading or being high loading in other component; these were 5, 8, 10, 14, 16, 17, 18, 21, and 24. For example, item 24 has a low correlation value of .311 in Table 5.7. More details will be presented in Table 5.8.

The second analysis was one of face-validity for the Arabic scale. The Arabic version of the scale was discussed and evaluated with six Arab teachers. The evaluators were experienced teachers, including mathematics teachers who were studying in England and a number of post-graduate students. They recommended dropping or changing ten items because of confusing wording, which could influence an opinion. These items were numbers 1, 4, 7, 8, 14, 15, 16, 17, 19, and 24. For example, item 1 (The best way to teach mathematics in an interesting way is through videos and puzzles) was dropped, even though its loading was high, because this item is concerned with the teaching of mathematics. The meaning of this item was inappropriate to the purpose of this scale. Some items were rewritten and improved to prepare the final version of the scale to be used in the main study. For example, as items 11 and 15 share the same theme, item 15 was dropped.

The third validity test was of the translation of the terms in the scale. The scale was translated from Arabic into English and retranslated into Arabic by another Arab translator who works as an editor and translator in Kuwait. The objective of this was to be confident that the items translated convey the correct meaning and accurately measure the beliefs about the nature of mathematics. For example, with regard to item 20, both translators decided that the sentence "Mathematics is a group of symbols and figures and limited to solving known mathematical problems" would be easier to understand if it were altered to "Mathematics is a tool required to find a solution". Table 5.8 summarises the reasons for deleting the items in each sub-scale of views about the nature of mathematics.

Table 5.8: The Reasons for deleting Items from the First Draft of the BNMS

No.	View	Deleted Item	Reason
1	P.S.	The best way to teach mathematics in an interesting way is through videos and puzzles.	This item is concerned with the teaching of mathematics, which is inappropriate for the scales' purpose.
4	P.S.	A teacher should help children to find their own solutions to mathematical problems by themselves.	Same as above.
5	P.S.	Mathematics is a subject whose laws are changeable.	Low loading in this group, that is .534.
7	P.S.	Mathematics can be taught to children through experimentation and discovery.	Even though this has a high loading, it is concerned with the teaching of mathematics.
8	P.S.	Mathematics consists of calculations, which give accurate and flexible solutions.	It has the lowest loading in the first component for this group, that is 494. Also, in translated and retranslated versions, the meaning was not exactly equivalent.
10	P.	Mathematics means the basic mathematical knowledge, which must be understood by all.	It has a high loading in both the first and the third component.
14	P.	Mathematics is rules, which are unchangeable.	This is a repeated sentence and it has high loading in the first and second component in this group.
15	P.	Mathematics means correlated actual relations, which cannot be erroneous.	Even though this has a high loading, it has the same meaning as item number 11.
16	P.	A mathematics teacher should teach the children only the exact mathematical relationships.	This has a low loading in the first component for this group, that is .390. Furthermore, its emphasis is on teaching.
17	P.	Mathematics means working out number and mathematical calculations already known.	This has the lowest loading in the first component for this group, that is .30. It is also very vague.
18	I.	A mathematical calculation has one right answer for each problem.	In this group this item has a high loading of in both the first and third component. It also includes the word "problem", which is a keyword for the problem-solving view.
19	I.	Presenting new information to students by asking them to solve similar examples in order to help them memorise this information.	This item is concerned with the teaching of mathematics, which is inappropriate for the purpose of this scale.
21	I.	Mathematics means a set of mathematical questions in need of a set of steps to find one correct answer.	This has a high loading in both the first and second component.
24	I.	Teaching mathematics to children through memorising laws and rules is better than teaching it through audio-visual aids.	This item is concerned with the teaching of mathematics, which is inappropriate for the purpose of this scale. It has the lowest loading, .311.

At the end of these steps, a few changes and amendments were made to items. The final draft of the scale contained the following ten items. In the amended items the keywords were underlined to ensure that items contained the exact keywords for each view.

Table 5.9: The Old and the Amended Items from the First Draft of the BNMS

No.	View	Old Item	Amended Item
2	P.S.	Children can acquire skill in mathematics through connecting it with the environment or appealing objects, as, for instance, by counting toys.	Children can acquire new concepts in mathematics through connecting it with their environment, e.g., by playing games.
3	P.S.	A child acquires mathematics by discussing and having the opportunity to think independently away from sheer memorising.	A child can solve mathematical problems by various methods, not only through memorising.
6	P.S.	Mathematics involves a continuous discussion to solve mathematical problems and continuous thinking of alternatives. It is a changeable subject.	Mathematics involves a continuous discussion to solve mathematical problems and is an evolving subject.
9	P.S.	Mathematics is a wide subject connected with most sciences and applied to the simplest matters of daily life.	Mathematics is a creative and broad subject connected with most sciences.
11	P.	Mathematics means mathematical calculations, figures, and the geometry created by man and it is a perfect truth.	Mathematics is exact and there is no scope for error.
12	P.	Mathematics, for me, means executing mathematical calculations, which demand an intellectual effort.	Mathematics, for me, means using the correct method developed by scientists and inherited from long ago.
13	P.	A mathematical calculation is a problem with only one solution arrived at by using old concepts.	Strong relationships between old mathematical concepts are the true meaning of mathematics.
20	I.	Mathematics is a group of symbols and figures and limited to solving known mathematical problems.	Mathematics is a tool required to find a solution.
22	I.	Mathematics means laws and theories used to solve problems in scientific questions only.	To find a solution for a mathematical problem, one must always follow the rules.
23	I.	Working on similar exercises is the best way to teach mathematics.	Routine practice of mathematical rules is the best way to learn mathematics.

A factor analysis test was then conducted in a second run over the same data (from 97 student teachers). After eliminating the items, as mentioned above, the researcher decided to do a second run for the BNMS scale, using the factor analysis test by entering the ten items, and including the three types of views as one group to confirm that the factors measure the right views. From the analysis we noticed that the items were divided, as shown in Table 5.10, according to three factors. Item 20 was found to be high in two factors: the problem-solving view (component 1) and the instrumentalist view (component 3). This was perhaps because the wording was confusing. For this reason we mentioned in connection with Table 5.9 that the wording for this item will change for the main study (see Section 5.5, Table 5.13).

Table 5.10: Rotated Factor Analysis for the BNMS

View	**No. of Item**	**Component**		
		1	**2**	**3**
Problem-Solving	**9**	.843		.268
	6	.831	.156	-.251
	3	.790	.121	
	2	.759	.142	.205
Platonist	**12**	.153	.893	
	15		.882	
	13	.324	.804	.152
Instrumentalist	**23**		.206	.833
	22		-.163	.750
	20	.526	.115	.566

As a final validity test, a copy of these final ten items of the BNMS was distributed to twenty-five mathematics primary teachers in Kuwait. After reading a brief explanation about the three views, these teachers were asked to link the items to the relevant belief (for a copy of this, see Appendix 3). This helps us to ensure that each item is correctly linked to the relevant view. Table 5.11 shows how the teachers answered and it will be noticed that almost all of them chose the right view for each item in the BNMS.

Table 5.11: Distribution of the Teachers' Answers in the Final Draft of the BNMS.

Item No.	Problem-Solving view	Instrumentalist view	Platonist view
2 (PS)	**23**	**1**	**1**
3 (PS)	**21**	**4**	**0**
6 (PS)	**24**	**1**	**0**
9 (PS)	**22**	**0**	**0**
11 (P)	**0**	**2**	**23**
12 (P)	**0**	**3**	**21**
13 (P)	**0**	**4**	**20**
20 (I)	**3**	**22**	**0**
22 (I)	**0**	**24**	**1**
23 (I)	**0**	**19**	**4**

In summary, fourteen items were dropped from this scale, for reasons of their low loading, the face-validity with six Arab teachers, and comparison of translation and re-translation. After these steps, the researcher felt confident that the resultant scale would accurately measure the beliefs of the student teachers in the State of Kuwait about the nature of mathematics.

5.3 The Final Draft of the BNMS Scale

The distribution of scale items based on the three views is shown in Table 5.12.The final Arabic version of the BNMS was translated into English as shown below.

Table 5.12: Final Draft of the BNMS

Old No.	New No.	View	Item
2.	**1.**	P.S.	Children can acquire new concepts in mathematics through connecting it with their environment, e.g., by playing games.
3.	**2.**	P.S.	A child can solve mathematical problems by various methods, not only through memorising.
6.	**3.**	P.S.	Mathematics involves a continuous discussion to solve mathematical problems and is an evolving subject.
9.	**4.**	P.S.	Mathematics is a creative and broad subject connected with most sciences.
11.	**5.**	P.	Mathematics is exact and there is no scope for error.
12.	**6.**	P.	Mathematics, for me, means using the correct method developed by scientists and inherited from long ago.
13.	**7.**	P.	Strong relationships between old mathematical concepts are the true meaning of mathematics.
20.	**8.**	I.	Mathematics is a tool required to find a solution.
22.	**9.**	I.	To find a solution for a mathematical problem, one must always follow the rules.
23.	**10.**	I.	Routine practice of mathematical rules is the best way to learn mathematics.

5.4 Data Collection for the Main Study

The next step was the main data collection for the BNMS. The second phase was the main study. The scale was distributed to 418 of the sample in the College of Education at Kuwait University and the College of Basic Education. More details about the findings of this stage are contained in Chapter Seven.

5.5 Statistical Analysis and the Validity and Reliability Tests

The data were analysed using the SPSS, which offers many kinds of analysis suitable to this type of scale. Factor analysis was also used to compare the pilot and main stages' results to confirm the validity of this scale since the factor analysis test is an appropriate tool for helping to identify the factors of a construct scale. Johnson and Wichern (1992) state that the essential purpose of factor analysis is to describe, if possible, the covariance relationships among many variables in terms of a few underlying, but unobservable, random quantities called factors. They also mention that all variables within a particular group are highly correlated among themselves but have relatively small correlation with variables in a different group. In addition, they mention that rotation helps to obtain factors that can be named and interpreted. In other words, it makes the large loading larger than before and the smaller loading smaller, so that each variable is associated with a minimal number of items. Table 5.13 shows the factor analysis results for the BNMS in the pilot and the main stages. The sample consisted of 97 student teachers in the College of Education at Kuwait University for the pilot study, and 418 student teachers in the College of Education at

Kuwait University and the College of Basic Education in the State of Kuwait for the main study.

Table 5.13: Factor Analysis Results for the BNMS (Pilot: N = 97; Main: N = 418)

View	Item No.	Factor One		Factor Two		Factor Three	
		Pilot	Main	Pilot	Main	Pilot	Main
Problem-Solving	9	.843	.930		.101	.268	
	6	.831	.913	.156	.106	-.251	
	3	.790	.875	.121	.150		
	2	.759	.700	.142	.175	.205	.200
Platonist	12	.153		.893	.882		.101
	15		.301	.882	.769		.181
	13	.324	.157	.804	.686	.152	.307
Instrumentalist	23			.206		.833	.887
	22			-,163	.358	.750	.743
	20	.528	.365	.115	.212	.566	.715

The above Table shows that the items in this scale are still in the same three factors in the pilot and main studies. Factor one represents the problem-solving view, factor two represents the Platonist view, and factor three represents the instrumentalist view. As previously noted, item 20 was in two factors, but after changing the wording of the statement, the factor analysis test score was low in the first two factors (.365 and .212) and high in the third factor (.715). This shows how the change in wording of this item greatly affected the result for the main stage.

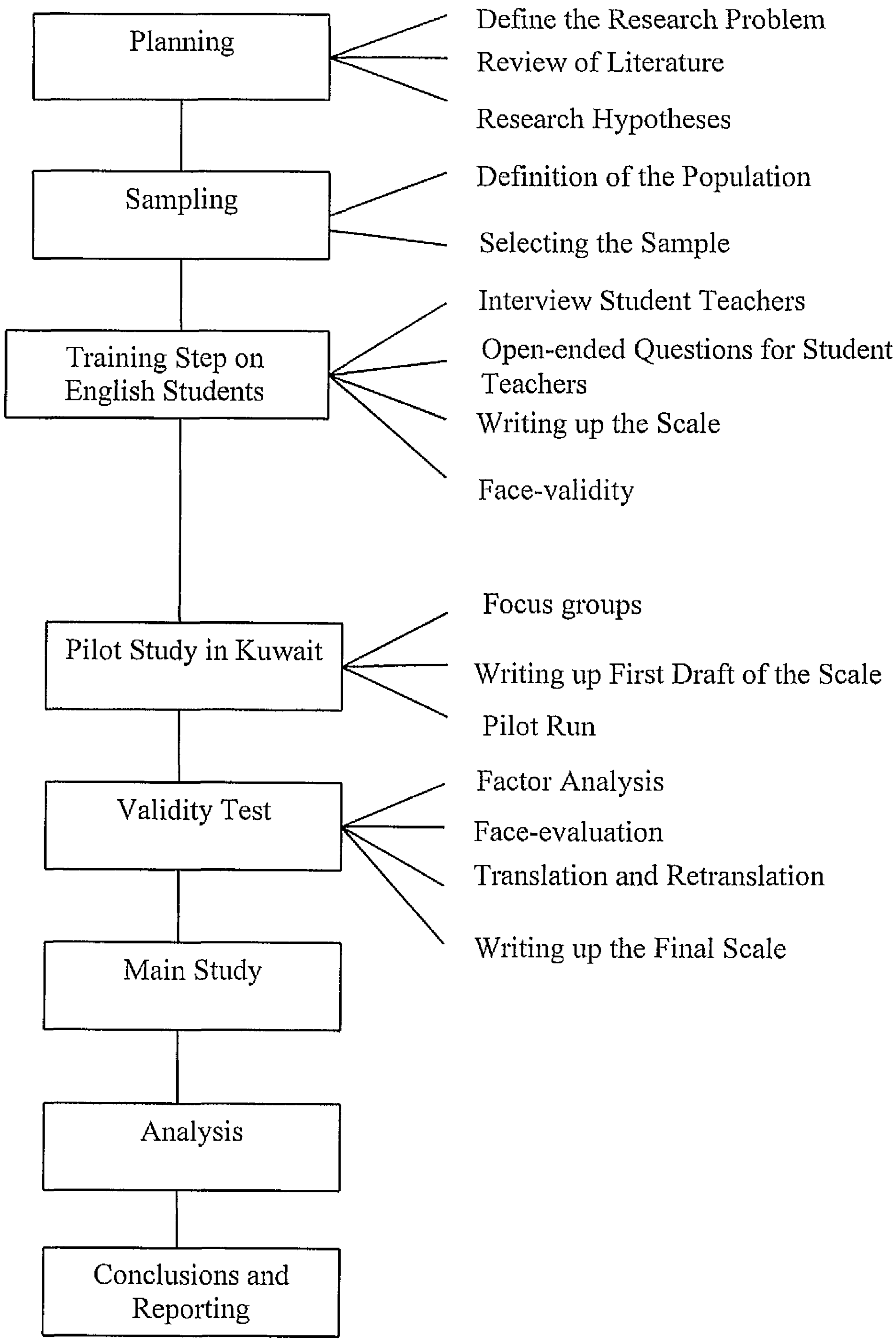
The reliability of the three sub-scales of the BNMS were calculated by the reliability coefficients (Cronbach (alpha)) for each sub-scale. Table 5.14 shows the extent of this reliability.

Table 5.14: The Cronbach (alpha) Reliability Coefficients (Pilot: N=97; Main: N=418)

Sub-Scale	Item No.	Pilot	Main
Problem-solving	4	.81	.89
Instrumentalist	3	.60	.76
Platonist	3	.84	.77

From the information in Table 5.14 we can conclude that reliability analysis based on the main data is equally consistent with the pilot data for all the sub-scales except in factor 3, which is lower. The final step is the reporting of conclusions and results in the main study chapter. Figure 5.4 summarises the steps involved in constructing the scale. The items in the boxes are the major steps, while to the right of them are shown the activities that come under each step.

Figure 5.4: Summary of the Steps involved in constructing the Scale



This chapter has sought to explain the developing of the BNMS. It is now appropriate to consider the validity and reliability of two other scales, namely, the attitudes toward mathematics scale (MAS) and the attitudes toward teaching mathematics scale (TMAS). This is the focus of the next chapter.

CHAPTER SIX

VALIDITY AND RELIABILITY ANALYSES OF THE MAS AND THE TMAS

6.0 Introduction

In the previous chapter, we looked at issues related to the developing of the BNMS, one of the scales used in this study. Student teachers' and teachers' opinions were discussed and transferred into the new scale. In this chapter major steps will be dealt with for the other two scales used in this study. First, in the pilot study the researcher try to understand the two scales, translation into Arabic language, and face-validity was done with two instructors in the State of Kuwait

Second, in the main study we deal with the reliability analyses for two of scales (the MAS and the TMAS) used in the main questionnaire. Items of part two in the main questionnaire address the MAS, while part four in the questionnaire is concerned with the TMAS. Factor analyses and Cronbach (alpha) reliability coefficient tests were applied to the main data obtained from the 418 student teachers to confirm the patterns that emerged from the original scales' data.

These are the two essential steps considered in this chapter.

6.1 The Pilot Study

For the current study there was a need for scales that contain items that can be used to test part of the research problem, that is, "to describe the attitudes towards mathematics and its teaching of the primary mathematics student teachers in the College of Education at Kuwait University and the College of Basic Education at the Public Authority for Applied Education ".

After reviewing relevant literature, there were found to be two scales applicable to this particular topic, namely the Fennema-Sherman mathematics attitude scales (MAS) and Nesbit's primary student teachers' attitudes to teaching mathematics scales (TMAS). We may state the reasons for using these two scales in the present study. First of all, the purpose for each scale matches the research problem being investigated here. For example, the Fennema-Sherman mathematics attitude scales were used to measure students' attitudes toward mathematics, while Nesbit's attitudes to teaching mathematics scales (TMAS) measured primary student teachers' attitudes to teaching mathematics. Second, the Fennema-Sherman mathematics attitude scales have been used in different countries. Many researchers have used this scale (Elliott, 1990), so that it would be useful to obtain the results from an Arab sample and to understand Arab students' attitudes towards this topic. Furthermore, the items in these scales are easy to translate into other languages and cultures because the wording seems not obviously culture specific. Third, the TMAS were developed for the same student sample as that surveyed in this study, that is primary student teachers, while the MAS was developed to suit the particular samples in the current study and has been used by many researchers to measure college students' attitudes (Butler and Austin-Martin, 1981: Heher 1988; Elliot, 1990). Elliot (1990) used this scale with college students and mentioned that " the Fennema-Sherman scale was modified to ensure its suitability of wording for adult instead of young children" (p. 161). Fourth, the MAS contains nine separate scales, so that the researcher was able to choose those of them which fitted the current study.

Having made this selection of appropriate scales, the next step was to discuss the approach with two educational instructors in Kuwait, who made a number of suggestions. For example, they suggested that the phrase 'math 200' in item number 8 of the MAS should be changed to 'calculus', as this term was more suitable since it was one with which Kuwaiti student teachers were familiar. Other items in these two scales were adjudged suitable for and understandable by student teachers in Kuwait. The instructors agreed that the rest of the items dealing with a basic and familiar subject can be understood whether one is an Arab or not. For example, one of the items in the usefulness of mathematics scale under the MAS, "I'll need mathematics for my future work", was quite understandable.

Another important step was to test the accuracy of the translation of these two scales from English into Arabic. To achieve this, two Arab translators in Kuwait translated these two scales into Arabic from English independently and discussed the results with the researcher. The object of this was to ensure that the translation of each item conveyed the correct meaning and that the scales were therefore capable of being used in measuring attitudes toward mathematics and the teaching of mathematics during the main study.

6.2 Statistical Tests for the MAS and the TMAS in the Main Study

The researcher subjected the 418 student teachers' data to certain statistical tests. First, a factor analysis was carried out in this stage. Factor analysis testing is used by researchers to unravel and understand the structure of a correlation matrix. There are four steps in factor analysis, viz:

> 1) The correlation or covariance matrix is computed. If a variable has very small correlations with all the others, you may consider eliminating it in the next run.
> 2) The factor loadings are estimated. Here, you decide whether the method of factor extraction is a principal component or one of the factor analysis methods of extraction.
> 3) The loadings are rotated to make the loadings more interpretable. Rotation methods make the loadings for each factor either large or small, not in-between. After seeing these results, you may want to request fewer factors than chosen by default.
> 4) For each case, scores can be computed for each factor and saved for use as input variables in other procedures (SPSS Base 7.5 applications guide, p.289).

In addition, the purpose of using the rotation is to obtain factors that can be named and interpreted. It makes the large loadings larger than before and the small loadings smaller. Then every variable is associated with a minimal number of factors. Consequently, the variables that load strongly together on a particular factor will indicate a clear meaning with respect to the subject area at hand. The next two sections explore the factor analysis for the MAS and the TMAS.

6.2.1 Factor Analysis of the Mathematics Attitude Scale (MAS)

The Fennema-Sherman mathematics attitude scales can be used as a total package to assess a variety of attitudes toward learning mathematics, or can be used individually. Four of these scales were used in this study: 'the mathematics anxiety scale', 'the confidence in learning mathematics scale', 'the mathematics as a male domain scale', and 'the mathematics usefulness scale'. In this study it was necessary to use the factor analysis test to ascertain that these four scales were divided into four factors. This test was applied to the 418 student teachers who answered the MAS in the main study. In the first run of the factor analysis test, the results showed that the 48 items in this instrument were divided into four factors. However, some of the items appeared in two factors. As Johnson and Wichern (1992) suggested, rotation helps to obtain variables that can be grouped into the same factor. Therefore, the four factors were rotated as shown in Table 6.1. Although some of the items appear to be in two factors at the same time, most of the other items in the same scale group with each other. That shows that the instrument is in some way divided as it is supposed to be.

Table 6.1: Rotated Component Matrix of the Factor Analysis of the MAS (N=418)

Sub-Scale	No.	Factor 1	Factor 2	Factor 3	Factor 4
Confidence	V 1	.874		-.183	.116
	V 2	.843		-.299	.122
	V 3	.832		-.285	.152
	V 4	.817		-.272	.135
	V 5	.813		-.294	.134
	V 6	.808		-.290	
	V 7	.805		-.276	.188
	V 8	.783		-.188	.166
	V 9	.774		-.264	.128
	V 10	.773		-.322	.135
	V 11	.751		-.211	
	V 12	.725		-.433	-.196
Male Domain	V 1		.864	.164	
	V 2		.864	.164	
	V 3		.865	.134	
	V 4		.841		
	V 5		.835	.149	
	V 6		.824		
	V 7		.805		
	V 8		.797		.115
	V 9	.114	.774		
	V 10		.765		
	V 11		.764		
	V 12		.644	-.111	

Sub-Scale	No.	Factor 1	Factor 2	Factor 3	Factor 4
Anxiety	V 1	-.294		.766	
	V 2	-.351		.754	
	V 3	-.433		.725	-.196
	V 4	-.305		.714	-.115
	V 5	-.441	-.101	.705	-.138
	V 6	-.401		.677	-.111
	V 7	-.416	-104	.677	-.105
	V 8	-.555		.625	-.190
	V 9			.609	
	V 10	-.509		.606	
	V 11	-.120		.603	
	V 12	-.564		580	-.113
Usefulness	V 1	.119			.827
	V 2		.142		.802
	V 3	.119	.		.798
	V 4				.775
	V 5	.212	.104		.755
	V 6	.111	.104		.738
	V 7				.736
	V 8		.128		.718
	V 9	.113		-.161	.688
	V 10		.117	-.152	.678
	V 11	.133			.587
	V 12				.450

6.2.2 Factor Analysis of the Teaching Mathematics Attitude Scale (TMAS)

As we mentioned previously, the factor analysis procedure is carried out to confirm that the items in this scale are in four factors as in the original scale. After translating the questionnaire into Arabic and collecting the data from 418 student teachers in the State of Kuwait, the factor analysis results were obtained as reported in Table 6.2. Nisbet (1991) divided the scale into four factors, namely 'the mathematics teaching anxiety scale', 'the confidence and enjoyment in teaching mathematics scale', 'the desire for recognition scale', and 'the pressure to conform scale'. As Table 6.2 shows, by using the rotated factor analysis, the result is exactly the same four factors in the original scale.

Table 6.2: Rotated Component Matrix of the Factor Analysis of the TMAS (N = 418)

Sub-Scale	No.	Factor 1	Factor 2	Factor 3	Factor 4
Confidence and Enjoyment in Teaching Mathematics	V1	.825	-.136		
	V2	.791	-.143		
	V3	.754		-.109	
	V4	.743	-.224		
	V5	.682	-.168	.279	
	V6	.650		.186	
	V7	.599	-.229	.304	
	V8	.530	-.138	.393	
Mathematics Teaching Anxiety	V1	-.195	.732	-.251	
	V2	-.246	.720	-.145	.157
	V3		.640	.160	
	V4	-.299	.621		
	V5	-.254	.606	-.182	.148
	V6	.111	.512		
	V7	-.373	.509	-.244	.132
	V8	-.149	.416	-.250	
Desire for Recognition	V1			.850	
	V2	.170		.779	-.113
	V3		-.129	.786	
Pressure to Conform	V1		.146		.902
	V2				.901
	V3				.865

6.2.3 Reliability of the MAS and the TMAS

Wiersma (1995, p.9) stated, reliability "of research concerns the reliability and consistency of the methods, conditions and results." This means if a study is reliable, we can interpret the results with confidence or generalise them to other populations and conditions. Wiersma (1995) also mentioned that reliability is a statistical concept based on the correlation between two sets of scores representing the measurements obtained through the instrument when it is used with a group of individuals. Reliability coefficients can take on values from 0 to 1.0. This means that if the reliability coefficient is 0, there will be no 'true' component in the observed score. On the other hand, if the reliability coefficient is 1.0, the observed score will contain no error.

6.2.3.1 Reliability Analysis of the Mathematics Attitude Scale (MAS)

This section will review the reliability of the mathematics attitude scales developed by Fennema and Sherman (1976). The MAS contains four sub-scales: 'the mathematics anxiety scale', 'the confidence in learning mathematics scale', 'the mathematics as a male domain scale', and 'the mathematics usefulness scale'. The definition of these scales will be introduced more clearly during Chapter Seven. The researcher will investigate any changes between these sub-scales in the original and the current study. Cronbach (alpha) reliability coefficients were calculated for the new data obtained in this study from Kuwaiti student teachers and were compared with the original scale. As shown in Table 6.3, three of the four sub-scales have almost the same reliability.

Table 6.3: The Cronbach (alpha) Reliability Coefficients of the MAS (Arabic: N = 418; Fennema-Sharman: N = 1233)

Sub-Scale	No. of items	Fennema-Sherman	Arabic
Mathematics Anxiety	12	.89	.91
Confidence in Learning	12	.93	.92
Mathematics Usefulness	12	.88	.90
Male Domain	12	.87	.94

6.2.3.2 Reliability Analysis of the Teaching Mathematics Attitude Scale (TMAS)

Cronbach (alpha) reliability coefficients were calculated for the four sub-scales of this scale. Table 6.4 shows the reliability scores for each of the four sub-scales: 'the mathematics teaching anxiety scale', 'the confidence and enjoyment in teaching mathematics scale', 'the desire for recognition scale', and 'the pressure to conform scale'. Nisbet developed the TMAS in 1991 in applying Australian primary student teachers (more details about each sub-scale in Chapter Three). Table 6.4 shows a comparison between the new data and the original data.

Table 6.4: The Cronbach (alpha) Reliability Coefficients of the TMAS (Arabic: N=418; Nisbet: N=155)

Sub-Scale	No. of Items	Nisbet	Arabic
Mathematics Teaching Anxiety	8	.80	.80
Confidence and Enjoyment in Teaching Mathematics	8	.89	.86
Desire for Recognition	3	.71	.80
Pressure to Conform	3	.74	.88

This indicates that there was a small difference in the reliability of subjects' responses between the first two scales. On the other hand, the last two indicate an increase in reliability. In general, we may conclude that there was no difference in this test between the Arabic and original scale.

6.3 Summary

Different types of tests were used to determine the reliability and validity of two of the scales used in the pilot and main studies. The factor analysis tests showed that the Arabic MAS and the TMAS were valid and reliable. After comparing the new data in this study with the original instruments (MAS and TMAS), we found that there were no major differences between them in the reliability and factor analysis tests.

CHAPTER SEVEN

MAIN STUDY RESULTS: STUDENT TEACHERS' BELIEFS AND ATTITUDES

7.0 Introduction

In this chapter the main data and results of this research are presented. The student teachers' responses to three scales-namely the mathematics attitude scales (MAS), the teaching mathematics attitude scales (TMAS), and the beliefs about the nature of mathematics scales (BNMS)-are analysed. Analysis is also made of the interviews conducted with some student teachers and instructors in the College of Education at Kuwait University and the College of Basic Education in Kuwait. The interviews and classroom observations are used to help interpret the statistical results. In the first section below we will introduce the characteristics of the research subjects. This will help us to identify any particular influence which will need to be considered in the main analysis. In the following three sections, we will focus in turn on each of the three scales mentioned above and consider in connection with each of these a number of background variables. The fifth section is concerned with the relationship between each of the scales examined. Finally, there will be a summary of findings.

A reliability and validity analysis was carried out on the three scales. In the previous two chapters the pilot data were presented, and the analysis indicated that these scales are a rational measure of student teachers' attitudes toward mathematics and teaching mathematics and their beliefs about the nature of mathematics.

7.1 The Subjects

Student teachers in this stage responded to questionnaires designed to elicit data to be analysed in the MAS, TMAS, and BNMS (see section 4.5 about the research design). The student teachers involved were enrolled in the mathematics and science for primary level major in the College of Education at Kuwait University and the College of Basic Education. Questionnaires relating to these three scales were completed by 418 student teachers from the two education colleges. Distribution of the student teachers' sample was made according to their gender, class level, age group, and nationality.

In addition, interviews were conducted with student teachers and instructors. A total of 16 students and 4 instructors were interviewed. Focus groups with the student teachers took place in both institutions after classes and were mainly conducted in the Teaching and Curriculum Department at Kuwait University and the College of Basic Education and lasted around 35 to 45 minutes. Semi-structured interviews with the instructors took place in their offices and lasted around 45 to 55 minutes. More details about these will be found in sections 4.6.5 and 4.6.6.

The focus groups with the 16 student teachers were conducted in groups of four students each owing to pressures of time. All the interviews were carried out in Arabic. Three of the interviews were recorded in writing with the assistance of another researcher, but only one was tape-recorded. The reason for not all of the interviews being tape-recorded was that, for cultural and religious reasons, the females refused to allow their voices to be recorded. Later these four interviews were translated into English. Section 7.1.1 presents the exploratory analyses of the student teachers' sample and section 7.1.2 shows the interview sample.

7.1.1 The Distribution of the Student Teachers' Sample

In this section we will consider the distribution of student teachers whose responses were measured on the three scales. The distribution was according to the variables analysed in the tables included in this section.

Table 7.1 shows distribution of the sample according to gender and class level. This table indicates that the number of third-year student teachers was the largest grouping. The reason for this was that most of the second-year student teachers were away in another college taking university requirement courses, while most of the third-year student teachers were taking their specialist courses in these two institutions concerned.

We also notice that females predominate, apparently because they are more interested in enrolling in this major than are males. So, for example, the number of females enrolled in the two colleges in the academic year 1997-1998 amounted to 741, while there were only 297 male student teachers (see Table 4.1 in Section 4.4).

Table 7.1: The Distribution of the Student Teachers' Sample according to Gender and Class Level

Gender	Class Level			Total
	Second Year	Third Year	Fourth Year	
Male	**30** **20.4 %**	**58** **39.5 %**	**59** **40.1 %**	**147** **100 %**
Female	**46** **17.0 %**	**128** **47.2 %**	**97** **35.8 %**	**271** **100 %**
Total	**76** **18.2 %**	**186** **44.5 %**	**156** **37.3 %**	**418** **100 %**

Using a chi-square test we try to answer this question: does class level vary by gender in this sample? Here the variable class levels and genders are used to form a table with two rows and three columns. The three class levels are second year, third year, and fourth year; the two sexes are male and female. A Pearson chi-square statistic is sought as a test of the independence of table rows and columns, that is for testing that class levels and gender are independent. Table 7.2 explains the result.

Table 7.2: Chi-square Test of Difference for the Distribution of the Student Teachers' Sample according to Gender and Class Level

	Value	**Df**	**Asymp. Sig.**
Pearson Chi-sq.	2.395	2	.302

N=418

The computed chi-square statistic in this table is 2.395 and has an associated probability (p value) or significance level of .302. Conventionally, if this probability is higher than 0.05 or 0.01, the hypothesis of independence is accepted. So, there is no association between class level and gender, and these two variables are considered independent in all subsequent analyses. Therefore, the interaction and main effects of these variables on the sample for this study will be explored.

Table 7.3 explains more about the relationship between age group and class level. The highest number of student teachers are in the third year and the age group ranging between 21 and 23, simply because this group is the focus in this study.

Table 7.3: The Distribution of the Student Teachers' Sample according to Gender and Age

Class Level	**Age Group**			**Total**
	17-20	**21-23**	**24 and over**	
Second Year	54 71.1%	18 23.7%	4 5.3%	76 100.0%
Third Year	60 32.3%	97 52.2%	29 15.6%	186 100.0%
Fourth Year	3 1.9%	87 56.5%	64 41.6%	154 100.0%
Total	117 28.1%	202 48.6%	97 23.3%	416 100.0%

The following Table explains whether the class level variable is independent from the age variable, as calculated by the Pearson chi-square.

Table 7.4: Chi-square Test of Difference for the Distribution of the Student Teachers' Sample according to Age and Class Level

	Value	Df	Asymp. sig.
Pearson Chi-sq.	137.9	4	.005*

N=418

In this table the computed chi-square statistic is 137.9, with an associated probability (p value) or significance level of less than 0.0005 (the probability is not 0), indicating an association between class level and age group. For example, the students in the final year at the college are older than the students in the earlier years.

Table 7.5 shows the sample distribution according to gender and age groups. In this sample the highest number is almost half of the sample (48.6 %), representing those in the group aged 21-23 years. This group includes 202 student teachers, 70 of whom are male, 132 female. Then nearly three out of ten (28 %), i.e. 117 student teachers, 23 males and 94 females, are aged between 17 and 20. The reason for these two groups being the highest in this sample is that most of those in these age groups are second-, third-, or fourth-year students.

Table 7.5: The Distribution of the Student Teachers' Sample according to Gender and Age

Gender	Age Group			Total
	17-20	21-23	24 and over	
Male	23 15.6 %	70 47.6 %	54 36.7 %	147 100 %
Female	94 34.9 %	132 49.1 %	43 16.0 %	269 100 %
Total	117 28.1 %	202 48.6 %	97 23.3 %	416 100 %

Using the Pearson chi-square test, Table 7.6 explains whether the gender variable is independent from the age variable.

Table 7.6: Chi-square Test of Difference for the Distribution of the Student Teachers' Sample according to Age and Gender

	Value	Df	Asymp. Sig.
Pearson Chi-sq.	30.1	2	.005*

N=418

The computed chi-square statistic in this table is 30.1 and has an associated probability (p value) or significance level of less than 0.05, pointing to an association between gender and age group.

The next table shows the sample distribution according to gender and nationality. It is interesting to note that very high proportions of the student teachers are Kuwaitis. In fact, almost 9 in every 10 (89 %) are Kuwaitis. Following the Iraqi invasion, the numbers of foreign students in Kuwait decreased. Many of the non-nationals are students from other Arab countries in the Arabian Gulf.

Table 7.7: The Distribution of the Student Teachers' Sample according to Gender and Nationality

Gender	**Nationality**		**Total**
	Kuwaiti	**Non-Kuwaiti**	
Male	129 88.4 %	17 11.6 %	146 100 %
Female	242 89.3 %	29 10.7 %	271 100 %
Total	371 89.0 %	46 11.0 %	417 100 %

7.1.2 The Distribution of the Interview Sample

The total number in the student teachers' interview sample is 16, 4 in each group interviewed (for more details, see section 4.6.6). Table 7.8 shows that the females outnumber the males, probably because of the reason previously noted. The following table shows this distribution.

Table 7.8: The Distribution of the Student Teachers' Focus Group Sample according to Gender and Class Level

Gender	Class Level			Total
	Second Year	Third Year	Fourth Year	
Male	**2**	**2**	**2**	**6**
Female	**4**	**3**	**3**	**10**
Total	**6**	**5**	**5**	**16**

7.2 The Findings of the Mathematics Attitudes Scales (MAS)

Section two will review the findings of the mathematics attitude scales developed by Fennema and Sherman (1976). The MAS contain four sub-scales: 'the mathematics anxiety scale', 'the confidence in learning mathematics scale', 'the mathematics as a male domain scale', and 'the mathematics usefulness scale'. The definition of these scales will be introduced during the results. We will investigate any correlation between these sub-scales, after which we will consider them against the background variables. As we mentioned previously in Chapter One outlining the significance of this study, these questions about the background variables were raised because they would enable educationists in the two Kuwaiti education colleges to design a more suitable curriculum for this major. The findings of this section will show the student teachers' attitudes toward mathematics and how these may depend on their class level and gender.

The student teachers' responses were coded from 1-5 in the MAS, where 'strongly disagree' scores 1 point and 'strongly agree' scores 5 points. The results were analysed using the Statistical Package for Social Sciences (SPSS). The tables in this section contain the results of the statistical analysis, offering, for example, means, correlation coefficients, t-Test, and ANOVA results.

7.2.1. Comparison of the MAS Sub-Scales with the Class Level Variable

Our aim in this section is to answer the following research questions, previously stated in Chapter One:

1. To what extent will class level and age influence student teachers' attitudes toward mathematics?
2. Does one class level score more highly in math-anxiety, confidence in mathematics, or other areas measured in the MAS?

The statistical results show that in their second year the student teachers exhibited a greater degree of mathematics anxiety and lower confidence in learning mathematics than in their fourth year, as is demonstrated in Table 7.9. The effect size for the mathematics anxiety scale between the second and fourth years is .54, while between the third and fourth years it is .35. This indicates that the more advanced are the levels in which the student teachers find themselves, the more confident they are and the less anxious.

Table 7.9: Mathematics Anxiety and Confidence in Learning Mathematics Scales' Mean Scores and Standard Deviations for Student Teachers by Class Levels

Class Level	N	Mathematics Anxiety		Confidence in Learning	
		Mean	S.D.	Mean	S.D.
Second Year	76	3.22	.99	3.07	1.08
Third Year	186	3.02	.89	3.15	1.04
Fourth Year	156	2.70	.93	3.51	.96

N=418

During the discussion with the 16 student teachers, the researcher gained the impression that the majority of them felt confident in mathematics, while some few of them did express their anxiety in one way or another. In focusing on the class level variable, it was noticeable that the majority of the 6 interviewed student teachers in their second year agreed that they felt anxious in their study at the college as second-year students. Thus, for example, one student teacher said,

> I chose this major because I knew there are not too many pure mathematics courses in it. I'm afraid that the courses at the college level are more difficult than at high school. (S 9, F, L2)

Another second-year male student teacher answered,

> In my life I have never been worried about sitting mathematics exams, but I was advised by my friends it would be better to enter this major because it contains less difficult mathematics courses than other majors. I still have the feeling about mathematics courses in the college, that they would be more difficult than high school mathematics. (S 6, M, L2)

Expressing another point of view, a second-year female student teacher answered,

> Some things worry me about studying the mathematics course, especially studying it in the English language at this college. (S 14, F, L2)

On the other hand, commenting on the question, "Are you confident in doing mathematics, especially the advanced mathematics course?" one fourth-year student teacher answered as follows:

> S 11, M, L4: I don't think I have any problem with this.
>
> The researcher: Is that true? You seem very sure?
>
> S 11, M, L4: Because I have already done these types of course. I studied calculus A and B and Algebra. The information and the assessment do not vary from the high school mathematics. I believe this should make the students in this major confident in doing mathematics, even the hard and advanced mathematics courses. I like this type of course. It makes me think carefully and try to use new methods.

Another third-student teacher said:

> I do believe that in this stage I'm positive in doing mathematics and capable of obtaining good grades in these courses. (S 2, F, L 3)

If we may generalise from the above statements, we may say that students in the second year of their college study have less confidence in learning mathematics than do the fourth-year student teachers. The fourth-year student teachers felt that in this stage their study in the mathematics courses helped them increase in confidence, whereas second-year student teachers felt the opposite for many different reasons which they mentioned.

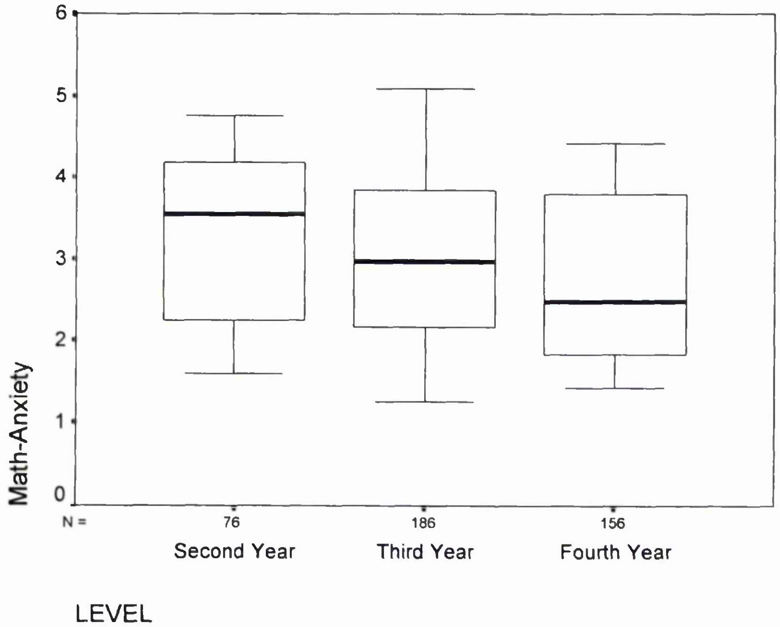
This, indeed, is supported by the statistical results. For example, there is a great difference in these student teachers' mean scores on the mathematics anxiety scale. Using the 5-point scale referred to earlier, the student teachers' attitudes varied from one class level to another. Accordingly, the mean score of second-year students was 3.22, that of third-year students was 3.02, and 2.70 was the mean score of fourth-year students. The effect size between the fourth year and the second year is .54. These clear differences indicate that in their final year student teachers are less anxious about their ability in doing mathematics.

In this major the student teachers are required to complete at least eight mathematics courses. The four instructors mentioned that these courses increase the student teachers' confidence in doing mathematics and help them to learn more about mathematics.

So, from the statistical results and the interview data, we can conclude that the fourth-year students are more confident in learning mathematics than are those in the second year. Also, as the chi-square test results reported in section 7.1.1 indicated, there is an association between the class level and age variables. For example, the mature students who are in their later years in college are less mathematics anxious than younger students, such as those are in the second year. As Leder (1992) noted with regard to the work of Fennema-Sherman (1977, 1978), the older females' being confident about doing mathematics was a good predictor of achievement. In this study the finding also points to the fact that mature student teachers, both males and females, are more confident in mathematics and less anxious than the younger student teachers. This result helps us to answer the question posed at the beginning of this section, since it indicates a class level in which student teachers' confidence and anxiety is affected. This being so, educators need to focus more on the needs of this specific level and try to free them from this anxiety.

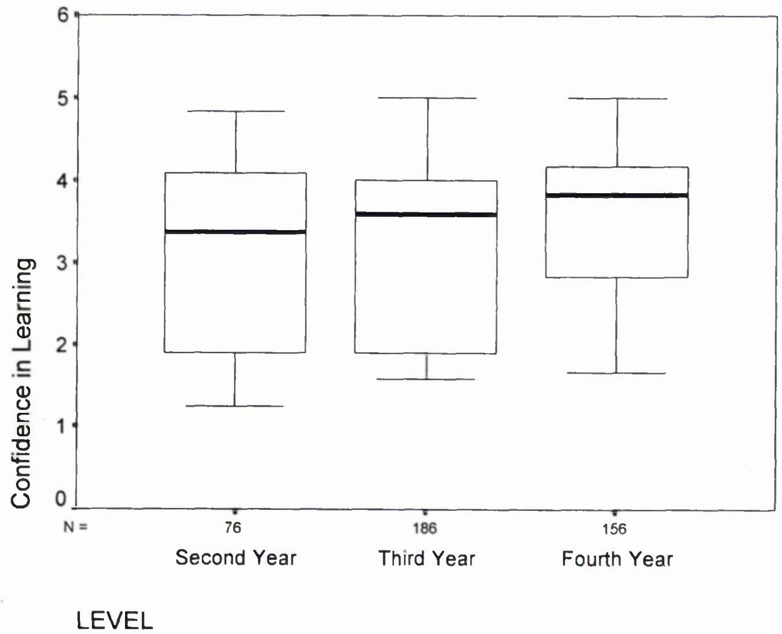
The following figures depict these results more clearly. The figures represent the mathematics anxiety and confidence in learning mathematics scales and the class level variable.

Figure 7.1: Estimated Marginal Means in the Comparison between the Mathematics Anxiety Scale and the Class Level Variables.



N= The number of the student teachers' sample according to class level.

Figure 7.2: Estimated Marginal Means in the Comparison between the Confidence in Learning Mathematics Scale and the Class Level Variables.



N= The number of the student teachers' sample according to class level.

The next scale, the mathematics usefulness scale, was designed to measure students' attitudes towards the usefulness of mathematics both currently and in relation to their future education or other activities. The mean scores in this scale ranged from 4.7 to 4.9, indicating that the sample in this study throughout the different class levels strongly agreed that mathematics was useful in their lives. Thus, Table 7.10 shows there is an insignificant result between the usefulness of mathematics scale and the class level variable.

Table 7.10: The Mathematics Usefulness Scale's Mean Scores and Standard Deviations for Student Teachers by Class Levels

Class Level	N	Mathematics Usefulness	
		Mean	S.D.
Second Year	76	4.07	.72
Third Year	186	4.09	.70
Fourth Year	156	4.08	.73

N=418

From the interview data with 16 student teachers in different class levels and 4 instructors, all of them seemed to agree concerning the importance of mathematics in their lives. In fact, the majority of student teachers showed a lot of zeal about the usefulness of mathematics in their future work as teachers or employees. As one young student teacher said,

> No one argues that mathematics is not one of the most important fields in the world. (S 5, F, 2)

This positive attitude toward the usefulness of mathematics should encourage the student teachers to teach mathematics with good motivation. As Fennema (1990: 174) commented,

> If teachers believe that mathematics is useful… it seems reasonable to assume that they will work harder to ensure that their students learn mathematics.

Furthermore, if a teacher has a positive attitude toward a particular subject, she or he will transfer it to other students and encourage other people. As Lazarus (1974) mentions, the attitudes of teachers and their feelings about mathematics are far more important than their actual knowledge. This is clearly the case since what student teachers feel about mathematics will certainly affect the way they teach the subject to their pupils. More details about this relationship between the usefulness of mathematics scale and the confidence in learning mathematics scale will be included in section 7.3.2.

One of the aims of this study is to know whether the Kuwaiti student teachers feel that mathematics is either a male or female domain. The male domain scale is the next variable to consider. Fenemma-Sherman defined 'male domain' as the degree to which students see mathematics as a male, neutral, or female domain in the following ways: a) the relative ability of the sexes to perform in mathematics; b) the masculinity of those who achieve well in mathematics; and c) the appropriateness of this line of study for each of the two sexes.

Table 7.11 shows scores on the male domain scale for the different class levels. The statistical results indicate no major difference, but they do indicate that student teachers in the fourth year are more in agreement than are the second-year student teachers, because the mean score for the second-year student teachers is 3.64, which is lower than that of the third-year student teachers (3.76) and that of the fourth-year student teachers (3.86). Also, the effect size between the second and fourth years is .24. The reason for this statistical result may be the effect of single-sex schools in Kuwait since, while second-year pupils do not work with the other sex, by the time they work together more, as in the fourth year, their attitudes begin to increase in intensity.

Table 7.11: The Male Domain Scale's Mean Scores and Standard Deviations for Student Teachers by Class Levels

Class Level	N	Male Domain	
		Mean	S.D.
Second Year	76	3.64	.98
Third Year	186	3.76	.94
Fourth Year	156	3.86	.85

N=418

From all the above results we can summarise that the student teachers in the last year of their studies have more confidence in mathematics and are less anxious. But all the class levels agree on the importance and usefulness of mathematics in their future education and other activities in their daily life.

7.2.2 Comparison of the MAS Sub-Scales with the Gender Variable

Using the t-Test and ANOVA test, our aim is to answer the following questions in section 1.3.2:

> Q2: To what extent will gender influence student teachers' attitudes toward mathematics?
>
> Q3: Does one gender score more highly in math-anxiety, confidence in mathematics, or other areas measured in the MAS?

Findings indicate that males are more confident and less anxious in learning mathematics than are females. A good many researchers, for example Fennema and Tartre (1985), Battista (1990), Leder (1982), and Hembree (1990), have discussed the gender issue in mathematics. Various areas of mathematics and different contributing factors have been examined in these studies.

In Hembree's study (1990) the findings were in accord with the present study's result. In his study, Hembree found that significant gender differences with regard to anxiety and confidence appeared among junior and senior high school students. He suggested the following reasons for these gender differences:

> This paradox may be explained along two lines: 1) female students may be more willing than males to admit their anxiety, in which case their higher levels are no more than a reflection of societal mores; 2) females may cope with anxiety better. Whatever the cause, at pre-college levels mathematics anxiety effects seem more pronounced in male than in female students (p.45).

This observation that females may be more willing to admit their anxiety than males needs to be borne in mind in interpreting the finding of this study that males are more confident and less anxious in learning mathematics than are females. In addition, Kelly and Tomhave (1985) posited that a high proportion of primary student teachers were 'math-anxious', and that primary student teachers, the majority of whom were women, may have perpetuated 'math-anxiety' with young girls in their classrooms.

In another study, undertaken by Olson and Kansky (1981), they found that the number of mathematics courses taken at the pre-college stage, as well as the highest level of mathematics achieved, varied with the sex of the student. While males generally took more mathematics courses and reached higher levels of achievement than did females, the differences were most pronounced in the largest school.

Also, the stereotyping of and social influence on females tend to make them less confidant in learning mathematics. In Table 7.12 the higher the score, the higher is the level of anxiety in learning mathematics, while in the last columns the lower scores indicate less confidence in learning mathematics. The effect size for the mathematics anxiety scale is .23 and for the confidence in learning mathematics it is .25.

Table 7.12: Mean Scores and Standard Deviations for Student Teachers in the Mathematics Anxiety and Confidence in Learning Scales by Gender

Gender	N	Mathematics Anxiety		Confidence in Learning	
		Mean	S.D.	Mean	S.D.
Male	147	2.80	.90	3.44	.98
Female	271	3.02	.96	3.18	1.05
t-Test	418	.022*		.014*	

N=418

From this statistical result we notice that the student teachers in the Kuwaiti environment produce similar results to those of student teachers in other environments, like the USA and other countries. It should be borne in mind, however, that in Kuwait girls' education began later and that boys have much more chance in their education, including mathematics learning. This may be one factor affecting females' confidence in learning mathematics.

Some other studies support the above results. Thus, Leder (1992) reported how the link between confidence and achievement in mathematics has been examined in a number of studies, especially that of Fennema-Sherman, who found that male students consistently showed greater confidence in their ability to do mathematics than did their female classmates, which accords with what we found with regard to the student teachers in the present study. Moreover, in Mura's (1987) investigation of differences in level of confidence, career plans, and gender among college students, she found that women tended to be less confident than men and that fewer women than men planned to take advanced mathematics.

Since interview data illustrate how a sample feels and reacts to the researcher's questions, in order to detect any further information, the interviewed student teachers were asked to give their opinion on this matter. In the four groups that I interviewed, 6 of the interviewees were males and 10 were females. Generally speaking, in the discussion about their confidence in learning mathematics, I noticed that the males seemed to express their confidence in their ability more immediately and directly than did females. Although some female student teachers tried to assert their confidence in learning mathematics, most of them appeared to be less confident. As one female student teacher explained,

> I chose this major because of the few requirements of the advanced mathematics courses. I like mathematics, but not other advanced courses and I am very worried about Calculus B. I'm not the type of student who scores well in mathematics. (S 3, F, L3)

Another female student teacher agreed with this statement and said,

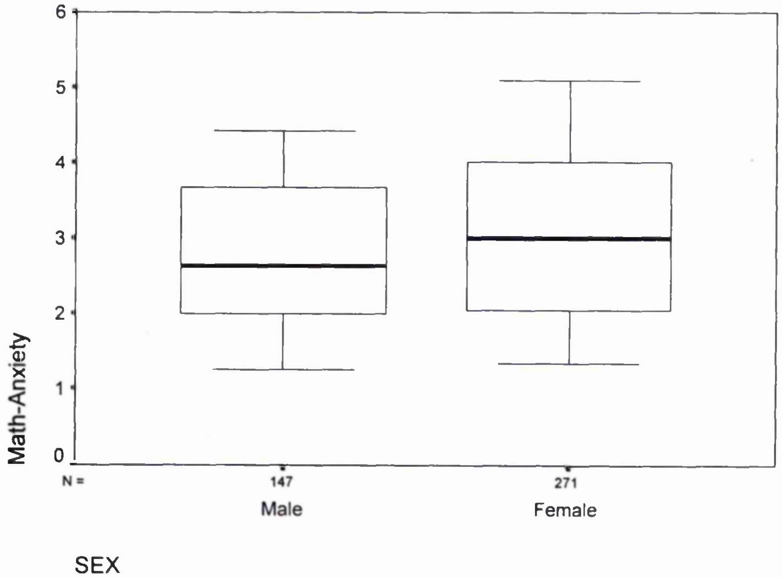
> You know that we will teach children in the primary level. I enjoy learning the basics and the foundation of mathematics, not the difficult topics in mathematics, I mean the advanced mathematics. I cannot deal with it. (S 13, F, L 2)

We notice that these two female student teachers tried to tell me that they liked and enjoyed basic mathematics but admitted that they were not good in the advanced mathematics. On the other hand, one of the male student teachers expressed his confidence in learning mathematics and asserted that this was one of the reasons that he chose this major:

> I think the main reason why I chose this major is my liking for mathematics itself. I have not generally worried about being able to solve mathematics problems or learn mathematics. Even when I was in high school I always had good marks in mathematics courses. I think mathematics has a strong relation with our lives in the trading market especially as we males always work and use mathematics in our families' companies or in our work when I worked in the summer job. (S 4, M, L2)

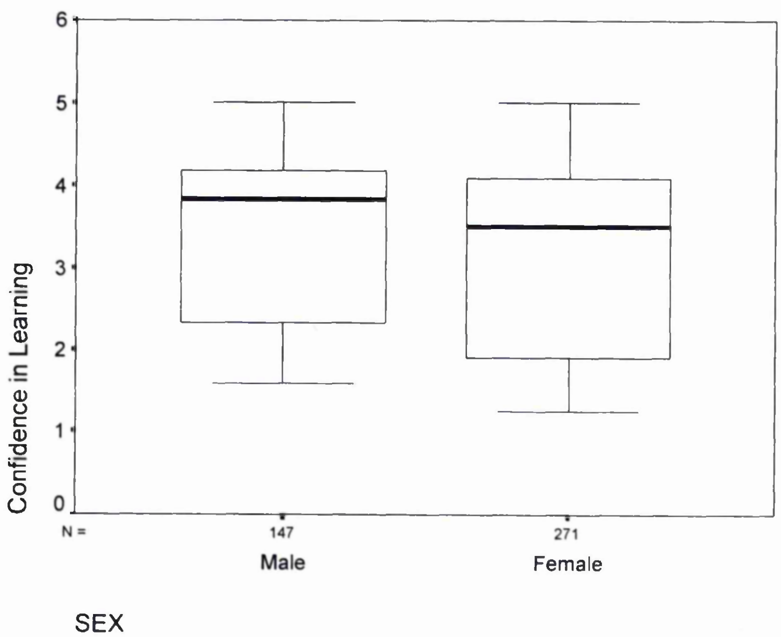
The above responses from these student teachers generally support the statistical results, which point to the fact that males are more confident and less anxious in learning mathematics than are females. The following two figures depict more clearly this relationship between these two scales and the gender variable.

Figure 7.4: Estimated Marginal Means in the Comparison between Mathematics Anxiety and Gender Variables.



N= The number of the student teachers' sample according to gender.

Figure 7.3: Estimated Marginal Means in the Comparison between Confidence in Learning Mathematics and Gender Variables.



N= The numbers of the student teachers' sample according to gender.

The next scale measures students' beliefs about the usefulness of mathematics currently and in relation to their future education, vocation, or other activities. Table 7.13 shows the usefulness scale scores, indicating that both sexes strongly agreed that mathematics was important in their future education and other activities. There was no great difference in the mean scores, indicating that there are no significant differences in this scale.

Table 7.13: Mean Scores and Standard Deviations for Student Teachers in the Usefulness of Mathematics Scale by Gender

Gender	N	Mathematics Usefulness	
		Mean	S.D.
Male	147	4.07	.70
Female	271	4.08	.72
t-Test	418	.895	

N = 418

As previously mentioned, almost all of the groups interviewed agreed on the importance of mathematics in their future lives. They studied mathematics because they knew how useful it is and this supports the above statistical result.

We next examine the male domain scale in the MAS according to the gender variable. This scale is designed to measure the degree to which students see mathematics as a male, neutral, or female domain. The mean scores in Table 7.14 indicate that females are in greater agreement than males in this scale, which means that females agree that both sexes are equal in this field. We also notice that the effect size in this scale is .43.

Table 7.14: Mean Scores and Standard Deviations for Student Teachers in the Male Domain Scale by Gender

Gender	N	Male Domain	
		Mean	S.D.
Male	147	3.52	.87
Female	271	3.91	.91
t-Test	418	.005*	

N=418

Leder (1992) noted that a large number of explanations have been put forward to account for the observed gender differences in mathematics learning. For example, the emphasis on the social environment, the influence of significant people in that environment, students' reactions to the cultural and more immediate context in which learning takes place, the cultural and personal values placed on that learning, and the inclusion of learner-related affective, as well as cognitive, variables have all been cited to account for this gender difference.

Therefore, in the context of the present study, we should consider that in Kuwait the male and female students study together for the first time at college level. Before college level they usually study in single-sex schools. This factor may have affected the females' responses graded in this particular scale as, before this stage, females study in Kuwaiti schools were not compared with male students by their teachers in the pre-college classes. From my experience, in some countries, for example the UK and the USA, both sexes of students study in the same school and there is a comparison between these two sexes in the class, especially in mathematics. This may encourage their positive opinion regarding females and mathematics.

In interviews with student teachers there was much argument by both sexes about this theme. Several male student teachers believed that mathematics, especially advanced mathematics, was primarily a male domain and observed that most mathematicians were males although nowadays females have their special position in mathematics. Also, female student teachers who were interviewed agreed that females were equal to the other sex and were not behind males in this subject, citing as evidence the fact that all the mathematics teachers in Kuwait were females in the girls' schools as well as in boys' primary schools. As one young female said,

> I know in our society women have less opportunity of presenting themselves in some areas because of religious reasons, but that does not mean that we are behind the men in mathematics. (S 5, F, L 2)

Another, a male student teacher, agreed by saying,

> It is not fair to say that we as men think or behave differently. If you look back at the high school results, you find that females are most likely to win good grades like us. But I think most women in Kuwait stay at home after finishing high school for a social reason. Even if they continue their college degrees, they prefer to be teachers rather than do other jobs. (S 11, M, L 4)

In this section we have considered the sub-scales in the MAS against the background variables. The following section will clarify the correlations between the sub-scales in the MAS and answer some of the questions posed in this study. Some of the correlations appear to be significant.

7.2.3 Findings Concerning the Relationship between the Scales in the MAS

Hinkel (1979) classified the numbers in the correlation into weak, moderate, and high according to the respective ranges 0-. 39, .40- .69, and .70- 1.00. This is not a rule to follow, but a way to organise this correlation. The results of a Pearson correlation coefficient test indicated a correlation coefficient between these scales, in the form of highly significant negative and positive correlations between these scales, as shown in Table 7.15.

Table 7.15: Correlation Coefficients between the MAS' Sub-scales

Sub-Scale	Math-Anxiety	Confidence in Learning	Male Domain	Mathematics Usefulness
Math Anxiety	.	-.718**	-.127**	-.282**
Confidence in Learning	.	.	.098*	.323**
Male Domain	.	.	.	.192**
Mathematics Usefulness	.	.	.	.

** Significant at the 0.01 level
* Significant at the 0.05 level

From the above table we notice that the confidence in learning scale has a high negative correlation of -. 71, $p< 0.01$ with the mathematics anxiety scale. This suggests that where there is confidence in learning mathematics, mathematics anxiety will be low. Because of this correlation, section 7.2 explored more about these two sub-scales with the background variables. The first null hypothesis (H 1), that "there is a relationship between the confidence in learning scale and mathematics anxiety", was accepted at the 0.01 level of significance. Thus, there is a significant relationship between the confidence in learning scale and the mathematics anxiety scale. Many studies agree with this result.

In addition, the confidence in learning scale has a low positive correlation with one of the sub-scales of the MAS, that is, the usefulness scale. A Pearson correlation coefficient test showed a correlation between the confidence in learning scale and the usefulness scale of .323, $p< 0.01$. On the other hand, the confidence in learning scale showed a very low positive correlation with the male domain scale, one of .09, $p< 0.05$.

The results of tests between the mathematics anxiety scale and the other sub-scales showed negative low correlations, namely, with the usefulness scale -. 28, $p< 0.01$, and a very low negative correlation with the male domain scale -. 12, $p< 0.01$. Thus, the null hypothesis (H 3), that "there is no relationship between the mathematics anxiety in learning scale and the usefulness scale, and male domain scale in the MAS", was rejected at the 0.01 level of significance. Thus, there is a significant relationship between the mathematics anxiety scale and the other scales. This correlation is negative, meaning that whenever anxious attitudes appear there are concurrent negative attitudes toward knowing the usefulness of mathematics in future life and the equivalence between male and female. Nevertheless, the usefulness of mathematics scale showed a low positive correlation with the male domain scale.

7.3 The Findings of the Teaching Mathematics Attitudes Scales (TMAS)

In this section, I will explore the findings of the TMAS. As was mentioned in Chapter Six, they contain four sub-scales, covering respectively the 'mathematics teaching anxiety scale', the 'confidence and enjoyment in teaching mathematics scale', the 'desire for recognition scale', and the 'pressure to conform scale'. First, the results will represent the relation between the first two, the 'mathematics teaching anxiety scale' and the 'confidence and enjoyment in teaching mathematics scale', and then these two scales will be considered in connection with the background variables. A similar method will be adopted in treating the last two scales: the 'desire for recognition scale' and the 'pressure to conform scale'. Depending on the results of a Pearson correlation coefficient test, the researcher decided to pair the first two scales and the other two scales together, the reasons for which the following sections will explain.

The responses of the student teachers were coded from 1-7 in the TMAS, where the 'strongly agree' end of the scale scores 7 points and the 'strongly disagree' end scores 1 point. These scores were subjected to computer analysis using the Statistical

Package for Social Sciences (SPSS). The tables in this section contain the results of the statistical analysis, offering, for example, means, correlation coefficients, t-Test, and ANOVA results.

7.3.1 Findings Concerning the Relationship between the Mathematics Teaching Anxiety Scale and the Confidence and Enjoyment in Teaching Mathematics Scale

The result of a Pearson correlation coefficient test indicated a correlation coefficient between the mathematics teaching anxiety scale and the confidence and enjoyment in teaching mathematics scale of -. 49, $p < 0.01$. This indicates a moderately significant negative correlation between the teaching anxiety scale and the confidence and enjoyment scale. Put simply, the more confidence student teachers have in teaching mathematics, the less anxious they are in teaching mathematics. The second null hypothesis (H 2), that "there is no relationship between anxiety and confidence and enjoyment in teaching mathematics", was rejected at the 0.01 level of significance. Thus, there is a statistically significant relationship between anxiety and confidence and enjoyment in teaching mathematics. Some other studies agree that there is a negative relationship between confidence and anxiety.

Because these two scales have this relationship, we next explore them in connection with the background variables. These two important scales have interesting results in connection with the background variables of class level, gender, and age, which are particularly relevant for the present study.

7.3.1.1 The Background Variables' Effects on Student Teachers' Attitude toward Teaching Mathematics

The data findings concerning the mathematics teaching anxiety scale and the confidence and enjoyment in teaching mathematics scale and other sub-scales, under the TMAS, assist in finding answers to the following questions in this study:

Q 2: To what extent will class level, gender, and age affect student teachers' attitudes toward teaching mathematics?

Q 3: Is there a certain class level, or gender that experiences more mathematics teaching anxiety, or confidence and enjoyment in teaching mathematics and other sub-scale than other class levels, or the other gender?

7.3.1.1.1 Class Level Effects on Student Teachers' Attitude toward Teaching Mathematics

First, the data findings have important results in connection with class level. For example, by using a one-way ANOVA, the statistical finding of this study is that student teachers in the final year at college experience more confidence and enjoyment in teaching mathematics and less anxiety in mathematics teaching than do students in second year. The effect size for the confidence and enjoyment in teaching mathematics scale between the fourth and second years is .31. This might stands to reason, since student teachers in this particular stage of their training have more experience and have studied more mathematics teaching courses, all helping to increase their confidence in teaching.

Table 7.16 reports the means and standard deviations for the mathematics teaching anxiety scale and the confidence and enjoyment in teaching mathematics scale scores, against the class level variables. A low score indicates low mathematics teaching anxiety, while a high score indicates greater confidence and enjoyment in teaching mathematics.

Table 7.16: Anxiety and Confidence and Enjoyment Scales' Mean Scores and Standard Deviations for Student Teachers by Class Levels

Class Level	N	Mathematics Teaching Anxiety		Confidence and Enjoyment in Teaching	
		Mean	S.D.	Mean	S.D.
Second Year	76	3.53	1.20	4.73	1.43
Third Year	186	3.37	1.14	4.99	1.25
Fourth Year	156	3.13	1.15	5.14	1.21

N = 418

In a study conducted by Ludlow and Bell (1996), they noted that at the beginning of the semester the students came to the course in the college with a generally negative attitude toward all aspects of mathematics and the teaching of it. Once the course began, the students began to differentiate more clearly between what really made them uncomfortable and those aspects of mathematics with which they could feel more confident, particularly in the teaching of mathematics. With regard to the sample of this study, these types of course are taken by the student teachers.

The evidence gathered from the interviewees was to the effect that the majority of them showed confidence. Interviews were conducted with 6 student teachers in their second year, 5 in the third year, and 5 in the fourth year. Focusing on the class level variable, we noticed that the majority of the 6 student teachers in their second year showed anxiety about teaching mathematics. One female second student teacher said,

> I am always thinking about the time after I become a teacher. I think it will be a hard job: you know, preparing the lessons, making sure that all the pupils in my class understand the lesson, and so on. (S 13, F, L 2)

In the same focus group another female second-year student teacher interrupted, saying,

> I disagree with your opinion. I agree that becoming a teacher is an important and very responsible job, but I think that studying more about the best way to teach and practise will help us. Also, the most important factor helping you to enjoy teaching is your desire to be a teacher. (S 14, F, L 2)

This second-year student teacher introduced a different reason to be confident and experience enjoyment in teaching mathematics. In addition, most of the third-and fourth-year student teachers who were interviewed agreed that the more mathematics teaching courses they studies, the more confident in teaching they would become. This naturally tends to mean that they acquire the greatest degree of confidence in teaching mathematics by their last year in the college. The following statements, made by student teachers, support this view.

> I prefer to learn more about teaching mathematics methods rather than just about mathematics, because it will help me in the future work and give me the encouragement to teach well in mathematics. Really, I enjoy teaching, especially mathematics. In this course the instructor gives us a lot of examples in teaching this subject, the different styles in teaching mathematics. He teaches me how to prepare lessons and use different kinds of materials and methods in teaching. (S 2, F & L3)

Another student teacher commented:

> We need more teaching mathematics methods courses and observation in school, because this encourages and helps us in the next stage, which is teaching and working. I like this particular course because it includes both mathematics and teaching mathematics. It is nice to connect these two things. For example, he gives us a project to plan a whole lesson and demonstrate in front of the class and discuss each step. That will make me confident in the real life situation. (S 7, F & L4)

The words of one student teacher, supporting this result, were:

> That makes teaching mathematics easier. That gives us confidence in knowing higher mathematics. The more knowledge of mathematics you have, the more positive and certain in teaching you will be. Before I took this course I was worried about teaching mathematics to children but now, after I have taken the teaching methods course, I think mathematics is an easy subject to teach to children. I don't have any doubt about my ability in teaching mathematics. (S 11, M, L4)

In addition, from the student teachers' answers we can notice that different factors increase their confidence in teaching mathematics, for example, the student teacher's desire to become a teacher; mathematical knowledge; the mathematics teaching methods course, which gives them a lot of ideas about methods in teaching mathematics and about activities in constructing a lesson; and group work and discussion about different issues in teaching mathematics at the primary level. From my observations of the four classes in the College of Education, I noticed that the student teachers liked these kinds of activities and that they were very active and enjoyed working in group discussions, as the following extract from an interview with one of the instructors illustrates:

> At the beginning and the ending of the course I usually give my students open-ended questions in order to gain some information about the student teachers in my course and about what they like and what dislike and they expect to learn from this course, and to evaluate my course. One of the questions asks them whether they like teaching mathematics. Most of them change their opinion about teaching this subject by the end of the course. (I 4, F)

Class levels are confounded with the age variable as Table 7.3 explained, on account of the fact that students in Kuwait enrol in college immediately after they graduate from high school and Kuwaiti regulations do not allow them to work, so that they have to choose between working and studying. The natural result of this is that mature student teachers are normally those in the fourth year of study and these mature student teachers exhibit greater confidence and enjoyment in teaching mathematics and, conversely, less anxiety than do the students in other age groups. This suggests that the mature student teachers have experiences which can support their confidence and provide enjoyment in the context of teaching mathematics to children. The student teachers aged from 17 to 20 have come directly from high school or are in their earlier years in the college, and so they are probably less experienced than the older student teachers, besides being still anxious about their new experience as students in a college of education, as indeed is supported by the interview data. We may compare two of the student teachers whom I interviewed. One of them was a 19-year-old female student in level 2, while the other was a female student in level 3 in her mid 30s who had been working as a teacher for four years. When I asked them about their confidence and enjoyment in teaching mathematics, the fourth-year student teacher said,

> I worked as a teacher for four years and I'm willing to continue my degree as a mathematics and science teacher at the primary level. I adore teaching, I really enjoy teaching mathematics. My experience helps a lot. But this kind of major will help me to be a specialist in teaching mathematics to children, especially the mathematics teaching methods courses. (S 16, F, L4)

On the other hand, the student in her second year answered,

> I like this future job but I feel it is difficult to teach. I saw how my high school teacher worked hard in teaching us mathematics. But maybe teaching younger children will be easier than high school pupils. I'm sure in this college they will help us to be less afraid than we are now. They will give us the opportunities to acquire knowledge and learn about teaching style and different ways of teaching mathematics at the primary level. (S 9, F, L2)

The interview data showed that these answers reflect how the experiences of the mature student teachers who are in their last year in college play an important role in their confidence and enjoyment in teaching mathematics. This means that the class level and age variables influence the student teachers' confidence and enjoyment and their anxiety in teaching mathematics.

With regard to the next scale, 'the desire for recognition scale', Nisbet (1991) mentioned that this scale is similar to the attitude toward success in mathematics scale in the Fennema-Sherman scales. This scale deals with the student teachers' desire to be recognised by other people in future as good teachers. On the other hand, the pressure to conform scale deals with the student teachers' feelings of distaste at being noticed or observed by other people in the way he or she teaches mathematics.

Differences in the level of student teachers' attitudes towards desire for recognition and pressure to conform, as measured in the TMAS, were tested statistically by a one-way ANOVA. The mean scores on this scale are shown in Table 7.17. These results indicate that the effects of class level on student teachers' desire for recognition and pressure to conform are clearly insignificant.

Table 7.17: Desire for Recognition and Pressure to Conform Scales' Mean Scores and Standard Deviations for Student Teachers by Class Levels

Class Level	N	Pressure to Conform		Desire for Recognition	
		Mean	S.D.	Mean	S.D.
Second Year	76	4.58	1.75	6.46	.92
Third Year	186	4.09	1.73	6.35	1.07
Fourth Year	156	4.22	1.86	6.40	1.10

N = 418

7.3.1.1.2 Gender Effects on Student Teachers' Attitude toward Teaching Mathematics

The results of the mathematics teaching anxiety scale and the confidence and enjoyment in teaching mathematics scale, under the TMAS, show significant variation with regard to gender. Using the t-Test, the findings indicate that males experience greater confidence and enjoyment and are less anxious in teaching mathematics than are females. In Table 7.18, the higher the score, the higher is the level of anxiety in teaching mathematics, while the lower scores indicate lower confidence and enjoyment in teaching mathematics. For the mathematics teaching anxiety scale the effect size is ES= .19, and for the confidence and enjoyment in teaching mathematics scale it is ES= .29. We have to take into account the fact, stated before, that males are less willing to admit their anxiety.

Table 7.18: Anxiety and Confidence and Enjoyment Scales' Mean Scores and Standard Deviations for Student Teachers by Gender

Gender	N	Mathematics Teaching Anxiety		Confidence and Enjoyment in Teaching	
		Mean	S.D.	Mean	S.D.
Male	147	3.16	1.14	5.24	1.21
Female	271	3.39	1.17	4.87	1.29
t-Test	418	.059		.004*	

N = 418

Data from the interviews with the 4 instructors in the two colleges for education in Kuwait provide us with another vantage point from which to look at this particular attitude. The researcher asked them if there was any difference between female and male student teachers in their confidence and enjoyment or in their anxiety about teaching mathematics. Two of them affirmed that there was. The following statement is an example of one of these instructor' opinions on the subject:

> I 1, M: From my experience I notice that the males are more confident in teaching mathematics as a subject.
>
> The researcher: Could you explain more about that?
>
> I 1, M: I mean that males are confident in explaining the concept of any mathematical information, using their own mathematical knowledge, while females spend a lot of time in showing and explaining certain mathematical information.
>
> The researcher: Does that mean women are less confident for this reason?
>
> I 1, M: In some way, I mean that males are confident in teaching mathematics problems in simple ways, but women try and spend time to prepare lessons that help them to make sure that they get the information for young pupils and follow the Ministry's curriculum. This, in my opinion, makes women good teachers. You may even notice that fewer males enrol in the primary major and prefer teaching the secondary major.

On the other hand, one male instructor disagreed with this view and expressed his opinion as followings:

> I 2, M: In my career in teaching student teachers the mathematics teaching methods, I found that there is no difference between males or females in their ability in teaching mathematics. We know that there is an individual difference between one person and another no matter what their gender.

> The researcher: What are these differences in your opinion?
>
> I 2, M: If there is a difference in teaching this subject it will refer to their knowledge, their personality. In most of the industrial countries around the world, teachers at the primary level are females. I never think that males are anxious or not anxious in teaching mathematics. In teaching them the teaching style or methods, I bear in mind that these are the future teachers. For example, in my course I do my best to persuade them that they are able to be good teachers, using their ability in teaching pupils mathematics by employing a lot of activities in this class. I think these activities contribute to their understanding by their discussing a variety of issues and working them out themselves.

On the other hand, interviewee I 3 expressed the opposite opinion, as the following indicates:

> I 3, M: You know, I think women are more confident in teaching mathematics at the primary level.
>
> The researcher: How is that?
>
> I 3, M: I know that females are more embarrassed and nervous than males in the presentation, but that doesn't make them feel they don't have enough experience to be perfect in teaching this subject. Women are more patient in teaching young pupils and very responsible in thinking hard how to introduce and prepare the lessons.

Clearly then, there are different opinions on this issue, as is indicated by the instructors' responses. But the majority agrees the trend that these are difference between the genders in teaching mathematics. As we have seen, two instructors agreed that males are more confident than female; but another remarked how females demonstrate their confidence by spending time preparing their lessons. Also, even though I 3 seems to disagree, he does mention that women feel nervous in teaching mathematics.

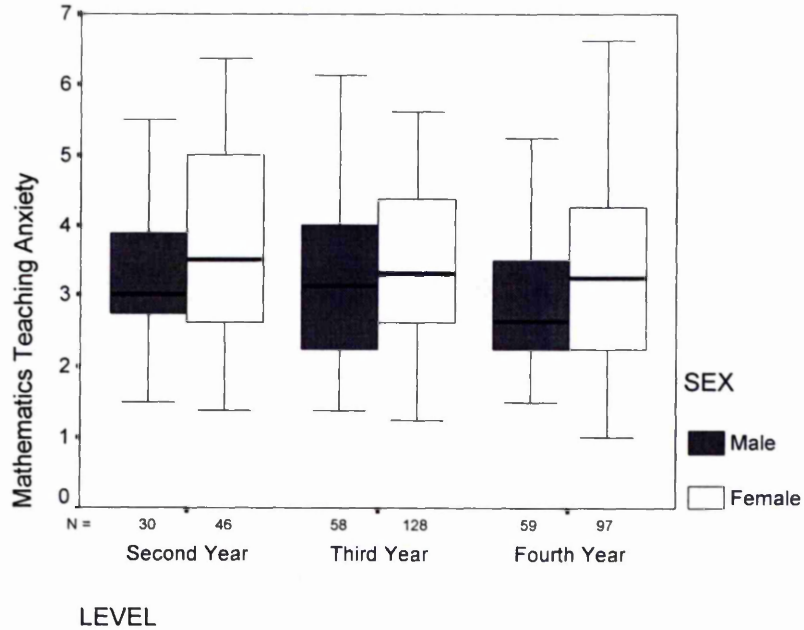
The student teachers' interview data indicate that females enjoyed the idea of teaching children mathematics but they were very concerned about their ability and confidence in teaching mathematics. They were very anxious about the proper way and the right style for teaching mathematics, as is reflected in the following student teacher's comments:

> When I think about the time after graduation and being a mathematics teacher, I am nervous. I know that teaching children is an enjoyable job, but mathematics is a difficult subject to teach. I'm worried about ensuring that my students understand and gain the basic mathematical knowledge that they should know at their age. (S 3, F, L3)

One of the focus groups, which involved three male student teachers, agreed that there was no reason at all to be anxious or worried about teaching, especially mathematics, because, they observed, mathematics is a subject that could be taught through a variety of activities. Also, as they were confident in mathematics, they felt they would be just as confident in teaching mathematics. This will be discussed later when considering the relation between attitudes toward mathematics and the teaching of mathematics. The interview data with the student teachers reinforced the finding from the instructors' interviews, which indicated that the majority of students teachers felt confident in teaching mathematics, although when focusing on gender, we found that females were anxious about whether they would be able to teach children mathematics.

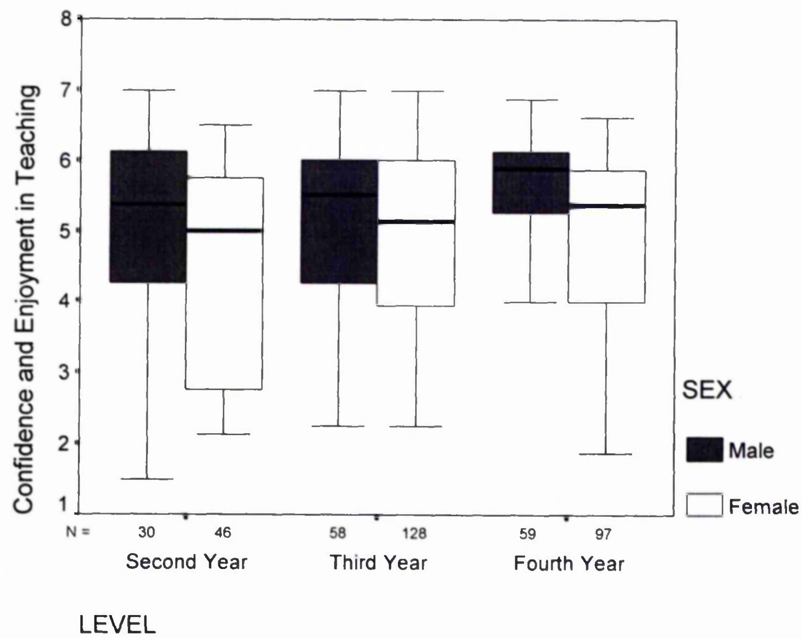
The next two figures show the above results more clearly. The scale is arranged on a seven-point Likert scale from 'strongly agree' to 'strongly disagree', with 'strongly disagree' scoring 1 point and 'strongly agree' scoring 7 points. Thus, males exhibit less anxiety but more confidence and enjoyment in teaching mathematics than do females in this scale. However, the student teachers in the fourth year are less anxious and more confident than second-year student teachers.

Figure 7.5: Estimated Marginal Means in the Comparison between Mathematics Teaching Anxiety and Class Level and Gender Variables.



N= The number of the student teachers' sample according to gender by class level.

Figure 7.6: Estimated Marginal Means in the Comparison between Confidence and Enjoyment in Teaching Mathematics and Class Level and Gender Variables.



N= The number of the student teachers' sample according to gender by class level.

Next, the results of the desire for recognition scale under the TMAS show insignificant variation with regard to gender. Using the t-Test, we notice that the desire for recognition scale the effect size is ES= .08, indicating that there is no effect of the gender variable on this scale. On the other hand, we notice the pressure to conform scale under the TMAS, show a significant variation. The statistical findings indicate that males are under more pressure to conform in teaching mathematics than are females. In Table 7.19, for example, the higher the score, the higher is the level of pressure to conform. For the pressure to conform scale the effect size it is ES= .37.

Table 7.19: Desire for Recognition and Pressure to Conform Scale's Mean Scores and Standard Deviations for Student Teachers by Gender

Gender	N	Desire for Recognition		Pressure to Conform	
		Mean	S.D.	Mean	S.D.
Male	147	6.33	.99	4.65	1.65
Female	271	6.42	1.09	4.00	1.82
t-Test	418	.401		.005*	

N = 418

From information gathered during the interviews with student teachers, it appears that female student teachers are more likely to seek recognition by others than are the males. As one female student teacher said,

> Everybody likes to be appreciated in his or her work. Especially in teaching, we as teachers will use many ways to help pupils to understand the lesson. It would be wonderful if everybody noticed that. (S 16, F, L4)

Another female student teacher said,

> I think one of the motivations in any job not just teaching is to be identified as a reliable and remarkable mathematics teacher. (S 2, F, L 3)

By contrast, almost all the male student teachers did not agree that they needed other people to encourage them or to recognise them. The following answer is an example of this view. A male student teacher emphasised,

> It is my job to teach the pupils. I don't need this behaviour from other teachers or parents. I would be very pleased if my pupils simply understood the lesson. (S 6, M, L2)

These interview data show that females are more likely to seek appreciation and recognition from other people in teaching mathematics.

7.3.2 Findings Concerning the Relationship between the Sub-Scales in the TMAS

In this section our aim is to discover whether or not there is a correlation between the sub-scales. The data and findings presented in this section therefore provide answers to question 1 in section 1.3.1 of Chapter One in this study:

Q 1: Is there a relationship between, on the one hand, either the anxiety or confidence and enjoyment in teaching mathematics scales and, on the other hand, either the desire for recognition or the pressure to conform scales?

Table 7.20: Correlation Coefficients between the TMAS' Sub-scales

Sub-Scale	Mathematics Teaching Anxiety	Confidence and Enjoyment in Teaching Mathematics	Desire for Recognition	Pressure to Conform
Mathematics Teaching Anxiety		**-.49****	**-.25****	**.24****
Confidence and Enjoyment in Teaching Mathematics			**.29****	**-.14****
Desire for Recognition				**-.09***
Pressure to Conform				

** Significant at the 0.01 level
* Significant at the 0.05 level

The answer to this question, revealed by a Pearson correlation coefficient test, indicates, first, a correlation coefficient between the desire for recognition and the mathematics teaching anxiety scales of -. 25, $p < 0.01$. This means there is a statistically highly significant low negative correlation between these two scales. Expressed generally, this means that if student teachers feel less anxiety in teaching mathematics, they will have more desire for recognition. The desire for recognition scale deals with a fundamental human need to be recognised as successful in one's career. This negative statistical relationship with the mathematics teaching anxiety scale perhaps arises because, if a student is anxious in teaching mathematics, he or she will be less willing to be recognised in his or her work.

On the other hand, a Pearson correlation coefficient test indicated a correlation coefficient between the pressure to conform and the mathematics teaching anxiety scales of .24, $p < 0.01$. This means there is a highly significant low positive correlation between these two scales. Expressed more familiarly, this means that if student teachers feel less anxiety in teaching mathematics, they are likely to feel less pressure to conform. This statistically positive correlation may be due to the meaning of this scale, in that it measures the conformity of the student teachers. Student teachers who feel anxious in teaching mathematics may be expected to feel themselves under pressure to be favourably observed by other people in their teaching of this subject.

Similar results appear in connection with the confidence and enjoyment in teaching mathematics scale. A Pearson correlation coefficient test indicated a correlation coefficient between the desire for recognition and the confidence and enjoyment in teaching mathematics scales of .29, $p < 0.01$. This means there is a highly significant low positive correlation between these two scales, indicating that if student teachers feel less confidence and enjoyment in teaching mathematics, they will have less desire for recognition. On the other hand, a Pearson correlation coefficient test indicated a correlation coefficient between the pressure to conform and the confidence and enjoyment in teaching mathematics scales of -. 14, $p < 0.01$, demonstrating a highly significant low negative correlation between these two scales. Simply put, this means that if student teachers feel less confidence and enjoyment in teaching mathematics, they will feel more pressure to conform.

Moreover, the result of a Pearson correlation coefficient test indicated a correlation coefficient between the desire for recognition scale and the pressure to conform scale of -. 09, $p < 0.05$, pointing to a significant very low negative correlation between these two scales. As was mentioned in the previous chapter, the desire for recognition scale was designed to measure the student teachers' need and desire to be recognised by other people. By contrast, the pressure to conform scale deals with the student teachers' feelings about other people's negative criticism of their mathematics teaching. In summary, it can be said that student teachers feel more pressure to conform might be less desire for recognition.

7.4 The Findings of the Beliefs about the Nature of Mathematics Scales (BNMS)

Section four will review the findings of the BNMS, which contain three sub-scales: the Platonist view scale, the instrumentalist view scale, and the problem-solving view scale. In this section, differences in the level of student teachers' beliefs across the three views on BNMS are investigated, after which they are compared against the background variables.

This scale was developed and shown to be valid at a previous stage and these developments were presented in Chapter 5. The BNMS is designed to measure student teachers' beliefs about the nature of mathematics. The student teachers' responses were coded from 1-5 in the BNMS, where 'strongly disagree' scores 1 point and 'strongly agree' scores 5 points. The results were analysed using the Statistical Package for Social Sciences (SPSS). The tables in this section contain the results of the statistical analysis, offering, for example, means, correlation coefficients, t-Test, and ANOVA results.

7.4.1 Class Level and Gender Effects on Student Teachers' Beliefs about the Nature of Mathematics

In this section our aim is to determine the variables' effect on the student teachers' beliefs about the nature of mathematics. The following questions are those which concern us in connection with these particular variables' effects on student teachers' beliefs about the nature of mathematics.

Q 1: Is there a certain class level, or gender of student teacher, which is more affected by one of the beliefs about the nature of mathematics?

Q2: What is the most accepted view about the nature of mathematics appearing in this sample?

7.4.1.1 Gender Effects on Student Teachers' Beliefs about the Nature of Mathematics

In considering the gender variable, use was made of the t-Test to determine the means and standard deviations of the 418 student teachers. We found that for the females the highest scores were for the instrumentalist view, followed by the Platonist view, and lastly the problem-solving view. On the other hand, we found that for the males the highest scores were for the problem-solving view, followed by the instrumentalist view, and lastly the Platonist view. The information in Table 7.21 presents these findings. The third column shows that the finding is significant between the problem-solving view and the gender variable. In this sample the males favoured this view more than did the females.

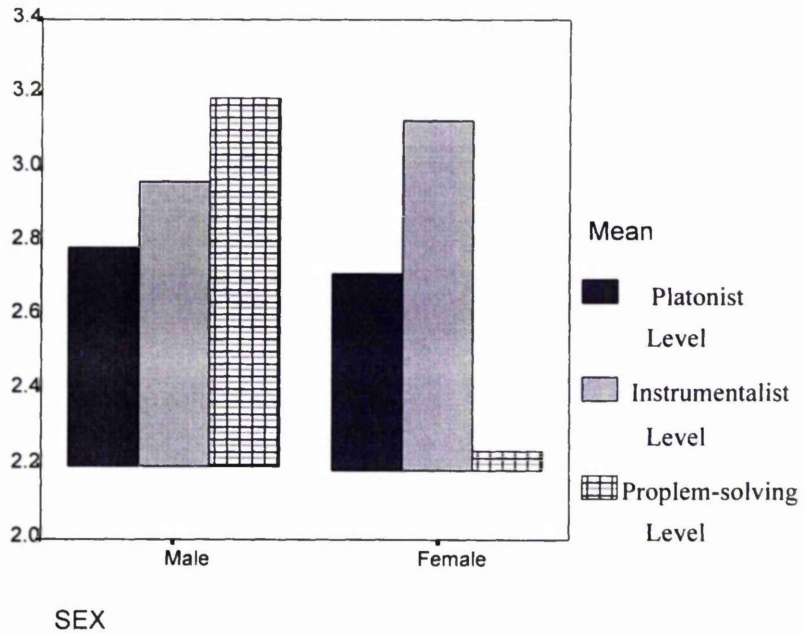
Table 7.21: Means and Standard Deviations for Student Teachers' Beliefs about the Nature of Mathematics by Gender

Gender	N	Platonist		Instrumentalist		Problem-Solving	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Male	147	2.78	1.06	2.96	.99	3.18	1.25
Female	271	2.71	1.01	3.12	1.06	2.23	1.10

N=418

The following figure depicts more clearly this relationship between these three scales and the gender variable.

Figure 7.7: Estimated Marginal Means in the Comparison between BNMS and the Gender Variable.



7.4.1.2 Class Level Effects on Student Teachers' Beliefs about the Nature of Mathematics

This section explores the class level variable against the BNMS. Table 7.23 shows the means and standard deviation scores in t-Tests of student teachers in the second, third, and fourth years of their study. The statistical results show no significant variation with regard to this variable. On the other hand, they indicate that in all three class levels the highest score was for the instrumentalist view. This may be because females outnumber males in this particular study and, as noted in the above section, more females than males favour the instrumentalist view. This is followed by the Platonist view and finally by the problem-solving view. From the result of an effect size statistical test, it would appear that the effect size between the Platonist view and the instrumentalist view scored .29 for the third year, while for the instrumentalist view and the problem-solving view it scored .48. This also means that the majority of Kuwaiti student teachers in this sample were believers in the instrumentalist view.

Table 7.22: Means and Standard Deviations for Student Teachers' Beliefs about the Nature of Mathematics by Class Level

Class Level	N	Platonist		Instrumentalist		Problem-Solving	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Second Year	76	2.934	1.03	3.33	.96	2.69	1.27
Third Year	186	2.693	1.02	2.99	1.051	2.44	1.22
Fourth Year	156	2.696	1.05	3.03	1.056	2.66	1.24

N=418

In comparing the sub-scales' results in the two variables, we notice that preference is first for the instrumentalist view, followed by the Platonist view, while the problem-solving view comes some way behind these two views in popularity. So, for example, with reference to the second class level variable (see Table 7.22), the instrumentalist view scored 3.33, the Platonist view scored 2.93, while the problem-solving view scored only 2.69. In another example, in relation to the gender variable (see Table 7.21), the female group scored 3.12 for the instrumentalist view, 2.71 for the Platonist view, and only 2.23 for the problem-solving view.

Turning now to the findings from the interviews, the majority of the sample expressed their feeling for the instrumentalist view. This was apparent from their answers to the following question: "Of the following three statements, which one do you prefer?

1. Mathematics involves continuous discussion to solve mathematical problems.

2. To find a solution to a mathematical problem, always follow the rules.

3. Mathematics is exact and there is no scope for error."

Seven out of sixteen student teachers, six females and one male, chose the statement which indicated a preference for the instrumentalist view (the second statement). In contrast, five out of sixteen student teachers, two females and three males, chose the statement indicating preference for the problem-solving view (the first statement). The researcher probed their reasons for making these choices and found that different reasons were offered in justification. One major factor was evidently the early schooling of these student teachers, as they mentioned that they were in the primary level during the 1980s, when the modern movement in mathematics was not commonly in use. As one of the students commented, "When I was in the primary school I was always told to memorise the mathematical rules." This should be recognised and borne in mind by the curriculum designers responsible for this major. The finding will be discussed in further detail in the next chapter.

Moreover, from the distribution results, we may note that two thirds (64.8 %) of the sample were females while a third (35.2 %) of the sample were males (see Table 7.23), which may have affected the overall tendency to prefer the instrumentalist view.

Table 7.23: The Distribution of the Student Teachers' Sample according to Gender

Gender	N.	Percentage
Male	147	35.2 %
Female	271	64.8 %
Total	418	100 %

To know more about these scales as they concern the student teachers' attitudes toward mathematics and its teaching, we need to locate the position of these three views in the other scales in this study. The next section will investigate this matter further.

7.5 Findings Concerning the Relationship between the MAS, the TMAS, and the BNMS

In the following sections we will try to answer the question that was introduced previously in section 1.3.2. We will use the Pearson correlation coefficient test to explore any correlation between the three scales. The Pearson correlation coefficient, r, measures the strength of a linear relationship between two quantitative variables. The correlations can be negative or positive. We will also use the multiple regression test. The particular questions addressed in this section are:

Q 1: Is there a relationship between the student teachers' attitudes toward mathematics and their attitudes toward mathematics teaching?

Q 2: Which of the sub-scales in the MAS have a strong relationship with the other sub-scales in the TMAS?

Q 3: Do the student teachers' beliefs about the nature of mathematics have a significant relation with their attitudes toward mathematics and teaching mathematics?

Q 4: Is student teachers' confidence and enjoyment in teaching mathematics affected by their confidence in learning mathematics or by one of the three views about the nature of mathematics?

7.5.1 Findings Concerning the Relationship between the MAS and the TMAS

The data and results of the analysis, presented in this section, may be used to help answer the question about the relationship between the student teachers' attitudes toward mathematics and their attitudes toward mathematics teaching. A Pearson correlation coefficient test indicated a correlation coefficient between almost all the sub-scales in the TMAS and the MAS. Table 7.24 shows the full results.

Table 7.24: Correlation Coefficients between the TMAS and the MAS

Sub-Scale	Mathematics Anxiety	Confidence in Learning	Male Domain	Mathematics Usefulness
Mathematics Teaching Anxiety	**.31****	**-.27****	**-.09***	**-.28****
Confidence and Enjoyment in Teaching Mathematics	**-.16****	**.15****	.02	**.23****
Desire for Recognition	**-.10***	**.15****	.04	**.18****
Pressure to Conform	**.12****	-.01	-.09	**-.16****

** Significant at the 0.01 level
* Significant at the 0.05 level

Another interesting result revealed by the statistical analysis is the correlation between student teachers' anxiety in mathematics and their anxiety in teaching mathematics. There is a moderate positive correlation between these two sub-scales of the TMAS and the MAS of .31, $p < 0.01$. In addition, the result reveals that the mathematics anxiety scale in the MAS has a negative correlation with other sub-scales except the pressure to conform scale in the TMAS.

A similar result appears with regard to student teachers' responses regarding confidence in learning mathematics and their responses regarding confidence and enjoyment in teaching mathematics. There is a low positive correlation between these two sub-scales of the TMAS and the MAS of .15, $p < 0.01$. Put simply, this means that the more confidence the student teacher feels in learning mathematics, the more confidence and enjoyment he or she feels in teaching mathematics. The confidence in learning mathematics scale reveals a very low negative correlation with the pressure to conform scale. This indicates that confidence is related to a positive attitude toward mathematics while pressure to conform is related to a negative attitude toward teaching mathematics. This means that if student teachers are confident in their ability in learning mathematics, they will not feel under pressure where other people observe them teaching mathematics.

To answer the first two questions of this section, we found from the above statistical results that there is a relationship between these two scales. However, the strongest relationship exists between confidence and anxiety in both scales.

The interview data indicated that almost all student teachers who feel confident about their abilities in mathematics are also confident in teaching mathematics and, similarly, that student teachers who are anxious in learning mathematics are also anxious in teaching mathematics. We may cite as an example of this the statement made by one student teacher (S2, F, L3), reflecting her confidence in learning mathematics, "I'm positive in doing mathematics." In addition, she said about confidence in teaching mathematics, "Really, I enjoy teaching mathematics."

Moreover, all instructors agreed that there is a relationship between confidence in learning mathematics and confidence in teaching mathematics. However, they noted that a few student teachers have different attitudes toward, on the one hand, learning mathematics and, on the other, teaching it. As one instructor observed,

> It is obvious that those who enroll in this major have confidence in learning and teaching mathematics, but there are still one or two students who like mathematics yet do not like to teach it.

However, two student teachers out of the whole interview sample claimed that there was no relationship between confidence in learning mathematics and confidence in teaching it. Thus, one student teacher in the third year said,

> I like mathematics itself, to solve mathematical problems and so on, but not teaching it to other people. I do not have that ability (S 1, F, L3).

7.5.2 Findings Concerning the Relationship between the TMAS and the BNMS

Further analyses of the data indicated that there was a significant lack of correlation between the TMAS and the BNMS. A Pearson correlation coefficient test revealed no significant correlation between student teachers' scores on the BNMS and their attitudes toward teaching mathematics as measured by the TMAS in this study. Although much emphasis has been attached to the importance of teachers' beliefs in changing their behaviour (Cooney and Jones, 1988; Ernest, 1989a), it was not certain whether that was the case in the sample of the current study. In this study we are dealing with beliefs about the nature of mathematics and attitudes toward teaching mathematics, not the behaviour of the sample and their teaching style.

However, correlation coefficients of .14, .15 $p<.001$ and .11 $p<.005$ did suggest a very low but highly significant positive correlation between the three views about the nature of mathematics and one of the sub-scales of the TMAS, that is the sub-scale measuring confidence and enjoyment in teaching mathematics, as is shown in Table 7.25.

Table 7.25: Correlation Coefficients between the BNMS and the TMAS

Sub-Scale	Mathematics Teaching Anxiety	Confidence and Enjoyment in Teaching Mathematics	Desire for Recognition	Pressure to Conform
Platonist	.01	**.14****	-.02	.03
Instrumentalist	.02	**.15****	- .02	.04
Problem-solving	.06	**.11***	-.05	.08

** Significant at the 0.01 level
* Significant at the 0.05 level

It is worth mentioning that although analyses of interview data suggested that the student teachers held clearly differing views about the nature of mathematics, the majority had confidence and enjoyment in teaching mathematics. For example, S2 mentioned that mathematics is "skills we use to solve our problems in our lives," adding that "mathematics is certain theories and rules ... we need to change it, but it still provides certain steps we should follow," which indicates that she probably held an instrumentalist view of mathematics. Answering another question about teaching mathematics, she said, "Really, I enjoy teaching, especially mathematics."

Student S 11 said, "I like mathematics, so it is a pleasure...it is a wide word meaning a lot of things in our life," and this student continued, "I think that in mathematics there is a part for creativity," which suggests that he probably held a problem-solving view of the subject. In reply to another question he answered, "I think mathematics is an easy subject to teach to children. I do not have any doubt about my ability in teaching mathematics."

Clearly, this seems to support the statistical result above indicating that the confidence and enjoyment in teaching mathematics scale has a correlation with all the nature of mathematics views. This means that whatever may be the student teachers' beliefs about the nature of mathematics, they still have confidence and enjoyment in teaching mathematics. It means that their beliefs about the nature of mathematics and their attitudes toward teaching mathematics are separate issues.

Turning to data from the interviews with the four instructors, when they were asked about their attitudes toward teaching mathematics and their beliefs about the nature of mathematics, none of them felt that their beliefs about the nature of mathematics would affect their attitudes toward teaching mathematics. The following statements support this conclusion. As one instructor said,

> I agree there are different views about mathematics, but that doesn't affect your attitude towards teaching mathematics. Since I have worked in this job, I have never thought about the nature of mathematics, as I teach the student teachers how to teach this subject. (I 3, M)

Another instructor said,

> I 4, F: Perhaps I like teaching by the new methods and the new movement in teaching mathematics, including more activities and creative work, but it doesn't affect whether I am confident or anxious in teaching this subject.
>
> The researcher: What about when you teach in your class?
>
> I 4, F: I teach the student teachers how to be good mathematics teachers, not what they should believe about the nature of mathematics. I believe I like teaching this subject even if I believe in a certain view.

Therefore, the information gained through the interviews with the student teachers and the instructors supported the statistical findings related to the linking of beliefs about the nature of mathematics and attitudes towards teaching mathematics. In section 7.5.4 there will be further explanation of this result and consideration of the other scales in this study using other types of statistical test.

7.5.3 Findings Concerning the Relationship between the MAS and the BNMS

In this section our aim is to discover whether or not there is any relationship between the three beliefs about the nature of mathematics and the student teachers' attitudes toward mathematics. Statistical analyses of the data produced a surprising result between the MAS and the BNMS. A Pearson correlation coefficient test revealed an insignificant and very low correlation between the student teachers' scores on the BNMS and their attitudes toward mathematics as measured by the MAS. Therefore, the null hypothesis (H 5) that "there is no relationship between the three views about the nature of mathematics and the student teachers' attitudes toward mathematics" was accepted, except in the case of one of the sub-scales of the MAS (confidence in learning mathematics) and one of the beliefs about the nature of mathematics (the instrumentalist view). So, there is no significant relationship between the three views about the nature of mathematics and the student teachers' attitudes toward mathematics.

A correlation coefficient of -. 11 $p< .05$ suggested a very low negative but still a significant correlation between one of the three sub-scales of the MAS and one of the views measured in the BNMS, that is, the instrumentalist view, as is shown in Table 7.26. We will use a multiple linear regression test in the next section to explore this relationship with other scales in this study.

Table 7.26: Correlation Coefficients between the BNMS and the MAS

Sub-Scales	Mathematics Anxiety	Confidence in Learning	Male Domain	Mathematics Usefulness
Platonist	.06	-.07	-.04	.03
Instrumentalist	.07	**-.11***	.02	-.05
Problem-Solving	.04	-.04	-.09	-.01

* Significant at the 0.05 level

7.5.4 The Relationship between the Confidence and Enjoyment in Teaching Mathematics Scale and other Sub-Scales

Using the multiple linear regression test, we try to find the answer to the following research question:

Q4: Is student teachers' confidence and enjoyment in teaching mathematics affected by their confidence in learning mathematics or by one of the three views about the nature of mathematics?

Where the confidence and enjoyment in teaching mathematics scale is the dependent variable and the confidence in learning mathematics scale and the three views about the nature of mathematics are the independent variables, the SPSS allows us to include more than two independent variables in multiple linear regression.

In addition to predicting the outcome variable for a new sample of data, regression analysis serves additionally two the following purposes:

- It allows us to assess how well the dependent variable can be explained by knowing the value of the independent variable.
- It allows us to identify which subset from many measures is most effective for estimating the dependent variable.

In a multiple regression model, R is the correlation between the observed and predicted value of the dependent variable (for example, in this case the correlation between the confidence and enjoyment in teaching mathematics scale and the value of confidence and enjoyment in teaching mathematics predicted by the model). R square is the value of this correlation. For this model with four variables, R square is .064, knowing that the four independent variables explain almost 6% of the variability of the confidence and enjoyment in teaching mathematics variable. The information is presented in Table 7.27.

Table 7.27: Summary Model of Multiple Linear Regression for the Confidence and Enjoyment in Teaching Mathematics Scale, the Confidence in Learning Mathematics Scale in the MAS, and the BNMS.

Model	R	R square	Adjusted R square	Std. Error of the estimate
1	**.253**	**.064**	**.055**	**1.2425**

In Table 7.28 the F statistic is highly significant, indicating that the simultaneous test that each coefficient is 0 is to be rejected. The fact that the associated probability (sig.) is so small does not imply that each of the independent variables makes a meaningful contribution to the fit of the model.

Table 7.28: Summary of ANOVA for the Confidence and Enjoyment in Teaching Mathematics Scale, the Confidence in Learning Mathematics Scale in the MAS, and the BNMS

Model	**Sum of Squares**	**Df**	**Mean square**	**F**	**Sig.**
1 Regression	43.782	4	10.945	7.090	.000
Residual	637.590	413	1.544		
Total	681.372	417			

In order to assess the usefulness of each predictor in the model, we cannot simply compare the coefficients. Even if the independent variables were all measured in the same unit, a comparison of their size may not be revealing. When they are correlated, it is hard to quantify the unique contribution of each variable. Beta coefficients are an attempt to make the regression coefficients more comparable. The t-Test statistic in the next column provides some clue regarding the relative importance of each variable in the model.

As a guide to useful predictors, we look for t values well below –2 or above +2. In Table 7.29 the t value for confidence in learning mathematics is 3.69, that for the Platonist view is .225, that for the instrumentalist view is 2.358, and that for the problem-solving view is 1.27. So, of these, only the first and the third variables meet the guideline, indicating that the confidence in learning mathematics variable is clearly the strongest predictor, followed by the instrumentalist view variable.

Table 7.29: Multiple Linear Regression between the Confidence and Enjoyment in Teaching Mathematics Scale in the TMAS, the Confidence in Learning Mathematics Scale in the MAS, and the BNMS

Model		Unstandardised Coefficients		Standardised Coefficients	T	Sig.
		B	Std. Error	Beta		
1	**(constant)**	3.399	.308		11.051	.000
	Confidence in Leaning Mathematics	.218	.059	.177	3.699	.000
	Platonist View	8.507	.070	.069	.216	.225
	Instrumentalist View	.158	.067	.129	2.358	.019
	Problem-Solving View	6.654	.052	.065	1.271	.204

These statistical results appear to support the findings of two other studies that we may notice in this place. Austin and Wadlington (1992) studied the effect of beliefs about mathematics on mathematics anxiety and math self-concept in primary teachers. They found that there were no significant differences in the levels of mathematics anxiety of student teachers and those of in-service teachers that could be based on their agreement or disagreement with any particular mathematics belief.

In another study Ludlow and Bell (1996) tried to investigate the attitudes and anxieties that future primary teachers may have toward teaching mathematics. College students were asked to respond to questions concerning attitudes towards mathematics and its teaching (ATMAT) at the beginning, in the mid term, and at the end of one semester. They noted that scores increased from the beginning to the end of the semester. At the beginning of the semester the students came to the course with a generally negative attitude toward all aspects of mathematics and the teaching of it, a finding which is not surprising. Once the course commenced, however, the students began to differentiate more clearly between what really made them uncomfortable and those aspects of mathematics with which they could feel more confident, particularly in the teaching of mathematics.

Ludlow and Bell's study showed that mathematics anxiety increased in tandem with mathematics teaching anxiety. This seems to accord with our own statistical results indicating a correlation and also with the regression test, through which we noticed that the strongest variable on the confidence in teaching mathematics is the confidence in learning mathematics.

There is no effect between confidence and enjoyment in teaching mathematics and the views that are held regarding the nature of mathematics, except in the case of the instrumentalist view. This exception may perhaps be accounted for by the nature of the view itself, since it considers mathematics to be a tool that may be used in solving problems. This kind of view about mathematics may be useful in teaching mathematics to young children who want to learn the basics of mathematics.

I interpret this to mean that the teachers' beliefs about the nature of mathematics will not affect their attitudes toward mathematics or its teaching. This means that if a teacher has a strong Platonist, instrumentalist, or problem-solving belief about the nature of mathematics, such a belief will not affect his or her confidence in teaching or doing mathematics. Teachers will still be anxious about their abilities no matter what views they believe in.

7.6 Summary of Findings

This summary will help us to know and highlight the findings of this study. In four sections we try to order these results under the scales used in this study.

7.6.1 The Findings of the MAS

- The results of a Pearson correlation coefficient test indicated that the mathematics anxiety scale in the MAS has a negative correlation with the other sub-scales in the MAS. On the other hand, the male domain scale showed a very low positive correlation with the other sub-scales. Also, there is a positive correlation between the usefulness of mathematics scale. Nevertheless, this scale showed a low positive correlation with the male domain scale.

- These sub-scales have interesting links with the background variables. The statistical results and the interview data indicated that the fourth-year student teachers were more confident in learning mathematics and less anxious in mathematics, and more in agreement about women's role in mathematics when compared with the student teachers in the second year. The one-way ANOVA showed that there is an insignificant result in comparing the usefulness of mathematics scale with the class level variable. This indicates that the sample in this study, throughout the different class levels, strongly agreed that mathematics was useful in their lives.

- Using the t-Test to explore the effect of the gender variable on the student teachers' attitudes toward mathematics, findings indicated that males were more confident and less anxious in learning mathematics than were females. The effect of the gender variable on the male domain scale indicated that females were in greater agreement than males in this scale. The results on the usefulness of mathematics scale showed that both sexes strongly agreed that mathematics was important in their future education and other activities.

7.6.2 The Findings of the TMAS

- The statistical results indicated a moderately significant negative correlation coefficient between the mathematics teaching anxiety scale and the confidence and enjoyment in teaching mathematics scale. Some other studies agree that there is a negative relationship between confidence and anxiety. Findings concern the relationship between the sub-scales in the TMAS. A Pearson correlation coefficient test indicated a negative correlation coefficient between the desire for recognition scale and (1) the mathematics teaching anxiety scale and (2) the pressure to conform scale, and a positive correlation coefficient between the desire for recognition scale and the confidence and enjoyment in teaching mathematics scale. This means that if student teachers feel less desire for recognition, they will feel more anxiety in teaching mathematics, more pressure to conform, and less confidence and enjoyment in teaching mathematics. On the other hand, a positive correlation coefficient was found between the pressure to conform scale and the mathematics teaching anxiety scale, while a negative correlation coefficient was found between the pressure to conform scale and the confidence and enjoyment in teaching mathematics scale. In simple terms this means that if student teachers feel more pressure to conform, they will feel more anxiety in teaching mathematics and less confidence in teaching mathematics.

- The scales have interesting results in connection with the background variable of class level. The results showed a significant variation with this variable. The student teachers in the final year at college experience more confidence and enjoyment in teaching mathematics and are less anxious in mathematics teaching than are those in the second year. On the other hand, this background variable shows an insignificant variation with the desire for recognition scale and the pressure to conform scale.

- The scales have interesting results in connection with the background variable of gender. Males experience more confidence and enjoyment and are less anxious in teaching mathematics than are females. The interview data supported the statistical results. The scores in the desire for recognition scale, as measured in the TMAS, were tested statistically by a t-Test and results indicated that the effects of gender on student teachers' desire for recognition were clearly insignificant. But the pressure to conform scale showed significant variation with regard to gender. The findings indicated that males feel more pressure to conform in teaching mathematics than do females.

7.6.3 The Findings of the BNMS

- The findings of comparisons made between the BNMS, designed to measure student teachers' beliefs about the nature of mathematics, and the background variables indicated a number of important results. In considering the gender variable, use was made of the t-Test to determine the means of this sample. We found that for the females the highest scores were for the instrumentalist view. On the other hand, we found that for the males the highest scores were for the problem-solving view.

- When viewed against the class level variable, results indicated that in all the three class levels, the instrumentalist view scored the highest in this study, while the least popular belief was the problem-solving view, which came some way behind the other two views in popularity.

7.6.4 The Findings with regard to Relationships between the Three Scales

- The data from the Pearson correlation coefficient test measuring of the relationship between the student teachers' attitudes toward mathematics and their attitudes toward mathematics teaching indicated a correlation coefficient between all these sub-scales (except for the male domain in the MAS) and three of the sub-scales of the TMAS. This was also true of the pressure to conform scale when measured against the three sub-scales of the MAS. There was found to be a moderate positive correlation between student teachers' level of anxiety in mathematics and their anxiety in teaching mathematics, as measured on the sub-scales of the TMAS and the MAS. This was also apparent with regard to student teachers' responses regarding their confidence in learning mathematics and their responses regarding confidence and enjoyment in teaching mathematics.

- The data indicated that there was a significant lack of correlation between the TMAS and the BNMS. A Pearson correlation coefficient test revealed no significant correlation between student teachers' scores on the BNMS and their attitudes toward teaching mathematics as measured by the TMAS in this study. In this study we are dealing with beliefs about the nature of mathematics and attitudes toward teaching mathematics, not the behaviour of the sample and their teaching style. However, correlation coefficients did suggest a very low but highly significant positive correlation between the three views about the nature of mathematics and one of the sub-scales of the TMAS, that is the sub-scale measuring confidence and enjoyment in teaching mathematics. The interview data supported this statistical result.

- Statistical analyses of the data produced a surprising result in comparing the MAS and the BNMS. A Pearson correlation coefficient test revealed an insignificant and very low correlation between the student teachers' scores on the BNMS and their attitudes toward mathematics as measured by the MAS. Except for one of the sub-scales of the MAS and one of the sub-scales of the BNMS, namely, the confidence in learning mathematics scale and the instrumentalist view scale, there was a significant low correlation.

- By using multiple linear regression, the research results indicated that confidence in learning mathematics increased in tandem with confidence and enjoyment in teaching mathematics. This is somewhat similar to the statistical result indicating that there is a correlation. The multiple linear regression test also suggested that the strongest variable was confidence in learning mathematics, while there was no correlation between the confidence and enjoyment in teaching mathematics scale and the three views on the nature of mathematics, expect for the instrumentalist view.

CHAPTER EIGHT

CONCLUSIONS AND DISCUSSION

8.0 Introduction

In the previous chapter, the findings from the fieldwork conducted for the present study were discussed and interpreted in the light of relevant studies. The purpose of the present chapter is to reflect on the study as a whole, to draw conclusions, to discuss the study, to acknowledge its limitations, and finally to put forward some suggestions for further related research.

The present study was designed to provide a framework for investigating student teachers' beliefs about the nature of mathematics and their attitudes towards mathematics and its teaching, and the relationship between these beliefs and their attitudes toward mathematics and the teaching of mathematics. Knowing these beliefs and attitudes is significant for the teachers' education in Kuwait. The study therefore focuses on current views about the nature of mathematics, attitudes toward mathematics and their teaching of mathematics held by student teachers in Kuwait. Some existing instruments for measuring the views about the nature of mathematics were found to be inadequate and unsuitable. Therefore, the beliefs about the nature of mathematics scale (BNMS) was developed based on literature sources, validated through a construct framework, and interpreted by various 'experts' prior to its being used in the study. Also, two existing instruments were adapted and validated: the mathematics attitude scales (MAS) and the teaching of mathematics attitude scale (TMAS).

Three methods were employed to generate data: a questionnaire, interviews, and observation. These were implemented in two colleges: the College of Education at Kuwait University and the College of Basic Education at the Public Authority for Applied Education and Training (PAAET) in Kuwait. Questionnaire data were gathered from 418 student teachers, and interview data from 16 mathematics student teachers and 4 instructors. In addition, observations were conducted in four classes in mathematics teaching methods courses.

8.1 Conclusions

the following is a summary of the main conclusions of the study.

1. The findings of this study showed that an Arabic translation of the American Mathematics Attitudes Scale (MAS) and the Australian Teaching Mathematics Attitudes Scale (TMAS) were valid for the Arab sample. The reliability and validity of the MAS and TMAS were established using interpretations of Arab experts' opinions, factor analysis testing, and Cronbach (alpha) reliability coefficients.

2. Student teachers' beliefs about the nature of mathematics are operationalised in our 'original' instrument, the BNMS, according to three views: the Platonist view, the instrumentalist view, and the problem-solving view. This instrument was shown to be valid by using different types of tests, including face-validity tests,

factor analysis, and Cronbach (alpha) reliability coefficients, as well as by referring to expert opinion.

3. A significant finding from the data of this study was that there are relationships between the student teachers' attitudes toward mathematics and their attitudes toward mathematics teaching. On the other hand, however, no educational correlation was found between the MAS or the TMAS and the BNMS. There seemed to be practically no relationship between student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics and the teaching of mathematics.

4. The MAS and the TMAS scales were found to have associations with certain background variables. In the study the fourth-year student teachers were found to be more confident in learning and teaching mathematics and less anxious in mathematics and teaching mathematics, and they were more in agreement about women's role in mathematics when compared with the student teachers in the second year. The gender variable findings, when applied to the findings about student teachers' attitudes toward mathematics, indicated that males were more confident and less anxious in learning and teaching mathematics than were females. But the females were in greater agreement than males about women's role in mathematics. The statistical data showed no significant difference between genders with regard to the desire for recognition, although the interview data revealed that females were more likely to appreciate recognition by other people in teaching mathematics.

5. Relating the gender variable to the BNMS, we found that for the females the highest scores were for the instrumentalist view. On the other hand, we found that for the males the highest scores were for the problem-solving view. When viewed against the class level variable, results indicated that in all the three class levels, the instrumentalist view scored the highest in this study, while the least popular belief was the problem-solving view, which came some way behind the other two views in popularity.

6. There was found to be a positive correlation between the confidence in learning mathematics scale in the MAS and the confidence and enjoyment in teaching mathematics scale in the TMAS. However, thses scale has a negative correlation with the mathematics teaching anxiety scale in the TMAS.

8.2 Discussion of the Findings

The above conclusions indicate the significance of this study and importance of beliefs and attitudes towards mathematics and the teaching of mathematics that are held by student teachers, since these people are at the centre of the educational system in Kuwait. Their own experience in their studies at one or other of these colleges can have a profound impact on their beliefs and attitudes toward mathematics and its teaching. We have seen in Chapter Three how keenly student teachers' beliefs and attitudes may affect their actual approaches to teaching. Therefore, the BNMS instrument may be a source of help in Kuwaiti teachers' education and Arab teachers' education in general.

The literature review indicated that different schemes of classification have been offered for theories about the nature of mathematics. In a recent study Ernest classified them into three views, namely the Platonist view, the instrumentalist view, and the problem-solving view. Ernest (1989b) cited the official reports of the NCTM (1980) and Cockcroft (1982) as recommending the adoption of the problem-solving approach to the teaching of mathematics, but this depends to a large extent on instructional reforms, including changes in the mathematics curriculum and changes in individual teachers' approaches to the teaching of mathematics. Ernest stated that these changes

> depends fundamentally on the teacher's system of beliefs, and in particular on the teacher's conception of the nature of mathematics and mental models of teaching and learning mathematics. Teachers' reforms cannot take place unless teachers' deeply held beliefs about mathematics and its teaching and learning change (p. 249).

For the current study student teachers' beliefs about the nature of mathematics are categorised in our instrument, the BNMS, into the three above-mentioned views, viz: the Platonist view, the instrumentalist view, and the problem-solving view. When viewed against the class level variable, results indicated that in all the three class levels, the instrumentalist view scored the highest in this study, while the least popular belief was the problem-solving view, which came some way behind the other two views in popularity. As the above quotation suggests, changes to improve the teaching of mathematics depend partly on the teachers' beliefs systems. We found that most of those in the Kuwaiti student teachers sample held the instrumentalist view. There should be more focus on student teachers' beliefs and it should be explained to them how reform in the teaching of mathematics depends on their adopting the problem-solving approach.

In constructing the research design for this study, the aim was to find the relationship between the student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics and the teaching of mathematics (see section 4.4 of Chapter Four). In Chapter Four we depicted our research design in Figure 8.1. We noted that the three views, namely the Platonist view, the instrumentalist view, and the problem-solving view, share a relationship with the student teachers' attitudes toward mathematics and the teaching of mathematics. Surprisingly, we found that there was no relationship between their beliefs about the nature of mathematics and their attitudes toward mathematics and the teaching of mathematics. Clearly, the student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics and the teaching of it are very important in their teaching practice, but they may well be influenced by the type of education system used in Kuwait, in particular the curriculum they are required to follow or the educational materials actually made available to them. Kuwaiti student teachers' beliefs, as measured by the BNMS in this study, relate to the nature of mathematics itself, not to the practice of teaching and the way in which they are supposed to teach. In this study we assumed that beliefs about the nature of mathematics have some relation with attitudes towards mathematics and its teaching. As Ernest (1989b) mentioned,

> Mathematics teachers' beliefs have a powerful impact on the practice of teaching. During their transformation into practice two factors affect these beliefs: the constraints and opportunities of the social context of teaching, and the level of teachers' thought (p. 253).

Figure 8.1: The Research Design

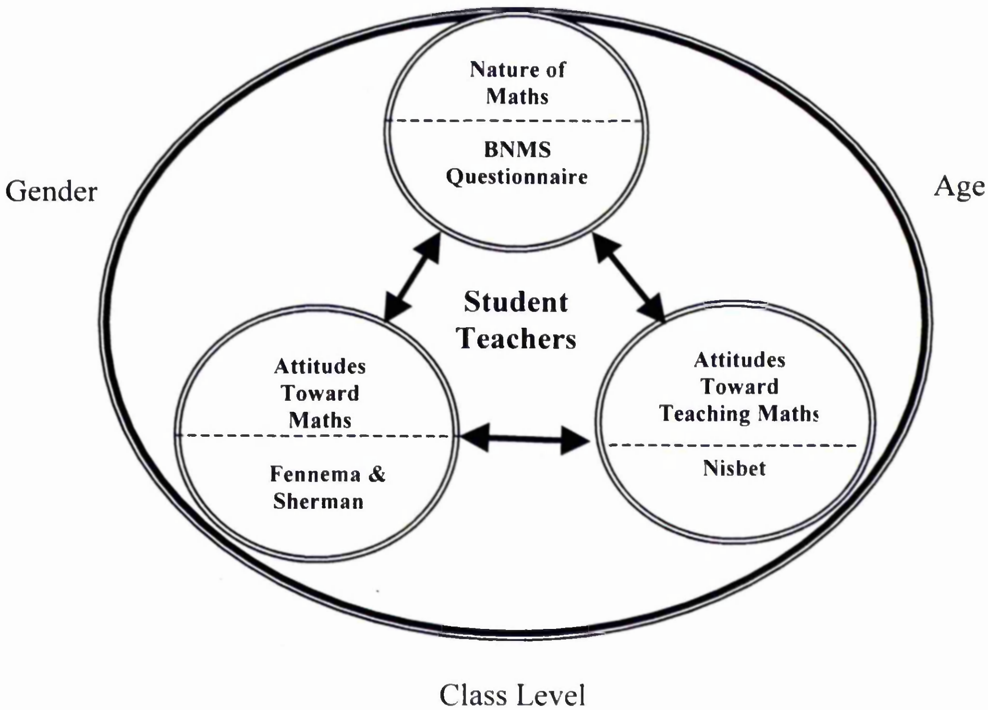
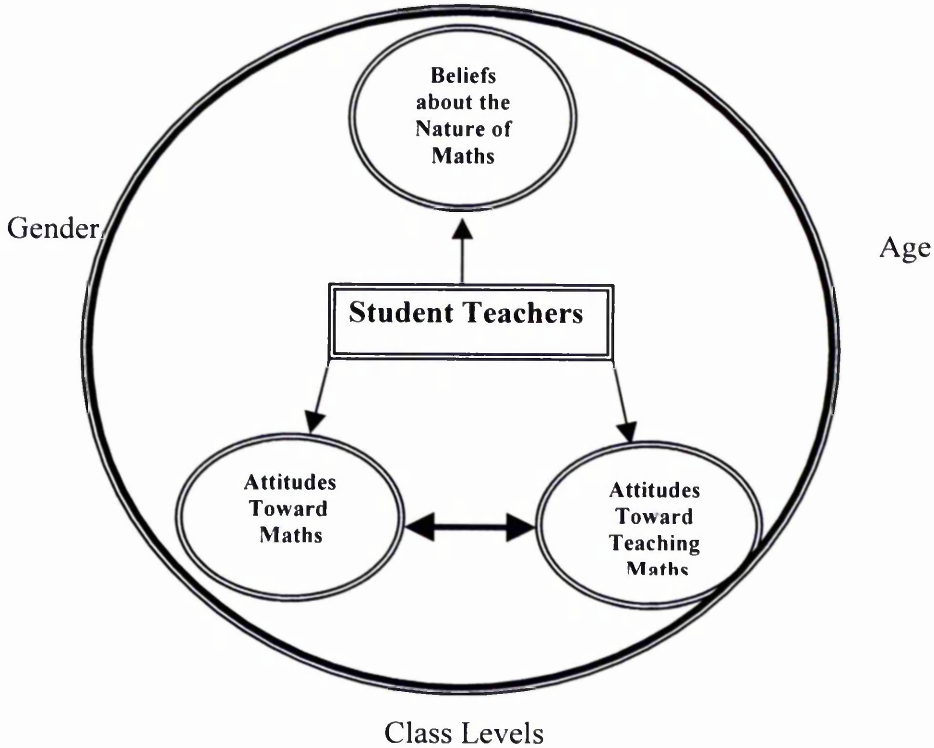


Figure 8.2 explains the research result after doing the study. It is demonstrated that no matter what the student teachers' beliefs about the nature of mathematics, they will not affect the student teachers' attitudes toward learning or teaching mathematics, but each dimension has its own impact on student teachers and may influence their teaching of mathematics.

Figure 8.2: The Research Result after doing the Study



→ = Significant
↔ = Correlation

In this study we were able to translate the MAS and the TMAS scales into Arabic, and these translation were validated before being used. We found the identical factors that had previously been established in the US and Australian cultures also divided in the same factors in the Arabic version. D'Ambrosio has used the expression 'ethnomathematics' for forms of mathematics that vary as a consequence of being embedded in cultural activities whose purpose is other than 'doing mathematics'. Everyday mathematics varies from one country to another, for example, because of different numeration systems used for calculating in different countries. D'Ambrosio (1990) mentioned that

> throughout the history of mankind every culture has recorded, in different ways, reports of travellers who have seen or heard about ways of coping with reality and explaining facts and phenomena which are different from their own. The encounters of cultures are, evidently, responsible for the dynamics of cultural changes (p. 121).

This led us to focus on new technology, since this facilitates speedy information exchange and transfer from country to country. It is also clear that these two scales may with safety be applied to other cultures since the statements in them evoke students' responses revealing their attitudes to mathematics and teaching mathematics, which seem to be concepts of international validity. Perhaps schooling, teaching and attitudes are universal constants.

However, one of the main findings from the data in this study was that there was a relationship between the student teachers' attitudes toward mathematics and their attitudes toward mathematics teaching. Their attitudes towards mathematics affect their attitudes toward the teaching of mathematics. For example, there was found to be a correlation between Kuwaiti student teachers' level of anxiety in mathematics and their anxiety in teaching mathematics, as measured on the sub-scales of the TMAS and the MAS. This was also apparent with regard to student teachers' responses regarding their confidence in learning mathematics and their responses regarding their confidence and enjoyment in teaching mathematics.

Furthermore, the influence of gender on the student teachers' attitudes found in this study relating to the State of Kuwait is supported by other studies. As Leder summarised, even if there is only a small difference related to gender in mathematics learning, the study sample's behaviour and beliefs still represent the wider society. She noted that

> there is some evidence that on average females are somewhat less confident about their ability to do mathematics, less certain that mathematics is an appropriate and needed area of study for them, more ambivalent about the value to them of success in mathematics; also they may be less functional than males in their attributions of success and failure and less likely to persist on the more challenging tasks (p. 616).

In this study both sexes appreciated the role of women in mathematics. Student teachers of both sexes must be encouraged during their study in these colleges to appreciate the role of each sex in this field. Student teachers should leave their college understanding this issue.

The findings of this study also indicated that student teachers in their early years in the College of Education at Kuwait University and the College of Basic Education come to their colleges with some degree of anxiety about learning and teaching mathematics. This decreases in later years through their teaching observation and experience during their college training. Their personal experience can have a powerful impact on their attitudes toward mathematics and the teaching of mathematics. So, for the sake of the way mathematics will be taught in primary schools by these student teachers, it will be helpful if they obtain as much practical experience as possible. For example, mathematics methods courses could be planned so that student teachers may study how particular concepts can be effectively presented to primary school children at the same time that they themselves are gaining practical experiencing of teaching these concepts in their mathematics courses. The purpose of this is to increase their confidence in mathematics and the teaching of mathematics so that they will have no anxiety about this in the future.

8.3 Summary of Limitations

A limitation is some aspect of the study that the researcher knows may negatively affect the results or the generalising capability of the results but over which the researcher probably has no control. In other words, something is not as 'good' as it should be but the researcher cannot do anything about it.

The present study has iunvestigated Kuwaiti student teachers' attitudes towards mathematics and their attitudes towards teaching mathematics, but this should not be taken as having any bearing on their teaching styles. The study is limited to reporting the variable of attitudes. No attempt is made to discover the reasons for these attitudes.

The sample was made up of a non-random sample of student teachers and instructors chosen from previously selected colleges in the State of Kuwait. The sample size was only 418 student teachers, although the total number of student teachers registered in this particular major at the College of Education and the College of Basic Education was 1,038, 297 males and 741 females. The sample was almost half the population but the sexes were nevertheless not equally balanced. That is beyond control because the number of females registered in this major is more than the number of males.

The interviews with the student teachers were held in groups rather than individual discussions because there was not enough time to pursue the latter option, especially as the students were very busy with their courses. The time, just three months, was also very limited.

8.4 Suggestions for Further Research

1. The outcomes of this study contribute to further knowledge in the field of educational research on student teachers' beliefs about the nature of mathematics and their attitudes toward mathematics and teaching mathematics. Because there have been no similar studies conducted on this in Kuwait, it is necessary to verify the outcomes of this study.

2. The main investigation of the present study has been into beliefs about the nature of mathematics, not beliefs about the attitudes toward this issue. Therefore, it is suggested that the issue of attitudes toward the nature of mathematics and what student teachers believe about the teaching of mathematics should be investigated to provide further insights into this important issue.

3. This study has been limited to student teachers' beliefs and attitudes. A similar study might be made of teachers in their first year of service in order to learn what happens to student teachers' beliefs as they begin to teach in schools and to see how the prevailing culture of the school might interact with their beliefs. By

applying the BNMS to them, it should be possible to gain more information on this particular topic.

4. It would be desirable by using the BNMS to identify what courses in the college stage have a powerful impact in the student teachers' beliefs about the nature of mathematics.

BIBLIOGRAPHY

Abelson, R. P. (1979), "Differences between belief and knowledge systems," *Cognitive Science*, 3, 335-366.

Ackroyd. S. and Hughes. J. (1992), *Data collection in context (aspects of modern sociology: social research),* UK, Pearson Education.

al-Abdul Ghafur, F. (1978), *Development of Education in Kuwait 1912-1972*, Kuwait, Dar al-Falaah.

al-Abdul Qader, F. (1986), *Islamic values and biology texts in Kuwait.* Unpublished Master's Dissertation, University of Wales.

al-Ghunaem, A. and Others, 1996), *The Iraqi Aggression on Kuwait: The Truth and the Tragedy.* Kuwait, Dar al-Seyassah.

Al-Nimir, S. (1989), *The Educational Development for Mathematics in the State of Kuwait.* Kuwait, Ministry of Education press.

Anderson, D. and Piazza, J. (1996), "Changing beliefs: teaching and learning mathematics in constructivist preservice classrooms," *Action in Teacher Education*, 18 (2), 51-61.

Austin, S. and Wadlington, E. (1992), "Effect of beliefs about mathematics on math anxiety and math self-concept in elementary teachers," *Education*, 112, 390-396.

Battista, M. (1986), "The relationship of mathematics anxiety and mathematical knowledge to the learning of mathematical pedagogy by preservice elementary teachers," *School Science and Mathematics*, 86 (1), 10-19.

Battista, M. T. (1990), "Spatial visualisation and gender differences in high school geometry," *Journal for Research in Mathematics Education*, 21, 47-60.

Becker, J. & Pence, B. (1996), "Mathematics teacher development: connections to change in teachers' beliefs and practices," *Psychology of Mathematics Education*, 1, 103-117.

Becker, J. R. (1986), "Mathematics attitudes of elementary education majors," *Arithmetic Teachers*, 33 (5), 50-51.

Bennett, N. (1976), *Teaching styles and pupil progress*. London; Open Books.

Bennett, N. and Desforges, C. (1991), "Primary education in England: A system in transition," *The Elementary School Journal*, V 92, (1), p. 61-76.

Best, J. W. (1981), *Research in education*. New Jersey: Prentice-Hall, Inc.

Bishop, A. (1988), "Mathematics Education in its Cultural Context," *Educational Studies in Mathematics*, 19, 179-191.

Blanton, L. (1992) 'Pre-service education: Essential knowledge for the effective special education teacher', *Teacher Education and Special Education*, 15, 87-96.

Berliner, D. (1987) 'Ways thinking about students and classrooms by more and less experienced teachers', in J. Calderhead (Ed.) *Exploring Teachers' Thinking*, pp.60-83, London, Cassell Educational Limited.

Bradley, A.(1994) 'Teacher training a key focus for administration', *Education Week*, xlli, 95, 1.

Borg, W. R. and Gall, M. D. (1979*), Educational research.* New York: Longman Inc.

Borg, W. R. and Meredith, D. (1989*), Educational research: an introduction.* London: Longman Inc.

Brayman, A. (1993), *Quantity and quality in social research*, London and New York, Routledge.

Bulmahn, B. and Young, D. (1982), "On the transmission of mathematics anxiety," *Arithmetic Teacher*, 30 (3), 55-56.

Burgess, L. (1984), *In the field: An introduction to field research*, London, Allen and Unwin.

Bush, S. (1989), "Mathematical anxiety in upper elementary school teachers," *School Science and Mathematics*, 8, (6), 499-509.

Butler, M. and Austin-Martin, G. (1981), High math-anxious female college freshman: what do they have in common?. *Paper presented at annual meeting of the American psychological association.*

Chavez, A. and Widmer, C. (1982), "Math anxiety and elementary school teachers," *Education*, 102, 272-276.

Clark, C. and Peterson, P. (1986), "Teachers' thought processes," in M. C. Wittrock (ed.), *Handbook of Research on Teaching,* New York: Macmillan, 225-296.

Cohen, L. and Manion, L. (1994), *Research methods in education*, London, Routledge.

Cooney, T. and Jones, D. (1988), "The relevance of teachers' beliefs for research in mathematics teachers education," *Paper represented at the Sixth International Congress on Mathematical Education*, Budapest, date.

Cooney, T. J. (1985), "A beginning teacher's view of problem solving," *Journal for Research in Mathematics Education,* 16 (5), 324-336.

Copes, L. (1979), " The Perry development scheme and the teaching of mathematics," *Paper presented at the annual meeting of the International Group for the Psychology of mathematics Education,* Warwick, England.

D'Ambrosio, U. (1996), "Ethnomathematics: where does it come and from?" in C. Alsina (eds.), *8th International Congress on Mathematical Education. Selected lectures*, S. L. :Thales, 119-128.

Dossey, J. (1992), "The nature of mathematics: its role and influence," in D.A. Grouws (ed.), *Handbook of Research on Mathematics Teaching and Learning*, New York: Macmillan, 39-48.

Elliot, J. (1990), "Affect and mathematics achievement of non-traditional college students," *Journal for Research in Mathematics Education*, 21, 160-165.

Ernest, P. (1989a), " The knowledge, beliefs and attitudes of the mathematics teacher: a model," *Journal of Education for Teaching*, 15(1), 13-33.

Ernest, P. (1989b), " The impact of beliefs on the teaching of mathematics," in P. Ernest (ed.), *Mathematics Teaching: the State of Art*, Basingstoke: Falmer Press, 249-254.

Ethington, G. (1990), "Gender differences in mathematics: an international perspective," *Journal for Research in Mathematics and Education,* 21, 74-80.

Fennema, E. (1989), "The study of affect and mathematics: a proposed generic model for research," in D.B. Mcleod and V.M. Adams (eds.), *Affect and Mathematical Problem Solving a New perspective*, New York: Springier-Verlag, 205-219.

Fennema, E. (1990), "Teachers' attribution and beliefs about girls, boys and mathematics," *Educational Studies in Mathematics*, 21(1), 55-69.

Fennema, E. and Sherman, J. A. (1976), " Fennema-Sherman mathematics attitude scales: instruments designed to measure attitudes toward the learning of mathematics by females and males," *Journal for Research in Mathematics Education*, 7, 324-326.

Fennema, E. and Tartre, L. A. (1985), " The use of spatial visualisation in mathematics by girls and boys," *Journal for Research in Mathematics Education*, 16, 184-206.

Fennema, E. and Tartre, L. A. (1995), " Mathematics achievement and gender: A longitudinal study of selected cognitive and affective variable grades 6-12." *Educational Studies in Mathematics*, 28, 199-217.

Fennema, E., Peterson, P. L. and Carpenter, T.P (1990), " Teachers' attributions and beliefs about girls, boys, and mathematics," *Educational studies in Mathematics*, 21, 55-69.

Gay, L. R. (1992), *Educational research: competencies for analysis and application.* New York: Macmillan Publishing Company.

Grigffin, C. (1985), "Qualitative methods and cultural analysis: young women and the transition from school to Un /employment," in Burgess, R (Ed.) *Field methods in the study of education*, London and Philadelphia, the Falmer Press.

Heher, R. P. (1988), The use of the Fennema-Sherman mathematics anxiety and confidence scales as predictors of success among "business calculus students" and "fundamental concepts of maths" students at the college level. Master's thesis, Salisbury State College.

Hembree, B. (1990), " The nature, effects, and relief of mathematics anxiety," *Journal for Research in Mathematics Education*, 21 (1), 33-46.

Hersh, R. (1986), "Some proposals for revising the philosophy of mathematics," in T. Tymoczko (ed.), *New Directions in the Philosophy of Mathematics,* Boston: Birkhauser, 9-28.

Hinton, P. (1995), *Statistics Explained: A guide for social science students*, New York, Routledge.

Hodges, H. L. (1983), "Learning styles; Rx for mathophobia," *Arithmetic Teacher*, 30, 7, 17-20.

Johnson, R. and Wichern, D. (1992), *Applied Multivariate Statistical Analysis,* New jersey, Englewood Cliffs: Prentice-Hall Inc.

Kelly, W. P. and Tomhave, W. K. (1985), "A study of math anxiety\ math avoidance in preservice elementary teachers," *Arithmetic Teacher*, 32 (5), 51-53.

Kloosterman, P. and Stage, F. K. (1992), "Measuring beliefs about mathematical problem solving," *School Science and Mathematics*, 92 (3), 109-115.

Klugh, H. E. (1974), *Statistics: the essentials for research,* London, John Wiley and Sons, Inc.

Kvale, S. (1996), *Interview,* London, SAGE Publications, Inc.

Lazarus, M. (1974), "Mathophobia: some personal speculations," *The National Elementary Principal*, 53 (2), 16-22.

Leder, G. (1992), "Mathematics and gender: changing perspectives," in D. Grouws (ed.), *Handbook of research on mathematics teaching and learning*, New York, Macmillam Publishing Company, (pp. 597- 622).

Leder, G. C. (1982), "Mathematics achievement and fear of success," *Journal for Research in Mathematics Education*, 15, 124-135.

Leder, G. C. (1990), "Gender and classroom practice," in L. Burton (ed.), *Gender and Mathematics: an International Perspective*, London: Cassel Education, 9-19.

Leedy, P. (1993), *Practical research planning and design*, New York, Macmillan.

Lerman, S. (1983), "Problem solving or knowledge-centred: the influence of philosophy on mathematics teaching," *International Journal of Mathematical Education in Science and Technology*, 14 (1), 59-66.

Linn, M. and Hyde, J. (1989), "Gender, mathematics, and science," *Educational Researcher*, 18, 17-27.

Ludlow, L. H., and Bell, K. N. (1996), " Psychometric characteristics of the attitudes toward mathematics and its teaching (ATMAT) Scale," *Educational & Psychological Measurement*, 56 (5), 864-881.

McLeod, D. (1992), "Research on affect in mathematics education: a reconceptualization," in D. A. Grouws (ed.), *Handbook of Research on Mathematics Teaching and Learning*, New York: Macmillan, 575-596.

McLeod, D. B., Carpenter, T.P., McCornack, P.L., and Skvarclus, P. (1978), "Cognitive style and mathematics learning: The interaction of field independence and instructional treatment in numeration system," *Journal of Research in Mathematical Education, 9*, 163-174.

Ministry of Education (1995), *The Educational Development in The State of Kuwait*, Kuwait.

Ministry of Education (1996), *National report on the development of education in the state of Kuwait*, Kuwait.

Ministry of Education (1998), *General statistics of education in Kuwait,* Kuwait.

Ministry of Information, (1986), *Spotlight on Kuwait*, Kuwait, Dar Al-Syassah.

Montgomery, D. and Peck, E. (1992), *Introduction to linear regression analysis*, New York, John Wiley & Sons, Inc.

Mura, R. (1987), "Sex-related differences in expectations of success in undergraduate mathematics," *Journal for Research in Mathematics Education*, 18, 15-24.

National Council of Teachers of Mathematics (1989), *Curriculum and Evaluation Standards for School Mathematics*, Reston, VA: NCTM.

National Council of Teachers of Mathematics (1991), *Professional Standards for Teaching Mathematics,* Reston, VA: NCTM.

National Research Council (1989), *Everybody Counts: a Report to the Nation on the Future of Mathematics Education*, Washington, DC: National Academy Press.

Nisbet, S. (1991), "A new instrument to measure pre-service primary teachers' attitudes to teaching mathematics," *Mathematics Education Research Journal, 3(2),* 34-56.

Nunes, T. (1992), "Ethnomathematics and everyday cognition," in D. Grouws (ed.), *Handbook of research on mathematics teaching and learning*, New York, Macmillam Publishing Company, (pp. 557- 674).

Olson, M. and Kansky, B. (1981), "Mathematical preparation versus career aspiration: sex-related differences among college-bond Wyoming high school seniors," *Journal for Research in Mathematics Education*, 12, 375- 379.

PAAET (1996), *Achievements 1995/96,* Kuwait: The Public Authority for Applied Education and Training.

Raymond, A. and Santos, V. (1995), "Preservice elementary teachers and self-reflection: how innovation in mathematics teacher preparation challenges mathematics beliefs," *Journal of Teacher Education, 46* (1), 58-70.

Regan, H., and Hannah, B. (1993) 'Ten teachers teaching: the interplay of individuals, their preparation and their schools', *Journal of Teacher Education*, 44 (4), 305-307.

Reyes, L. H. (1984), "Affective variables and mathematics education," *Elementary School Journal*, 84, 558-581.

Richardson, F. and Suinn, R. M. (1972), "The mathematics anxiety rating scale: psychometric data," *Journal of Counselling Psychology*, 19, 551-554.

Sfard, A. (1991), On the dual nature of mathematical conceptions: Reflections on processes and objects as different sides of the same coin. *Educational Studies in Mathematics, 22*, 1-36.

Sirkin, R. (1995), *Statistics for the Social Science*, London, Sage publications.

Skemp, R. R. (1978), "Relational understanding and instructional understanding," *Arithmetic Teacher*, 78 (Nov.), 9-15.

Slavin, R. E. (1984), *Research methods in education: a practical guide*. New Jersey: Prientice- Hall, Inc.

Smith, S. E. and Walker, W. J. (1988), "Sex differences in New York State regents examinations: support for the differential course-taking hypothesis," *Journal for Research in Mathematics Education*, 19 (1), 81-85.

Sovchik, R., Mecori, L. J., and Steiner, E. (1981), " Mathematics anxiety of pre-service elementary mathematics methods students," *School Science and Mathematics*, 81(8), 643-647.

SPSS Base 7.5 applications guide. (1997), USA: SPSS Inc.

Swafford, J. O. (1980), "Sex difference in first-year algebra," *Journal for Research in Mathematics Education,* 11, 33-346.

Swafford, J. O. (1994), "Teacher preparation," in I. M. Carl (ed.), *Prospects for School Mathematics*, Reston, VA: NCTM, 157-174.

Thompson, A. (1984), "The relationship of teachers' conceptions of mathematics teaching to instructional practice," *Educational Studies in Mathematics*, 15, 105-127.

Thompson, A. G. (1992), "Teachers' beliefs and conceptions: a synthesis of the research," in D.A. Grouws (ed.), *Handbook of Research on Mathematics Teaching and Learning*, New York: Macmillan, 127-146.

Tobias, S. and Weissbrod, C. (1980), "Anxiety and mathematics: an update," *Harvard Educational Review*, 50 (1), 63-70.
Unpublished master dissertation, University of Wales.

Van Dalen, D. (1979), *Understanding Educational Research*, New York, McGraw-Hall.

Van Voorhis, J. and Anglin, J. (1994), "Teachers share their mathematics background: telling it like it was," *School Science and Mathematics*, 94 (8), 407-412.

Verma, G. K. and Mallick, K. (1999), *Researching education: perspective and techniques*. London: Falmer Press.

Wiersma, W. (1995), *Research methods in education: an introduction*. Massachusetts: Allyn and Bacon.

Wood, T., Cobb, P., and Yackel, E. (1991), "Change in teaching mathematics: a case study," *American Educational Research Journal*, 28 (3), 587-616.

APPENDICES

APPENDIX 1

Appendix 1

THE NATURE OF MATHEMATICS AND ATTIETUDES TOWARD TEACHING MATHEMATICS AND MATHEMATICS QUESTIONNAIRE

Introduction

The concern of some items in this questionnaire is to determine your beliefs about the nature of mathematics. The other category items are concerned with your attitude toward mathematics and teaching mathematics which the researcher is interested in knowing that.

Please allow your response to reflect your true felling. That is, you may agree of some items and you may disagree with others, according to your beliefs. There are three parts to this questionnaire.

In part I, you are indicating a general information about yourself. In part II, you are indicating on five points scale which you agree or disagree with statement about your attitude towards mathematics. The same scale for part III, but it shows your belief about the nature of mathematics.

In part IV you are indicate on seven points scale the extend to which you agree or disagree to the statement about your attitude about teaching mathematics.

After you have carefully read a statement, decide whether you agree or disagree with it. If you agree, decide whether you agree strongly or mildly. If you disagree, decide whether you disagree strongly or mildly. Then, find the space on the answer sheet that agree with your feelings and mark it accordingly.

SA if you strongly agree

A if you agree

U if you undecided.

D if you disagree

SD if you strongly disagree

------------------------------Example:

No	Statement	SA	A	U	D	S D
00	Mathematics is useful subject	×				

(The person who marked this example agrees strongly that mathematics is useful subject)

Part I: General Information

1. Sex: Male [ ] Female [ ]

2. Age: _________

3. Nationality: Kuwaiti [ ] Non-Kuwaiti [ ]

4. Class Level: __________

Part II: Attitude toward Mathematics

No	Statement	SA	S	U	D	DS
1	I'll need mathematics for my future work.					
2	Math doesn't scare me at all.					
3	Generally I have felt secure about attempting math.					
4	I would expect a women mathematician to be a masculine type of person.					
5	I study mathematics because I know how useful it is.					
6	I haven't usually worried about being able to solve math problems.					
7	I think I could handle more difficult math than Calculus.					
8	Women certainly are logical enough to do well in mathematics.					
9	Knowing mathematics will help me earn a living.					
10	I almost never have gotten rattled during a math test.					
11	I can get good grades in mathematics.					
12	It's hard to believe a female could be a genius in mathematics.					
13	Mathematics is a worth while and necessary subject.					
14	I usually have been at ease during math classes.					
15	I have a lot of self-confidence when it comes to math.					
16	When a woman has to solve a math problem, it is feminine to ask a man for help.					
17	I'll need a firm mastery of mathematics for my future work.					
18	I usually have been at ease during math tests.					
19	I'm no good in math.					
20	I would have more faith in the answer for a math problem solved by a man than by a woman.					
21	I will use mathematics in many ways as an adult.					
22	Mathematics usually makes me feel nervous and uncomfortable.					
23	I don't think I could do advanced math.					
24	Girls who enjoy studying math are a bit peculiar.					
25	Mathematics is of no relevance to my life.					
26	My mind goes blank and I am unable to think clearly when working mathematics.					
27	I'm not the type to do well in math.					
28	Mathematics is for men; arithmetic is for women.					

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

No	Statement	SA	S	U	D	DS
29	I get a sinking feeling when I think of trying hard math.					
30	Mathematics will not be important to me in my life's work.					
31	For some reason, even though I study, math seems usually hard for me.					
32	Females are as good as males in geometry.					
33	Mathematics makes me feel uncomfortable, restless, irritable, and impatient.					
34	Taking mathematics is a waste of time.					
35	Most subjects I can handle O.K, but I have a knack for flubbing up math.					
36	Studying mathematics is just as appropriate for women as for men.					
37	A math test would scare me.					
38	In term of my future life it is not important for me to do well in mathematics in college.					
39	Math has been my worst subject.					
40	Males are not naturally better than females in mathematics.					
41	Mathematics makes me feel uneasy and confused.					
42	I except to have little use for mathematics when I get out of college.					
43	I am sure I could do advanced work in math.					
44	I would trust a woman just as much as I would a man to figure out important calculations.					
45	It would bother me at all to take more math courses.					
46	I see mathematics as subject I will rarely use in my daily life after I graduate from college.					
47	I am sure I can learn mathematics.					
48	Girls can do just as well as boys in math.					

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

Part III: Beliefs about the Nature of Mathematics

No	Statement	SA	S	U	D	DS
1	Mathematics is a creative and broad subject connected with most sciences.					
2	Mathematics involves a continuous discussion to solve mathematical problems and is an evolving subject.					
3	Mathematics is a tool required to find a solution.					
4	Children can acquire new concepts in mathematics through connecting it with their environment, e.g., by playing games.					
5	Mathematics is exact and there is no scope for error.					
6	Routine practice of mathematical rules is the best way to learn mathematics.					
7	Strong relationships between old mathematical concepts are the true meaning of mathematics.					
8	A child can solve mathematical problems by various methods, not only through memorising.					
9	To find a solution for a mathematical problem, one must always follow the rules.					
10	Mathematics, for me, means using the correct method developed by scientists and inherited from long ago.					

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

Part IV: Teaching Mathematics Attitude.

The following are statement on teaching mathematics, about which your opinion is sought. Please indicate the extent to which you agree or disagree with the statements by circling the relevant answer.

AS Agree Strongly
AG Agree Generally
AL Agree a Little
UN Undecided
DS Disagree Strongly
DG Disagree Generally
DL Disagree a Little

No	Statement	AS	AG	AL	UN	DL	DG	DS
1	Generally I feel secure about the idea of teaching mathematics.							
2	Of all the subjects, mathematics is the one I worry about most in teaching.							
3	It would make me happy to be recognised by other teachers as an excellent teacher of mathematics.							
4	I would get a sinking feeling if I came across a hard problem while teaching mathematics at practice teaching.							
5	I'd be proud to be the outstanding teacher of mathematics amongst my peers.							
6	The thought of teaching mathematics makes me feel restless, irritable and impatient.							
7	I would like the school pupils to recognise me as a good teacher of mathematics.							
8	I am confident about the methods of teaching mathematics.							
9	Teaching mathematics at practice teaching makes me feel nervous.							

AS = Agree Strongly AG = Agree Generally AL = Agree a Little UN = Undecided
DL = Disagree a Little DG = Disagree Generally DS = Disagree Strongly

No	Statement	AS	AG	AL	UN	DL	DG	DS
10	Being an outstanding teacher of mathematics would make me feel unpleasantly conspicuous.							
11	I have a lot of self-confidence when it comes to teaching mathematics.							
12	The thought of teaching mathematics makes me feel nervous.							
13	My peers would think I was strange if I was an outstanding teacher of mathematics.							
14	I feel at ease when I'm teaching mathematics at practice teaching.							
15	I would not want to let on that I was good at teaching mathematics.							
16	I enjoy the challenge of teaching a new and difficult concept in mathematics.							
17	I'm not the type of person who could teach mathematics very well.							
18	Time passes quickly when I'm teaching mathematics at practice teaching.							
19	Teaching mathematics at practice is enjoyable and stimulating to me.							
20	Mathematics is the subject I'm least confident about teaching.							
21	Teaching mathematics doesn't scare me at all.							
22	I like teaching mathematics at practice teaching.							

AS = Agree Strongly AG = Agree Generally AL = Agree a Little UN = Undecided
DL = Disagree a Little DG = Disagree Generally DS = Disagree Strongly

APPENDIX 2

Appendix 2 (a)

Pilot Study

Questions in the Kuwaiti Mathematics Student Teachers' Focus Group

The Purpose of the Focus Group:

To develop a new scale designed to understand Kuwaiti student teachers' beliefs about the nature of mathematics. The aim is to collect information about their opinions on the nature of mathematics and to write up the items of the beliefs about the nature of mathematics scale.

In this focus group there were major questions and a number of minor questions:

Major Question

1. In your opinion, what is mathematics all about?

Minor Questions

1. How would you define mathematics?
2. Is mathematics similar to other subjects in our life?

3. How is mathematics different from other subjects? If it is, can you cite some examples?
4. Is mathematics a creative subject?
5. Does mathematics need certain skills?
6. What types of skill do you think are best for pupils to use in learning mathematics, e.g. memorising, discovery, and solving problems? Why?
7. Can the children learn mathematics by seeing a movie or solving puzzles?

Major Question

1. How should we learn mathematics?

Minor Questions

1. Should children follow specific rules to solve mathematical problems?
2. When you were in primary school, how did you learn mathematics?
3. Should children memorise facts to learn mathematics?
4. Does solving puzzles help children develop their thinking?

Appendix 2 (b)

Main Study

Questions in the Kuwaiti Student Teachers' Focus group

The Purpose of the Focus Group:

To assess and evaluate the three scales used in this study: the MAS, the TMAS, and the BNMS. The aim is to understand more about the Kuwaiti student teachers' opinions on the nature of mathematics, and their attitudes toward mathematics and, the teaching of mathematics.

Group One:

Focusing on their beliefs about the nature of mathematics.

Questions

1. In your opinion, what is mathematics all about?
2. How would you define mathematics?
3. From the following three statements which one you prefer to choose?
    - Mathematics involves continues discussion to solve mathematical problems.
    - To find a solution to mathematical problem always follow the role.
    - Mathematics is exact and there is no scope for error.

4. Do you think that mathematics is a creative subject like writing a poem?
5. Is mathematics similar to other subjects in our life?
6. Does mathematics need certain skills to solve mathematical problem?
7. Does mathematics a changeable subject or is it a constant subject?
8. How should we learn mathematics?
9. Do you agree that there is one way to solve mathematical problems that has been used since a long time ago?

Group Two:

Focusing on their attitudes regarding mathematics and their teaching of mathematics.

Questions

1. Are you confident in doing mathematics, especially the advanced mathematics course?
2. Does the mathematics course enhance your learning of mathematics or teaching of mathematics?
3. Do you think you are confident in teaching mathematics to primary pupils?
4. Is this work enjoyable? If so, why?
5. Is this subject useful and important in your daily and future life?

Group Three:

Focusing on Gender issues in mathematics and the teaching of mathematics.

Questions

1. Do you think that teaching mathematics is a woman's job? If so, why?
2. Who would you prefer to see teaching mathematics, a woman or a man?
3. As a female or male student teacher do you like to be observe as a good teacher in the future? Why?

Appendix 2 (c)

Main Study

The Interview Questions with the Instructors

The Purpose of the Interview:

The purpose of this interview is to investigate the instructors' beliefs about the nature of mathematics and their students' attitudes toward mathematics and the teaching of mathematics. The aim is to understand more about Kuwaiti student teachers' beliefs and attitudes, and to view their beliefs and attitudes from another angle.

The following are the major questions:

1. In your course do you explain the different views about the nature of mathematics?

2. Do you think that your beliefs about the nature of mathematics in some way affect your attitude toward mathematics? E.g., if you believe that mathematics is a matter of problem-solving, will you be more confident in mathematics or teaching mathematics?

3. Do you think there is a relationship between student teacher attitude toward mathematics and its teaching?

4. Do you think that your beliefs about the nature of mathematics influence your teaching of your students?

5. If you look to the gender issues, which, as you know, is a sensitive issue in mathematics education, is there a difference between males and females in their confidence in teaching mathematics, and their enjoyment or in the subject?

6. Do you think that male like to be recognised as good teacher more than female?

7. From the statistical table about the number of students enrolled in this major we notice that most of them are women! Why do you think this is so?

8. From your experience, do you believe that the mathematics courses increase the confidence of the students in learning or teaching mathematics? If yes, why?

9. Do you think the number of mathematics courses is enough for these student teachers to master sufficient mathematical knowledge to equip them as future mathematics teachers?

APPENDIX 3

Appendix 3

Letter to Participants in the Study

Dear Mathematics Teacher,

As I prepare for a doctoral research in Mathematics Education at the University of Manchester in the United Kingdom, I am gathering data for my research which concerns measuring the beliefs about the nature of mathematics. One goal of this research is to bring about future improvements in the field of mathematics education in the higher education in the State of Kuwait. The success of a considerable part of this research rests upon your contribution as a mathematics teacher in answering the attached questions.

Your honest and serious answers to this questionnaire will contribute significantly to both the validity and the accomplishment of this research. After reading a brief explanation about the three views, you are asked to choose and link the item to the relevant belief view, and the data obtained will be used only for the purpose of the research.

Should you desire, a summary report of the research findings will be made available to you upon completion of the research.

Thank you for your co-operation, assistance, and the time devoted.

The Researcher

Noha Alrwaished

Introduction

Ernest, one of the writers in the mathematics education, propounded one of the classifications of the nature of mathematics. He defined, first, the problem-solving view, second, the Platonist view, and, third, the instrumentalist view. Ernest (1989a) defined them as follows:

> First of all, there is a dynamic, problem-driven view of mathematics as a continually expanding field of human inquiry. Mathematics is not a finished product, and its results remain open to revision (the problem-solving view). Secondly, there is the view of mathematics as a static but unified body of knowledge, consisting of interconnecting structures and truths. Mathematics is a monolith, a static immutable product, which is discovered, not created (the Platonist view). Thirdly, there is the view that mathematics is a useful but unrelated collection of facts, rules and skills (the instrumentalist view) (Ernest, 1989, p.21).

He identified the impact of beliefs on teaching represented and summarising in the following Table:

View of Mathematics	**Model of Teacher**	**Intended Outcome**
Instrumentalist	Transmission	Child's compliant behaviour and skills mastery.
Platonist	Explainer	Learning as the reception of knowledge.
Problem-solving	Facilitator	Learning as autonomous problem posing and solving, and as the active construction of understanding.

Choose the right view for each item you think mach the best:

Item	Platonist	Instrumentalist	Problem -solving
Mathematics is a creative and broad subject connected with most sciences.			
Mathematics involves a continuous discussion to solve mathematical problems and is an evolving subject.			
Mathematics is a tool required to find a solution.			
Children can acquire new concepts in mathematics through connecting it with their environment, e.g., by playing games.			
Mathematics is exact and there is no scope for error.			
Routine practice of mathematical rules is the best way to learn mathematics.			
Strong relationships between old mathematical concepts are the true meaning of mathematics.			
A child can solve mathematical problems by various methods, not only through memorising.			
To find a solution for a mathematical problem, one must always follow the rules.			
Mathematics, for me, means using the correct method developed by scientists and inherited from long ago.			

APPENDIX 4

Appendix 4

Explanation for the Interviews' Coding

S= Student Teacher

I= Instructor

F= Female

M= Male

L= Class Level

-------------------------------- Example:

> When I thought about after graduation and being a mathematics teacher I be nervous. I know that teaching children are enjoyable job but mathematics is a difficult subject to teach. I'm worried from that. **(S5, F, L2)**

(S5, F, L2) that mean this statement was said by student teacher number 5, she is a female, and studying in the third year at the college.

APPENDIX 5

The Distribution of Using Interviews' Statements in the Sub-Scale by Distribution of Groups

Scale	Sub-scales	Group 1	Group 2	Group 3	Group 4
BNMS	Platonist View	Yes	No	Yes	No
	Instrumentalist View	No	Yes	Yes	No
	Problem-solving View	No	No	Yes	Yes
MAS	Mathematics Anxiety	Yes	Yes	No	Yes
	Confident in Learning	Yes	No	Yes	No
	Male Domain	No	Yes	Yes	No
	Mathematics Usefulness	No	Yes	No	No
TMAS	Teaching Anxiety	Yes	No	No	Yes
	Confident and Enjoyment	Yes	Yes	Yes	Yes
	Pressure to Confirm	No	Yes	No	No
	Recognition Desire	Yes	No	No	Yes