

Chapter Four

Findings of the Study

This study aims to investigate the changes and developments witnessed in curriculum of mathematics Education, which were approved by the Ministry of Education (MOE) in Jordan during the period 1964-1999. This chapter presents the findings of the study. The response and opinion of interview samples (decision-makers, curricula-experts, teachers and supervisors) to the items of a study tool as well as the results of content analysis of Mathematics curricula in light of Principles and content Standards are presented according to the study questions.

4.1 The First question:

What developments have the learning objectives of mathematics curricula in Jordan witnessed during the period 1964-1999?

The learning objectives, which includes mathematics curricula described according to the development through three sub-periods and a summary of the opinion of interview sample described, as follow:

4.1.1 Development of learning objectives of mathematics during the period 1964-1972.

- *Analysis of MOE documents*

There are two documents of curriculum issued by the Ministry of Education(MOE, 1965; 1971) on teaching mathematics during this period. The first document is for compulsory stage students and the second document is for the secondary stage students (See appendix:1).

- ***Learning objectives of the compulsory stage during the period 1964-1972 (MOE, 1965)***

The *compulsory* stage consists of two educational stages, elementary and preparatory. The elementary stage includes grades 1 through to 6, while the preparatory stage includes grades 7 through to 9. The general aims of teaching mathematics for compulsory stage (1 to 9 grades) includes (see appendix 2):

1. Providing students with mathematical knowledge through the acquisition of arithmetical skills.
2. Memorizing the facts and concepts mentioned in the mathematical content.
3. Developing the ability of logical thinking, enabling students to use numbers and comprehend relationships between them through comparison and contrast and to use them in their daily lives.
4. Developing the ability to use proofs in justify the validity of geometrical facts.

- ***Learning objectives of the secondary stage during the period 1964-1972 (MOE, 1971)***

This stage consists of the first to the third secondary grades. The document of secondary stage concerning teaching mathematics to the students, which includes the following general aims:

1. Providing students with mathematical knowledge and helping them to acquire this knowledge.
2. Understanding the logic of the mathematical structure and the nature of direct and indirect proof.
3. Utilizing the ability of arithmetic skills

On investigation of the two documents, it appears that the aims of teaching mathematics are characterized by ambiguity, focusing on the cognitive domain and ignoring the affective and psychomotor domains. In addition, neither of the documents identified the general aims of teaching the topics forming the various branches of mathematics, nor any indication of the specific objectives related to the mathematical content of each of the branches of mathematics for any class in the educational stages, whether in the compulsory or secondary stages.

It was also noticed that neither of these documents demonstrated how to achieve the aims of teaching mathematics to students in the different educational stages. In addition, there was lack of attention to the correlation between the aims of teaching the various branches of mathematics, (arithmetic, algebra, geometry, trigonometry etc) to the same level or across the different educational stages. Moreover, the aims did not take into account the needs and capabilities of the students. Additionally, the aims of mathematics instruction in Jordan during this period did not follow international developments in this area, which were focusing on mathematical structures, the unification and integration of mathematical topics and the introduction of unified concepts such as the set, group, relation and the function and reducing the focus on Euclidean geometry and trigonometry topics.

- ***Results of the interview related to the learning objectives during the period 1964-1972, (see appendix:9).***

The interview included view/opinions of decision makers in the Ministry of Education as to these learning objectives and showed that the learning objectives during the period 1964-1972 were ambiguous in respect to both the teacher and learner being limited and narrow by their concentrating on memorizing the mathematical facts and concepts introduced in the school text books; mastering arithmetical skills, ignoring the applied aspect of mathematics, concentrating on the cognitive aspect and on the logical sequence of the mathematical material(see appendix:9).

The opinions of curriculum experts, teachers and supervisors (see appendix 9) indicated that the general learning objectives of teaching mathematics during this period, concentrated on the cognitive dimension (the educational material) represented by the text books and helping students to acquire this knowledge, concentration on mathematical skills and understanding logical structure of the mathematical knowledge. Also, the special learning objectives of teaching mathematics weren't identified for all grades of the different educational stages.

4.1.2 Development of learning objectives of mathematics during the period 1972-1987.

- *Analysis of MOE documents*

As mentioned, during this period the Ministry of Education issued two documents for teaching mathematics (MOE, 1984 A; MOE, 1984 B),(see appendix: 1) . The first document was for the elementary stage, grades 1 through to 6 and the second document was for the students of preparatory and the secondary stages.

- *Learning objectives of the Elementary Stage during the period 1972-1987, (MOE, 1984 A).*

The document of the mathematics curriculum for students of the elementary stage included the general aims of teaching mathematics (see appendix:3), there were:

1. Understanding the meanings of the terms, definitions and notions on which the fundamentals of arithmetic and geometry are based.
2. Developing pupils' abilities to utilize arithmetic and geometric facts, concepts and skills in real life situations.
3. Developing the capability of logical thinking by using numbers and comparing principles, as well as recognizing the relations between numbers.
4. Providing students with the necessary degree of mathematical skills and experience for them to succeed in other fields of learning and in pursuing their current studies.
5. Developing personal attributes through coordination, accuracy, patience, the enjoyment of achievement and the integrity of performing to the best of their ability.
6. Acquiring self-confidence and good behavior in diverse situations.

The documents for the elementary stage, also included the specific objectives related to the mathematical units of content, in each of the elementary stage curricula (grades 1 through to 6), according to the elements of the mathematical content (concepts and symbols, generalization and skills) and topics of the mathematical content represented by the natural numbers, number theory, operations on natural numbers, properties of

operations, fractions and operations, measurements and geometrical concepts and problem solving.

- ***Learning objectives of the Preparatory and Secondary Stage during the period 1972-1987, (MOE, 1984 B).***

The general aims of teaching mathematics at the preparatory and secondary stages included in the document (see appendix 3), concentrated on understanding the nature of mathematics as an organized structure of knowledge, being familiar with the language of mathematics and its characteristics as well as the role played by symbols. This is represented by:

1. Concentration on abstraction through mathematical topics
2. Familiarization with the techniques of information organization such as statistical means and operational flow-charts
3. Developing computation skills utilizing a variety of different means and providing students with the mathematical knowledge necessary for pursuing university studying.
4. Developing the capability of logical thinking and mathematical proof.

In addition, the curriculum document of the preparatory and secondary stages, included special behavioral objectives related to concepts, generalizations and basic skills in conjunction with the topics of the educational units taught to each grade, in accordance with the fields in which the mathematical content is based (see appendix 3). These are represented by:

1. Primary fundamental concepts.
2. Sets of numbers (natural, integers, proportional and real).
3. Mathematics and algebraic operation.
4. Various concepts in geometry.
5. Equations and inequalities.
6. Logic and proof techniques.
7. Mathematical structures.
8. Statistics and probability.
9. Special functions.
10. Mathematical analysis (calculus and its applications).

With the analysis of the contents of the two Ministry of Education documents on mathematics curricula the following observations were made: In the document covering the period 1972-1987, the teaching aims were stated more clearly than in the previous document. The Elementary stage curricula document (grades 1 through to 6) included and identified the general aims of the compulsory stage as well as the general aims of the elementary grades (1 to 6); Also, the aims included the three cognitive domains: mental, affective and psychometric. The curriculum for each grade consisted of a number of units dealing with a topic and each containing the relevant mathematical content and stated educational objectives. Moreover, the document included the allocation of a certain number of lessons per week for teaching this mathematical content, throughout each of the different educational grades (see appendix: 3).

The analysis of curricula for both elementary (1-6) and preparatory (7-9) stages, showed that the general and special aims of teaching mathematics did not include any indication of the need to consider the pupils' individual differences while teaching. As for the aims of the educational content included in the curriculum document, it can be said that they were in line with the international development in the integration and unification of the different branches of mathematics and the implication of modern topics to be taught in the secondary stage such as: probability, sets, correlation, functions, etc.

- ***Results of the interviews related to the learning objectives during the period 1972-1987, (see appendix 9).***

The interviews with the decision-makers (Al-Massray ; Hiyasat,) and the curricula experts described the method adopted by the developing curricula, during this period. This method included procedure followed for curriculum development: identifying the aims for the educational stage, then the special learning objectives for each grade of the educational stage and following this, by identified the special learning objectives of each unit of that curriculum and grade of the stage (see appendix:9).

Furthermore, the integration of the mathematical topics (arithmetic, algebra, geometry) was taken into consideration, so that the emphasis was on the general concepts that link the branches of mathematics. These were being looked upon as a united

construction based on a number of fundamental concepts such as sets, relations, functions and operations, in addition to the main structures that could be built from these concepts.

In light of this, concentration was directed towards teaching these structures such as the concepts and properties of group, ring and field and including them in the educational curricula.

As for the results of the interviews with teachers and mathematics supervisors and curricula experts (Joum'ah,; Al- Ssmady; and Al Zuobi), their points of view showed that the general aims needed to be identified and clarified; despite dealing with the three cognitive domains: cognitive, affective and psychometric, the focus was on understanding the mathematical structure throughout the various grades and the terms of the curricula content. Also included in their comments was the need for students to acquire concepts and mathematics facts and skills in the fields of statistics and probability, through the topics included in the content of curricula for grades 7-12. In addition to this they indicated that the time allocated to achieve the special objectives of teaching the content to some grades, throughout the different educational stages, was unrealistic (see appendix: 9).

4.1.3 Development of learning objectives of Mathematics during the period 1987-1999.

- Analysis of MOE documents

During the period 1987-1999, there were two documents of curricula issued by Ministry of Education (MOE, 1991; 1993) concerning to the teaching of mathematics. The first document was for the Basic stage (grades 1 to 10) while the second document was for the secondary stage (grades 11 and 12), (see appendix: 1).

- Learning objectives of the Basic Stage during the period 1987-1999, (MOE, 1991).

The aims of the mathematics curricula for the basic education grades (1-10) included dividing the general aims of the curriculum into four fields: Concepts and

mathematical information; mathematical skills; improving thinking and problem solving techniques, and positive tendencies and attitudes towards mathematics (see appendix 4).

As for the special learning objectives, these are divided into three sub-domains: communication, mathematical thinking and basic mathematical skills and the affective domain. Both the general and special aims focus on developing higher mental skills such as the forming and testing of hypotheses, analysis and induction patterns, exploring patterns and inference, application and proof; asking questions, representing and interpreting data; and the association between mathematical concepts (see appendix 4).

The curriculum document also included detailed schemes of educational units through each grade, including the special objectives of the topic elements contained in the units.

- ***Learning objectives of the Secondary Stage during the period 1987-1999, (MOE, 1993).***

The general aims of learning mathematics contained in the curriculum document for the secondary stage, concentrated on developing mathematical communications skills, exploration and creativity, conclusion and prediction, judging and decision making, logical thinking, assigning variables in different situations and comprehending relationships between them. This is done through providing students with information, concepts and skills needed for their current studies, university studies and in pursuing academic and technological developments, as well as in the fields of applied mathematics in different disciplines (see appendix 4).

The special objectives of mathematics curricula for the secondary stage grades (11-12) contain detailed schemes of teaching units that include behavioral objectives related to each of the grade's units. The first secondary grade curriculum includes objectives relating to the domain of algebra represented by: real numbers, bases, logarithms, methods of counting and binomial theorem, sequences and series; the domain of geometry, it is represented by: vectors in the plane and in space and their applications; the domain of triangles it included triangular laws; identities and triangular formulas;

and in the domain of statistics and probability; samples, natural distribution, correlation and regression and regular numerical.

The curriculum of the second secondary grade included on the special behavioral objectives associated with complex numbers in the domain of algebra, conic sections and polar coordinates in the domain of geometry; law of sine, cosine, solution of plane triangle and applied problems in two and three dimensions in the domain of trigonometry. In the domain of statistics and probability the aims include conditional probability and independence, distribution probabilities, random variables, density function of probability and expectation (see appendix 4).

Finally, in the domain of calculus, the aims include limits and continuity, different applications of calculus and applications of integration.

Through inspection of the curriculum document for the Basic stage grades (1-10) it becomes clear that the aims of mathematics teaching during this stage have the following characteristics:

1. They are clearer, with the general and special aims of teaching mathematics being more detailed than in the previous periods, defining the aims through mathematical knowledge.
2. Deciding the minimum acceptable percentage of achieving each aim, in all curricula in the educational stage (grades 1-10).
3. The aims include familiarization with the fields of applied mathematics and employing them in everyday life, by concentrating on solving mathematical problems through the topics in the curriculum.

The mathematics curriculum document for the secondary stage (grades 11-12) does not contain the details seen in the Basic stage curriculum document, being restricted instead to detailed schemes of the educational aims contained within the mathematical content of the educational units, throughout the curricula of the grades in the educational stage. However, the aims of teaching mathematics in the secondary stage observe the individual differences between students, through various teaching and learning activities. It was also noticed that there is a weakness in the connections between the aims that are contained within the two curricula documents, with respect to the mathematical topics across the curriculum content for grades of stages.

- ***Results of the Interviews Related to the learning objectives during the Period 1987-1999, (see appendix 9).***

The results of interviews with the decision-makers and the curricula experts (see appendix 9) in the Ministry of Education show that, in their opinion, the stated aims are clearer than those of previous periods and that they cover the domains of cognition in a better manner.

Due to the availability of political support the follow-up of the stages of development by the political leadership in Jordan; the participation of local universities, international Organizations, professional communities and parents. Consequently, aims are concentrated on higher mental skills of thinking, critical thinking and problem solving.

As for the interviews with teachers and mathematics supervisors (see appendix: 9), their points of view indicated that the aims are clearer for both the teacher and the learner; they concentrate on developing higher mental skills of thinking and the scientific method in thinking; they are in line with the modern aims of teaching mathematics, in light of Jordan's limited resources, through focusing on problem-solving in most of the topics contained in the curriculum. Furthermore, the special objectives of the content were taken into consideration the scope and sequence of mathematical knowledge through the school grades (see appendix. 4).

4.2 The second question:

What developments have the mathematical content of mathematics curricula in Jordan witnessed during the period 1964-1999?

In order to investigate the developments that the mathematics curricula in Jordan have witnessed during the period 1964-1999 and to answer this question, the researcher has analyzed the content of mathematics curricula documents determined by the Ministry of Education for this period. The results of analysis process will be presented as follows:

- Analyzing the curriculum documents during the period according to the “Principles of NCTM for School Mathematics” (see appendix 10).
- Analyzing the curriculum documents during the period according to the “Process Standards of NCTM for School Mathematics” (see appendix: 10).
- Analyzing the curriculum documents during the period according to the “Content Standards of NCTM for School Mathematics” (see appendix 10).

4.2.1 Results of Analysis mathematics curriculum according to the Principles of NCTM for school mathematics (see appendix 10).

This study aims to investigate the changes and developments witnessed in mathematics curriculum, in Jordan during the period (1964 -1999) according to the “Principles for School Mathematics”, issued by NCTM (2000). The principles will be described and compared according to the division of the whole period into the three sub-periods as follows:

1. The first period 1964-1972
2. The second period 1972-1987
3. The third period 1987-1999

- *The Equity principle*

On investigation of the curriculum documents during the first period, it appears that the document neither includes or indicates the taking into consideration of the support or the opportunity for students who are achieving high levels of achievement. Nor did

it offer interesting instructional programs for each different group of students. Also the curriculum document did not include enrichment programs or additional resources for talented students, or for those with disabilities.

Moreover, the resources and support for the classroom and students represented by curriculum material (textbook), traditional and simple instructional tools, as well as the qualifications and professional development of teachers, not being required to help and understand the students needs who have specific disabilities or possess talent in mathematics, because there are some teachers who are not specialized in teaching the mathematics subjects.

The curriculum document of teaching mathematics during the second period 1972-1987 did not include or indicate the taking into consideration of supporting or determine the oportunities for students who are achieving a high level of achievement. Neither did the documents include enrichment programs or additional resources for talented students or those with difficulties. Curriculum material was represented by textbook, traditional and simple instructional tools, all of which were used as resources and support for classroom and students.

But the MOE during this period had conducted various educational reforms (MOE, 1980), which were considered as being a spark in the development. Through conducting the training courses for all students, which included a review of mathematics topics as a result to the weakness of students in mathematics achievement. Preparing and qualifying teachers through conducting training courses on the method of teaching the content of the new curriculum. By taking into consideration the growth stages, scope and sequence, connection and integration between the mathematical topics through the process of designing the textbooks. Preparing and issuing manual for the teachers of the preparatory stage, which consisted of samples of tests for some mathematical topics in individual grades. Also the MOE used educational T.V in presenting some lessons of mathematics for grades, particularly the grades of the secondary stage.

During the period 1987-1999 the MOE had done various educational reforms (MOE, 1988) which included the inputs, the processes and the outputs of the Educational System construction. The curriculum document of teaching mathematics includes guidelines indicated to promote students thinking, address their needs and individual differences and build up their conceptual understanding and linking their learning to every day life. However the guidelines did not explain the meaning of these

orientations, nor discuss how these were to be reflected in the curriculum designed for the different grades. Neither did the guidelines explain or give any treatment as how to develop the individual differences and thinking skills.

According to the supporting and determining opportunities for students who are talented and achieve high levels in learning mathematics, the MOE looked after this sample of students through establishing and founding the pioneer centers for gifted students; providing the textbooks with advanced questions and mathematical problems for each lesson or topic. For the students who have difficulties the proposals were limited to categorizing the exercises and questions in the textbooks into three levels. MOE supports classroom by supplying curriculum material (textbooks), instructional tools such as overhead projectors, educational T.V and video and invited the teachers to provide the library (of schools) with the suitable mathematical resources. As well as training courses conducted for teachers in methods of teaching the content of the new curriculum, procedures of looking after with the individual differences, developing critical thinking skills, steps for problem solving, investigation skills, diagnostic evaluation and the procedures of treatment the difficulties and weakness in mathematics, also training courses on how to build a test in a valid method and how to assess the higher cognitive level.

- *The Curriculum principle*

The curriculum document for teaching mathematics in Jordan during the first period includes different topics, but these topics were not interconnected and the coherency between mathematical topics took into consideration. However the linking of mathematical topics was weak and the mathematical thinking and reasoning skills were neglected, among the curriculum document. The connection was not as well as possible among the branches of mathematical topics. The curriculum document did not focus on the concepts or mathematical ideas, which are considered the basis for developing problem solving within or outside mathematics. Moreover, the articulation of mathematical topics across all grades of educational stages did not adequately and the curriculum documents for teaching mathematics did not include on a guide to explain the scope and sequence the concepts, skills and mathematical topics, which would give teachers guidance regarding to the importance ideas and topics.

The curriculum document of teaching mathematics during the second period took into consideration, the linking of mathematical topics, unified between branches of teaching mathematics. The document also contained new concepts and topics in relations, functions, statistic and probability. The interconnection between the branches of mathematics, the lessons and the topics sequence coherently across the units of content each grade, but the integration between the mathematical topics across the educational stages did not following onto the grades affectively. The content of teaching mathematics was not focused on the basic skills or on presenting sufficient amount of activities and applications of mathematical knowledge. And although the content was plentiful with the abstract concepts and topics, the allocation of weekly mathematics periods for grades of educational stages were not sufficient.

Moreover, the display level of the mathematical content in the most cases came to converse the teacher, or the students who had higher than average achievement level, which meant the student could not read and understand alone these mathematical topics in most times.

The document of teaching mathematics contains a map explaining the distribution the topics and the sequencing of the concepts and skills across the grades, which means this articulation gives teachers guidance regarding the importance and the depth of concepts and skills or major topics.

The curriculum document for teaching mathematics during the third period, witnessed developments represented by focusing on the basic skills and connecting them with real life, concentrating on developing the students abilities on problem solving. The curriculum document also stayed as much as possible away from the abstract concepts, which related to the functions, relations, mathematical systems and groups; by increasing the allocation of weekly mathematics periods with average one period weekly for each grade. The document of teaching mathematics included a map to explain the articulation topics among the content, to give teachers guidance regarding to the important concepts and mathematical topics and sequencing the topics of content across the grades. The mathematics curriculum was also designed and built the content according to the same basic strands or key axes that were identified and revisited in progressive grades, thereby giving the curriculum a spiral organization. On investigation of the curriculum documents it appears that the integration was not as well done as it could have been, among the mathematical content of the grade or the all stage, thereby the lack of linking of the basic strands or key axes. The process of

organization and display the mathematical content of curriculum characterized in designing the content for all grades, not as the previous periods were designed separately for grades of each stage.

- **The Teaching principle**

The teaching of mathematics during the first period was not effective, because some teachers who taught mathematics were not specialized in the subject, therefore, they did not understand the deep knowledge, the curriculum goals, the knowledge about how mathematical ideas can be represented to teach its effectively and those ideas can be able to represent mathematics as a coherent. Also, the teachers role during this period focused on explaining and teaching the mathematics to the students in a sufficient.

The actions of teachers did not encourage students to think, ask questions, solve problems or discuss their ideas, strategies and solutions. This way due to student role being manner to receive the mathematical knowledge and recognize it, into able passes the examination. Neither did the teachers analyze what students were doing or consider how those actions are effecting the students learning, but the improvement of teaching mathematics and students progress was measured through the success in the achievement of passing the examination.

Teaching mathematics during the second period, witnessed a kind of development as a result of the entrance of modern mathematics and the change of the mathematics curriculum. So the effects of mathematics teaching was not as successful as had been expected, because there was still a group of teachers teaching mathematics until the beginning of the 1980s, who were not specialized in the subject. Although, the MOE trained teachers on the methods of teaching the new content of the modern mathematics curriculum, the styles and strategies for helping students to learn particular mathematical ideas, which used by the teachers were limited on the traditional methods which aimed to reach and provide students with the mathematical knowledge as in the textbooks.

During this period the MOE in Jordan, looked after the student, the stages of growth, methods of learning and giving them a special importance and considered them the center (one of the axes) of the educational process, but the teachers actions for encouraging the students to think, solve mathematical problems, discuss their ideas,

strategies and solutions were not as sufficient as expected. The MOE invited teachers to analyze what their students were doing and consider how these actions effected students ability to learn, all of which was to be a benefit to the teachers.

Teaching mathematics during the third period, became more effective compared to the two previous periods, because all teachers were specialized in teaching mathematics, moreover, the teachers had a deep knowledge about mathematics, the curriculum goals as well as knowing and understand in great depth the mathematics they taught and they could pass on their knowledge with flexibility in their teaching tasks.

The MOE trained teachers on different styles and strategies for helping students to learn the mathematical ideas. Although there is no one right way to teach, they encouraged teachers to use appropriate instructional tools and techniques, developing critical thinking, problem solving and adapting instruction to move toward the mathematical goals. The teachers roles through teaching mathematics aimed at looking after the students capabilities and abilities and encouraging them to think, ask questions, solve problems and discuss their ideas, strategies and solutions.

Teachers were also trained on the strategies of analyzing what the student was doing through the mathematics instruction. As well as trained to considering how these actions were effecting the student learning. The MOE also conducted a meeting, whereby they encouraged the collaboration between mathematics teachers to exchange views of teaching, observations, discussions on methods of teaching for students who have difficulties or progressive in mathematics.

- ***The Learning principle***

Mathematics education during the first period, focused through learning mathematics on the proficiency of arithmetical skills, so mathematics curriculum did not take into consideration neither the conceptual understanding in the mathematical knowledge and nor the activity of those who were proficient in the subject? So learning mathematics focused on using what students learn to solve mathematical problems were fixed in the textbook, not to solve the new kinds of problems they will faced in the future. The kinds of experiences which provide by teachers to students were not clear in determining the extent and quality of students learning and understanding the mathematical ideas, because the mathematical knowledge does not designed and builds

in a way to engage tasks and experiences, to deep students understanding of mathematical knowledge.

Mathematics education during the second period, took into consideration the importance of the conceptual understanding in the knowledge and activities of students who are proficient, through introducing a new content for mathematics curriculum. This knowledge was designed and built in spiral method to prepare students to solve mathematical problems and become proficient in mathematics; it also used the explorer method in presenting the content. Whereas, the content presentation in the textbooks was presented in a way over the students' capabilities to understand and continued learning by their selves. The mathematical knowledge which presented has decreased the students attitudes, confident in self learning of mathematics.

Therefore, the lack of proficiency in the teaching mathematics through the experiences and activities of the new mathematical content, due to the teachers following more traditional teaching methods and not using the new mathematics as designed in the textbooks, which was also reflected in the learning of students.

But mathematics education, in Jordan during the third period, focused on the conceptual understanding. The MOE designed and established the content of mathematical curriculum referring to developing the students abilities on problems solving, critical thinking and becoming proficient in solving problems ,which they will be faced in the future within or outside mathematics. Teachers have the knowledge of the mathematical content, what they are will teach the students, how to teach some of the mathematical ideas or topics and engaged with application approach and teachers trained on and provides with several methods of teaching.

- *The Assessment principle*

On investigation of the curriculum documents of teaching mathematics during the period 1964-1972, it appears that the mathematics assessment did not consider the integral part of classroom practice to enhance students learning and nor the assessment considered as a test give to students at the end of instruction to see how students perform under special conditions. So, teachers did not use assessment techniques such as observations, conversations and interviews with students, or the benefits for the students, from the feedback in making decisions about their students thinking, levels of proficiency and attainment or about the content or forms of instruction. Moreover, the

assessment methods that were selected by the teachers did not take into consideration the student age, experience and special needs related to the ability of some students.

But on investigation of the curriculum document of teaching mathematics, it appears that mathematics assessment during the second period (1972 – 1987) witnessed, in light of changing the curriculum content of teaching mathematics development. This included the introduction of new mathematical topics and required new methods of teaching and assessing the new content. In addition, the importance that was given to the individual student by the MOE in Jordan can be seen as one of the main input of the educational process. The new curriculum was followed by a short training course, conducted by MOE. And again the assessment methods that were selected by teachers did not give any consideration to the age, experience or special needs, related to the ability of the students. In spite of that teachers did not understand their mathematical goals depth and how the students felt about the subject, due to the weakness in the academic and educational preparing of teachers. And the results of educational research in Jordan indicated that most of the teachers qualification who taught mathematics in the preparatory stage were less than the bachelor's degree and in the secondary stage were bachelor's degree, or less than.

The methods of mathematics assessment during the third period (1987–1999) witnessed development and included programs for developing and preparing teachers and supervisors on how to construct tests that measure the higher levels of the cognitive objectives and focused on measuring the higher level of thinking skills. Mathematics assessment was considered an integral part of classroom practice to enhance students learning.

Furthermore, teachers and supervisors were trained on using and selecting such assessment methods as observation, conversation and interview with students. As well as shown how to prepare achievement and diagnostic tests and how to use the feedback from the assessment in analyzing and describing students responses and determining students' levels of proficiency, as well as how the classroom discussions could help students to understand the characteristics of the complete and correct response.

Remedial plans were set for manipulating students' weaknesses in Mathematics. The content of the textbooks contained models of achievement tests for all classes. One major development in the domain of assessment of students' achievements was Jordan's participation in the international study for evaluating the eighth grade students' achievement. This resulted in improving the mathematics' curriculum and

the methods used for teaching mathematics. As a result, remedial plans were put forward for helping the students' weaknesses in mathematics.

- ***The Technology principle***

On investigation of the curriculum documents during the period 1964-1999, it appears that the document neither includes or indicates supports or determines the opportunities for teaching or learning mathematics by using electronic technology.

The reason behind the complete neglecting was due to the use of computers and the teaching basic skills on the computer within the educational system in Jordan being relatively new.

Whereas, the MOE in Jordan started the experiment of teaching computer as a selecting material in two government secondary schools in the academic year 1984/1985, as much as one period every week for each grade and each school was supplied with 11 computers. A notebook to guide the teaching the basic skills, the experiment carried on within 6 schools in the next year 85/86 and in 86/87 30 schools were included with 22 schools supplied with only one computer. In light of the Jordanian government decision, the MOE appointed teacher for teaching this subject. Then teaching of the basic skills of computer was adopted by MOE as main material and generalized at all secondary schools during a period 1986 – 1990.

4.2.2 Results of Analysis mathematics curriculum according to the Process Standards of NCTM for School Mathematics (see appendix 10).

This study aimed to investigate the changes and developments witnessed which the mathematics curriculum in Jordan during the period 1964-1999, in light of the process standards for school mathematics issued by the NCTM (2000). The process will be described and compared according to the division of the whole period into the three sub-periods as follow: the first period 1964-1972, the second period 1972-1987, The third period 1987-1999. During each sub-period there were two documents of curriculum for teaching mathematics issued by the Ministry of Education in Jordan (MOE).

- *The problem solving*

On investigating, the Curriculum of teaching mathematics during the first period 1964–1972, it showed not enough consideration was given to the problem solving or giving students the chance to build new mathematical knowledge through the textbook. It also lacked the development of confidence in their abilities to explore and solve problems and did not encourage students to adjust to the new strategies which were to be used by students in problem solving. Whereas, the concentration came in the elementary school on mastering the arithmetical skills, the focus in middle grades has limited on problem solving through the topics in measurement, accounting for the simple and compound profit and solving mathematical problems in geometry topics through the content of the secondary grades.

Students rarely have any idea about problem solving, because the teacher presents the results of mathematical exploration in an organized and coherent fashion and the students task was to write these notes and solutions of mathematical problems in their notebooks.

The document of teaching mathematics during the second period 1972–1987, indicated and considered the role of the student as one of the main axes of the educational process. This was reflected in the design as well as presents in the new topics for teaching mathematics “the modern mathematics”, which included focusing on teaching the abstract concepts and topics. The content of teaching mathematics was represented in the textbooks for the 7th –12th grade, involved presenting the topics by using the discovery method, to build and develop students’ mathematical knowledge, but this method came to converse teachers and the students whose mathematical knowledge was above the average level. Consequently, this was reflected negatively in the students learning of, and interaction with mathematical content. Moreover, the focus on the abstract aspects through the content topics became more obvious than the mathematics applications or solving real life problems, as was as expected. Also, teachers taught the new content using traditional methods in presenting and explaining the mathematical content to students, because teachers did not understand the method which was used in constructing the new content of mathematics. In addition to this, teachers were not sufficient trained in methods of teaching the new content.

On investigating, the document of teaching mathematics during the third period 1987–1999, the guidelines of the curriculum indicated the consideration given to the

importance of teaching and learning problem solving, to give students the chance to build the new mathematical knowledge and to develop critical thinking skills. The mathematical content of the curriculum represented in the textbooks for all grades, was designed in a way as to cover and concentrate on problem solving as well as applying mathematics to real life problems. This was done by the textbooks giving examples and exercises involve all topics of content. Moreover, teachers of teaching mathematics trained in methods and strategies of teaching problem solving and how to help students to develop their confidence in their abilities to explore and solve problems and encourage students to adjust to the strategies which were to be used in solving the problems. As well as helping students to think systematically about possibilities, to organize and record their thoughts.

- **Reasoning and Proof**

The curriculum of teaching mathematics during the first period 1964–1972, does not take into consideration reasoning and proof as well as it could and does not focus on recognizing reason and proof as a fundamental aspect of mathematics or reflect the beauty of mathematics. Also, the curriculum of teaching mathematics does not focus on learning and testing the mathematical conjectures in the elementary school and the students at all grade levels did not learn to investigate the mathematical conjunctions by using the concrete material and other tools. Moreover, reasoning and proof was limited to proof theorems in geometry topics for only the high level grades.

The document of teaching mathematics during the second period (1972 – 1987), took into consideration the reasoning and proof for school grades 7 – 12, according to the method which was present in the content, to explore the mathematical conjectures. Whereas, the content of textbooks for these grades focused on the inclusion of the abstract conceptual through the mathematical systems and the activities of exploring and investigating the conjectures came over the level of the students understanding and converse the teachers level. Consequently, the mathematical content does not encourage or help students to develop and evaluate the mathematical arguments or proof, or to select and use various types of reasoning and methods of proof, as a result appeared the negative attitudes towards learning mathematics. However the content of the mathematics curricula for the elementary grades (1st-4th) included the teaching of investigation and testing, with use of the concrete material and other tools.

On investigation, the curriculum of teaching mathematics during the third period, the guidelines were orientated towards the importance of reasoning and proof as a fundamental aspect of mathematics for basic and secondary school and the students at all grades level, to promote students thinking skills and build their conceptual understanding and link their learning to every day life. But the document of teaching mathematics does not explain the meaning of these orientations, nor do they discuss how these orientations are to be reflected in the design of curriculum. In mathematics textbooks, students are introduced to mathematical concepts and procedural knowledge through activities; however, the induction of concepts and rules are done by the textbook and not by students.

The importance that was reflected by the aims and objectives of mathematics curriculum with respect to developing mathematical thinking skills was not represented well through the specific learning objectives of units, which the curriculum set out for all grades. The curriculum document does not include an outline (conceptual map) explanation in depth, scope or sequence of mathematical thinking skills.

- **Communication**

The curriculum of teaching mathematics during the first period 1964–1972 does not focus on communication as an essential part of mathematics education. On top of this the teachers did not help or encourage students to organize and enhance their mathematical thinking, through conversation, involving students in discussions or justifying solutions, especially where the ideas of these students may differ from classmates or the teachers.

Teachers did not focus in the early grades, on helping students explain their answers and describe their strategies, nor did they encourage students to ask questions, as far they were concerned students were there to receive and believe what they were taught.

The document of teaching mathematics during the second period 1972–1987, indicates the use of the mathematics language to express mathematical ideas while communicating with others and developing the understanding the nature of mathematics as an organized structure of knowledge and to acquire researching abilities , ask questions and to enhance creative thinking; but the curriculum did not explain or discuss how these changes were to be reflected the curriculum. Students

were not helped or supported, by being given the opportunities to use mathematical language, to express ideas, or to analyze and evaluate mathematical thinking and strategies of others. Teachers were not trained as well as on they could have been the skills, strategies and methods of how to organize, enhance, analyze and evaluate mathematical thinking through communication.

On investigation, the curriculum of teaching mathematics during the third period had witnessed development and appears to have taken into consideration the importance of communication as an essential part of mathematics education, also, the curriculum also identified the aims of mathematical communication for all educational stages, such as: organizing information in tables and graphs, using numbers to express quantities and measures, the use of symbols to express ideas accurately, to develop as well as provide skills needed in different situations, to draw conclusions and to pursue higher education. But the document of teaching mathematics did not explain the meaning of these orientations, nor do they discuss how these orientations were to be reflected in the designed curriculum.

During this period the MOE trained teachers and supervisors on how to use various methods of teaching the new mathematics content. Using methods such as strategy of problems solving, using directive explorative methods, investigating mathematical results, workshops for brainstorming and the method of cooperative learning, to achieve the objectives of the curriculum and develop the skills of critical thinking.

- **Connections**

The curriculum of teaching mathematics during the first period, focused on teaching concepts and skills in arithmetic, algebra and geometry. The logical ordering was used in organizing and building the content, but the curriculum did not include an outline (conceptual map) explaining the connection between the mathematical branches, nor did it support teachers with a clear view of understanding how mathematical ideas and topics interconnected and built on one another to produce a coherent whole. Also, apply mathematical topics outside mathematics does not take into consideration through the content of curriculum.

The document of teaching mathematics during the second period witnessed development through the unification and connection between the different branches of mathematics becoming one structure. The curriculum content took into consideration

how mathematical ideas and topics interconnected and built on one another to produce a coherent whole. This was shown through distributing the content according to ten concepts or fundamental cores, taking into consideration the scope and sequences among the school grades, according to level of mathematics with increasing the depth and detail. Whereas, teachers can understand and know the needs of their students as well as the mathematics that studies in the preceding grades and what they will study in the following grades.

On investigation, the curriculum of teaching mathematics during the third period had witnessed development and these changes were considered one of the fundamental cores of the modification and educational development process. The curriculum of teaching mathematics took into consideration how mathematical ideas and topics interconnected and how they built on one another to produce a coherent whole, through distributing the content according to a map explain the scope and sequence the mathematical concept among the school grades. It also provided teachers with the knowledge about the mathematical topics that were studied in the preceding grades and what the students would study in the following grades. Also, the curriculum of teaching mathematics took into consideration the connection, integrating and apply mathematics in context out side of the classroom.

- **Representation**

The curriculum of teaching mathematics during the first period showed to be poor on the mathematical representation among the display of the mathematical content. The mathematical ideas that presented through the activities did not include representations, to help, understand and explain these ideas to students. Neither did the mathematical content offer opportunities to students, to use, apply, or to translate among the mathematical representations to understand the mathematical ideas, or to solve problems. Whereas, the mathematical content focused on procedures of teaching the mathematical skills.

The document of teaching mathematics during the second period took into consideration the use of mathematical representations through presenting some concept among the content. The school textbooks of teaching mathematics in the elementary grades (1- 6), included representation for some concepts and mathematical ideas better than the representations that were presented in the textbooks of grades (7

to 12), because the content of teaching mathematics for these grades became focused on the abstract concepts and topics.

The mathematical content of elementary grades offered opportunities to the students to use mathematical representations among some topics, to use, apply, understand and translate the mathematical ideas among these representations to solve problems.

On investigation, the curriculum of teaching mathematics during the third period (1987–1999), it showed development; the mathematical content of teaching mathematics represented with school textbooks witnessed changes and development too. The guidelines and orientations of the curriculum document indicated a focus on use of problem solving, which was designed and built into the new mathematical content.

The content of teaching mathematics took into consideration the importance of writing and understanding representations of mathematical ideas, as well as offering the students the opportunities to recognize the connections among related mathematical concepts. The content also included some activities in applying mathematics to real life problem through modeling. Teachers were also trained on methods of teaching the new content, which focused on problem solving, investigation, developing thinking skills and the importance of using representations by students and how to encourage represent their ideas in ways that make sense to them.

4.2.3 Results of Analysis mathematics curriculum according to the “Content Standards” of the NCTM for school mathematics (see appendix 10).

To investigate the developments of mathematical content, the mathematics curriculum was analyzed according to the Content Standards of the NCTM for School Mathematics with the detailed results for each grade presented in appendix (5). The following chapter presents’ itself as a summary for all the grades according to the documents of mathematics which were identified by the MOE during the three sub-periods as following:

1. ***Mathematical Content analysis of mathematics curricula during the period 1964-1972, (see appendix:5).***

The first period consisted of two documents (MOE, 1965; 1971) on the teaching of mathematics curricula: the first document was for the compulsory stage (grades 1-9) and the second document was for the secondary stage (10-12 grades), (see appendix 1). The content standards which were included in the document issued by the NCTM came to describe the standards of content among the grades, through four stages: the first K-2 grade, the second 3-5 grade, the third 6-8 grade and the fourth 9-12 grade (see appendix 10). The results of the mathematical content analysis of the mathematics curriculum of the two documents, will be described as a summary according to the standards of the analysis revealed with the following characteristics:

- ***The mathematical content analysis of mathematics curriculum for the compulsory stage (see appendix:5).***

The results of content analysis exhibited in appendix (5) for the compulsory stage (grades 1-9) showed the characteristics of the mathematical content. It was noticed that the characteristics of content for the grades 1-4 included the concentration on teaching the mathematical concepts and skills associated with the standards of the content:

Numbers and operations: the content included was as follows:

- Reading and writing numbers, counting, ordinal numbers.
- The place value of a number.
- Matching number with symbol, comparing and ordering numbers.
- The four fundamental operations on numbers.
- Common and decimal fractions (reading and writing).
- Properties of operations on decimal fractions (addition and subtraction).

Measurement: the content included the following: Recognizing concepts and relationship between the units of measurement systems length, weight, time, capacity, currency, angles and utilizing the standard and non-standard measuring units in the solving problems.

Geometry: the curriculum content included: the Recognition of on the geometric shapes such as; circle, square, rectangle, triangle and drawing straight lines and shapes with a ruler.

But the content of mathematics curriculum for grades 1–4 did not include teaching concepts and skills according to the numbers theory, statistic and probability.

The content analysis of mathematics curriculum for grades 5-9, according to the standards of content, concentrated on the following:

Numbers and operations:

the content concentrated on fundamental concepts, skills and facts, such as:

- Using properties of operations on numbers, common and decimal fractions.
- Utilizing the rules of operations in solving numerical and fractional problems.
- Investigating relationships between fractions, percentages.
- Rounding numbers: to one or two decimal places or the nearest ten.
- Applying concepts and rules of ratio, proportion and percentage in solving problems related to buying and selling.

Geometry:

The curriculum content included focusing on:

- Recognizing geometric shapes and their characteristics.
- Drawing, describing and comparing geometric shapes.
- Discovering and applying geometric relationships in solving problems.
- Proving some geometric facts and theorems.

Algebra:

The curriculum content included teaching the concepts of:

- variables, algebraic expression, equations.
- fundamental operations on algebraic expression.
- linear and non-linear equations.
- applying algebraic techniques to solve various mathematical and daily problems.

But the content of mathematics curriculum for grades 5 – 9 did not include the study of concepts and properties of solving inequalities in accordance with the algebra standard.

Measurement:

The curriculum content included:

- Recognition of the units of measurement systems.
- Relationship between units.
- Conversion between measurement units.

Moreover, the analysis results showed that the mathematical content of the curricula for grades 5-9 included learning simple concepts and skills through the relations, functions, trigonometry and the numbers theory.

But the curriculum content for grades 5–9 did not introduce any concepts or skills for teaching through the (statistics and probability) Data Analysis and Probability standard.

It is clear from the process of content analysis of the mathematics curriculum document for the compulsory stage, that the distribution of mathematical topics among the standards of content, did not take into consideration the scope and sequence, nor the connections between concepts and skills in a logical progression through the grades. Nor was there adequate focus on fundamental skills such as estimating and approximation, these concepts were restricted to the students of the first grade (7th grade) of the preparatory stage in learning Rational Numbers.

The curriculum document did not include an organizational framework that explained scope and sequence, inter connection of mathematical topics with each other, or topics association through the grades. The organization and exhibition of the content did not take into consideration students' needs and capabilities.

- ***The mathematical content analysis of mathematics curriculum for the secondary stage (see appendix: 5).***

The results of the content analysis of mathematics curriculum for the Secondary stage in respect of content standards showed the following,:

Numbers and Operations:

- characteristics and rules of ratio and proportion.
- characteristics of operations in number systems (such as real and complex numbers).

- using mathematical tables in solving numerical and applied problems with logarithms.
- complex number, facts of fundamental operations.
- solving physical problems associated with speed and acceleration, force and Newton's laws of motion.
- numerical systems to base other than ten and simple mathematical operations
- introduction on Permutations and combinations, binomial theory with integers and natural exponential

Algebra:

The content included the study of :

- concepts, generalizations and skills related to the topics in sets theory and groups.
- properties of operations on sets theory.
- representing linear equation and inequalities and quadratic equations graphically.
- solving linear and quadratic equation and inequalities graphically and algebraically.
- properties of operations on number systems (group, ring);
- using the mathematical Induction Method in proving relationships in arithmetic , geometric and sequences.
- solving algebraic and real life problems.

The content of mathematics curriculum included through teaching the Relations and functions on:

- recognize the concept of relations, types of relations and representing them graphically.
- types and properties of functions (linear, quadratic, polynomial, basis and logarithmic).
- Representing functions graphically and using them in solving applied problems.
- facts of operations on functions and representing functions by algebraic formulae.

The study of trigonometry topics was represented by:

- concepts of Trigonometric ratios (sine, cosine, tangent....).
- the relationship between Trigonometric ratios.
- using Trigonometric ratios in solving real life problems.

- recognizing the concepts of trigonometric and circular functions.
- the algebraic formulas of functions and representing them graphically.
- solving trigonometric equations.
- verifying the trigonometric identities.
- connecting the relationships between trigonometric functions and polar coordinates with complex numbers.

The content of mathematics curriculum involved through teaching the mathematical systems on the following:

- properties of binary operations: closure, commutative, association, identity and inverse elements
- distribution operation of addition and multiplication on Numbers systems: Natural, integer, rational, real numbers;
- proving theories associated with different mathematical structures (group, field).

Geometry:

The content included the study of :

- topics in geometry locus;
- finding mathematical relationships resulting from the movement of a point in space under certain conditions;
- proving theories in plane geometry associated with equivalence, areas and similarity,
- straight line and the relationships between them; using these in solving applied problems;
- drawing geometric shapes
- Pythagorean theory and applications in solving right angle and circle problems;
- using logical proof in proving geometrical theories;
- topics of analytic and special (solid) geometry.

Data Analysis and probability:

The curriculum included teaching the following concepts and skills:

- *Statistics:* The mathematics curriculum content included the study of statistics in the third secondary grade (12th grade) involving the organization and representation of statistical data, tables summarizing data, central tendency scale,

dispersion scale, natural distributions, correlation coefficients, facts of operations (arithmetic conversions) on the control tendency's scales and dispersion.

- *Probability*: the content of mathematics curriculum involved studying the concepts and skills among the topics of probability standards, which was restricted only to third secondary grade students: sample space, event and its type.
- theoretical and empirical probability.
- probability laws and using them in problem-solving.
- the concept of random variables; independent events.
- expectations, finding and interpreting discrete distribution probabilities and representing them graphically.
- concept of binomial distribution.

Through the analysis of the content of the mathematics curriculum for the secondary stage (see appendix 5), it is noticed that there is a lack of clear correlation between mathematical topics. Whereas it is noticed that there is a focus on abstraction from the topics included in the mathematical content of the curriculum. Also the curriculum document did not include an organizational framework to exhibit the extent, scope and sequence and the depth of mathematical topics within one specific grade, or between all the grades of that stage. Moreover, the content did not concentrate adequately on the applied and solving problems. It was also noticed that the organization of the content did not take students' potential and needs into consideration.

Additionally, it is clear, through inspecting the mathematical content of the mathematics curriculum in Jordan during this period, that the design and structure of the curriculum took the form of separate subjects. That is, the curriculum consisted of separate branches such as: arithmetic, algebra, geometry etc.

2. Results of the mathematical content analysis of mathematics curricula during the period 1972-1987.

There were two curricula documents issued by the Ministry of Education (MOE, 1984 A; 1984 B) for teaching mathematics during this period. The first was for the elementary stage (1st to 6th grade) and the second document was for two stages, the first preparatory (grade 7) to the third preparatory (grade 9) and the secondary stage

from the first secondary (grade 10) to the third secondary (grade 12), (see appendix 1). The mathematical content of the two documents was analyzed according to the standards of content issued by the NCTM (see appendix 10). The detailed results of the analysis are presented in appendix 5. The results of analysis showed the following:

- *The mathematical Content of the Mathematics Curriculum for the Elementary Stage (see appendix 5).*

The results of the content analysis of the mathematical document for the grades of elementary stage (1–6) during this period, indicate that the mathematics curriculum witnessed developments according to some of the standards of content analysis (see appendix 5). These developments were represented in studying the following:

Numbers and operations

- concepts, facts and skills associated with Numbers and operations with seven digits.
- effects of multiplying numbers by 10 and 100.
- using estimation and justification in computation on numbers.
- concepts and skills associated with number theory, such as: teaching properties of commutative and associative operations in addition and multiplication on numbers and fractions.

Geometry

- Studying some fundamental concepts according to geometry such as: recognition of geometric shapes within two and three dimensions, as well as classification according to characteristics.

Measurement

The content included performing conversions between units

- using rounding techniques when measuring to find the area and circumference of geometric shapes.
- using drawing instruments to measure angles and lengths.

Despite the developments witnessed in the mathematical content during the second period, the curriculum did not include the study of any concepts or skills relating to Data Analysis and Probability standard. or Algebra.

It was noticed, through analysis of the mathematical content of curriculum for the elementary stage (see appendix 5), that the distribution of mathematical topics regarding to standards of content, had taken into consideration scope and sequence. As well as recognizing the connections between the concepts and skills in the mathematical topics content, according to the standards of content analysis, for grades 1-6 represented by: Numbers and operations, Numbers theory, measurement and geometry.

Moreover, the curriculum document included an organizational framework that demonstrated the scope and sequence, coherent of the content of mathematics curriculum; and the correlation of the mathematical topic with each other and across the grades.

Although, the organization and presentation of the mathematical content did not take into consideration students' needs and capability or encourage students to participate and interact with the mathematical content. The content of the curriculum for this stage did not contain concepts or skills relating to Data Analysis and Probability standard, which related with collection, organizing and describing data, developing the skills of reading and interpreting data graphically, or training students to solve problems that involve data analysis to explore concepts of probability by chance, conjecture and prediction.

- ***The mathematical Content analysis of Mathematics Curricula for Preparatory and Secondary Stages during the period (1972 -1987).***

The Ministry of Education in Jordan worked on reviewing and changing the content of Mathematics curricula during this period, in a way commensurate with the changes in the society and in line with the changes and developments in advanced countries. The investigation of these developments is presented as follows:

- *The mathematical Content analysis of Mathematics Curriculum for the Preparatory Stage (see appendix 5).*

The results of the analysis of the mathematical content of mathematics teaching curriculum in this educational stage, showed the development of content through the distribution of the topics according the standards of content, which included in the analysis process (Appendix 5), including the significant concepts and skills according to the content standards as follows :

Numbers and operations:

The curricula content of mathematics included in teaching:

- Properties of operations on integers, rational and real numbers and their laws.
- The Number theory: properties of commutative and associative operations on adding and multiplying numbers and distributing multiplication on addition.

Algebra

The algebra content was represented in studying the concepts and topics, which related to:

- Sets theory, groups, algebraic expressions, solving algebraic equations, simultaneous equations, systems of simultaneous equations in two variables, operations on algebraic expressions and fractions.
- Functions and relations: included :studying concept of relationships, linear and quadrate functions and representing them graphically.
- Mathematical structure included the study of the binary system and its characteristics.
- Trigonometric ratios and the relationship between them; using tables in solving practical problems on trigonometric ratios; the relationships between them.
- Using tables in solving practical problems on trigonometric ratios.

Geometry

The geometry included on studying the concepts and skills associated with:

- angles and straight lines.
- the relationships between shapes.
- congruence of triangles.

- equivalence of geometric shapes.
- using proof in deducing geometric facts and mathematical laws.

Data Analysis and Probability

The content includes on teaching the concepts and skills through the following.

- *Statistics* including: studying the concepts and skills of computing central tendency scales.
- *Probability* including: studying the concepts and skills related to representing data, probability, events and probability laws.

Through the analysis of the mathematical content of the mathematics curriculum document for the preparatory stage. It was noticed that the distribution of topics did not take into consideration scope and sequence and connection among the concepts and skills of some content analysis standards and was not presented across the curriculum content of all grades.

The mathematical content did not adequately concentrate on the fundamental skills or link them and utilize them in everyday life. Further more, the document included an organization framework which demonstrated the sequence, succession and gradation of the content and the correlation between the mathematical topics throughout the various grades.

Whereas the organization and presentation of the mathematical content of the document did not take into consideration students' needs and capabilities, it did focus was on introducing certain modern concepts in detail, such as mathematical systems and groups.

Furthermore, there was a lack in the curriculum in dealing with fundamental topics and skills in trigonometry, statistics and probability. Additionally, the number of lessons allocated to teaching the mathematical content was insufficient.

- *The mathematical content analysis of mathematics curriculum for the secondary stage (see appendix 5).*

During this period the content of the mathematics curriculum for the secondary stage witnessed development and modernization, which was noticed through the analysis of the curriculum content. It included topics in accordance with the standard of:

Numbers and operations:

The content includes the study of:

- number systems, powers and exponential.
- logarithms and their laws.
- operations on matrices, permutations and combinations.
- *calculus* included on: studying limits, continuous and theories associated with them.
- differential concept through the average of the change;
- principles of deviation, extremism and applications.
- integration, this is presented in the concept of integration and rules.
- integration and its characteristics; integration including finding the area and rotating volume.

Geometry:

The content includes studying:

- the circle and space geometry.
- vectors in space.
- conic sections and properties.
- geometric transformations.
- utilizing logic and proof techniques in proving theories.

Algebra

The curriculum includes studying:

- the characteristics of relationships and functions.
- types and operations of function, circular function, polynomials, exponential and logarithmic.
- characteristics of functions and graphic representation.

- linear programming.
- solving equations, simultaneous and quadratic functions, solving system of equations by using matrices.
- the characteristics of mathematical systems with two operations, such as the field and ordered field.

Data Analysis and Probability:

The mathematical content includes:

- methods of representing *statistical* data.
- natural distribution, correlation and its coefficient.
- calculating the central tendency and dispersion scales.
- *probability* laws, random variables.
- distribution probability and expectations.

It was noticed from the analysis of the mathematics curriculum for the second phase of the secondary stage (appendix 5), that the content was presented using logical correlation between the mathematical topics. Was also noticed focus on abstraction throughout the topics included in the curriculum. Moreover, the content is densely packed with modern concepts such as relationships and functions, mathematical systems, numeration systems and groups. This was a contributory factor in the observation that insufficient lessons were allocated for teaching the mathematical content and on training students on the fundamental skills. However, the curriculum documents included an organizational framework that demonstrated the extent, sequence, succession and depth of mathematical topics to be taught within the grade using the educational units set for each grade. The mathematical content of the curriculum did not, however, focus sufficiently on the applied side and problem solving, nor did the organization of the content take into consideration needs or potential of the student.

It was noticed, however, that one of the most significant features of development and modernization was the inclusion of fundamental concepts associated to the sets theorem, the characteristics of operations on intersection and union of sets, the concepts of mathematical structure, such as the group and properties through the study of number sets. These fundamental concepts were in addition to the inclusion of topics

such as descriptive statistics, probabilities, and the use of the spiral method in organizing and presenting the content of the mathematics curriculum.

3. *Results of Mathematical Content analysis of Mathematics Curriculum during the Period 1987-1999.*

The Ministry of Education in Jordan issued two documents(MOE, 1991; 1993) throughout the period *1987-1999*, concerning the modernization and development of mathematics curricula, the first for the basic stage, grades 1 to 10 and the second for the secondary stage, grades 11 and 12 (see appendix 1). The content of both documents was analyzed in order to investigate the development in the content of the mathematics curricula throughout the grades of each educational stage.

- *The Mathematical content analysis of mathematics curriculum for the Basic Stage (see appendix 5):*

Analysis of the mathematical curricula for this stage shows that the focus of mathematical knowledge is on the cognitive structure of mathematics through the distribution of the mathematical content on standards.

Numbers and Operations

The mathematics curriculum includes teaching topics and skills such as:

- the concept of the number reading, writing and properties of operations
- decimal and common fractions :concept and operations properties.
- the four basic operations on real numbers.
- properties of addition and multiplication on real numbers.
- Laws of exponents and roots.
- exponentials and applications on small and large numbers.

Algebra

The curriculum includes:

- using symbols in solving equation with one variable.
- algebraic expressions and terms and the four basic operations on expressions.
- finding the value of algebraic expression by substitution.

- algebraic expression addition and subtraction.
- linear and quadratic functions.
- solving quadratic equation through: factors analysis, general law and graphs.
- solving fractions equations and application problems.
- factorizing algebraic expressions by common factor.
- open statements, set of substitution and solution set.
- solving linear equations with one variable.
- the linear inequality of two variables and their graphical presentation.
- solving system of linear inequality with two variables.

Geometry

The curriculum contains the study of:

- measuring angles and types of angles.
- draw a triangle if two angles and a side are given and if the given angle lies between two sides.
- parallel, perpendicular and intersectional lines.
- cases of triangle congruency.
- cases of triangle similarity.
- properties of right angled triangle and Pythagoras theorem.
- the relationship between triangle sides and the angles.
- circle tangents and their theorems.
- the circular quadrilateral shapes and their properties

Measurement

The curriculum contains the study of:

- metric units for areas and volume
- litre and millilitre in order to measure the capacity.
- the relationship between the metric units.
- using non standards measurements.
- temperature units.
- adding and subtraction measurement units.
- finding the area of: triangle and parallelogram,
- total area of cubic and rectangular solids.

Data Analysis and Probability

The curriculum contains the study of:

- data representation by sectors and frequency tables.
- the mean for data grouped in frequency tables.
- random experiment (concept of sample space).
- data dispersion through frequency distribution curves.
- deviation measurement, the range and standard deviation.
- effects of linear transformation on measurements of tendency and deviation.

One of the most significant characteristics of development and modernization of the mathematics curricula during the third period, is the adherence to the scope and sequence in teaching concepts and skills associated with Numbers and Operations, Measurement and Geometry throughout the various grades of this stage. The analysis also shows clear gradation and depth in presenting the mathematical knowledge through the using of the spiral method of content display.

In addition, it was noticed that the curriculum document has a strong focus on abstraction. It divides the content into concepts and symbols, generalizations, skills and algorithms and problem-solving in order to achieve a good balance.

The analysis of the mathematical curriculum raises concern about the inclusion of certain topics of algebra, statistics and probability throughout the content of the graded curricula, despite the weakness of correlation and integration between these elements and their distribution according to the standard of content throughout the grades of this stage.

For example, the content includes teaching the expression topics by symbols, solving simple equations and problems which contain open sentences in relation to algebra, as well as some concepts and skills associated with familiarization of statistical data. Reading, representing and interpreting statistic starts from the sixth grade.

Furthermore, the mathematical content pays great attention to gradation through the teaching concepts and fundamental principles according to the geometry standard and starting from the first basic grade. It was also noticed that the number of weekly mathematics periods were insufficient. Considering the vast content of mathematical topics.

It is also obvious that the content does not focus on teaching certain fundamental concepts of probability and statistics throughout the basic grades (from the first to the fifth). In addition to this, there is weakness in the correlation and continuity of learning concepts and skills according to these standards and other standards throughout the mathematics curricula for the other grades (as demonstrated by Appendix 5).

- ***The mathematical Content analysis of the mathematics curriculum of the Secondary Stage (see appendix 5):***

It was noticed from the content analysis of the mathematics curriculum for the secondary grades, that the mathematical content of these curricula was generally stable in the inclusion of most mathematical topics contained in the curriculum document for this educational stage(see appendix 5).

Numbers and Operations,

The mathematical content includes:

- studying the characteristics of real numbers and operations on real and complex numbers.
- using mathematical tables, laws and bases in solving problems by using the absolute value.
- verifying the validity of the solution.
- recognizing and using the properties of operations on matrices.
- summation and multiplication by inverse of matrix.

Algebra

The curriculum contains:

- relationships and functions.
- the skills of using tables, algebraic formulas and diagrams to represent functions.
- qualities and familiarization with the changes of graphic representation of functions.
- the properties of operations on functions.
- familiarization with general formula of functions.

Geometry

The content contains the study of :

- vectors in plane and in space.
- the characteristics of operations on vectors and representing them geometrically.
- the characteristics of conic sections and polar coordination.
- proving theories and concluding relationships.
- using the relationships to solving mathematical problems.
- trigonometric laws and solving the right angle triangle by using triangular ratios
- the relationships between these laws and ratios.

Data Analysis and Probability

The content includes teaching *statistics topics and skills through:*

- representing data by frequency tables.
- natural distribution and different types of correlation.
- the concept of regression and its equation.
- interpreting data and making suppositions.
- finding areas under curves.
- probability, content included on the concepts, random experiments, sample space, event and its types.
- probability and laws of probability.
- the concept of the random variable, identifying its types and its relationship with the function of probability and density.
- interpreting separate and joined probability distribution and representing it graphically.
- identifying the concepts of expectation and binomial distribution.
- using relationships in solving mathematical and applied problems.

The analysis also demonstrates that the inclusion of associated integration and sequence is among the many significant characteristics of development and modernization characterizing the mathematical content. The study of the characteristics of real numbers and properties of operations is widely seen throughout the grades of this stage including the seventh grade. In the twelfth grade focus moves to the study of the characteristics of complex numbers and operations.

Furthermore, the content contains integration between the studies of sequence and series, permutations and combinations in the 11th grade along with the study of certain

topics in differential, integration and probability in the twelfth grade. It was also noticed that the number of lessons allocated for teaching the mathematical content and topics was insufficient comparison to the abundance of topics contained in the curriculum.

Moreover, the mathematical content can be described as having an academic character despite the attempt to include some daily applications such as: index numbers and calculating areas and volumes. It also did not take into consideration individual differences among students with respect to its content and the activities included. Neither did it introduce strategies to deal with talented or low achievement students.

- *Results of the interviews related to the mathematical content during the period 1964-1999, (see appendix 9).*

The interview included viewpoints of experts, teachers and supervisors groups (see appendix: 9) and indicated that the mathematical content during the period 1964-1972 was distributed between more than one book. There was one book for teaching arithmetic skills, one for teaching geometry and one for teaching algebra. It was also noticed that there was no balance in topic distribution between the grades of stages and that the mathematical content for the secondary stage focused more on abstract topics and the process of content organization, therefore not taking into consideration the needs of the students. Moreover, the allocated time for teaching mathematics topics in secondary and middle stages was not sufficient and was also not in proportion to the mathematical content. In addition the applied aspect of mathematics was ignored through some topics of content.

The analysis of the decision-maker group interview indicates that the teaching of mathematics has witnessed many developments during the period 1972-1987. these developments include the new concepts and topics being added to the mathematical content and changing the curricula content for all stages of education and unifying branches of mathematics in one book for each grade. The content of the mathematics curriculum also began to focus more on teaching mathematical structures and systems

The analysis of opinions from supervisors and teachers (see appendix: 9) indicates that the process of organization of mathematical content does not encourage the students

and does not take into consideration the abilities of students. There was also a lack of connection between mathematical content and real life, through the application of mathematics concepts in solving real life problems. They also indicated that the mathematics curriculum content was too large and that the time allocated for teaching these units was insufficient.

The analysis of opinions decision-maker and experts groups (see appendix: 9) indicates that the mathematical content during the period 1987-1999 took into consideration the scope and sequence through the distribution of concepts and mathematical topics in the content. Also, the content was organized to focus on problem solving and developing skills of thinking and using the spiral method in designing the content. The mathematics content was divided into major topics identifying the basic skills and concepts for the each grade.

The analysis of opinions supervisors and teachers(see appendix:9) indicates that the content of the mathematics curricula includes presenting new subjects in the early grades, such as statistics and probability, but the method of displaying the content does not take into consideration the different capabilities of students. Also they indicated that the allocated time for teaching the content in some grades insufficient.

4.3 The Third question

What developments have the instruction methods of mathematics curricula in Jordan witnessed during the period 1964-1999?

The developments of the instruction methods of teaching mathematics are considered a main element of the curriculum in relation to the development of mathematics curriculum. The content of mathematics documents that existed during the period 1964-1999, (see appendix:5), was analyzed to investigate the developments in instructional methods of teaching mathematics in Jordan.

4.3.1 Development of *instruction methods during 1964-1972*

During the period 1964-1972 the mathematics curriculum for teaching students at the compulsory stage (from the first to the ninth grades) included general directories and guidelines for teaching the different areas of mathematics. Arithmetic, algebra and geometry represent the areas of mathematics and took a separate form of discipline (MOE, 1965).

The directives included focus on pupils' understanding of mathematical facts, concepts and operations using tangible educational means, using mental calculation when performing operations on numbers and training pupils to use simple geometric tools when drawing geometric shapes. There was also emphasis on acquainting pupils with geometric facts and relationships through shapes, training pupils on proving the facts and using numerical applications in geometric relationships.

The Mathematics curriculum document (MOE, 1971) for the students of the secondary stage did not include any directives or guidelines relating to methods of teaching mathematical content to the grades at this stage or to the usage of tools, techniques and educational activities.

The analysis of interviews with Dr. Hiyssat (see appendix 9) indicated that the methods which were used by teachers in teaching mathematics could be described as classical methods. This is because sometimes these methods were used by teachers who were not specialized in mathematics and focused on covering topics of mathematical content to prepare students for final examinations.

The analysis of interviews with Al ssmady (see appendix 9) indicated that the methods of teaching mathematics during the first period saw the teacher as the main role and a unique source of knowledge. The objective of teaching mathematics was to concentrate on providing students with mathematical knowledge and to focus on the proficiency of arithmetic skills.

The results of the analysis of interviews with Joum'ah and Ta'mneh (see appendix 9) indicated that the methods of teaching mathematics in the 1960s focused on providing students with mathematical knowledge. The methods of teaching used by teachers depended on their experience and their own personal efforts. The majority of teaching methods used by teachers concentrated on presenting the mathematical topics and proficiency of the mathematical skills by explaining the topics, examples and solving mathematical problems.

The analysis of interviews with Dr. Mogdadie, Dr. Namarneh and Dr. Al Zuobi (see appendix 9) about the role and methods of teaching Mathematics used by teachers during the period 1964-1972 also indicated that they were the classical methods. That is, they focused on using example and explanation of the mathematical material, according to experience and personal efforts of the teachers. This was the result of teaching by teachers who were not specialized in the mathematics and also the scarcity of teacher training courses on methods of teaching mathematics. Thus, teachers explained the topics to the students and then used examples relating to the topics. Therefore the student role was merely writing down the examples and completing homework for the following day. However, sometimes higher-ability students were given the opportunity of solving problems on the board. It can therefore generally be said that the methods of teaching focused on recalling relevant facts and performing certain steps in order to reach a solution.

4.3.2 Development of *instruction methods during 1972-1987*

During the period 1972-1987 the mathematics curriculum document(MOE, 1984 A) for the Elementary stage (1-6) included general directives in teaching mathematics for this stage, such as guiding the teacher to use tangible resource tools, concern with mental calculation, focus on mastering arithmetic skills, arousing pupils' incentive and using varied questions forms to suit different capabilities of pupils.

The mathematics curriculum document (MOE, 1984 B) for the preparatory and secondary stage (7-12) during this period included some ideas and general principles related to the importance of classroom awareness such as: individual differences, gradation in teaching through primary comprehension, deepening comprehension, application and transmission of the effect of teaching, establishing concepts and relationships, learning by taking part, succession in learning, training, motivation, discovery and problem-solving. This was in addition to the organization of the mathematical content using the discovery technique.

The analysis of interview with the decision-maker indicated that the teaching methods of mathematics had witnessed development and modernization. This included designing the mathematical structure on the basis of integration of the branches of mathematics (arithmetic, algebra, geometry etc.), the modern attitude towards mathematics as a cognitive structure with its own logic characteristics, the introduction of new concepts such as the set, relation, function and descriptive statistics. Due to Jordan's participation in the UNESCO project, training was required for both supervisors and teachers in the methods of teaching the new mathematical content. In addition to this there was also concern regarding student participation and reaction to the new mathematical content, through using the discovery method in presenting the content of the preparatory and secondary stages (Hiyasat and. Al massray, see appendix:9).

4.3.3 Development of *instruction methods during 1987-1999*

the fifth guideline of the curriculum documents for the basic stage (1-10) during this period was “General tendencies in mathematics teaching techniques and their evaluation”. This includes included using the directed discovery method in acquiring concepts, generalizations and relationships. The aim is to develop higher mental operations through involving pupils in various activities which may increase their comprehension of discovered concepts, generalizations and help them associate acquired knowledge to everyday situations. From basic comprehension to advanced comprehension. Students should establish concepts and relationships with the aim of transferring and using this knowledge in new situations.

Also the general directives stated the need to use various means and techniques to suit students' levels. Additionally, the curriculum document identified the techniques and activities of the mathematical content included in the educational units.

The fifth guideline of the curriculum document for the secondary stage (11-12) referred to "the techniques and means of teaching and educational activities". This included the matters that have to be observed when choosing and practicing teaching techniques, flexibility in observing individual differences through participation and discussion, conclusion and directed discovery, auto-learning, dividing students into homogenous groups according to their potential, the effectiveness of techniques in developing mental skill and creative capabilities through the gradation of learning from basic comprehension to advanced comprehension and comprehension of applications. Analyzing situations, making judgments with the aim of using the knowledge thus acquired, using and applying in learning available technology, such as calculators and educational computer programs and utilizing feedback in motivating students to advance and raise the level of performance are also important.

Interviews with curriculum experts and supervisors (see appendix:9) indicated that the instructional methods for teaching mathematics had witnessed development through changing and modernizing the curriculum content. Through these innovations, the Ministry of Education aimed at developing thinking skills, using the scientific method of problem-solving, using libraries, providing schools with educational media and equipment, training supervisors and teachers in the methods of teaching the new curricula and in the use of educational media and equipment, training them to use various methods and techniques (such as cooperative learning, problem-solving techniques, the skill of asking questions and brain-storming and diagnostic evaluation as a teaching technique), focusing on the methods of developing thinking and observing individual differences in capability amongst students.

During this period, the Ministry of Education also worked on providing schools with different educational equipment and media such as projectors, recorders and TV sets which can assist teachers in improving teaching methods.

In addition, short courses were held to train teachers in using educational media. The Ministry of Education also held training courses to qualified teachers holding high school certificates, compulsory and secondary stage teachers and teachers holding college degrees. These training courses were run in conjunction with the Jordan and Yarmouk Universities (supervisors and teachers, see appendix: 9).

Furthermore, the decision-maker(see appendix:9) said that the Ministry of Education in Jordan worked on raising teacher efficiency through allowing teachers who hold a bachelor degree to study in Jordanian state universities for diplomas in curricula and methods of teaching.

4.4 The fourth Question

What developments have the Evaluation methods of mathematics curricula in Jordan witnessed during the period 1964-1999?

The mathematics curriculum documents during the period 1964-1999 were analyzed in order to investigate the development relating to methods of evaluation.

4.4.1 Development of Evaluation methods during 1964-1972

The mathematics document(MOE, 1965; 1971) for the compulsory stage during the period 1964-1972 contained general principles in evaluating pupils' and teachers' work through students' memorization and understanding of the educational material they had studied, school examinations, participation in discussion and doing homework.

With respect to the method of evaluation that was used during the first period, the decisions -makers and experts of the curriculum (see appendix: 9) said that it focused on the material content represented by the textbook, on adjusting the number of periods, the method of content presentation and adding or omitting topics, according to remarks from mathematics teachers and supervisors. As for evaluating the achievement of students, this was carried out by tests which focused on memorizing and remembering mathematical concepts, facts, steps and mechanisms of solving mathematical problems.

The methods of evaluation focused on measuring mathematical knowledge and proficiency of arithmetic skills, by tests were which prepared by teachers and concentrated on the low levels of thinking relating to the cognition domain. MOE also depended on three general examinations at the end of educational stages (elementary, preparatory and secondary) which were prepared by a special team within the MOE. Students with on average achievement were transferred from one stage to the next (Al Zuobi: see appendix 9).

4.4.2 Development of Evaluation methods during 1972-1987

During the period 1972-1987 the content of the mathematics curriculum document for grades 1-12 contained some views and principles in the evaluation such as:

- classification of learning objectives relating to mathematics teaching into three domains: the cognitive (mental), affective and psychomotor.
- identifying learning objectives and levels listed within the cognitive domain as: knowledge, understanding, application and skills.
- preparing a sample to demonstrate the method of building the specification table which combines the elements of the mathematical content with levels of learning objectives.
- characteristics and properties of questions types (multiple-choice and essay).

Decision-makers and supervisors (see appendix: 9) said that the evaluation process of the mathematics curriculum was the responsibility of the Jordanian National Team for developing the content of mathematics curriculum, through experimentation of teaching with school textbooks. Information and remarks about the suitability of textbooks were gathered from teachers and supervisors. These remarks were then studied by a Jordanian National Team for developing content of mathematics curriculum in the Ministry of Education and suitable modifications were made. As for teachers' evaluation of students, this focused on essay questions, or multiple-choice questions. There was also a lack of balance in content distribution in of the aims of the levels in the cognitive domain.

The analysis of interviews with teachers and supervisors(see appendix:9) indicated that the methods of assessing students by teachers focused on written questions, or multiple-choice questions. The main task of teachers was to prepare students to take the general examination at the end of the secondary stage and pass the final school examination.

4.4.3 Development of evaluation methods during 1987-1999

The evaluation procedures suggested by the curriculum document (MOE, 1991; 1993) of the basic and secondary stages during the period 1987-1999 (as mentioned in the fourth item: evaluation techniques in the curriculum document) included the preparation of achievement tests to measure a student's knowledge on the taught mathematical content according to a table of specifications. This table combined the elements of the mathematical content and the levels of the cognitive behavior. 35% of the questions were assigned to understanding, 25% to calculations, 25% to application and 15% to higher mental operations (according to Bloom's classification). Naturally, these two ratios (25% to application and 15% to higher mental operations) reflected a clear concern with more advanced thinking skills.

With regard to evaluating and developing the content of the mathematics curricula during the period 1987-1999, both decision-makers and curricula experts in the Ministry of Education (see appendix: 9) indicated that this process was carried out by seeking assistance of experts from international institutions and studying their remarks. This was in addition to evaluation reports of the curricula submitted by specialized committees of teachers and supervisors. Also mentioned was the durability of the content of the curriculum. Moreover, there was a wide variety of techniques for teaching and evaluating students in all grades, for example, achievement tests, exercises and activities at the end of educational units, and evaluation samples included in teachers' books.

The methods of evaluation during the early 1990s focused on the development of thinking skills and preparing teachers and supervisors on how to construct tests in order to measure the higher levels of the cognitive objectives. Moreover, due to the results of the participation of the eighth grade students in the international study, MOE presented the feedback to teachers, aiming to improve the mathematics curriculum and the methods used by mathematics teachers (Arabiat and Gharaibeh: see appendix 9). Finally, the tests and general examinations were used by the Ministry of Education in Jordan as a way of measuring and evaluating achievement in educational processes as identified by the act 16 of MOE in 1964. Teachers measured the achievement of students with different materials according to regulations issued by MOE. Teachers

were also permitted to construct and carry out exams according to the learning objectives of particular subject.

Before the 1960s students used to sit the Elementary Certificate examination. However, this examination was cancelled in the academic year 1952/1953. In academic year 1954/1955 the length of compulsory elementary education was increased by a year to six years. A new examination called the Admission Examination for the first preparatory was also introduced and was taken by students until the academic year 1959/1960. At the end of third preparatory class, students sit the Preparatory Certificate Examination, which was sat for the first time in 1960 (AL-Tall, 1979, p 228).

This exam faced many decisions. During the period 1961-1969 was adopted, then in 1970 it was canceled. During the period 1971-1975 it was readopted and then during the period 1976-1984 it was canceled again. It was readopted again during the period 1985-1988 but has been canceled since 1989 (MOE, 1980 and Al-Tall, 1992, p 63).

Acceptance to the first secondary stage depends on the age of the students, his score average in the Preparatory Certificate Examination and the number of vacancies in schools. The students education type, academic or vocational, can also be depicted from this exam and is therefore also taken into consideration.

The secondary stage ends with a general secondary education examination (the Tawjihi) which is considered to be the oldest general examination in Jordan. There is no a correlation between this exam and the school examinations, therefore the acceptance of students in universities and colleges depends on their score in the general secondary education examination (the Tawjihi) (MOE, 1988).

The general secondary education examination (Tawjihi) witnessed developments as follows: before 1977-1978, the MOE organized and applied a central exam for the end of the academic year. However, after this period the academic year consisted of two semesters and therefore the MOE organized two central exams, one at the end of each semester. The curriculum content of mathematics and other materials was also divided into two parts. The exam (Tawjihi) for secondary stage has also witnessed developments during the 1990s associated with the developing the mathematics

curriculum according to the recommendation of the educational conference in 1987 for development of educational processes (MOE, 1988 and Obidat et al, 1993).

4.5 Summary

The Ministry of education in Jordan has conducted various educational reforms in the curriculum during the period 1964-1999. one of the main developments was the education's law number 16 for the year 1964. As a result of this, thought was put into the curriculum and textbooks. As curriculum and school books are considered to be the basic means for achieving the objectives of education, a large developments seen here such as establishing the department of curriculum and school textbooks.

The Ministry of Education managed to develop the curriculum and school textbooks in Jordan to match curricula of advanced countries through its participation in the educational seminars, sessions and conferences. A major part in this development in Jordan was the conference of educational development in 1987. The conference was a comprehensive process of development for many elements of the education including the curricula and school textbooks.

In the late of sixties Jordan participated in the project of developing the content of mathematics curricula and methods of teaching in the Arab world under the supervision of UNESCO. Modern mathematics was included into the school curriculum throughout the different stages. In modern mathematics the focus was on studying the mathematical structures of algebra, numbers and geometry. Algebraic structures included elements such as groups, field and properties of operations on numerical systems.

The concept of the mathematics curriculum was affected by the development in Jordan. Unlike the traditional view, topics of the content for mathematics contained the learning objectives, topics, methods of teaching, school textbooks, trained teachers and methods of evaluation. As a result, the mathematics curriculum underwent three stages of content development and modernization. The mathematics curriculum taught during the period 1964-1972 was described as traditional, that is, the mathematical topics were taught separately (arithmetic, algebra, geometry...etc.).

The objectives of teaching mathematics were vague and unclear throughout the classes and focus was on the cognitive domain. There was no link between the objectives of teaching mathematics throughout the educational stages. Topics of the mathematical content were badly linked and sequenced across the classes. Although the content was logically organized, the methods of teaching focused on memorization and dictation of mathematical knowledge. Students were not encouraged to innovate and develop their own thinking skills. The concern was on the theoretical applications rather than on the practical ones. Methods of evaluation mathematics teaching were based on achievement tests which measure memorizing and mastering the mathematical content. Moreover, there was a lack of focus on the higher mental levels such as affective and psychomotor skills.

The content of the mathematics curriculum also witnessed development and change during the second period 1972-1987. This change was seen through the unification of different branches of mathematics to include new concepts and topics into the content of the curriculum such as sets theory, groups, relations, functions and number systems. The objectives of teaching mathematics became more clearer and the three domains of mathematics knowledge (cognitive, affective and psychomotor) were included. This was represented using the spiral method of presentation the mathematical content and was set out according to students abilities, growth level, scope, sequence and coherence of mathematics content throughout the grades. However, there was still a focus on abstract concepts. This period did not focus adequately on the basic skills and the development of students' abilities in mathematical problem solving or thinking skills related to everyday use of mathematical applications.

Topics of mathematics curriculum were not linked and sequenced correctly across the curriculum for the different classes. The content focused more on teaching modern concepts such as correlation, statistics, mathematical systems, properties of operations and groups. It was also noticed that the allocated time for teaching mathematics was insufficient considering the vast amount of concepts and topics included in the content.

The way in which the mathematical content for some grades of stages was presented in a higher level. The content presentation of some school textbooks comes to appropriate teachers level and students level of average. Also, it is difficult for students to read and understand the mathematics content by themselves. Regarding the methods of teaching mathematics, most teachers used methods centralized around the teacher (lectures),

therefore presenting mathematical knowledge, discussions and examples, but ignoring the student from participating. As a result, students were not encouraged to be innovative or to think independently and creatively because teachers relied on school textbooks to present topics and examples. Although the mathematical content was displayed using exploratory style, teachers did not use this method when teaching. This was mainly due to poor preparation of mathematics teachers.

Achievement tests were the main form of evaluation.

These tests were concentrated on the lower levels of specific objectives in the cognition domain. Moreover, teachers neglected homework and did not give immediate feedback on students' performance.

During the third period 1987-1999 the mathematics curriculum witnessed development which was represented through clear objectives in the classes of the different educational stages. This period also focused on the basic skills related to everyday life. Developing students' abilities in solving mathematical problems, triangular rules, spatial geometry, methods of solving equations, decreasing the level of abstract concepts and increasing the number of periods allocated for teaching the new mathematical content were all included. The spiral method was used in designing the content of the mathematics curriculum. The content was divided into topics under major headings, therefore identifying the basic skills and concepts in the curriculum for each class. The sequence, integration and distribution of the mathematical concepts and skills across the teaching units of the curriculum for the different educational stages were also taken into consideration. The content of the curriculum included new topics such as statistics, probability and the theory of numbers. Adding some topics from the secondary stage to the curriculum led to inadequacy in the number of periods allocated for teaching the content in some classes.

The methods of teaching have also witnessed development in light of the curriculum modernization. Teachers and supervisors were trained on how to teach mathematics content using various methods such as strategy of problem solving, using directive explorative investigating the mathematical results, brainstorming, cooperative learning and developing skills of critical thinking. Training programs for preparing teachers academically and educationally were included.

The methods of evaluation included programs for developing and preparing teachers and supervisors on how to construct tests to measure the higher levels of the cognitive objectives with a focus on measuring higher level of thinking skills. Furthermore, they were trained on how to prepare achievement and diagnostic tests for the basic stage classes. Remedial plans were set to reduce students' weakness in mathematics. The content contained samples of achievement tests for all classes. One major development in the domain of evaluating students' achievement was Jordan's participation in the international study for evaluating eighth grade students. This resulted in improving the mathematics' curriculum and methods used by teachers of mathematics.