

**Learning Styles and Strategies of Ethiopian
Secondary School Students in Learning
Mathematics**

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Declaration

I declare that **Learning Styles and Strategies of Ethiopian Secondary School Students in Learning Mathematics** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.



SIGNATURE

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October 15, 2009

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Abstract

The purpose of this study was to identify preferred learning styles and strategies of secondary school students and to examine the prevailing problems that restrict them to use their own preferences. The study was intended to highlight a number of issues that need to be revealed and addressed in the learning of mathematics.

The types of preferred learning styles and strategies students need to employ in learning mathematics, the assistance students require from their teachers, the conduciveness of the design of mathematics curriculum and the challenges they might face to use their own preferred learning styles and strategies in the learning of mathematics were addressed as basic research questions. The study dealt with various elements that were related to environmental, emotional, sociological, physiological and psychological categories of learning in the identification of the types of learning styles and strategies.

This study is believed to contribute a lot in addressing the problems of learning styles and strategies, provide feedback to the concerned government bodies to help them improve the teaching learning processes in secondary schools. It is also to reduce the bias or prejudice on mathematics by assisting students to use their own preferred learning styles and strategies, and contribute to further investigations to make the learning of mathematics more enjoyable, participatory and lifelong career.

This study was conducted in four secondary schools in West Shoa Zone. A qualitative method that was descriptive in nature was employed in the study while the instruments of the study were questionnaires and an interview. The sample comprised of 249 (128 male and 121 female) secondary school students and 30 (25 male and 5 female) secondary school mathematics teachers selected randomly.

The result has shown that students were not learning mathematics on the basis of their preferred learning styles and strategies and the teachers were practicing autocratic teaching styles. Most of the students did not prefer learning mathematics through plasma television; they required brief outlines and concrete presentations, and indicated that there is not enough time to check and recheck the answers they found for the problems. These imply that the organization of secondary school mathematics curriculum requires reform to accommodate the preferred learning styles and strategies of students.

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Chapter 1

Background and Overview of the Study

1.1 Introduction

My experience as a mathematics educator and educational leader at various levels has shown me that the preferred learning styles and strategies of secondary school students are not considered in the learning of mathematics. According to Dunn (1995) the mismatch between the teaching styles of teachers and the learning styles of students leads to frustration and lack of continued educational development. Similarly, Doolan and Honigsfeld (2000), explain that when students are taught with methods dissonant from their learning style preferences, they do not succeed in mastering the subject matter as quickly as they could have. Moreover, students are expected to construct their own mathematical knowledge, discover relationships and find facts by using their own learning styles and strategies rather than memorizing mathematical formulas and procedures (Cangelosi, 1996).

Mathematics teachers need to develop their practice so as to fit more closely with the roles, values and philosophies underpinning the mathematics curriculum they teach. Park (2001) asserted that teachers need to match their teaching styles to students' preferred learning styles for difficult tasks, and to reinforce the learning of contents by employing diverse teaching strategies. The study conducted by the Ministry of Education (MoE) of Ethiopia, the National Curriculum Guideline indicates (MoE, 2003:11) that:

Mathematics teachers are not necessarily good at teaching in schools by using active learning methods for exploiting the advantages coming through promoting learners' learning styles and strategies.

Moreover, my practical experience as a mathematics educator showed me that most secondary school students consider mathematics as one of the most difficult subjects. This prejudice might obstruct students not to use their own talents to learn mathematics.

The above mentioned practical experiences and theoretical backgrounds have initiated me to investigate the preferred learning styles and strategies of secondary school students in the learning of mathematics in Ethiopian context.

1.2 Purpose of the Study

The purpose of the study is primarily to investigate the preferred learning styles and strategies of secondary school students in the learning of mathematics. It is envisaged that students will guide their learning of mathematics with regard to their preferences. Secondly, the impediments students might encounter to use their own learning preferences will be identified. Thirdly, the assistance students require to use their own learning preferences will be determined. When children do not learn the way they are taught, then the teachers must teach them the way they learn (Dunn, 1995). This shows that teachers must teach according to the interest of their students and organize their teaching strategies so as to fit the learning styles and strategies of their students. Moreover, Searson and Dunn (2001) stressed that learning styles are mostly an individual's personal characteristics and these characteristics are subdivided to include environmental, emotional, sociological, physiological and psychological categories.

In general, this study has sought to identify the preferred learning styles and strategies of secondary school students in Ethiopia and to examine the prevailing problems that inhibit them to use their preferences.

1.3 Statement of the Problem

The study conducted by the Ministry of Education has shown that the problems of mathematics instruction are diverse and multidimensional:

Some of the mathematics instruction problems include the traditional teaching approaches followed by mathematics teachers, the existing wrong perceptions and conceptions on mathematics, lack of reference materials, poor preparation of mathematics teachers, lack of professional development programs developed in the school systems, and the absence of encouraging students' prior experiences. The other fundamental problem that also occurs in secondary mathematics instruction is the inability to provide opportunities for the students to use their own learning styles and strategies in the learning of mathematics (MoE, 2003:27).

My personal experience (I have worked as (i) a mathematics teacher in various secondary schools of Ethiopia for six years, (ii) a head of Education Office of West Shoa Zone in Oromia Region (Ethiopia) for 7 years, and (iii) a senior curriculum and research expert in Oromia Regional Education Bureau for 5 years) and practical observations have inspired me to address secondary school learners' prevailing problems in the learning of mathematics in Oromia Region. The study

investigates whether or not secondary school students are learning mathematics in their own preferred learning styles and strategies.

As Dunn (1995) argues, students should be encouraged to use their preferred learning styles and strategies in order to understand the subject they learn. Similarly, Cano (2005), Burke and Dunn (2002), Dyer and Osborne (1999) discuss the importance of learning styles and strategies for learners' better achievement. To this end, following the ratification of its Education and Training Policy (ETP) in 1994, the government of Ethiopia has been engaged in a very comprehensive reform process to re-align its education system to meet the needs of learners. As the policy clearly stipulated in its objectives:

the development of the physical and mental potential and the problem-solving capacity of learners; bringing up citizens who.... appreciate aesthetics and show a positive attitude towards the development and dissemination of science and technology in society; and cultivating the cognitive, creative, productive and appreciative potential of citizens by appropriately relating education to environment and societal needs (MoE, 1994:7-8).

More importantly, one of the major reforms designed by the policy is the measure taken to improve the teaching of science and mathematics which in turn contributes to the production of qualified professionals that in turn enhances the development of science and technology in Ethiopia. In order to address the relevance and quality of education, the country's education system was overhauled. School curricula were revised and a huge number of teachers were trained to meet the targets set by the Ministry. The Ethiopian Ministry of Education has also undertaken the Teacher Education System Overhaul (teachers' education improvement program) in order to contribute to the improvement of the education system of the country. Moreover, the Ministry has designed and implemented continuous teachers' professional development program for higher education teachers in order to improve the pedagogical aspects of the teachers' training processes (MoE, 2003). This action coincides with the experiences of developed nations like USA and Japan that have given great attention to improve mathematics education in their countries by reforming their mathematics curriculum. Moreover, the Republic of South Africa has made a curriculum reform by designing an outcomes-based education program which is implemented in 2005 (Van Niekerk, 1998).

Despite all these attempts, however, there is a lot to do to improve the quality of education at the classroom level. The knowledge of learning styles and strategies is essential for educating or

developing the potential of children in different ways according to learners' abilities, learning characteristics and/or needs (Chan, 2001). This is where my study comes in.

1.4 Research Questions

The following four major research questions are posed to be addressed in this study.

1. What types of learning styles and strategies do secondary school students in Ethiopia prefer to use when they learn mathematics?
2. How do secondary school mathematics teachers in Ethiopia assist their students to use their own preferred learning styles and strategies to learn mathematics?
3. How does the country's secondary school mathematics curriculum encourage students to use their own preferred learning styles and strategies?
4. What could be the major challenges that students might face in using their own preferred learning styles and strategies while learning mathematics?

1.5 Significance of the Study

The Education Sector Development Strategy of Ethiopia puts mathematics as one of the most essential subjects for everybody since it is relevant to the daily life and is also a tool for science and technology (MoE, 1994). Thus, the attention given to mathematics education in the country's education system is encouraging to investigate secondary school students' preferred learning styles and strategies in mathematics classes, which, in turn, is believed to improve mathematics instruction in the country. Mathematics instruction becomes more meaningful and understandable when the preferred learning styles and strategies of students, the challenges they might face and the assistance students require are addressed in a desirable manner. According to Beck (2001:13),

When a student reacts favourably or unfavourably to a lesson, it may be due to the subject matter or the teaching strategy followed by the teacher and whether it matches the learning styles preferences of the students.

Thus, the significance of this study is to:

- a) address the problems of learning styles and strategies;
- b) provide feedback to the concerned bodies (notably government and non-governmental institutions, curriculum designers, teachers, researchers, and students themselves) to help them improve the teaching-learning processes in secondary schools.

- c) reduce learners bias or prejudice towards mathematics by assisting them to use their own preferred learning styles and strategies;
- d) contribute to further studies that make the learning of mathematics more enjoyable, participatory and sustainable.

In the light of the above mentioned significances, it becomes necessary to conduct the investigation of the preferred learning styles and strategies of secondary school students when they learn mathematics.

1.6 Definition of Key Terms

Some of the terms used in this study should be understood in the following context.

An Investigation

It is looking closely at the formal learning styles and strategies that are preferred by secondary school students in learning mathematics in West Shoa Zone of Oromia Region. Formal learning here refers to institutional learning processes at secondary level.

Secondary School

In Ethiopian context, secondary school is regarded as the learning ladder that serves as a transitional zone between junior classes and tertiary learning levels and covers from grades 9 to 12.

Oromia Region and West Shoa

This is one of the nine regional states in the Ethiopian (east-Africa) Federal Administration System and is situated at the central area and covers the largest part of the country. West Shoa is likewise, a part and parcel of Oromia Region and is one of the administrative zones in the Region having 20 secondary schools.

Style

According to Zhang (2001), style is not the ability but rather one's preferred way of using the abilities one has. Similarly, Park (2001) defined style as a pervasive quality in the learning strategies or behavior of an individual.

Learning Style

Searson and Dunn (2001) defined learning style as a biologically and developmentally determined set of personal characteristics that make identical instruction effective for some and non-effective for others. The National Association for Secondary School Principals (NASSP) Task Force defined learning style as “the composite of characteristic, cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment” (Keefe *et al.*, 1986). Similarly, Dunn and Dunn (1993) described learning style as the way that each person begins to concentrate on, process, internalize and retain new and difficult academic information.

Learning Strategies

Oxford and Green (1996) defined learning strategies as specific behaviors that learners use to improve their own learning while She (2005) described learning strategies as specific techniques used to promote learning, such as demonstration and group repetition.

Preferred Learning Styles and Strategies

In this study, preferred learning styles and strategies need to be perceived as the primary choices and mechanisms in the studies of mathematics at secondary school level for mastering the subject matter.

Acronyms

ETP - Education and Training Policy

IICBA - International Institute for Capacity Building in Africa

LSI - Learning Styles Inventories

MoE – Ministry of Education

NASSP - The National Association for Secondary School Principals

NCTM - National Council of Teachers of Mathematics

TV – Television

UNESCO - United Nations for Education Science and Cultural Organization

USA – United States of America

1.7 Delineation of the Study

In Ethiopia, mathematics is taught as a subject from Kindergarten to higher education as a compulsory subject. This study is delimited to grade 11 students, for the purpose of uniformity and manageability. These students have relatively sufficient experiences with mathematics learning. It is also considered that they have passed the National Examination given at the end of grade 10 for the completion of General Secondary Education. Grade 11 students attend the Preparatory Program to get prepared for the entrance exam of university studies. Mathematics teachers of grade 11 were considered to be relevant since they are currently engaged in teaching mathematics and practically observing the learning of these students.

1.8 Overview of the Study

This study is composed of five chapters. Chapter 1 includes the introduction and background of the study, the purpose of the study, statement of the problem, significance of the study, definition of key terms used in the study, limitation of the study, delineation of the study, research questions and lastly the summary of the study.

Chapter 2 reviews literatures related to historical perspectives of learning styles, the nature of mathematics and mathematics education, learning styles, strategies and experiences, the role of teachers in assisting students to use their own preferred learning styles and strategies, studies related to learning styles and implications of this study to mathematics education in Ethiopia.

Chapter 3 constitutes the design of the study, instruments of the study and their development, administration of pilot-test, population of the study, samples and sampling techniques, administration and procedures of data collection, and ethical considerations.

Chapter 4 deals with the Presentation and Analysis of Results. Finally, chapter 5 presents the Summary of Findings, Recommendations and Conclusion of the study.

Chapter 2

Review of Related Literature

2.1 Overview

This literature review is divided into five main parts. Part One discusses the historical perspectives of learning styles and strategies which describe the basic notions for the inception and need for the study of learning styles and strategies. Part Two deals with the nature of mathematics and mathematics education describing the meaning of mathematics and mathematics education and the reasons for the study. The notion, meaning and the instruments of learning styles, strategies and experiences of students in learning mathematics are discussed in Part Three. In Part Four the role of teachers in assisting students to use their preferred learning styles and strategies is considered. Different studies conducted by various researchers on learning styles and strategies of students and the implication that this investigation brings to mathematics education in Ethiopia form Part Five.

Part 1: Historical Perspectives of Learning Styles

Identifying the learning styles and strategies students prefer to learn mathematics and creating opportunities to use their own preferences are essential to learning and understanding mathematics. Stewart (2002) argued that flexible combinations of learning and teaching styles allow all students to develop effective ways of gaining positive educational outcomes. The existence of various learning styles and strategies among individuals apparently lead to the speculation and interpretation of learning styles and strategies.

Burke and Dunn (2002:103) looked at the debate held between Stephen Douglas and Abraham Lincoln in 1858 which drew attention throughout USA. They stated that:

The two people were those who sought a U.S. Senate seat from Illinois. After 140 years of their debate, another historic event took place in Freeport which again drew widespread attention throughout the nation. Teachers in the Freeport School District (FSD) began teaching to individual learning styles to ensure that all of their students performed well in school. The teachers insisted that there was no debating issue that students learn differently from one another. The teachers further insisted that when students are taught using approaches and resources that complement their particular learning styles, their achievement increases significantly.

This debate has paved the way for further study on students' preferences to learning styles and strategies in the USA. Pewewardy (2002:23), in his study of learning styles of American

Indian/Alaska Native students, stated that the investigation of learning styles is not without criticism. For example:

- 1) Kleinfeld and Nelson (1991) contended that studies of teaching methods adapted to American Indian/Alaska Native students called visual learning styles provided virtually no support for the hypothesis that culturally adapted instruction increased achievement.
- 2) Stellern, Collins, Gutierrez and Peterson (1996) argued that American Indian/Alaska Native students are not necessarily right hemispheric dominant and therefore there is no need to adapt instruction especially geared to the right brain learners.
- 3) Bland (1975) holds that there is no such thing as American Indian/Alaska Native students' learning styles.

Based on the above comments, Pewewardy concluded that research on learning styles is one of the latest fashions in education. Furthermore, by quoting Gould (1996) and Guthrie (1998), Pewewardy (2002) said that long before educators became interested in learning styles research, it was generally assumed by non-Indian researchers that American Indian/Alaska Native children lacked the innate intelligence and ability to succeed in formal school programs.

Chan (2001) described that the assessment of students' preferences for specific learning styles is basically to help teachers employ strategies that are congruent with students' preferences in order to maximize the learning outcomes of Chinese students. Although there are differences to conceptualize the learning styles of students, it is generally assumed that students learn best when their preferred learning styles and strategies are employed in the process of learning.

I also believed that the study on students' preferred learning styles and strategies in learning mathematics is not yet developed in Ethiopia. This is what the study is hoped to contribute to the development of mathematics education in Ethiopia.

Part 2: The Nature of Mathematics and Mathematics Education

There are a number of philosophical views, beliefs and conceptions on the nature and learning of mathematics. Schoenfeld (1992) states these philosophical views, beliefs and conceptions have paved the way for different teaching-learning methodologies of mathematics since teaching-learning process is a means through which teachers, learners, curriculum and other variables are organized in a systematic manner to address the needs and benefits of mankind. Supporting this,

Cangelosi (1996) says that from the pedagogical point of view, there is no definite and better way of teaching mathematics. Cangelosi stipulated the cooperative method, the project method, the mastery learning method, and the problem solving methods as some of the basic learning strategies to be employed in the learning and teaching of mathematics. However, there are various challenges in employing the above-mentioned learning strategies which seem to emanate from the preparation of mathematics teaching materials, the training of mathematics teachers, and the existing beliefs and conceptions on the nature of mathematics itself. The study conducted by the Ministry of Education of Ethiopia (MoE, 2003) indicated that, mathematics teachers are not necessarily good at teaching in the schools by using active learning methods for exploiting the advantages coming through promoting learners' learning styles and strategies.

Principally, the National Council of Teachers of Mathematics (NCTM) (1991) described that mathematics education requires qualified teachers that guide students to meet the educational goals and objectives and support students, among other goals, to employ their own preferred learning styles and strategies. In addition to this argument, students need to be able to deploy meaningful learning strategies and use an insightful approach to mathematics learning since mathematics is one of the basics for the development of science and technology. Thus, one can easily see that the advancement of science and technology is realized by the proper application and utilization of mathematical knowledge, which in turn helps to curb societal problems. Cangelosi (1996) noted that the use of calculators and computers has avoided the long and tiresome calculations being previously made by human mind. They helped to avail all information in the world on a table within a fraction of seconds using computers. Similarly, Schoenfeld (1992) illustrated that mathematical knowledge is associated with the socio-economic situation of the community and it helps to enhance the development of the citizens. Likewise, Pewewardy (2002) stated that mathematics connects one to his or her universe in many ways by incorporating language, culture and daily living practices.

Mathematics education deals with the nature of mathematics, teachings and learning of mathematics. In support to this view, Austin and Howson (1979) portrayed that mathematics education centers upon attempts to understand how mathematics is created, taught and learned most effectively. The NCTM (1991) indicated that the basic elements in mathematics education process include teachers, learners, curriculum and pedagogy of instruction. The integration of these

elements is mandatory to create a full-fledged operational result. Austin and Howson (1979) further elaborated that mathematics education can be viewed as both a process of individual construction and as a process of acculturation into the mathematical meanings and practices of wider society. One can learn from this point that the role of the learners is of paramount importance in the learning of mathematics. As noted in the standards (NCTM, 1989), traditionally people view learners as objects, which are to be filled with knowledge from a knowledgeable person, the teacher. Learners are expected to memorize the rules and procedures, formulas and follow the only steps given by their teacher in order to solve other mathematical problems and there is no way to construct their own mathematical knowledge. Moreover, traditional viewers consider the basic features of mathematics are expected to be crammed and given back as received by the learners.

On the other hand, constructivists view learners as the architects to construct their own knowledge, to discover the relationships, and to form their own concepts. Cangelosi (1996:14) supported this view by stating that,

Mathematics will not be meaningful to students unless they develop certain key concepts in their own minds and discover key relationships for themselves. The learners are not considered as white slates on which something is to be written by a knowledgeable person. Learners should be given the opportunity to exercise different learning styles and use different learning strategies.

Constructivism emphasizes the way that an idea is built up in the mind of the learner and on providing appropriate experience of students. Von Glasserfeld (2001) stipulated that creating concepts according to constructivist view is a form of construction of knowledge and this construction involves reflection, i.e. recognition of the connections that can be made by coordinating sensory elements or mental operations. Students should reflect on their own activities. So, students should learn mathematics for understanding and teachers should teach mathematics with understanding. The role of teachers should be changed to guidance and facilitation rather than inculcating ready-made knowledge. Moreover, teachers have to employ participatory and problem-centered teaching approaches in the teaching-and-learning of mathematics in which the use of ones preferred learning styles and strategies is a part. Graven (2002) further noted that, by its very nature, mathematics education needs conceptual understanding and intense effort in the construction and reconstruction of knowledge. Similarly, Flavell (1979) also showed that learning should focus on students' empowerment, which is developed by involving students in activities that allow them to construct well-organized bodies of knowledge.

Since mathematics education deals with the learning and teaching of mathematics, I needed to investigate the learning status of mathematics at secondary education level. The purpose of secondary education in the view of Cano (2005) is to develop critical thought, problem solving skills and learning to learn. To this, Cangelosi (1996) stated,

The attainment of mathematical problem solving ability is dependent on five interrelated components. These interrelated components are concepts, skills, processes, attitudes and metacognition. The cognitive and metacognitive developments of the learner have greater impact on the learning and teaching of mathematics.

Here, Cano (2005) stated that the metacognitive perspective focuses on the analysis of students' beliefs about knowledge and learning or epistemological beliefs. To Flavell (1987) and Livingston (1996) *metacognition is,*

The ability to monitor one's own thinking processes in mathematical problem solving and it enables students to benefit from instruction and influences the use and maintenance of learning strategies. These processes include constant and conscious monitoring of the strategies and thinking processes used in carrying out a task, seeking alternative ways of performing a task and checking the appropriateness and reasonableness of answers.

Since concepts refer to the basic mathematical knowledge needed to solve mathematical problems, the number of concepts possessed and the efficiency with which cognitive relationships are organized measure intelligence. The more concepts one has stored in one's mind, the more one is able to learn because there are more categories to which to anchor incoming information. Concepts are abstract ideas and definitions. If the student doesn't know the concept, a teacher has to create a comparative advance organizer, relating the new concept to something already known, and to create an expository advance organizer of a verbal explanation of the main features of the concept in order to establish it as a category in the students' cognitive structure. In addition to having conceptual knowledge, mathematical skills are also crucial to solve mathematical problems. The study of Greeno (1991) has shown that mathematical skills refer to the topic related to manipulative skills that pupils are expected to use when solving mathematical problems. They include estimation and approximation, communication, arithmetic manipulation, algebraic manipulation, mental calculation, use of mathematical tools and handling data.

On the other hand, mathematical processes refer to the thinking and heuristics involved in mathematical problem solving and attitudes refer to the affective aspects of mathematics learning and these include enjoying mathematics, showing confidence in using mathematics, appreciating the beauty and power of mathematics and persevering in solving a mathematical problem. Thus, the

above descriptions on the nature of mathematics were given special emphasis to clearly stipulate the investigation on the preferred learning styles and strategies of students in the learning of mathematics. In line with the above mentioned points, Freudenthal (1991) stated that learning mathematics should have the characteristics of cognitive growth and not of a process of stacking pieces of knowledge. This view is inconsistent with a more general view that the way in which mankind developed mathematical knowledge is also the way in which individuals should acquire mathematical knowledge. He criticizes that mathematics education should take its point of departure primarily in mathematics as an activity, and not in mathematics as a ready-made-system. For him the core of mathematical activity is mathematizing-organizing from a mathematical perspective-, which is considered as reinventing mathematics. He further stated that since students are not expected to invent everything by themselves guided reinvention-which emphasizes on the character of learning process, is essential and selective. Freudenthal considers mathematizing to involve both mathematizing everyday-life subject matter and mathematizing mathematical subject matter. Reinvention demands that the students mathematize their own mathematical activity as well. In relation to this, Treffers (1987) discerns horizontal and vertical mathematization. Horizontal mathematization refers to the process of describing a context problem in mathematical terms – to be able to solve it with mathematical means. Vertical mathematization refers to mathematizing one's own mathematical activity. Through vertical mathematization the student reaches a higher level of mathematics. It is in the process of progressive mathematics-which comprises both the horizontal and vertical components-that the students construct new mathematics. I used these major conceptual issues during the development of theoretical background and development of instruments of the study.

Part 3: Learning Styles, Strategies and Experiences

2.3.1 Learning Styles

Before discussing learning styles, it seems advisable to briefly look at the concepts of these terms. Style is often perceived as the way one acts to receive information and reacts to that information. Zhang (2001) stated that style is not the ability it is rather one's preferred way of using his/her ability. He further indicated that students' learning styles contribute more to their academic performance over and above their abilities. This view focuses to address that those students with an effective learning style need to use their abilities creatively in a norm-challenging way and with a

sense of priority. In line with this argument, Chan (2001) pointed out that the individuals' differences in ability contribute highly to their successes or failures in academic achievement. In this case, a style of learning becomes a determining factor for the academic achievement of students.

Learning styles can thus be seen as the preferred ways of using abilities that one possesses and significantly influence academic performance of the students. Searson and Dunn, (2001:22) in support said,

learning styles as biologically and developmentally determined set of personal characteristics that make identical instruction effective for some and non-effective for others. The biological learning modalities of the learners include the responses, intake of food or drink, time of day, mobility, sound, light, temperature and seating preferences while motivation, responsibility (conformity), and need for structure or flexibility are thought to be sociological.

Furthermore, Burke and Dunn (2002) described learning styles as mostly an individual's personal characteristics and these characteristics are subdivided as environmental, emotional, sociological, physiological and psychological categories. There are also different elements that can be traced under the above subdivision to indicate students' preferences of learning. Also Prescott (2001) depicted that preferences and characteristics that distinguish one individual learner from another as learning styles. Thus, an individual's learning style is the setting in which one prefers to be when learning new and difficult information. Dunn and Dunn (1993) indicated that students' preferences for sound or silence, bright or soft-lighting, warm or cool temperatures and formal or informal seating in classes during the learning process are traced under the environment category. Motivation, persistence, responsibility and need for structure or flexibility come under emotional category of learning. The learner's preference to learn either with peers or alone or team or adult or need for presence of authority figures, parent motivation, and a teacher motivation comes under sociological category of learning. Time-of-day, need for intake, mobility and perceptual strengths like auditory, visual, tactual and kinesthetic skills come under physiological and the way in which the student processes information analytically or globally, left or right impulsive or reflective can be seen under psychological category in the process of learning.

Although a student usually has a predominant or preferred learning style, these may be influenced by features of the learning context, such as course content, assessment or the teachers' conception of teaching. Cano (2005) pointed out learning styles deployed by students may well reflect the

quality of the education they are receiving. Learning styles are usually described as the cognitive, affective, and physiological traits that students exhibit as they interact in the classroom environment. Studies by Orlich *et al.* (2001) indicated that students with different learning styles understand problems in different ways and they try to solve them in different ways. Again Simpson (2001) cited Perry (1994) and defined 'learning style as a relatively consistent pattern of perception, interaction with and response to stimuli in a particular learning environment'. Similarly, Hear (2002) also elaborated learning styles as individual's differences in which information is perceived, processed, and communicated. Basically, each class consists of diverse learners who require individualized programs if they are to be able to experience success. Additionally, Mathews (1996) argued that a person's learning style develops because of hereditary factors, life experiences, and the demand of the present environment. Thus, learning styles are characterized by the degree to which the student emphasizes abstractness over concreteness in perceiving information and the degree to which the learner emphasizes action over reflection in processing information in a learning situation. Thus, the knowledge of preferred learning styles of students is of paramount importance to guide the proper teaching learning process.

2.3.2 Mathematics Learning Styles

Mathematics learning styles are part of a comprehensive learning system rather than just focusing on one dominant style in the learning of mathematics. Specifically, mathematics learning styles are styles that enable students to learn mathematics for understanding the way they prefer. Mathematics learning styles help students to fine-tune their ways of learning mathematics. Cangelosi (1996) states learning as a fundamental skill and mathematics learning styles as ways to improve learning performance of students. The use of different learning styles in the learning of mathematics arouses the curiosity of learners to see what they learn from different angles. Campbell (1996) also argues that using different mathematics learning styles and multiple intelligences for learning mathematics is a relatively new approach to learn mathematics for understanding. When students preferred mathematics learning styles are identified, they contribute towards students using their preferred learning styles in the learning of mathematics. Since mathematics learning is an active and constructive process, it is certain that students are not passive recipients of information and are required to use their preferred mathematics learning styles to learn mathematics. It has been reflected in the studies of Cangelosi (1996) and Schoenfeld (1992) that students need to actively construct their mathematical knowledge and skills through interaction with the physical and social

environment, and through reorganization of their prior mental structures. Wheatley (1991) also states that mathematics learning is an active construction of meaning on the part of the student and is facilitated by interactive discourse in the classroom which requires the use of preferred learning styles of each student.

On the other hand, mathematical learning styles are not fixed attributes but are conditions of one's ability. Students' individual and environmental attributes towards mathematics can enhance or obstruct the learning of mathematics. If students properly use their preferred learning styles and strategies during the learning of mathematics, they can enhance their participation and if not properly used it can obstruct their learning of mathematics. Connection to this view, Orlich *et al.* (2001) mention that students' cultural and background experiences influence how they understand mathematical concepts and how they respond to and benefit from mathematics instruction. Differences in background, experience, and socio-economic status, culture and language all influence the mathematics learning styles of students. In classroom practice, just as mathematics teachers have their own preferred teaching styles, similarly students have their own preferred mathematics learning styles which may affect the learning outcomes. Orlich *et al.* (2001) also discuss that mathematics learning style has a significant influence on students' choice of mathematics learning strategies, and that both learning styles and learning strategies affect learning outcomes.

Anthony (1997) points out that current mathematics learning perspective incorporates three important assumptions. These are seeing mathematics learning as a process of mathematical knowledge construction, mathematics learning as mathematical knowledge dependent, and the student being aware of the process of cognition, controlling and regulating mathematics learning processes. The arguments presented imply that students need to use their own preferred mathematics learning styles to learn mathematics for understanding. Since learning is an idiosyncratic, active and evolving process, the use of mathematics learning styles is a necessary process for students to effectively cope up with high level of demands placed on them to build their own mathematical knowledge structures (Cangelosi, 1996). Mathematics learning is therefore not a passive receiving of ready-made mathematical knowledge, rather it is a process of construction in which students themselves are the primary actors (Von Glasserfeld, 2001). I believe that students

need to be active in interpreting and creating meanings for their mathematics learning by using their mathematical knowledge structure and using their preferred mathematics learning styles.

If mathematics teachers use their preferred teaching style and do not adjust to the preferred learning styles of students, students will not cope with mathematical lessons. In my view a mathematics teacher needs to be aware of his/her preferred teaching style and the preferred learning styles of his/her students. Mathematics teacher needs to design learning experiences that could accommodate the needs of students as much as possible in their classroom practice. Teachers need to have the knowledge that guides their students learn in a better way. In the words of Polya (1985:1)

The students should acquire as much experience of independent work as possible and if left alone with the problem without any help or with insufficient help, they make no progress at all. If the student is not able to do much, the teacher should leave him at least some illusion of independent work and help the student discreetly in the learning of mathematics.

The difference between learning styles and mathematics learning styles lies on the nature of mathematics education itself. That is, the interactive discourse between mathematics teachers and students in mathematics classes allow mathematics teachers to determine what students know about patterns, concepts and to plan experiences to challenge those theories. This ongoing monitoring of students' understanding of mathematics and the use of their own preferred learning styles allow mathematics education to become more continuous and relevant to students.

2.3.3 Learning Strategies

Learning strategies are explicit techniques students use to enhance their own learning. These strategies include listening, guessing or inferring, taking notes, identifying progress and focusing. Oxford and Green (1996) describe learning strategies as specific behaviors that learners use to improve their own learning while learning styles are the broad approaches to learning a new subject or solving a problem. In addition Cangelosi (1996) has pointed out that learning strategies include cognitive, metacognitive, affective and resource management. However, Mayer (1992) noted that, to cope up with the high level of cognitive, metacognitive, affective and resource management demands, students must regulate their learning, develop expertise in how to learn and use that expertise to construct knowledge.

Students need to be cognitively, metacognitively and affectively active in the learning process to learn effectively. Simpson (2001) cited Stewart Sykes (1997) and stated that, 'in every classroom

some students will experience learning difficulties due to variety of causes like emotional disorder, hearing impairment, intellectual disability, language disorder and the like'. Thus, students' levels of learning process are important in determining how effectively they can construct knowledge and retain knowledge. Students who learn in meaningful ways tend to have learning that is more effective and everlasting. Hence, providing learners meaningful learning strategies brings more successful and immediate learning outcomes. To achieve the desired educational outcomes in mathematics each student need to be engaged in the activity of learning using his/her own preferred learning strategies in mathematics classes.

2.3.4 Mathematics Learning Strategies

Mathematics learning strategies are behaviours and thoughts that affect students' motivation or affective state, or the way in which they select, acquire, organize and integrate new mathematical knowledge. As Cangelosi (1996) states mathematics learning strategies are specific techniques used to promote and enhance mathematics learning. The use of mathematics learning strategies has emerged as a critical variable in the mathematics learning process. According to Wolters (1999), there are six cognitive and metacognitive learning strategies and these are rehearsal, elaboration, organization, planning, monitoring and regulation. Rehearsal measures the degree to which students use repetition and memorization to learn school material and elaboration evaluates students' use of strategies in which they connect new material to what they already know. Organization shows students reported use of strategies such as making outlines or diagrams to organize study materials while planning reflects students' tendency to set goals or think through what they wanted to get done before beginning a task. Monitoring asserts the degree to which students mentally supervise or observe their use of cognitive strategies like self-questioning while regulation measures how frequently students control or adjust their cognitive strategy use to fit ongoing task requirements. Wolters further stated that mathematics learning strategies are often-conscious steps or behaviours used by mathematics learners to enhance the acquisition, storage, retention, recall, and use of new information. Thus, knowing the preferred learning strategies of students in the learning of mathematics helps to conduct effective mathematics instruction.

Mathematics learning strategies can be assessed in a variety of ways, such as diaries, think-aloud procedures, observations, and surveys. Oxford and Green (1996) showed that gifted learners use a wider range of learning strategies in a greater number of situations than other learners. Oxford

(1990) further pointed out that many different learning strategies can be used by mathematics students: metacognitive techniques for organizing, focusing, and evaluating one's own learning; affective strategies for handling emotions or attitudes; social strategies for cooperating with others in the learning process; cognitive strategies for linking new information with existing schemata and for analyzing and classifying it; memory strategies for entering new information into memory storage and for retrieving it when needed; and compensation strategies (such as guessing or using gestures) to overcome deficiencies and gaps in one's current language knowledge.

I perceive that students need to be taught to use better strategies to improve their mathematical performance. Similarly, teachers need to assist their students by designing instruction that meets the needs of individuals with different stylistic preferences and by teaching students how to improve their learning strategies. Some mathematics learning strategies may actually have the effect of subverting the learning of mathematics in mathematics classes. Memorization and imitation of examples may meet the short-term goal of completion, but fail to address the long-term goal of strong acts of mathematical knowledge construction. The production of the right answer may override the more difficult endeavours of constructing the idea and of coordinating its interactions with other qualities of powerful constructions (Cangelosi, 1996). As mentioned above, the primary aim of mathematics education is to enable students to develop their ability in mathematical problem solving. Mathematical problem solving includes using and applying mathematics in practical tasks, in real life problems and with mathematics itself. Thus, the knowledge of the preferred mathematics learning strategies of secondary school students in Ethiopian secondary schools is of paramount importance to enable students develop their problem solving abilities in mathematics and to assist them learn mathematics with and for understanding.

2.3.5 Mathematics Learning Experiences and Attitudes

Practical observations show that the world is changing from time to time and those who understand and can do mathematics will have significantly enhanced opportunities and options to shape their future. Learning can be more effective when the student is interested in learning. The relationship between teachers and learners is beneficial in the learning of mathematics. Connected to these points, Kingsley (1989) has shown that, the more effective learning becomes more educative when there is more effective learning relation and communication between the teacher and his pupils. It can be argued that everyone needs to understand mathematics and mathematics is not designed for

few. The NCTM (2000) studies reflected that, all students should have the opportunity and the support necessary to learn significant mathematics with depth and understanding. Students need to learn mathematics with understanding, thus actively building new knowledge from experience based on previous knowledge. Hence, the opportunity to solve mathematical problems in order to acquire ways of thinking, habits of persistence and curiosity and confidence should be given to students. Solving mathematical problems should not be the only goal of learning mathematics but a major means of learning mathematics.

Aggarwal (2002) describes that learning includes experiences gained through the formal and informal processes of education that is either from the environment or from the schooling system. Different scholars gave special emphasis to the prior experiences of the learners for the learning of mathematics. This can be shown in the words of Kochhar. As he explained:

There are three levels of learning experiences that plays a major role in the teaching and learning of mathematics. These levels are direct experiences, vicarious experiences and symbolic experiences. Direct experiences in mathematics learning include having immediate sensory contact with the actual object. If the learner goes to the business firm, s/he gains direct experiences, which gives first hand information and which facilitates the learning process. Vicarious experiences include use of models, films, specimens, television, radio, pictures, drawings, etc in terms of the real objects. Symbolic or abstract experiences are offered through verbal symbols—oral or written. They occur at conceptual level. The teacher translates the original item into the symbol and passes to the pupil who then has to translate it back to the original image. Thus as the child advances in age and his store of information increases, symbolic experiences become essential since the child is expected to apply and create his own knowledge. The degree of emphasis increases at this level (Kochhar, 2001:61).

In support to Kochhar's view, Harmer (1983) also has pointed out that direct and vicarious experiences provide a concrete basis for conceptual thinking. Thus, the learning experiences of students have a great impact on the learning and understanding of mathematics. According to Grouws and Cebulla (2000), the attitudes of the teachers and students towards mathematics are highly decisive to make the teaching of mathematics either attractive or to learn mathematics with full interest and enthusiasm. Based on these facts, I believe that, a teacher who has a positive attitude towards mathematics shows that mathematics is understandable by employing meaningful methods of teaching. Similarly, if learners have positive attitude towards the learning of mathematics, they use their prior knowledge to construct newer knowledge, fully involve in the learning process to develop relationships and relate mathematics to the contextual situations to solve real life problems.

Moreover, there are certain factors that affect the attitudes of the learners towards learning mathematics. These factors include the actual classrooms' environment, the teaching methods employed by teachers, the instructional materials used, and teachers' mastery of the subject matter, school facilities and their achievements in mathematics. Cangelosi (1996), Callan (1996) and Cooney and Shealy (1991) asserted that, teachers' effectiveness in the classroom has been shown to benefit greatly from looking at various developmental stages of students and considering cognitive science and other contributions from educational research. Too often, teachers do not focus on how students learn and the critical importance of these cognitive issues for their teaching. Doolan and Honigsfeld (2000) added that,

If we want students to have a deeper knowledge of a mathematical concept so that they can apply the knowledge in new situations, we must offer students numerous opportunities to engage with related knowledge, facts, and examples of the concept.

The success of students is a driving force to be motivated to learn mathematics with understanding and apply mathematics as a problem-solving tool. On the other hand, the failure in achievements becomes a restraining force and de-motivates students. Sometimes they may hate mathematics. Schools should be smart and attractive in order to improve the attitudes of students. The argument of Harmer (1983) showed that the physical conditions of a room have great effect on learning and can influence students learning either positively or negatively. Thus the schools have to be equipped with the necessary facilities in order to improve the teaching-learning situation of the students. Instructional materials have a great role in facilitating the teaching and learning process since it would provide concrete and observable models for the learner to grasp concepts. Cangelosi (1996) elaborates that teacher's pedagogical content knowledge increases within the context of a strong knowledge of mathematical content, their ability to impact student learning also increases. The use of different teaching strategies is effective in helping children to learn concepts, discover efficient procedures, reason mathematically, and become better problem solvers. These teaching strategies include having high expectations for all students, collaborate with others, promoting cooperative learning, using technology as a tool, using inquiry based learning, promote mathematical reasoning, promoting problem solving, reflecting on teaching and learning, integrate assessment and instruction, clustering concepts, integrating content areas, and basing practices on educational research.

I believe that the teaching strategies teachers employ in mathematics classes has its own contribution in enhancing mathematics learning. In line with this view, Keefe (1979) has pointed out as follows.

teaching strategies that need to be applied by mathematics teachers include use of concrete representations, provision of time to students to play, use of examples and non-examples, introducing and implementing technology, use of contextual and prior knowledge of the learner, and actively engage students in learning.

When the teaching for understanding takes place, the children's knowledge builds up and mathematical ideas take roots and grow. Supporting this view, Cangelosi (1996) argued that

Children learn mathematics with understanding when they solve mathematical problems. Teachers have to minimize teaching by telling and facilitate to learn mathematics with understanding. The setting in which students immediately participate should be organized.

Thus, teachers have to teach mathematics for understanding by employing proper teaching experiences, styles and strategies. Similarly, teachers and other partners have to work hand in hand in order to build a children's thinking about mathematical ideas.

Part 4: The Role of Teachers in Assisting Students to Use Their Own Preferred Learning Styles and Strategies

Teaching and learning are inseparable. It can be argued that both entities are important in enhancing or impeding the learning processes of students. Also, teachers' view on learning styles and strategies of their students is one of the factors that affect the learning of mathematics and has a great implication for learning. The well-trained teachers know how to guide the learning of their students in the teaching-learning process. Biggs and Moore (1993) have strengthened this idea when they argued that, the more the teacher mastered his/her subject, the better he/she will be able to teach it and the more pupils will learn at the end. A teacher is very important to carry out responsibility in changing and shaping pupils behaviour in school. In order for teachers to be more effective with diverse students, Pewewardy (2002) mentioned that it is crucial for teachers to recognize their own world views and understand the preferences of their students. Canfield (1992) further described that, knowing the kinds of learning styles that students most prefer may help teachers to develop alternative course structures that provide a better fit between their teaching styles and the learning style preference of their students.

Pewewardy (2002) and Park (2001) have discussed that matching the teaching styles of teachers with learning styles is important for reinforcing the learning content, for employing diverse instructional approaches and for maximizing the learning of students. In line to this view, teachers need to allow their students to learn through their senses with the use of multimedia presentations and multi-sensory resources. Park (2001) also has mentioned that teachers could meet the learning needs of all students with multiple opportunities for learning, given the reality that mathematics classes usually consist of diverse learners. Mathematics teachers need to help secondary school students to identify their learning styles and strategies and describe their strengths, and to show students how to help themselves to learn through their learning preferences. They need to provide their students with instruction on diverse and specific learning strategies and assist them to become effective strategy users as well as competent and self-directed learners in order to improve their academic performance since learning and academic performance are influenced by numerous cognitive variables. Moreover, as NCTM (1989) studies indicate teachers are expected to understand emerging standards and views of learning to change their roles and practice accordingly.

Teachers are expected to assist and guide their students but not too much and not too little, so that the student shall have a reasonable share of the work. Sound teaching usually begins with questions and phenomena that are interesting and familiar to students, not with abstractions or phenomena outside their range of perception, understanding, or knowledge. Engage students actively, concentrate on the collection and use of evidence, provide historical perspectives, insist on clear expression, use a team approach and do not separate knowing from finding out. Polya (1985) also mentioned that the task of understanding the emerging standards and students preferences is not easy and it demands time, practice, devotion and sound principles. A teacher must actively engage students in the learning process, so students construct their own knowledge and should take into account the different learning styles of his/her students. Moreover, a teacher should provide equal opportunity for all students to learn mathematics, regardless of gender or other personal characteristics. Polya (1985) distinctly has elaborated that the teacher should put himself in the students place and should try to understand what is going on in the students mind. The teacher who wishes to develop her students' ability to do problems must instil some interest for problems into their minds and give them plenty of opportunities for imitation and practice. If the teacher wishes to develop in her students the mental operations, which correspond to the questions and suggestions, she puts to the students as often as she can do so naturally. Moreover, when the mathematics teacher

solves a problem before the class, she should dramatize her ideas a little and she put her self the same questions which she uses when helping the students.

The Mathematics teacher has a great opportunity of either killing the interest of the students by filling the allotted time with routine operations or giving them a taste for independent thinking by setting them the problems proportionate to their knowledge. On the other hand, mathematics teachers need to use teaching aids and technological tools to enhance mathematics teaching and learning. As Kay (1971) has suggested, teaching aids make teachers take easier and effective and motivate students' attention to be active learners. It improves students learning. Additional learning materials like TV, Radio, Calculators and Newspapers are important to increase the learning abilities of the learners. Similarly, Batcher (1971) argue that good environmental experience leads to increased learning ability of the students. Wallace and Louden (2003) added that,

the teacher is to make use of educational media such as computers to improve the effectiveness of instruction; and in the teaching of computation, the teachers should make use of hand-held calculators and computers, appropriate to the occasion, to improve the effectiveness of learning.

Goldenberg *et al.* (1997) assert that students must learn how to think from a mathematical point of view and that they have to develop a habit of mind to understand mathematics. The development of habit of mind perspective is important since mathematical ways of thinking have valuable applications outside of mathematics as well as within it. In connection with this, Stellwagen (2001) has stated that the primary role of the teacher is to recognize the many potentialities of his/her students and to consciously plan for the balanced development of each individual across each of the learning styles. Mathematics teachers need to teach mathematics to develop understanding, mastery, self-expression and interpersonal awareness in their students. Stellwagen (2001:267) further pointed out that,

basically teachers need to accomplish the tasks of fostering mathematical literacy of students, enhancing the ability of students thinking mathematically, giving attention on the ability to do and use mathematics intelligently rather than on covering a wide area of mathematical content or on using sophisticated mathematical content, integrating the various branches of mathematics and the role of technological tools in enhancing mathematics learning.

Besides stressing on the role of teachers, Stellwagen has described vital points to be addressed by mathematics teachers as,

how they adjust their teaching styles to account for different learning styles, how they identify learning styles, how they know whether they have achieved their desired educational

out come (student learning) or not, how they talk about their students' different learning styles, how they respond to their students' different learning styles, and why teachers respond to their students' different learning styles (teachers responsibility, commitment and confidence).

The role of teachers seems to be immeasurable to improve the mathematics learning which in turn contributes to the development of a nation. Hear *et al.* (2002:143-144) have stated that,

excellent teachers seem to sense what and how to teach; they know, care, and can reach their students; they are adamant that all students can learn; they are committed to their profession and willing to do what it takes to ensure a student learns, and know what to do. They took responsibility for the learning of their students in their classes and purposefully sought out the best ways to reach them. They did not necessarily teach using their own dominant learning styles and should identify individual learning styles and work with students by actively seeking out the best ways to connect with them.

The students prior knowledge need to be given due attention to improve mathematics education. Hear *et al.* (2002) by citing Haycock and Robinson (2001) noted that teachers who consistently get results from all groups of students clearly know their subjects and how to teach them. The teachers also know that all students come to school with some prior knowledge on which they can build, and see the range of student abilities, cultures, and races in their classrooms as challenges, not as impediments. When teachers give due assistance to students to use their own preferred learning styles and strategies, students start to feel at ease and learn mathematics in a relaxed manners. In connection to this view, by citing Dunn (1995), Chan (2001) has described that students have typical ways of taking in, processing, internalizing, and retaining information and skills which are generally considered as students' learning styles. Effective student learning comes when teachers design and use appropriate teaching strategies for specific and preferred learning styles of students. The planning of instruction should be geared to employ different learning styles of the students (Dunn and Dunn, 1993: Dunn 1995; Fischer and Fischer, 1979).

Teachers teaching strategies need to be geared to match the learning styles and strategies of students. In connection with the teaching strategies, Chan (2001) identified nine teaching strategies and mentioned these to be discussion, drill and recitation, independent study, lecture, peer teaching, programmed instruction, projects, simulations, and teaching games. Chan further pointed out that, since student's learning style preferences might be different for different specific groups and across different cultural settings, it is necessary that the preferred learning styles of students can be identified and assessed so that the corresponding change in teaching strategies will allow these students to learn through the method of their choice (pp.36-37). On the same breadth Beck

(2001:10) argued that, matching teaching strategies of teachers to the learning styles of students will help to increase the achievement of students. To do this, teachers need to make learning inventories of their students. Learning Styles Inventories (LSI) serve in diagnosing learning difficulties, advising and placing students, selecting teaching materials, and arranging the classroom atmosphere.

Beck further elaborated the most common reason for implementing a learning styles inventory (LSI) is to help teachers select the most appropriate teaching strategies to meet the learning styles of their students. As teachers become more cognizant of learning styles diversity, they develop a deeper sense of responsibility for reaching and motivating their students. Before beginning to match learning styles to teaching strategies, it is important to establish a comprehensive and clearly defined set of teaching strategies to serve as a reference. The instruction and learning of mathematics improves when mathematics teachers use multiple teaching strategies in coincidence with the learning style preferences of their students (Dyer, 1996; Dyer and Osborne 1999). Teachers can guide students as they move through several stages in the process of developing deep, flexible knowledge. Mathematics teachers should revisit the same concept repeatedly over an extended period, in order to encourage thinking of their students about the similarities and differences in the examples. As a result, the mathematics teachers have significant role in creating good atmosphere for the learning of mathematics and to arouse the interest of students to use their own preferred learning styles and strategies in the learning of mathematics. I believe that teachers can play a major role in assisting the students to use their own preferred learning styles and strategies by adjusting their teaching styles and strategies.

Part 5: Studies Related To Learning Styles and Implications of These Studies to Mathematics Education in Ethiopia

2.5.1 Discussion of Different Studies Related to the Learning Styles and Strategies

A review of the studies conducted on the learning styles and strategies of American Indian/Alaska Native students, Pewewardy (2002) described the learning styles and strategies of these students using seven classification of learning styles. These classification were field dependence versus field independence, perceptual strengths (visual, auditory and kinaesthetic), reflective versus impulsivity, classroom management and behaviour, role of the family (tribe and elders), teacher/pupil relationships and cooperation versus competition. Since field independence and field dependence

refer to how students learn rather than what they learn, Pewewardy's study revealed that field dependence or global learning was the preferred learning style of American Indian/Alaska Native students (p.28). He reflected that, visual learners learn best when they are able to see the material they are expected to learn. Though traditionally many students view mathematics as a spectator sport rather than one in which they can participate, one of the findings of Pewewardy indicated that many American Indian/Alaska Native students appear to perform best in classrooms with an emphasis on visualization, especially in mathematics. They tend to learn best when the teacher provides a myriad of visual learning opportunities such as graphs, films, demonstrations and pictures (p.29). Likewise, Pewewardy in his study revealed that the American Indian/Alaska Native students tend to be reflective learners examining all side of an issue as well as possible implications and solutions related to the problems (pp.30-31). Here, reflection can be observed as the tendency to stop to consider options before responding often resulting in greater accuracy while impulsiveness as the tendency to respond immediately more fluently, yet inaccurate problem solving occurs.

Furthermore, Pewewardy showed that in the traditional American Indian/Alaska Native cultures, obedience is approached through explanations of the desired behaviour often through grandparents (p.32). In schools, students respond more effectively when the teacher gives them warnings of bad behaviour. Shame or embarrassments were common disciplinary tools and humour is revealed to be a useful teaching strategy of these students at all ages. Teachers were required to employ culturally responsive teaching styles because of distinct learning style preferences of these students (p.37). Similarly, he stressed that, family, elders and a tribe plays an important role in the teaching learning process of American Indian/Alaska Native students (p.33). Status and rewards are often derived from adherence to tribal structure. These students are taught to treat family members with respect. Observation, time-orientation, sharing and cooperation were identified to be the best learning strategies of these students (p.34). His study further indicated that the teaching styles teachers employ have a significant role on whether students learn or fail. When teachers fail to recognize the differences in students learning styles preferences, the American Indian/Alaska Native students may react in negative ways to their instruction (pp.34-35). Pewewardy summarized that matching teaching styles with learning styles of the American Indian/Alaska Native students has improved the achievement of these students (p.35). It is this finding that has motivated me to include identifying the role that teachers play in helping their students to use their preferred learning styles and strategies in the learning of mathematics as one of the issues. Finally, Pewewardy revealed that the

researches he reviewed indicated that the American Indian/Alaska Native students tend to favour cooperation, harmony, unity and a basic oneness over competition. They preferred cooperative learning strategies (pp.35-36).

Chan (2001) also investigated the learning styles of 398 gifted and non-gifted Hong-Kong Chinese secondary school students using the Chinese version of the Learning Styles Inventory (LSI). The learning styles inventory that Chan used in his study was the one prepared by Renzulli, Smith and Rizza in 1998 and translated into Chinese version. This instrument helped to assess students' preferences for nine teaching modes including discussion, drill and recitation, independent-study, lecture, peer-teaching, programmed-instruction, projects, simulations and teaching-games. Chan included the dimensions of preferred learning activities common for gifted and non-gifted students to be factors interpretable as learning through verbal interaction, learning by role playing, and learning by doing. In this study, gifted students indicated significantly greater preference for learning styles related to interpersonal verbal exchanges and autonomous learning. Although there were no significant gender differences in learning style preferences, the younger age group indicated significantly greater preference for learning styles related to structured activities and games than the older age group. Moreover, the study revealed that both gifted and non-gifted students prefer learning styles that are related to verbal interaction between teachers and students and among students. Gifted and non-gifted students share a similar dislike of teacher-directed structured activities involving drilling and recitation. I adapted some of the components of this instrument with other learning styles inventories and use it as instrument for my investigation of the learning styles and strategies in the learning of mathematics.

Likewise, Stitti-Gohdes (2001) conducted a study on business education students preferred learning styles and their teachers preferred instructional styles. The purpose of his study was to determine whether there is a match between the learning styles of secondary school business students and the teaching styles of their teachers. He stated that the descriptive study method is the method found to be appropriate for such type studies. Eight volunteer teachers and 212 students have participated to complete the questionnaire prepared using the Canfield learning styles inventory and Canfield instructional styles inventory. These instruments were aimed to assess the individual's learning style preferences related to conditions for learning, area of interest, modes of learning and expectations for course grade and the teaching styles of the teachers (p. 140). In the Canfield learning styles

inventory method, learning styles are described as an individual's preferences for the conditions of where, when and with what in the learning process that can have effect on one's learning were identified. His findings indicated that there is a modest match between students' learning styles and their teachers' instructional styles. I intended to use similar descriptive method in the study of preferred learning styles and strategies in learning mathematics.

Rayneri, Gerber and Wiley (2003) discussed research findings of different researchers on the causes of underachievement of learners in mathematics. According to their reviews, these researchers have hypothesized different factors that contributed to the underachievement of the students in mathematics. For example, Riding and Al-Hajji (2000) stated that gifted learners are not being involved in meaningful school experiences that would stimulate achievements in mathematics due to inflexible curricula and lack of acceleration opportunities. Restack (1979) mentioned lack of teachers training in gifted education as the cause for underachievement of students in mathematics while others linked it to the mismatch between the learning styles of high ability students and the instructional approaches used in the classroom (Rayneri *et al.*, 2003). On the other hand, the interaction of various environmental factors affects each person differently as he/she learns mathematics. The study by Restack (1979) indicated that 60 % of one's learning style composes biological and developmental set of characteristics which describes that even underachieving students perform well in mathematics when their learning styles are accommodated in the classroom learning (Rayneri *et al.*, 2003). Besides other factors, the improvement of students' performance in mathematics when their preferred learning styles and strategies are accommodated has initiated me to investigate the preferred learning styles and strategies of students in the learning of mathematics.

2.5.2 Implications of Studies on Learning Styles and Strategies to Mathematics Education in Ethiopia

As discussed above, the results of the studies related to preferred learning styles and strategies of students conducted by researchers have shown the improvement of mathematics learning at different levels. Connected to this view, Stitti-Gohdes (2001) pointed out that knowing the kinds of learning experiences that students' value may help teachers to develop alternatives that provide a better fit between their instructional goals and the learning style preferences of their students. Moreover, the accommodation of learning styles and strategies in the learning of mathematics has made underachieving students to perform better.

According to Ethiopian context, this investigation of preferred learning styles and strategies of secondary school students in the learning of mathematics basically helps:

1. To reveal students' preferred learning styles and strategies needed to be considered during the learning of mathematics;
2. Students to learn mathematics more effectively in their own ways;
3. To engage students in the process of learning mathematics rather than sitting idle in mathematics classes;
4. To identify the major impediments that hinder the implementation of students' preferred learning styles and strategies during the learning of mathematics;
5. Teachers to be flexible in their mathematics instruction rather than employing autocratic teaching styles;
6. Teachers to adjust or match their teaching styles to the identified students' preferred learning styles and strategies;
7. Teachers to design different alternatives to improve mathematics instruction;
8. To increase students' awareness to initiate their teachers to meet their individual needs whenever possible;
9. Curriculum developers to give attention to the learning preferences of students during the designing of mathematics curriculum;
10. To initiate policy makers to suggest the improvement of mathematics instruction as to meet the preferences of the students in order to produce capable citizens; and
11. To propose for further research in improving mathematics instructions that copes with understanding of students.

2.6 Conclusion

This chapter gave the general description of the theoretical background on the learning styles and strategies. The attempt was made to describe the historical perspectives of learning styles and strategies. The nature of mathematics was discussed. Identifying the learning styles and strategies students prefer to learn mathematics and creating opportunities to use their own preferences was found to be essential to learn mathematics for understanding and to improve the academic achievement of students. Learning styles are seen as the preferred ways of using abilities that one possesses and significantly influence academic performance of the students while mathematics learning styles are styles each student employs to learn mathematics for understanding. The

importance of learning styles and strategies is discussed. The prevalence of various learning styles and strategies among individuals apparently led to the speculation and interpretation of learning styles and strategies. The individuals' differences in ability highly contribute for their successes or failures in academic achievement (Chan, 2001). Learning styles can further be described as an individual's personal characteristics and these characteristics are subdivided as environmental, emotional, sociological, physiological and psychological categories (Burke and Dunn, 2002). Learning strategies are specific behaviors that learners use to improve their own learning and include listening, guessing, taking risks, identifying progress and focusing (Oxford and Green, 1996). Mathematics learning strategies are behaviors and thoughts affecting the students' motivation or affective state, or the way, in which students select, acquire, organize and integrate new mathematical knowledge. Students' levels of learning process are important in determining how effectively they can construct knowledge and retain knowledge. Students who learn in meaningful ways tend to have learning that is more effective and everlasting. To achieve the desired educational outcomes in mathematics, each student must be engaged in the activity of learning using his/her own preferred learning styles and strategies in mathematics classes. Knowing the preferred learning styles and strategies of the students in the learning of mathematics helps to conduct effective mathematics instruction. Flexible combinations of learning styles and teaching styles allow students to develop effective ways of gaining positive educational outcomes. Moreover, knowing the kinds of learning styles that students most prefer may help teachers to develop alternative course structures that provide a better fit between their teaching styles and the learning style preference of their students (Canfield, 1992).

Different studies conducted by different researchers were discussed to reflect the importance of conducting this study in Ethiopia. Since the purpose of secondary education is the development of critical thought, problem solving skills and enhancing the learning of students, students need to use their preferred learning styles and strategies to learn mathematics in a meaningful way (Cano, 2005:215). Mathematics connects one to his or her universe in many ways by incorporating language, culture and daily living practices (Pewewardy, 2002). One can clearly stipulate that the advancement of science and technology is realized by the proper application and utilization of mathematical knowledge, which in turn helps to curb societal problems. Though students are expected to create their own mathematical knowledge with the guidance of teachers, the National Council of Mathematics Teachers in USA underlined that integration of the teachers, the learners,

the curriculum and the pedagogy of instruction to be mandatory to create a full-fledged operational result (NCTM, 1991). So, knowing the individual's differences in which information is perceived, processed, and communicated during the learning of mathematics made this investigation of preferred learning styles and strategies used by students in the learning of mathematics important in Ethiopian secondary schools. The next chapter explores the research design and methodology used to conduct this study in the West-Shoa Zone of Oromia Region, Ethiopia.

Chapter 3

Research Design and Methodology

3.1 Introduction

The study focuses on the investigation of the preferred learning styles and strategies of secondary school students in Ethiopia when they learn mathematics. Specifically, the study tries to answer the basic research questions that are addressed in this study. These research questions are:

1. What types of learning styles and strategies do secondary school students prefer to use to learn mathematics?
2. How do secondary school mathematics teachers assist their students to use their own preferred learning styles and strategies to learn mathematics?
3. How does the designed secondary school mathematics curriculum encourage students to use their own preferred learning styles and strategies to learn mathematics?
4. What could be the major challenges that students might face in using their own preferred learning styles and strategies when they learn mathematics?

Thus, in order to address the above mentioned research questions, this chapter included the following important points. These are the design of the study in which the qualitative method is used. Since the data to be dealt with were categorical data than quantitative data, and the information gathered were categorized, a qualitative method was considered as appropriate research design for this study. Two types of questionnaires and interview guide were developed. The validity and reliability of the instruments were assured through employing professional comments from mathematics experts and pilot-tests. The populations of the study were identified to be secondary school students and their mathematics teachers. The administration of data collection was guided by ensuring consents from school principals, sampled students and teachers. The ethical considerations to be followed were set and practiced during data gathering processes.

3.2 Research Design

Research design is considered as the blue-print and cornerstone of any study since it facilitates various research operations. In this regard, Kothari (2006) argues that research design helps the researcher for advance planning of the methods to be adopted for collecting the relevant data and techniques to be used during analysis. The nature and the objectives of the problem to be studied and the means of obtaining information are the most important factors to be considered in order to choose the appropriate research design. Regarding the selection of the research design, Kothari (2006:33) and Brown and Dowling (1998:37) noted that,

If the major emphasis of the study is on discovery of ideas and insights the appropriate research design is found to be exploratory (experimental) while if the purpose of the study is on the accurate description of a situation the appropriate research design is descriptive.

Since the purpose of this study is to investigate the preferred learning styles and strategies of secondary school students in learning mathematics, a qualitative study method is found to be more appropriate for this study. Steffens and Botha (2002) have stated that a qualitative or categorical variable indicates to which group a subject belongs or the absence or presence of some or other quality. Employing this qualitative approach is believed to be more appropriate method to investigate the topic under discussion - learning about the preferred learning styles and strategies of the secondary school students in the learning of mathematics. Besides this, this qualitative approach is useful to look carefully for flaws and inadequacies that might be induced un-intentionally in this study. Similarly, this qualitative approach also enabled me to categorize the preferred learning styles and strategies of the subjects of the study under investigation.

3.3 Research Instruments

Research instruments are the basic tools to gather data to seek possible solutions for the observed problems. In order to answer the above mentioned research questions, the research instruments developed in this study were:

- (a) close-ended questionnaire for students
- (b) open and closed-ended questionnaire for mathematics teachers, and
- (c) an interview guide for mathematics teachers that had a semi-structured character to conduct the study. The interview guide was developed to explore mathematics teachers' observations on the experiences of their students' use of their own preferred learning styles and strategies.

I developed the interest of pursuing questionnaires and interview guide as instrument of this study while reviewing the research literatures on learning styles and strategies. In relation to this idea, Trochim (2003) argues that alternative forms were designed to be equivalent in the types of questions... that leads to the outcome. Likewise, Kothari (2006) describes that the collection of primary data for qualitative studies is either through questionnaire or through interviews. Moreover, Chan (2001) has employed questionnaires when he investigated the learning styles of 398 gifted and non-gifted Hong-Kong Chinese secondary school students. Dunn and Dunn (1993) had also used the questionnaires while they were developing the Dunn and Dunn's Learning Styles Inventories.

The development of two types of questionnaires and an interview guide is also useful to triangulate the responses of sample students and their teachers. The interview guide that was set for teachers was directly linked to some of the items set in the questionnaires. I considered responses obtained from mathematics teachers on the same item through questionnaire and interview guide to reveal consistency of responses. This triangulation of responses helped me to avoid the threat of bias that might be induced unintentionally. In relation to this point, Dooley (2004) stated that triangulation of instruments serve as a means of lighting a phenomenon from multiple angles and helps the researcher to reveal a better detailed evidence of any study.

3.3.1 The Development of the Questionnaire for Students

In order to answer the research questions, the items of the questionnaire are developed using simple and clear words that were appropriate and helped students to respond to the questions with understanding. During the development of this questionnaire, I used the related theoretical background reviewed for my study; I adapted the instruments used by Dunn's during the development of Learning Styles Inventory, I adapted the instruments Chan used during his study of Chinese students Learning Styles Preferences and I used my teaching experiences as secondary school mathematics teacher. Kothari (2006) has described that a questionnaire should be carefully constructed, sequenced, properly set and clearly worded to gather adequate responses. It was also sequenced from simple to complex having explicit questions with fixed alternatives to be chosen from. As Kothari (2006) stressed the structured questionnaires have fixed alternative questions in which responses of the informants are limited to the stated alternatives. This questionnaire contained Part I and Part II having 36 questions. Part I has 10 alternative (multiple-choice) questions for which the students were requested to choose the best answer of their choice from the

alternatives ranging from (A) to (C). Part II also contains 26 Likert scale questions in which students were requested to choose among strongly-agree (5), agree (4), not-identified (3), disagree (2) and strongly-disagree (1). For example, for the questions like 'I prefer to learn and work mathematics problems in a silent environment', the respondents were required to express their agreement or disagreement by ticking one of the above given Likert choices. The items of the students' questionnaire were categorized as environmental, emotional, sociological, physiological and psychological when the findings are analysed. The items included under each category are described below.

- a) The environmental category includes preferred learning styles and strategies for learning environment, and preferred learning styles and strategies for seating arrangements.
- b) The emotional category contains preferred learning styles and strategies for structured ways of learning mathematics and preferred learning styles and strategies for recalling (remembering) mathematical concepts.
- c) The sociological category comprises of preference for introvert or extrovert style of learning mathematics and preferred learning styles and strategies for working on mathematics projects (assignments).
- d) The physiological category includes preferred learning styles and strategies for the time of day, preference for visual explanations during mathematics classes, preferences on either working on mathematics problems or memorizing their solutions to learn mathematics, preferences on free choice of working on mathematical problems to explore one's talents and abilities (trial and error), preferences for learning mathematics through solving different mathematical problems, preference for developing and making mathematical graphs and charts in learning mathematics, and preferences for explanations of diagrams, graphs, or visual directions in mathematics classes.
- e) The psychological category comprises of preferred learning styles and strategies for detail explanations or getting highlights (global or analytic styles), preference for learning mathematics by listening lessons presented by the teachers, and preferences for learning mathematics to widen ones logical reasoning and develop one's thinking ability.

These categories identified the types of preferred learning styles and strategies of the students under investigation. The students' questionnaire items were divided into four groups based on the research questions they were envisaged to answer.

Twenty three items refer to the types of preferred learning styles and strategies of the students. These were classified under five categories. Thus, the questionnaire items under each category were set as follows.

1. Environmental category:

- 1.1. *I prefer to learn and work mathematics problems in a silent environment.*
- 1.2. *I prefer to learn and work mathematics problems in a noisy environment.*
- 1.3. *I prefer formal ways of seating arrangements in the mathematics classrooms.*
- 1.4. *I prefer informal ways of seating arrangements in the mathematics classrooms.*

2. Emotional category

- 2.1. *I prefer structured ways during the process of working on mathematical problems.*
- 2.2. *I prefer to see information written on a blackboard and supplemented by visual aids.*
- 2.3. *I can remember best about a subject by listening to a lecture that includes information, explanations and discussion.*

3. Sociological category

- 3.1. *I enjoy studying and working mathematics problems alone by my self (introvert style).*
- 3.2. *I prefer studying and working on mathematics problems in groups with my peers or in teams (extrovert style).*
- 3.3. *How do you work when the group project is given by your mathematics teachers?*

4. Physiological category

- 4.1. *I prefer to learn mathematics in the morning classes.*
- 4.2. *I prefer to learn mathematics in the afternoon classes.*
- 4.3. *How do you start working on mathematics problems?*
- 4.4. *I like to work on mathematics problems rather than memorizing their solutions.*
- 4.5. *I prefer free choice of working on mathematical problems to explore ones talents and abilities (trial and error).*
- 4.6. *I prefer to learn mathematics through solving different mathematical problems.*
- 4.7. *How do you more easily remember mathematical concepts?*
- 4.8. *I enjoy developing and making mathematical graphs and charts.*

4.9. *I require explanations of diagrams, graphs, or visual directions in math classrooms.*

5. Psychological category

5.1. *I prefer detail explanations on all of mathematics problems or topics (analytic style).*

5.2. *I prefer general highlighting or general ideas rather than detail explanations on all math problems (global style).*

5.3. *I prefer to learn mathematics by listening to lessons presented by teachers.*

5.4. *I learn mathematics to widen my logical reasoning and develop my thinking ability.*

- Three items were set to investigate the assistance students require to use their own learning styles and strategies in the learning of mathematics. These questionnaire items were described as follows.

1. *I prefer when mathematics teachers...*

2. *I prefer mathematics teachers who...*

3. *Mathematics teachers' use of their preferred teaching styles to help us understand mathematics easily...*

- Six items were set to identify the design of mathematics curriculum conduciveness to motivate students to use their own learning styles and strategies. The items were set as follows.

1. *When I am solving mathematical problems in classrooms, I ...*

2. *If teachers start their mathematics lessons with an outline of what they will cover, such outlines are...*

3. *I prefer mathematics lessons that emphasize on...*

4. *When teachers are presenting mathematical and statistical data in classrooms, I prefer it to be ...*

5. *The learning of mathematics at primary level in my vernacular (mother tongue) helped me to understand secondary school mathematics easily. So, I ...*

6. *I prefer learning mathematics through plasma television (curriculum organization). So, I...*

- Four items were also set to examine the challenges students might face to use their own preferred learning styles and strategies in the learning of mathematics. These questionnaire items were:

1. *When I solve mathematics problems, I ...*
2. *Lack of using my preferred learning styles has contributed for my achievement in mathematics to be poor. I ...*
3. *I learn mathematics because it is given as a compulsory subject in my school. I ...*
4. *For me, mathematics is a difficult subject and I don't understand it easily. I ...*

The construction of this questionnaire items is more strengthened using the professional comments given by colleagues and the feedback obtained during the pilot test (the detail is given in section 3.4.4).

3.3.2 The Development of Teachers' Questionnaire

Similarly, in developing the Teachers' Questionnaire I used the related theoretical background reviewed for my study and the experiences I passed through as a secondary school mathematics teacher. Moreover, the motivation for the development of this questionnaire is the role that mathematics teachers play in assisting their students to use their own preferred learning styles and strategies in learning mathematics. This questionnaire contains structured and semi-structured items having close-ended and open-ended questions. The professional colleagues mentioned above, reviewed and commented on its forms and settings. For instance, they commented to change words like 'themes' to 'topic', 'lectures' to 'instructions'... This questionnaire was used to gather data from teachers that participated in this study. According to Cangelosi (1996), teachers' view on learning styles and strategies of their students is one of the factors that affect the learning of mathematics and has a great implication for learning. Also, Pewewardy (2002:35) asserted that,

matching the teaching styles of teachers with learning styles is important for maximizing the learning of students. He further stated that, in order for teachers to be more effective with diverse students, it is crucial for them to recognize their own world views and understand the preferred learning styles and strategies of their students.

Moreover, Canfield (1992:1) and Beck (2001) noted that,

knowing the kinds of learning styles that students most prefer may help teachers to develop alternative course structures that provide a better fit between their teaching styles and the preferred learning styles and strategies of their students.

The questionnaire developed has 12 multiple choice items in which the alternative ranges from (A) to (D). Since the close-ended questions limit the options to the respondents by restricting the answers to be given to the question (Dooley, 2004), I incorporated the open-ended questions as alternative options for teachers who were involved in the study process to share what they have accumulated through their practical experiences (Almack, 2006). For example, for the questions like 'If your students do not understand the mathematical topic under discussion, what measures do you prefer to take?' The respondents were requested to write other factors besides the alternatives set under the item.

The teachers' questionnaire items were divided into three groups based on the research questions they were esteemed to answer. Six items were set to investigate the assistances students may require to use their own preferred learning styles and strategies. These questions were:

1. *What type of teaching styles do you mostly apply in your mathematics classrooms?*
2. *Do you help your students to use their own learning styles in the process of teaching mathematics?*
3. *If your students do not understand the mathematical topic under discussion, what measures do you take?*
4. *Most preferably, how do you invite (make) your students to participate in the discussion during your mathematics classroom?*
5. *How do you allow your students to solve mathematical problems?*
6. *How do you support your students learn mathematics?*

On the other hand, four items were set to identify the design of mathematics curriculum to motivate students to use their own preferred learning styles and strategies. These questions were:

1. *As a mathematics teacher, I more like to teach a lesson ...*
2. *What are your most preferred strategies of teaching mathematics?*
3. *Does the transmission of mathematics lessons through plasma television encourage students to use their own preferred learning styles and strategies?*
4. *The preparation of mathematics curriculum for the grade you are teaching is...*

And 2 items were set to examine the challenges students might face to use their own preferred learning styles and strategies in the learning of mathematics. These questions were:

1. *What are the factors that negatively influence students' success in mathematics?*

2. *Does students' prior knowledge and mathematical background have greater influence on their mathematics learning and academic achievement?*

The construction of these questionnaire items is more strengthened using the professional comments given by colleagues and the feedback obtained during the pilot test (the detail is given in section 3.4.4).

3.3.3 The Development of Interview Protocol for Teachers

The other instrument designed for this study was a semi-structured interview guide set for mathematics teachers. The interview guide is similarly developed using the teaching experiences I had as secondary school mathematics teacher and the related theoretical background reviewed for my study. This interview guide was devised to fill the gap of the limitations of the questionnaires and to explore teachers' observations on the experiences of their students' use of their own preferred learning styles and strategies in the learning of mathematics. Likewise, this interview guide was also reviewed by professionals immediately after its construction and they commented on its forms and arrangements. For instance, they commented to arrange the sequence of the items in line with the posed research questions. The motive for including teachers' interview as a research instrument in this study was by considering teachers as sources on observing their students in their daily activities of teaching mathematics. As Stellwagen (2001) indicated, the primary role of the teacher is to recognize the many potentialities of his/her students and to consciously plan for the balanced development of each individual across each of the learning styles and strategies. Mathematics teachers need to teach mathematics to develop understanding, mastery, self-expression and interpersonal awareness in their students. In association to these ideas, Brown and Dowling (1998) have shown that interviews enable the researcher to collect contextual information not accessible using a respondent administered questionnaire.

The interview guide has eight questions that helped the researcher to hold insightful discussion with teachers. The interview guide was set from the angle of the experiences and roles of respondents corresponding to the preferred learning needs of their students. The interview guide set for the teachers are indicated below.

1. What are the styles of learning your students prefer to use in mathematics classes?
2. What are the strategies of learning your students employ in mathematics classes?

3. How do you assist your students to use their own preferred learning styles and strategies in your mathematics classes?
4. Do the parents of your students contact you to discuss their children's learning styles and achievement in mathematics? How often?
5. How do you see the importance of students using their own preferred learning styles in your mathematics classes?
6. Do your students contact you freely to get your professional assistance to employ their own learning styles and strategies? If not, what are their problems?
7. What are the obstacles that hinder students to learn mathematics according to their preferred learning styles and strategies?
8. What teaching styles do you employ in order to assist your students to use their own learning styles and strategies?

3.4 Administration of Pilot-Test

To minimize the flaws that might prevail in the construction of this instrument, I have shown the draft questionnaire to the colleagues and experts working in the field of mathematics. These colleagues were three mathematics curriculum experts at Educational Bureau of Oromia Region and Federal Ministry of Education who have the experience of designing mathematics curriculum for primary and secondary educations. These colleagues and experts reviewed and commented on the form and arrangements of the questions. For example, they recommended changing the word 'theme' to 'topic' to make the questions clearer for students. In the construction of this questionnaire, I followed the advice of Dawson (2003) that states that after constructing a questionnaire ask people who have not been involved in its construction to read it through and see if there are ambiguities which you have not noticed.

Besides getting comments of professional colleagues it became necessary to pilot it on a small group that have the same profile with the subjects of the study (Dowling, 1998) and that are not part of the study. The reason lies in the fact that pilot-testing helps to learn where undesired mistakes were made and gives an opportunity to modify the questions of the study. Specifically, it avoids ambiguities, assures the simplicity and clarity of the communication, and avoids double-barrelled questions in the items contained in the questionnaires and interview guide. As Dooley (2004) noted, if the pilot study does not produce sensible results, then the researcher modifies and resets the items

until s/he gets proper instrument that can generate what it is supposed to. I made a prior contact with the principal of secondary school where I planned to conduct a pilot test. After my request was granted, I arranged my schedule to meet sample students and their mathematics teachers. The students and their mathematics teachers were met separately. An explanation of the purpose of the study and request for their consent to participate on the pilot-test was done. Both of them agreed to participate on the pilot-test.

This pilot-test was conducted on 25 grade 11 students and 4 mathematics teachers of l'ESPERANCE Adventist School not supposed to be included in the actual study, in April 2008. I selected these students randomly by using their odd roll numbers from their call list and distributed the questionnaire to be completed. One teacher was interviewed while the remaining three teachers of this school were made to complete the questionnaire based on random approach. Responses to this pilot-test enabled me to ensure for consistency and helped me to avoid ambiguities in the instruments of the study. For instance, for the questions like 'What is your achievement in mathematics?' The students have commented that this question is vague since it doesn't state at which grade and level their achievement was requested. I accepted the feedback of these students and omitted it from the final questionnaire. Moreover, a number of modifications were also made to the questionnaires. For example, questions like 'How do you perceive mathematics?' were totally cancelled from the teachers' questionnaire since it has no relationship with the purpose of the study. The construction of questions was also checked in the mathematics teachers' questionnaire. For instance, questions like 'What type of teaching styles do you apply in your mathematics classes?' is changed to 'The type of teaching styles you mostly apply in your mathematics classes'. Other non-relevant choices were also omitted from both questionnaires. From the students' questionnaire, 10 Likert scale questions were cancelled based on the feedback of the pilot test. For example, questions like:

- 'I prefer to obtain information about an interesting subject by reading about it',
- 'I hold objects in my hands during learning periods',
- 'I think the best way to remember something is to picture it in your head' and the like were omitted since they didn't address to answer the basic research questions.

The second administration of the pilot-test was conducted with the same instrument to the same group of 25 grade 11 students and their mathematics teachers within an interval of 10 days to

confirm the reliability of the instrument. Based on the feedback from both pilot administrations, the instruments and the items were finalised. Finally, the questionnaires and interview guide having clear instructions were made to collect data from students and their mathematics teachers. This was done in line with Dawson's (2003) advice which states that once piloting has been done alter the questions according to the feedback obtained and then send out a number of questionnaires to the type of people who will be taking part in the main study.

3.4.1 Validity and Reliability of the Instruments

3.4.1.1 Validity of the Instruments

As discussed above, all the items that were developed to address the research questions under investigation were made to maintain the face validity of the instruments of the study. Best and Kahn (2002) describe that the items of the instrument should represent a significant aspect of the purpose of the investigation. Content validation was established by cross-referencing the content of the instruments to those elements contained in the basic research questions to determine if there was indeed a match. That is, the items constructed were in line with the answer to the research questions. Content validity addresses to what extent the appropriate content is represented in questionnaires and interview guide items. Cox (1996) and Huck and Cormier (1996) state that validity looks at whether the instrument measures what it is intended to measure and whether the instrument elicit accurate information.

On the other hand, the definitions of new terms used in the study were included to help the respondents to complete the questionnaires by understanding the questions asked and to freely express their views during interviews. These definitions were given to assist the respondents respond in line with the meanings set in the definitions. For instance, styles, learning styles and learning strategies were defined to have the same meaning for all the respondents. According to Brown and Dowling (1998) and Best and Kahn (2002), the validity of a study can be checked by defining the meaning of all terms in the instrument so that they give the same meaning for all respondents. I also changed the construction of some items in the questionnaires and interview guide based on the consultation of colleagues and the feedback received during the pilot-testing. Vithal and Jansen (2003) have pointed out that the validity of a study can be checked by considering rival explanations given by different respondents for the same issue or question under investigation.

3.4.1.2 Reliability of the Instruments

The main issue of reliability is addressing the consistency of the instruments in relation to what they intend to measure. According to Huck and Cormier (1996), the basic idea of reliability is summed up by the word consistency. Likewise, as Cox (1996) asserted, test-retest reliability asks, ‘Does the instrument measure consistently over time?’ Cox further mentioned that for questionnaires, consistency is generally the most important issue. As mentioned above, I consulted my colleagues and experts in the field of mathematics during the development of the instruments. Moreover, the instruments were pilot-tested twice within an interval of 10 days to the same group of students and their mathematics teachers to ensure the reliability of the instruments.

As Best and Kahn (2002:247) recommend, the reliability of the responses is inferred by a second administration of the questions and by comparing the responses given to those of the first. I personally met all the respondents and gave a detail orientation to complete all the items in order to avoid the unintentional bias. The respondents were advised not to bother to recall what they responded on the prior administered pilot-test and were asked to respond as they truly feel about the items set on the questionnaires. As Brown and Dowling (1998) argue, the researcher has to do everything to foster the good response rate and to minimize the unintentional bias during pilot testing. Hence, there was no significant variation observed in the responses of the respondents. All these processes enabled me to modify the items that have discriminative power to be used for the actual data collection.

3.5 Sources of Data

3.5.1 Population of the Study

The aim of the study was to investigate the preferred learning styles and strategies of secondary school students of West Shoa Zone in Oromia Region. Oromia Region is one of the nine regional states in the Ethiopian (East-Africa) Federal Administration System and is situated at the central area covering the largest part of the country. West Shoa is one of the administrative zones in the Region having 20 secondary schools. In Ethiopia, the secondary school ladder ranges from grade 9 to grade 12. As the national standard, each classroom (section) is designed to accommodate 50 students.

The major sources of data for this study were secondary school students and their mathematics teachers. The reason was that:

- a) secondary school students who study mathematics currently could reflect their learning preferences from their practical experiences and,
- b) mathematics teachers who were engaged in teaching are in a position to reflect what they are experiencing in the daily practices in assisting their students and in identifying the design of curriculum to encourage students to use their own preferred learning styles and strategies. From practical experiences, mathematics teachers have the capacity of identifying the factors that impede students to use their own preferred learning styles and strategies. Mathematics teachers are expected to create conducive learning environment and motivate their students to use their own preferred learning styles and strategies in the study of mathematics (Beck, 2001).

3.5.2 Sampling Techniques

Conducting a study on a whole population of 20 secondary schools of the zone, 600 grade 11 students and 54 mathematics teachers of four sampled schools is not manageable to run the investigation in a desirable manner. What is preferred is taking a representative sample size. According to Kothari (2006), the researcher should determine his/her sample size to be optimum fulfilling the requirement of efficiency, representativeness and reliability. Based on this,

1. Out of 20 (15 urban and 5 rural) secondary schools that exist in West-Shoa Zone (MoE, 2005), 4 (20%) secondary schools were selected on purposive sampling technique. The reason for selecting these four secondary schools purposively is to have highest student population and to represent urban and rural schools. Three of these sampled secondary schools represent urban schools and one of them represents rural setting. In purposive sampling, researchers choose their data sources because of certain characteristics (Dooley, 2004).
2. Out of 600 grade 11 students of the four secondary schools, 249 (41.5%) students were randomly selected to complete the questionnaire. To administer the random selection, the list of students was collected from their homeroom teachers. In accordance with their roll-numbers, the researcher wrote the roll-number of each student on a piece of paper of equal size and rolled it. Since in random sampling, each individual has an equal chance of being selected (Best and Kahn, 2002), all the rolled roll-number slips were mixed and the students were invited to draw the slip of numbers without replacement (Steffens and Botha, 2002). The drawing process

continued until the required sample size is reached and the students whose roll-numbers were drawn were made to complete the questionnaire. The reason for selecting grade 11 students was they have stayed for two years in the secondary school education system; they have passed national examination given at the end of grade 10 completion and persistently attending their studies to prepare themselves for the entrance exam of higher education. Their English communication skill is at a better condition relative to grade 9 or grade 10 students. Grade 12 students were not selected in the study sample because they are preparing for entrance exam to Universities and Colleges. I worried that they drag me back to conduct my study on the basis of my schedule. The age of sampled students is 14 to 18 and more than 18 years. As the age categories of sampled students indicate, 121 of them were between 14 and 18 years while 128 of them were more than 18 years. The population and sample of the study are given below representing their respective schools.

Table 1: Population of students and respondents corresponding to each school

Name of the secondary school	Location	Population of Students (Grade 11)			Sample of Respondents (Grade 11)			Age category of respondents in years	
		M	F	T	M	F	T	14 – 18	Above 18
School A	Urban	94	58	152	33	30	63	43	20
School B	Urban	107	52	159	34	32	66	17	49
School C	Rural	79	44	123	28	23	51	18	33
School D	Urban	102	64	166	38	31	69	43	26
Total sum		382	218	600	133	116	249	121	128

Source: Database of each school, June 2008.

- In the case of mathematics teachers' selection, a list of 54 mathematics teachers was collected from mathematics department heads of the sample schools and the name of each teacher was written on a piece of paper of equal size. I rolled these pieces of paper and after mixing it, I invited the teachers to draw the slips without replacement. 23 (42.6%) teachers whose names appeared in a first round draw were given paper to complete it and 7 (12.9%) teachers whose names appeared in the second round draw were invited for an interview. Out of the 30 selected teachers, 25 of them had Bachelors or Masters Degree and five of them had diploma in mathematics. Moreover, 10 of them were 20 to 30 years old and 20 of them were above 30 years

old. Their work experience showed that 4 of them served below 5 years, 17 of them served 6 to 20 years and 9 of them served above 20 years. As could be observed in Table 2, these teachers had been professionally engaged in the teaching-learning activities of secondary school mathematics. This means, they could be potential sources in providing ample information in relation to the preferred learning styles and strategies of secondary school students. The figure of mathematics teachers' of sampled schools that completed and returned the questionnaire and participated in an interview is given in Table 2.

Table 2: Figure of sampled teachers with their qualifications

Name of sampled secondary schools	Location	Sample teachers' corresponding to their qualifications						Age category in years		Work experiences in years		
		BSc/BEd/MSc/ MEd			Diploma (12+2)			20-30	Above 30	Below 5	6-20	Above 20
		M	F	T	M	F	T					
School A	Urban	9	-	9	-	1	1	3	7	2	6	2
School B	Urban	6	-	6	-	-	0	2	4	1	3	2
School C	Rural	6	-	6	2	-	2	4	3	1	4	2
School D	Urban	4	-	4	2	-	2	1	6	-	4	3
Total sum		25	-	25	4	1	5	10	20	4	17	9

Source: Database of each school, June 2008.

3.6 Administration and Procedures of Data Collection

3.6.1 Administration of Data Collection

I received the letter that formally introduces me and the purpose of my study from my sponsor - United Nations for Education, Science and Cultural Organization's International Institute for Capacity Building in Africa (UNESCO/ IICBA) - to communicate with all sample secondary schools for my study. Having this letter of access, I made a prior contact with the principals of each secondary school and handed them the letter. The principals of the schools cooperated by arranging a schedule to meet the students and their mathematics teachers. I personally met the students and mathematics teachers of these secondary schools and explained the purpose of the study to get their consent. I assured the respondents that the information they provide would be kept strictly

confidential. This helped to avoid fears and suspicions that might come in the minds of the respondents and enhanced their cooperation for the study. This was done according to the advice of Best and Kahn (2002) that states the researcher to have the responsibility to keep the subjects who gave him/her information safe by not revealing their identity in all his/her records and reports. On the other hand, the Ethiopian secondary schools are guided by 'Parent-Teacher Association' in which parents are represented. This managerial body gives the school principals absolute right to decide on the affairs of their students and their schools' academic issues. Thus, getting the consent of students and school principals enabled me to get the consent of parents.

3.6.2 Procedures of Data Collection

3.6.2.1 Students' Questionnaire

As previously described for the school principals, I met students in their classes. I introduced myself to them and explained the purpose of the study. I also guaranteed them the responses would be kept confidential and serve only for research purposes. After getting their consent, I used a simple random sampling technique (discussed above) to identify the samples that would complete the questionnaire. Then, I distributed the questionnaire to the sampled students and made arrangements as when this completed questionnaires need to be returned back. A total of 249 completed and returned the questionnaire on the set date.

3.6.2.2 Teachers' Questionnaire

The principals of each school cooperated and introduced me to their mathematics department heads. These department heads arranged a schedule to meet the mathematics teachers of their schools. Using this opportunity of access, I explained the purpose of the study and assured them about the confidentiality of their responses. After getting their consent, I used a simple random sampling technique (discussed above) to identify the samples that would complete the questionnaire. Then, I distributed the questionnaire to the sampled teachers and made arrangements as when this completed questionnaires need to be returned back. A total of 23 completed and returned the questionnaire on the set date.

3.6.2.3 Teachers' Interview

I used a random sampling technique to select seven mathematics teachers from all sample secondary schools for an interview. After securing their consents, we arranged the place and fixed

the date for the interview. Prior to conducting an interview, I ensured them that their views and opinions are kept confidential. Following this, I explained the guideline of the interview and asked their consent to take notes of their responses. With their affirmative responses the interview was made to proceed.

3.7 Ethical Considerations

In research, ethical consideration is one of the most important points that deserve attention. This is mainly due to:

- a) the necessity to strictly respect the consent of the participant whether they are willing to participate in the research or not. Likewise, it is to assure to the subjects of the study that they are free to withdraw from participating in the study whenever they found it necessary;
- b) the necessity to protect subjects of the study from possible dangers that might be encountered;
- c) confidentiality, the actual names of participants in the study are kept secret while the sex or age of respondents might be used where it seems appropriate.

In relation to these points, Trochim (2003) argued that closely related to the notion of voluntary participation is the requirement of informed consent. Thus, I assured the students and their mathematics teachers that the research is strictly governed by the above ethical principles and they have also agreed. This was done during data collection.

3.8 Methods of Data Analysis

After the completion of data collection, I have edited, coded, classified and tabulated the data. Since the purpose of editing is to detect errors and omissions (Kothari, 2006) I have made a careful inspection of the completed questionnaires during the collection of the questionnaire from each respondent. I found no problem of editing in the interviews since I have participated in an interview process and took my own notes and transcribed it. Since coding is necessary for efficient analysis I primarily took coding decisions during the designing stage of the questionnaires. Kothari (2006) described the purpose of coding as to assign the items in certain categories and accordingly I categorized the items of questionnaires and interview based on the research questions of the study (discussed above).

I classified the collected data into groups of classes on the basis of common characteristics as to answer the basic research questions. As some scholars argued, classification helps the researcher to reduce a large volume of raw data into homogeneous groups to get meaningful relationships (Brown and Dowling, 1998; Dawson, 2003; Dooley, 2004; Kothari, 2006). Accordingly, the types of learning styles and strategies were classified under environmental, emotional, sociological, physiological and psychological categories.

I have transcribed the data from the questionnaire to a coding sheet and the responses were tallied on the tally sheet. The item number and the alternatives given to the items were horizontally written on the tally sheet and for each item a stroke is marked against the alternative under which it falls. After every four small vertical lines in each alternative, the fifth line for the item falling in the same group is indicated as diagonal line through the four strokes representing the fifth alternative. This was to facilitate the counting of responses given to each alternative so as to represent it in tables. Since tabulation is the process of summarizing raw data and displaying the same in compact form (Kothari, 2006; Best and Kahn, 2002), I have arranged the tallied data in some kind of concise and logical order so as to indicate which of the alternatives scored the highest. Best and Kahn (2002) mention that presenting data by frequency counts has a number of limitations and may have little meaning. So, I have converted the tabular scores into percentage responses which enabled me to compare sub-groups of un-equal size meaningfully. Each table had a title stating the subject matter it describes and has a distinct number placed above the table. Different items incorporated in the same table were separated by double lines to make them clear for the reader. Each table contained the items of the questionnaire, the alternatives set for the item, the number of respondents and the percentage of responses. These percentage points were used for data interpretation and analysis in this study. The percentages calculated for strongly agree and agree as well as for strongly disagree and disagree were added together during the analysis of the items. On this basis, the highest percentage of responses reflected the highest preferences.

Data collected through the open-ended items and responses of interviewees were considered during data analysis. For example, for the interview question that says ‘what are the obstacles that hinder students to learn mathematics according to their own preferred learning styles and strategies?’ about 61 % of teachers responded the provision of mathematics lesson through plasma television to be the

main challenge and this view has coincided with the response of students (67 %) who completed the questionnaire.

3.9 Conclusion

This chapter has dealt with the research design in which the qualitative method was employed to conduct the study. Qualitative method is chosen since the data collected to investigate the preferred learning styles and strategies of secondary school students to learn mathematics is categorical. Two types of questionnaires one for students and the other for their mathematics teachers, and an interview guide for teachers were developed to gather data for the study. The next chapter presents the data and analyses of the results.

Chapter 4

Presentation and Analysis of Results

4.1 Introduction

This chapter presents the major findings of the study. The data was organized in tabular form and analysed in line with the basic research question of investigating the preferred learning styles and strategies of secondary school students to learn mathematics. The data analysed in this chapter is intended to address these research questions:

1. What types of learning styles and strategies do secondary school students prefer to use when they learn mathematics?
2. How do secondary school mathematics teachers assist their students to use their own preferred learning styles and strategies to learn mathematics?
3. How does the country's secondary school mathematics curriculum encourage students to use their own preferred learning styles and strategies?
4. What could be the major challenges that students might face in using their own preferred learning styles and strategies while learning mathematics?

Each question and its results are presented. The interview data was transcribed and used during the analysis of the results.

4.2 Presentation and Analysis of Results

4.2.1 Students' Learning Style and Strategy Preferences to Learn Mathematics

The results of learners' responses to learning style & strategy preferences (research question 1) are summarized into five categories. These five categories were environmental, emotional, sociological, physiological and psychological. These categories were considered as an individual's personal characteristics of learning (Burke and Dunn, 2002).

4.2.1.1 Environmental Category

In this category, there were four questions that were administered to know the students' preferences as far as the learning environment is concerned: whether they prefer to learn mathematics in a silent

or in a noisy environment (see Table 3) and in formal or informal seating arrangements (see Table 4).

a) Students’ Preferences for Learning Environment

Table 3: Summary of Responses of Students’ Preferences to Learning Environment

Questions		Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
Q.1	I prefer learning and working mathematics problems in a silent environment	Respondents	133	96	16	4	-
		Percentage of responses	53%	39%	6%	2%	0%
Q.2	I prefer learning and working mathematics problems in a noisy environment	Respondents	6	23	26	75	119
		Percentage of responses	2%	9%	10%	30%	48%

As shown in Table 3 above, the great majority of the respondents (92%) reported that they preferred to learn mathematics in a silent environment. Only very few of the students (2%) revealed that they did not want to learn mathematics in a silent environment while 6% of the students did not identify their preferences. Here, silent environment is to indicate lack of disturbances either to listen to the detail presentations of their teachers or to make private trials of the problems before joining other peers for group work which they preferred (shown in Table 6).

Students’ responses to the second question (see Table 3) further strengthen their position as far as learning environment preferences is concerned. Most of the students (48% strongly disagreed & 30% disagreed) indicated that they did not want to learn mathematics in a noisy environment. Only a minority of the students (9% and a further 2%) agreed to learn mathematics in a noisy environment.

Generally, both responses reflected that these secondary school students preferred to learn mathematics in a silent environment. When the students know the environment in which they want to learn mathematics, this will have great impact on their achievement. This agrees with Pewewardy (2002) when he argued that one’s surroundings or field-independence and field-dependence affect how one learns rather than what he/she learns.

b) Preferences for Seating Arrangements

Table 4: Summary of Responses of Students for Preferences of Seating Arrangements

Questions		Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
Q.3	I prefer formal ways of seating arrangements in mathematics classes	Respondents	75	125	28	18	3
		Percentage of responses	30%	50%	11%	7%	1%
Q.4	I prefer informal ways of seating arrangements in mathematics classes	Respondents	20	37	40	108	40
		Percentage of responses	8%	15%	16%	43%	18%

Table 4 presents the results of seating arrangement preferences. The preferred seating arrangements in learning mathematics include the choice between formal and informal seating arrangements. As shown in Table 4 above, the majority of the students (30% strongly agreed and 50% agreed) prefer formal ways of seating arrangements. Only very few students did not prefer formal seating arrangements in mathematics classes while 11% of them chose not to identify their preferences.

With regard to informal seating arrangements, 18% of the students strongly-disagreed while many students (43%) disagreed to informal seating arrangements. 16% chose not to identify their preferences. Only 15% of the students agreed and some of them (8%) strongly agreed to the informal seating arrangements in mathematics classes. Generally, the result revealed that most of the students (80%) preferred formal seating arrangements while 61% of them did not prefer the informal seating arrangement in mathematics classes. Both results indicated that these students preferred the formal seating arrangements when they learn mathematics.

4 2.1.2 Emotional Category

Under emotional category, the way students prefer to learn and the way they prefer to recall mathematical concepts were investigated. Three questions were presented to the students. The results are shown in Table 5.

Table 5: Summary of Responses of Students for the Emotional Category

Questions		Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
Q.11	I prefer structured ways during the process of working on mathematical problems	Respondents	53	134	37	21	4
		Percentage of responses	21%	54%	15%	8%	2%
Q.14	I prefer to see mathematical lessons written on a blackboard to be supplemented by visual aids	Respondents	49	118	39	32	11
		Percentage of responses	20%	47%	16%	13%	4%
Q.13	I can remember best about mathematics by listening to a lecture that includes information, explanations and discussions	Respondents	81	106	27	25	10
		Percentage of responses	33%	43%	10%	10%	4%

a) Students' Preferences to Structured Ways of Learning Mathematics

From Table 5 shown above, one can observe that three-fourth of the students (54% agreed and another 21% strongly agreed) preferred to learn mathematical problems in structured ways. 15% of the students chose not identify their preferences. On the other hand, 10% of the students did not prefer to learn mathematics in structured ways. Thus, the result for structured ways of learning mathematics has shown that most of the students preferred structured ways of learning mathematics.

b) Preferences for Supplementing Mathematical Lessons with Visual Aids

Regarding the preference to supplementing mathematical lessons written on the blackboard by visual aids, many students (47%) agreed and 20% of the students also strongly agreed to learn mathematics lesson supplemented with visual aids. 16% of the students did not identify their preferences. Only few of the students (13% disagreed and 4% strongly disagreed) did not prefer lessons supported by visual aids. Thus, the response indicated that 67% of them preferred mathematical lesson to be supplemented by visual aids during learning mathematics (see Table 5). According to this finding, mathematics lesson needs to be supplemented by visual aids to be understood by students.

c) Preferences for Recalling Mathematical Concepts

As shown in Table 5, students preferences for considering listening to a lecture that includes information, explanations and discussions as a preferred learning style and strategy to recall

mathematical concepts reveals that 76% of them have agreed to be their preference. Conversely, 14% of them disagreed while 10% of them did not identify their preferences. This finding has coincided with the finding that depicted students' preference for mathematics lessons to be supplemented by visual aids.

Moreover, this finding was also substantiated by the responses of the interviewed mathematics teachers. For the interview question that states 'What are the styles of learning your students prefer to use in mathematics classes?' the mathematics teacher interviewees reflected that their students preferred listening with concentration to the instruction of mathematics lessons as part of their learning styles. On the other hand, for the question that states 'What are the strategies of learning your students employ in mathematics classes?' the interviewees responded that 'guessing' and 'watching the plasma television' were observed to be their students' preferred learning strategies.

4.2.1.3 Sociological Category

Sociological category includes the study of students' preferences for introvert or extrovert learning styles in learning mathematics and their choices for working on mathematics projects. According to Burke and Dunn (2002), sociological category of learning involves students' preference to learn either with their peers or alone or either with a team or adult or need for the presence of an authority figures, teacher motivation, and parent motivation. Similarly, students' responses to social category are shown in Table 6 and Table 7.

Table 6: Responses of students on preferred learning styles and strategies in introvert and extrovert learning styles

Questions		Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
Q.5	I enjoy studying and working mathematics problems alone by myself (introvert style)	Respondents	11	87	27	73	51
		Percentage of responses	4%	35%	11%	29%	20%
Q.6	I prefer studying and working on mathematics problems in group with my peers or in teams (extrovert style)	Respondents	117	91	25	8	8
		Percentage of responses	47%	37%	10%	3%	3%

a) Preferences for Introvert Learning Styles in the Learning of Mathematics

The responses for the preference of studying and working on mathematics problems by the student himself or herself alone indicated that 20% of the students strongly-disagreed and 29% of them disagreed to work alone on mathematics problems. Eleven percent of the students did not identify their preferences while 35% of them agreed and 4 % of them strongly-agreed to work and study mathematics problems by themselves. Thus, the result indicated that 49% of them disagreed to work on their own while 39% of them agreed to work on their own.

b) Preferences for Extrovert Learning Styles in the Learning of Mathematics

The students' preferences of working with their peers or in group indicated that 47% of the students strongly agreed and 37% of them also agreed to study and work on mathematics problems with their peers or in group. On the other hand, 10% of the students did not identify their preferences while 6% of them strongly disagreed or disagreed to study and work on mathematics problems with their peers or in group.

The results of both preferences revealed that 49% of the students did not prefer to work on mathematics problems by their own in the preference for introvert learning styles and 84% of the students preferred to work with their peers in the preference for extrovert learning styles. The findings of these introvert and extrovert learning style preferences of these secondary school students coincided with the result of the study conducted on Chinese secondary school students. The result of that study also indicated that both groups of gifted and non-gifted Chinese secondary school students highly preferred to work with their peers (Chan, 2001).

c) Preferences for How to Work on Mathematics Projects/Assignments

Regarding how students prefer to work when group project is given by their mathematics teachers, 28% of the students responded that they preferred primarily to work by their own and then come to the group to compare their work with group members. The majority (67%) of the students responded that they preferred to work with the group members to generate ideas within the group and 5% of them responded that they did not prefer group work (see Table 7).

Table 7: Responses of students on preferred learning styles and strategies for working on mathematics projects

Q.4 (students)	Choices	No. of Respondents	Percentage of responses
When a group project/assignment is given by mathematics teachers	a) I primarily prefer to work alone and then come to the group to compare my work with group members.	69	28%
	b) I prefer to work with the group members to generate ideas within the group	166	67%
	c) I don't prefer to work group project.	14	5%

The finding of this question has shown similar result like the findings of the preferences for introvert and extrovert mathematics learning styles discussed above. Both results indicated that these secondary school students preferred to work on mathematics problems either in group or with their peers rather than working alone. From these findings one can observe that students' did not desire to work on mathematics problems on their own they rather prefer to work in groups.

4.2.1.4 Physiological Category

Physiological category deals with the preferred learning styles and strategies for the time of day students favour to learn mathematics and the preferred learning styles and strategies for either of memorizing mathematical solutions or working on mathematics problems to learn mathematics are included. It also involves learners' preferences of how to proceed solving mathematical problems in the learning of mathematics. Moreover, preferences for free choice of working on mathematical problems to explore one's talents, preferences for learning mathematics through solving different mathematical problems, preferences for making mathematical charts and graphs and preferences for requiring explanations on mathematical diagrams are also included under this category (see Table 8). Furthermore, it includes responses of students on preferred learning styles and strategies for procedures of working on mathematical problems (see Table 9) and responses of students on preferred learning styles and strategies for remembering mathematical concepts (see Table 10). Generally, the results of these nine questions are summarized and shown below.

Table 8: Responses of students on preferred learning styles and strategies for physiological category

Questions		Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
Q.7	I prefer learning mathematics in the morning classes	Respondents	86	106	47	6	4
		Percentage of responses	35%	43%	19%	2%	2%
Q.8	I prefer learning mathematics in the afternoon classes	Respondents	15	6	56	77	95
		Percentage of responses	6%	2%	22%	31%	39%
Q.15	I like to work on mathematics problems rather than memorizing their solutions to learn mathematics	Respondents	89	67	43	36	14
		Percentage of responses	36%	27%	17%	14%	6%
Q.12	I prefer free choice of working on mathematical problems to explore ones talents and abilities (trial and error)	Respondents	58	99	40	42	10
		Percentage of responses	23%	40%	16%	17%	4%
Q.18	I prefer learning mathematics through solving different mathematical problems	Respondents	136	69	31	8	5
		Percentage of responses	55%	28%	12%	3%	2%
Q.19	I enjoy developing and making mathematical graphs and charts	Respondents	63	112	50	17	7
		Percentage of responses	25%	45%	20%	7%	3%

a) Preferred Learning Styles and Strategies for Time of a Day to Learn Mathematics

The responses to the preferred learning styles and strategies for the time of a day to learn mathematics indicated that most of the students (43%) agreed and 35% of the students also strongly agreed to learn mathematics in the morning. Few of the students (19%) did not identify their preferences while very few of them (4%) did not prefer the morning classes. On the other hand, for the preferred learning styles and strategies of attending mathematics classes in the afternoon, 39% of the students strongly disagreed and 31% of them disagreed. 22% chose not to identify their preferences while only 8% of the students agreed to learn mathematics in the afternoon. Generally, these findings have indicated that the majority of the students (78%) preferred the morning classes while 70% of them disagreed to attend the afternoon classes. Thus, both results reflected that these secondary school students preferred the morning classes to the afternoon classes to attend mathematics (see Table 8).

b) Preferences for Working on Mathematics Problems Rather Than Memorizing Their Solutions in the Learning of Mathematics

The results of preferred learning styles and strategies of working on mathematics problems rather than memorizing their solutions indicated that 36% of the students have strongly agreed as well as 27% of them have agreed. Conversely, 20% of these students have preferred memorizing the solution of mathematical problems to working on them and 17% did not identify their preferences. In short, the results revealed that most of the students (63%) preferred to work on mathematics problems to memorizing the solutions to the problems (see Table 8).

c) Preferred Learning Styles and Strategies for Free Choice of Working on Mathematics

As shown in Table 8, the response for free choice of working on mathematical problems to explore one's talents and abilities revealed that 23% of the students have strongly agreed and 40% of them agreed. On the other hand, 17% of the students disagreed and very few (4%) of them strongly disagreed while 17% of them did not identify their preferences. Generally, the finding indicated that 63% of the students have agreed to work on mathematical problems to explore one's talents and abilities. The result of this question has coincided with the finding for the preference of working on mathematical problems rather than memorizing the solutions to learn mathematics (see question 15 on Table 8). Supporting this result, Cangelosi (1996) put forward that the attainment of mathematical problem solving ability of the students is dependent on interrelated components like concepts, skills, processes, attitudes and metacognition of students.

d) Preferred Learning Styles and Strategies for Solving Mathematics Problems in Learning Mathematics

The responses for the question that states 'I prefer learning mathematics through solving different mathematical problems' reflected that a majority (55%) of the students strongly agreed, and 28% of them have agreed. A few (3% disagreed and only 2% strongly disagreed) prefer the problem solving approach while 12% of them did not identify their preferences. The result indicated that the great majority of the students (83%) preferred problem solving approach to learn mathematics. This finding has similar conclusion with the results of preferring to work on mathematical problems (63%) rather than memorizing the solutions given to mathematics problems to learn mathematics (see Table 8).

e) Preferred Learning Styles and Strategies for Visual Explanations During Mathematics Classes

As shown in Table 8, the responses for the question that states ‘I enjoy developing and making mathematical graphs and charts to learn mathematics’ revealed that 25% of the students have strongly-agreed and 45% of them also expressed their agreements. On the other hand, 7% of students strongly-disagreed and 3% of them disagreed to prefer visual explanations. 20% of them did not identify their preferences. The result of the finding indicated that 70% of students preferred making graphs and charts to learn mathematics.

f) Preferred Learning Styles and Strategies for Explanations on Diagrams and Graphs

The responses for the preference of requiring explanations of diagrams, graphs, or visual directions in mathematics classes have shown that 30% of students strongly-agreed and 43% of them agreed. On the contrary, 7% of the students disagreed and 2 % of them have strongly disagreed while 18% of them were not in a position to identify their preferences. Generally, the finding showed that 73% of the students preferred the visual approach in learning mathematics (see Table 8). Supporting this result, Pewewardy (2002) asserted that visual learners learn best when they are able to see the material they are expected to master and when the teacher provides them a myriad of visual learning opportunities such as graphs, films, demonstrations and pictures.

g) Preferences for Procedures of Working on Mathematical Problems

Table 9: Responses of students on preferred learning styles and strategies for procedures of working on mathematical problems

Q.8 (students)	Choices	No. of Respondents	Percentage of responses
When I start working on mathematics problems, I am more likely to:	a) try to understand the problem first before solving the problem	207	84%
	b) start working on the solution before understanding the problem.	26	10%
	c) guess the solution of the problem	16	6%

As can be seen from Table 9, the response for how students start working on mathematics problems 84% of them responded that they primarily try to understand the problem before starting to solve the problem while 10% of them responded that they start working on the solution before

understanding the problem. On the other hand, very few (7%) of them responded that they guess the solution to the problem. This result implied that the majority of these secondary school students make every effort to understand the nature of the problem before starting its execution. Cangelosi (1996) supports this result by stating that learners should be given the opportunity to exercise different learning styles and strategies learning mathematics.

h) Preferred Learning Styles and Strategies for Remembering Mathematical Concepts

Table 10: Responses of students on preferred learning styles and strategies for remembering mathematical concepts

Q.10 (students)	Choices	No. of Respondents	Percentage of responses
I more easily remember	a) Something I have done.	204	82%
	b) Something I saw.	31	12%
	c) I have no preference.	14	6%

Table 10 indicates that the students were requested how they remember mathematical concepts. The responses to the problem revealed that most of the students (82%) remember something they have done and only 12% responded that they remember something they saw. 6% of the students have responded that they have no preferences. In support to this result, Manner (2001) expressed that those students who learn through personal meaning or by doing process information and remember what they have done since it has relationship to them. Thus, the findings of this question indicated that these secondary school students preferred working on mathematical problems since they more easily remember what they have done rather than memorizing the solutions of mathematics problems to learn mathematics.

4.2.1.5 Psychological Category

Under psychological category, the study tries to identify the preferences of students for detail explanations on all mathematics problems and topics to learn mathematics. The preferences of students for general highlights to learn mathematics and the preferred learning styles and strategies for listening to the lessons presented by teachers in learning mathematics are included. Moreover, the needs of learning mathematics to widen one’s logical reasoning and to develop one's thinking ability are also incorporated. The responses given for the 4 questions included under this category are summarized and given in Table 11.

Table 11: Responses of students on preferred learning styles and strategies for psychological category

Questions		Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
Q.9	I prefer detail explanations on all of mathematics problems or topics (analytic style)	Respondents	102	90	20	32	5
		Percentage of responses	41%	36%	8%	13%	2%
Q.10	I prefer general highlighting or general ideas rather than detail explanations on all maths problems (global style)	Respondents	19	43	34	60	93
		Percentage of responses	8%	17%	14%	24%	37%
Q.17	I prefer learning mathematics by listening lessons presented by the teachers	Respondents	56	105	41	33	14
		Percentage of responses	22%	42%	16%	13%	6%
Q.22	I learn mathematics to widen my logical reasoning and develop my thinking ability	Respondents	32	70	6	18	123
		Percentage of responses	13%	28%	2%	7%	50%

a) Preferences for Detail Explanations on All of Mathematics Problems or Topics

As shown in Table 11, the results for the preference of the need for detail explanations on all of mathematics problems or topics indicated that many of the students (41%) have strongly agreed and a further 36% agreed that they prefer detail explanations. On the other hand, a few of the students (12% disagreed and (2%) strongly disagreed) did not prefer detail explanations while 8% of them did not identify their preferences for detail explanations on every problem to learn mathematics. Generally, the majority of the students (77%) have preferred the detailed explanations on all mathematics problems or topics to learn mathematics. This result is contrary to the study of Von Glasserfeld. Von Glasserfeld (2001:120) pointed out that,

Mathematics learning is not a passive receiving of ready-made mathematical knowledge rather it is a process of construction in which the students themselves are the primary actors by using their preferred mathematics learning styles in the learning of mathematics.

b) Preferences for General Highlights (General Ideas) to Learn Mathematics

For the question posed to identify students’ choice for preferred learning styles and strategies of getting general highlights rather than detail explanations during the learning of mathematics, the result found is summarized in Table 11. Many of the students (37%) have strongly disagreed and

another 24% of them disagreed to be given only general ideas rather than detail explanations. Conversely, 17% of the students have agreed and 8% strongly agreed to prefer the general ideas to detail explanations while 14% of them did not identify their preferences. On the whole, the result revealed that 61% of the students did not prefer to get only general highlights or general ideas to learn mathematics. Thus, the finding of the above two questions (questions 9 and 10) showed that more than 60% of the students preferred detailed explanations on all mathematics topics to getting general ideas to learn mathematics. These results require due attention by policy makers and curriculum developers to consider change in the approaches to learning mathematics. The preferred approaches should build the confidence of students to work on mathematical problems on their own thus encouraging them to increase their contribution in the development of science and technology of the nation.

c) Preferences for Learning Mathematics through Listening to the Lessons Presented by Teachers

For the question that states ‘I prefer learning mathematics by listening lessons presented by the teachers’, 42% of the students agreed and 22% of them also strongly agreed to learn mathematics by listening to the lessons presented by their teachers. Contrary to these responses, only 6% of these students strongly disagreed and 13% of them disagreed to learn mathematics by listening. Sixteen percent of them did not express their preferences. Hence, 64% of the students have preferred to learn mathematics by listening to the presentation of their teachers (see Table 11). The result of this problem has an analogy with the result of preferences for detail explanations to learn mathematics in which 60% of the students have expressed their choices for detail explanations.

d) Preferences for Learning Mathematics to Widen Ones Logical Reasoning and Develop Ones Thinking Ability

As indicated in Table 11, the result for preference to learn mathematics to widen one’s logical reasoning and to develop one’s thinking ability’ revealed that 13% of the students have strongly agreed and 28% of them agreed. Contrary to this, the majority (50%) of the students have strongly disagreed and 7% of them disagreed that they learn mathematics to widen their logical reasoning and to develop their thinking abilities while very few, 2%, did not express their feelings. Thus, this result reflected that 57% of the students have agreed that they are not learning mathematics to widen their logical reasoning and to develop their thinking abilities. This finding requires due

attention in order to bring change in the learning of mathematics. The students should be primarily given proper orientation and convinced to learn mathematics to develop their own thinking abilities.

4.2.2 How Teachers’ Assist Students to Use Their Preferred Learning Styles and Strategies to Learn Mathematics

Mathematics learning is facilitated when there is a match between the learning styles of students and teaching styles of teachers. Knowing the styles and strategies students prefer to learn mathematics helps teachers to assist students to use their own learning styles and strategies. In order to treat the second research question, 3 questions from students’ and 6 questions from teachers’ questionnaires were considered. So, the following nine questions were presented to the students and teachers to identify what types of assistances students require to encourage them learn mathematics according to their own preferred learning styles and strategies. The responses are summarized in Tables 12 to 19.

a) Preferred Students’ Responses on the Teaching Styles of Their Mathematics Teachers

The following two questions identified the support students expect from their teachers in relation to the activities of the teachers during mathematics classes (see Table 12).

Table 12: Responses of students on the preferred teaching styles of their mathematics teachers

Questions to students	Choices	No. of Respondents	Percentage of responses
Q.7) I prefer when mathematics teachers	a) explain mathematics lessons in a clear and sequential order.	171	69%
	b) give me an overall picture of the lesson to work it by myself.	66	27%
	c) I don’t like mathematics.	12	4%
Q.9) I like mathematics teachers who	a) explain all mathematics lessons in detail and solve all the problems	129	52%
	b) explain only the main points	55	22%
	c) support me to use my own learning styles and strategies to learn mathematics.	65	26%

1. As shown in Table 12, the result for the question that asks students which teaching styles they prefer from their mathematics teachers revealed that the majority of students (69%) preferred teachers who explain mathematics lessons in a clear and sequential order. Only 27% of them

preferred mathematics teachers who give them an overall picture of the lesson and allows them to work by their own, while 4% of the students responded that they did not like mathematics. In this connection, Stitti-Gohdes (2001:139) described that:

what students learn may be affected and effected by how they learn or how they use their own preferred learning styles and strategies since learning styles indicate how students concentrate best, remember best and how motivation and support they get influence their learning.

On the other hand, matching the teaching styles with the learning styles and strategies of students is of paramount importance in maximizing the leaning of the students (Pewewardy, 2002). The teachers need to induce proper teaching styles in order to motivate students to learn by their own rather than waiting for ready made knowledge. The result obtained here has similar finding with the responses given to the preference for detail explanations on all mathematical topics to learn mathematics (see question 9 of Table 11).

2. The result for the type of mathematics teachers' students like to learn mathematics indicated that 52% of the students responded that they like mathematics teachers who explain all mathematics lessons in detail and solve all the problems. On the other hand, 22% of them expressed that they like mathematics teachers who explain only the main points while 26% of them responded that they like mathematics teachers who assist them to use their own preferred learning styles and strategies to learn mathematics (see Table 12). The findings of these questions revealed that students depend on the efforts of their teachers to learn mathematics. Contrary to this finding, Doolan and Honigsfeld (2000) discussed that teachers need to identify and match students' unique learning styles with classroom delivery of the subject they teach and they are more expected to teach all students to be responsible for their own learning. Moreover, Polya (1985:1) also has argued that if the student is not able to do much, the teacher should leave him at least some illusion of independent work and help the student discreetly in the learning of mathematics rather than solving all problems. So, the results obtained for these two problems require due consideration in order to help students learn mathematics by their own rather than relying only on the efforts of their teachers.

b) Mathematics Teachers' Use of Their Own Preferred Teaching Styles to Enable Students Understand Mathematics

The result of mathematics teachers' use of their own preferred teaching styles to enable students understand mathematics easily indicated that most of the students (82%) have agreed that mathematics teachers' use of their own preferred teaching styles in teaching helped them to understand mathematics easily. On the other hand, only 8% of them disagreed to this view and 10% of the students did not want to commit themselves (see Table 13).

Table 13: Students response to their mathematics teachers' teaching styles

Q.21 (students)	Choices	No. of Respondents	Percentage of responses
Mathematics teachers' use of their own preferred teaching styles may help us understand mathematics easily	Strongly Agree	101	41%
	Agree	101	41%
	Not Identified	24	10%
	Disagree	17	6%
	Strongly Disagree	6	2%

In support of this finding, Doolan and Honigsfeld (2000) argue that mathematics teachers should promote partnership that will increase parental involvement and participation in their children's learning style strengths which can lead to more productive homework sessions.

c) Teaching Styles Mostly Used by Mathematics Teachers to Teach Mathematics

As shown in Table 14, the responses for the type of teaching styles teachers mostly use in their mathematics classes indicated that about three-fourth (74%) of them responded that they employ autocratic teaching styles. Thirteen percent of them use participatory teaching styles and a further 13% of them responded that they use both participatory and autocratic teaching styles.

Table 14: Responses on teaching styles mostly used by mathematics teachers to teach maths

Q.3 (teachers)	Choices	No. of Respondents	Percentage of responses
The type of teaching styles you mostly use in your mathematics classes is	a) autocratic	17	74%
	b) participatory	3	13%
	c) both a and b	3	13%

From the result, one can observe that the majority of teachers were mostly employing autocratic teaching styles in which students do not take part in the learning process. This does not encourage students to learn by participation.

With regard to the types of teaching styles they employ, the interviewed teachers disclosed that lesson presentation, giving assignments and class-works and conducting discussions is their own preferred mathematics teaching styles. Additionally, they explained that the transmission of plasma television takes about 30 minutes and the remaining 10 minutes is not sufficient for students' interaction. They further explained, the fact that the time they are left with after the transmission of plasma television is less than ten minutes doesn't allow them to employ participatory approach which encourages the learning and teaching of mathematics.

d) Teachers' Responses to Assisting Their Students to Use Their Own Preferred Learning Styles and Strategies

The teachers were asked whether they assist their students to use their own preferred learning styles and strategies or not. The result shows that most of the teachers (87%) didn't assist their students to use their own preferred learning styles and strategies during their teaching of mathematics. Only less than 5% witnessed that they assist their students, and 9% of them responded that they don't have any idea about the learning styles and strategies of their students (see Table 15).

Table 15: Teachers' response in assisting students to use their own preferred learning styles and strategies

Q.4 (teachers)	Choices	No. of Respondents	Percentage of responses
Do you assist your students to use their own preferred learning styles and strategies in the process of teaching mathematics?	a) yes	1	4%
	b) no	20	87%
	c) I have no idea about their learning styles.	2	9%

In general, the result indicates that the majority of the secondary school mathematics teachers do not assist their students to use their own preferred learning styles and strategies.

The finding of this question is also supported by teachers' interview result. In response to the question 'How do you support your students to use their own preferred learning styles and strategies in your mathematics classes?' most of the interviewed teachers indicated that their support to students was impeded by shortage of time after plasma television transmission, poor prior mathematical background of students, teachers' limited knowledge on the students preferred learning styles and strategies and the large size of contents of mathematics topics to be covered within the specified academic year. Moreover, most of these teacher interviewees view the

differences in approaches to learning as problems inherent in the students themselves rather than encouraging their students to learn in their own ways. All of the teacher interviewees mentioned that despite the establishment of teacher-parent association at all schools to assist students' learning; no parent has contacted them to deal with the issues of their children's mathematics learning with them since they began teaching.

e) Measures Taken By Mathematics Teachers to Assist Their Students to Understand Mathematics Lessons

Regarding the question that asks 'If your students do not understand mathematical topic under discussion, what measures do you take?' most of the teachers (70%) responded that they discussed the topic repeatedly. A further 30% of teachers said that they allow their students to discuss the topic and come up with ideas. No one has responded to skip the topic and pass to the next topic if students do not understand the topic under discussion (see Table 16).

Table 16: Responses of mathematics teachers in assisting their students

Q.5 (teachers)	Choices	No. of Respondents	Percentage of responses
If your students do not understand mathematical topic under discussion, what measures do you take?	a) I skip the topic	-	-
	b) I discuss the topic repeatedly	16	70%
	c) I allow students to discuss on the issue by themselves and come up with ideas	7	30%

The finding in Table 16 indicates that the majority of teachers discuss mathematics topics thoroughly in order to assist their students understand mathematics better. The result obtained for this question has direct relation with students' preferred learning styles and strategies for the detail explanations on mathematics lesson under discussion. On the preference for either getting detail explanations or general highlights in the learning of mathematics, 60% of the students responded that they preferred teachers who give them detail explanations rather than those who give them general highlights (see Table 11).

f) How Teachers Motivate Students to Participate in Classroom Discussions

As shown in Table 17, 13% of the teachers responded that they pose questions and wait for voluntary hands. Only 4% of them responded that they randomly call their students and ask them to

give answers. However, the majority (83%) of them responded that they use both techniques to motivate their students to participate in the discussion during mathematics classes.

Table 17: Responses of teachers for how they motivate their students in classroom discussions

Q.7 (teachers)	Choices	No. of Respondents	Percentage of responses
Most preferably, how do you motivate your students to participate in the discussion during your mathematics classes?	a) By posing the questions, I wait for voluntary hands.	3	13%
	b) I randomly call their names and ask to answer	1	4%
	c) I will use both techniques mentioned	19	83%

Despite the shortage of time after the transmission of plasma television, if properly used, both techniques encourage students to learn mathematics.

g) Procedures Students Follow When Solving Mathematics Problems

For the procedures to be followed to solve mathematical problems, 70% of teachers responded that they allow their students to follow similar procedures they used to teach them and a few (17%) allow their students to use their own preferred learning styles and strategies. On the other hand, 13% of them responded that they allow their students to work according to the examples given in their textbooks (see Table 18).

Table 18: Responses of teachers in allowing their students when solving mathematics problems

Q.8 (teachers)	Choices	No. of Respondents	Percentage of responses
How do you allow your students to solve mathematical problems?	a) I allow them to solve using similar procedures I used to teach them	16	70%
	b) I allow them to work using their own preferred learning styles and strategies	4	17%
	c) I only allow them to work according to the examples given in their textbooks	3	13%

Therefore, the majority of the teachers (70%) allow their students to follow similar procedures the teachers have shown them to solve other mathematics problems. Moreover, it can be observed that

this finding has a direct relationship with teachers' preference for autocratic teaching styles (see question 3 of Table 14).

h) Guidelines Provided to Students to Learn Mathematics

Regarding the question ‘how do you guide your students to learn mathematics?’, 52% of the teachers responded that they explain mathematical topics using textbooks, give them examples and instruct them to solve other related problems. Only few of them (13%) responded that they discuss mathematical topics with the participation of the classes and encourage them to solve other problems. On the other hand, 13% of the teachers responded that they give lectures and instruct their students to work other mathematical problems on their textbooks while 22% of them responded that they use both techniques to assist their students (see Table 19).

Table 19: Responses of teachers in guiding their students to learn mathematics

Q.9 (teachers)	Choices	No. of Respondents	Percentage of responses
In most cases, how do you guide your students learn mathematics?	a) I explain mathematical topics using textbooks, give examples and instruct them to solve other related problems	12	52%
	b) I discuss mathematical topics with the participation of the classes and encourage them to solve other problems	3	13%
	c) I give them lectures and instruct them to work other mathematical problems on their textbooks	3	13%
	d) All of the above	5	22%

This implies that students follow the procedures teachers has shown them rather than looking for other methods to solve similar problems.

4.2.3 The Role of Curriculum in Encouraging Students to Use Their Own Preferred Learning Styles and Strategies

The organization of instructional materials needs to include the ways by which the intended goals are attained and become a spring board for motivation of students. In connection to this idea, Stitti-Gohdes (2001) states that learning is most effective when instructional materials are presented in a clear and organized fashion including the learning style preferences of the students. In the same

way, Riding and Al-Hajji (2000:33) also discusses that students learn best when the structure, the content and the mode of presentation suit their learning preferences. Corresponding to these views, this study devoted to point out how mathematics curriculum being currently used in secondary schools in Ethiopia is conducive for students to use their own preferred learning styles and strategies. To answer the third research question, 6 questions from students' and 4 questions from teachers' questionnaires were considered. Thus, there were 10 questions presented to students and teachers and the results of these questions are summarized in Tables 20 to 28.

a) The Use of Mother Tongue at Primary Level to Enhance Mathematics Learning at Secondary Level

Since the primary level mathematics curriculum was designed in the mother tongue of the students, it is useful to learn the impact this curriculum organization might have had on their learning of mathematics in secondary school. For the question that states “The learning of mathematics at primary level in my mother tongue helped me to understand secondary school mathematics easily”, many of the students (39% strongly-agreed and 29% agreed) confirmed that the use of mother tongue at primary level education has enhanced their learning of mathematics at secondary level. 16% of the students chose not identify their preferences. A few of the students (11% disagreed and 5% strongly-disagreed) responded that the use of mother tongue at primary level education didn't help them to understand secondary school mathematics (see Table 20).

Table 20: Responses of students for preferred learning styles and strategies in vernacular

Q.24 (students)	Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
The learning of mathematics at primary level in my mother tongue helped me to understand secondary school mathematics easily	Respondents	98	73	39	27	12
	Percentage of responses	39%	29%	16%	11%	5%

Thus, one can see that the majority of the students (68%) agreed that the learning of mathematics at primary level in their vernacular has helped them to understand secondary school mathematics easily.

b) Preferred Learning Styles and Strategies Through Plasma Television

For the preferred learning styles and strategies of learning mathematics through plasma television, many of the students (40% strongly-disagreed and 27% disagreed) preferred not to learn mathematics through plasma television. Contrary to this view, a few of the students (12% strongly agreed and 9% agreed) indicated their preference to learn mathematics through plasma television. Only 11% of the students did not identify their preferences (see Table 21).

Table 21: Responses of students for preferred learning styles and strategies through plasma television

Q.25 (students)	Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
I prefer to learn mathematics through plasma television (curriculum organization)	Respondents	30	22	29	68	100
	Percentage of responses	12%	9%	11%	27%	40%

On the whole, 67% of students did not prefer learning mathematics through plasma television.

c) Steps Students Follow When Solving Mathematical Problems in Classes

As shown in Table 22, the result for how students proceed when they solve mathematical problems in classes reflected that 53% of the students responded that there is no enough time to check and recheck their answers to the problems. On the other hand, 18% of them responded that they find checking the solutions tiresome whilst 29% of them responded that they tend to repeat and recheck all the steps used to solve the problems.

Table 22: Responses of students for steps followed when solving mathematical problems in classes

Q.1 (students)	Choices	No. of Respondents	Percentage of responses
When I am solving mathematical problems in classes	a) I tend to repeat all my steps and check my solutions carefully	71	29%
	b) I find checking the solutions obtained tiresome and don't make such attempt	46	18%
	c) There is no enough time to check and recheck my answers to the problems	132	53%

The intention of this item is to identify whether there is enough time to repeatedly check the steps they used to reach upon the solution for the mathematical problems given during the classrooms

period. The responses given to the question revealed that more than half of the students (53%) responded that there is no enough time to check and recheck their solutions to the problem. The time limitation has a linkage with the design of the mathematics curriculum itself. The responses obtained from teacher interviewees also revealed the same – shortage of time. All of the interviewed teachers expressed that there is no enough time to check and recheck what students do in a regular class time after plasma lesson presentation.

d) Use of Mathematics Lessons Outlines in Enhancing Students’ Learning

Table 23 indicates that the response for preferring mathematics lesson outlines to learn mathematics showed that the majority of the students (65%) responded that mathematics lessons with an outline of what they will cover are very helpful to them. On the contrary, 29% of them responded as somewhat helpful to them and 7% of them responded that it is not helpful to their mathematics learning.

Table 23: Responses of students on the use of mathematics lessons outlines

Q.2 (students)	Choices	No. of Respondents	Percentage of responses
If teachers start their mathematics lessons with an outline of what they will cover, such outlines are:	a) very helpful to me	161	65%
	b) somewhat helpful to me	71	29%
	c) not helpful to me	17	7%

e) Preferred Learning Styles and Strategies on Mathematics Lessons Presentations

As Table 24 indicates, the response for the emphasis of mathematics lessons revealed that 60% of the students prefer concrete presentations (facts and data). Only 27% of the students prefer both abstract and concrete presentations while 14% of them responded that they prefer abstract presentations (concepts and theories),

Table 24: Responses for preferred learning styles and strategies of students on mathematics lessons presentations

Q.3 (students)	Choices	No. of Respondents	Percentage of responses
I prefer mathematics lessons that emphasize on	a) abstract presentations (concepts, theories)	34	14%
	b) concrete presentations (facts, data)	149	60%
	c) both abstract and concrete presentations	66	27%

The result indicated that more than 60% the students preferred concrete presentations to learn mathematics.

f) Forms of Mathematical and Statistical Data Presentations

When teachers are presenting mathematical and statistical data in classes, more than half of the students (55%) preferred it to be presented both in tabular form and charts or graphs. On the other hand, 24% of the students preferred it to be presented only in the form of charts or graphs and 13% of them preferred it to be presented only in tabular form. A few of the students (7%) did not express their preferences (see Table 25).

Table 25: Responses of students on forms of mathematical and statistical data presentations

Q.5 (students)	Choices	No. of Respondents	Percentage of responses
When teachers are presenting mathematical and statistical data in classes	a) I prefer it to be presented in tabular form only	33	13%
	b) I prefer it to be presented in the form of charts or graphs only	61	24%
	c) I prefer it to be presented both in the form of tables and charts or graphs	137	55%
	d) I have no preferences.	18	7%

Most of the students (55%) preferred mathematical and statistical data to be presented in classes to be in either tabular, charts or graphs. As shown in Table 24, the majority of the students (60%) preferred concrete presentations to learn mathematics and thus for this question they preferred the charts or graphs as concrete evidence for the problem under consideration.

g) Design of Mathematics Curriculum That Teachers Preferred To Teach

Regarding the design of the mathematics curriculum that mathematics teachers prefer more to teach, most of the teachers (74%) responded that they like to teach mathematics lessons that deal with facts and real life situations. Only 17% of the teachers responded that they like to teach ideas and theories. 9% of the teachers did not identify their preferences of mathematics lessons (see Table 26).

Table 26: Responses of teachers on the design of mathematics curriculum they preferred to teach

Q.1 (teachers)	Choices	No. of Respondents	Percentage of responses
As a mathematics teacher, I more prefer to teach a lesson	a) that deals with facts and real life situations.	17	74%
	b) that deals with ideas and theories	4	17%
	c) if any, please specify them	2	9%

Thus, the majority of these mathematics teachers indicated that they preferred to teach lessons that deal with facts and real life situations.

h) Teachers' Most Preferred Teaching Strategies

With regard to the teaching strategies mathematics teachers preferred most, many of the teachers (74%) preferred lecture method. A few teachers (22%) preferred collaborative method and only 4% of them indicated their preference for project method (see Table 27).

Table 27: Responses of teachers' on most preferred teaching strategies

Q.6 (teachers)	Choices	No. of Respondents	Percentage of responses
What are your most preferred strategies of teaching mathematics?	a) Lecture method	17	74%
	b) Project method	1	4%
	c) Collaborative method	5	22%

Most of the teachers responded that they preferred lecture method to any other methods in their teaching of mathematics. Possibly, it can be deduced from the responses of teachers that teachers in employing the lecture method during their mathematics classes might have pressured the students to prefer the detail explanations in the learning of mathematics. On the other side, lack of employing the project method and collaborative method seems to have affected the effective teaching-learning of mathematics and the achievement of the learners.

i) Observation of Mathematics Teachers on Presentation of Mathematics Lessons through Plasma Television

As indicated in Table 28, the response for the preference of lessons through plasma television to encourage students to use their own preferred learning styles and strategies revealed that most of the

teachers (61%) responded ‘no’ while 30% of them responded ‘yes’. On the other hand, 9% of them indicated that they do not have idea.

Table 28: Responses of teachers on mathematics lessons presented through plasma television

Q.10 (teachers)	Choices	No. of Respondents	Percentage of responses
Does the transmission of mathematics lessons through plasma television encourage students to use their own preferred learning styles and strategies?	a) Yes	7	30%
	b) No	14	61%
	c) I have no idea	2	9%

Thus, the finding indicated that mathematics lesson presentation through plasma television as revealed does not encourage students to use their own preferred learning styles and strategies. Similar result was also obtained from interview data. The interviewed teachers unanimously reported that the presentation through plasma television ranges for about 30 minutes and limits the participation of students in the learning process. They further explained that the interaction of students is limited due to language barriers they encounter and the students simply sit idle and listen without grasping key points of the lesson. Since plasma television restricts the interaction between teachers and students these interviewed teachers were worried about students understanding of the subject.

j) Secondary School Mathematics Curriculum Preparation

The responses to express their observations on the preparation of mathematics curriculum they teach 57% of teachers responded that it is time-bounded and didn’t allow them to encourage students to use their own preferred learning preferences in the learning of mathematics. Contrary to this view, 35% of the teachers responded that it is student-centered and allow students to use their own learning preferences. Very few of the teachers (9%) indicated that they did not have any idea.

Table 29: Responses of teachers on the preparation of mathematics curriculum

Q.11 (teachers)	Choices	No. of Respondents	Percentage of responses
The preparation of mathematics curriculum for the grade you teach is	a) student centered and allows students to use their own learning styles and strategies	8	35%
	b) time- bounded and no gap to encourage students to use their own preferred learning styles and strategies	13	57%
	c) I have no idea	2	9%

The finding, here, has shown that secondary school mathematics curriculum is largely time-bounded and doesn't allow students to use their own preferred learning styles and strategies. This also requires due attention of policy makers and curriculum designers to make the curriculum design flexible that enables the students to use their preferred ways of learning.

4.2.4 Major Challenges Students Might Face in Using Their Own Preferred Learning Styles and Strategies

To answer this fourth research question, 4 questions were presented to students and 2 questions to their mathematics teachers. The responses obtained through these questions were summarized and given in Tables 30 to 33.

Table 30: Responses of students on challenges they might face to use their own preferred learning styles and strategies

Questions		Responses	Strongly Agree	Agree	Not Identified	Disagree	Strongly Disagree
Q.23	I learn mathematics because it is given as a compulsory subject in my school	Respondents	62	86	37	40	24
		Percentage of responses	25%	35%	15%	16%	10%
Q.26	For me, mathematics is a difficult subject and I don't understand it easily	Respondents	102	60	34	37	16
		Percentage of responses	41%	24%	14%	15%	6%
Q.20	Lack of using my preferred learning styles have contributed for my achievement in mathematics to be poor	Respondents	70	64	41	37	37
		Percentage of responses	28%	26%	16%	15%	15%

a) Learning Mathematics as a Compulsory Subject

As shown in Table 30, the result for the question that states 'I learn mathematics because it is given as a compulsory subject in my school' indicated that 35% of the students have agreed and 25% of them also strongly agreed that they learn mathematics since it is given as a compulsory subject. Contrary to this response, 16% of the students have disagreed and 10% of them strongly disagreed to the view of learning mathematics for it is given as a compulsory subject in their school. Only 15% of the students did not specify their choices. The finding has shown that 60% of students have agreed that they learn mathematics since it is only given as a compulsory subject at secondary school level. This finding seems to be due to lack of proper orientation. Cangelosi (1996) supports

this view by stating that mathematics will not be meaningful to students unless they develop certain key concepts in their own minds and discover key relationships for themselves.

b) Students Perception on the Nature of Mathematics

For the question that requests students how they perceive mathematics, most of them (41% of the students have strongly agreed and 24% of them also agreed) indicated that mathematics is a difficult subject and they do not understand it easily. Only few of the respondents (15% of the students disagreed and 6% of them strongly disagreed) did not perceive mathematics as a difficult subject to understand it easily. 14% of the students didn't identify their perceptions on the nature of mathematics (see Table 30). Thus, the result shows that majority of the secondary school students (65%) perceive mathematics as a difficult subject and not easy to understand. Also Pewewardy (2002) argued that, many students view mathematics as a spectator sport rather than in which they can participate which makes students to develop a prejudice to mathematics.

c) Students' Reaction on Their Achievement in Mathematics

As indicated in Table 30, the response for their poor achievement indicated that 28% of students have strongly agreed and 26% of them also agreed that lack of using their own preferred learning styles and strategies made their achievement in mathematics poor. There was no difference between those who disagreed and strongly disagreed (15% each) to the idea of lack of using their preferred learning styles and strategies made their achievement in mathematics poor. But 16% of the students did not identify their choices. From this result one can observe that more than half of the students (54%) have agreed that lack of using their own preferred learning styles and strategies have contributed to their poor achievement in mathematics.

d) The Way Students Solve Mathematical Problems

As shown in Table 31 below, for the question that asks how students solve mathematical problems, 54% of the students responded that they usually work in their own ways to solutions one step at a time. On the contrary, 42% of them responded that they often just see the solutions but then struggle to figure out the steps to get to them and only 4% of them responded that they don't like to solve mathematical problems.

Table 31: Responses of students on how they solve mathematics problems

Q.6 (students)	Choices	No. of Respondents	Percentage of responses
When I solve mathematics problems	a) I usually work in my ways to the solutions one step at a time	134	54%
	b) I often just see the solutions but then struggle to figure out the steps to get to them	105	42%
	c) I don't like to solve mathematical problems.	10	4%

Thus, the result indicated that students were not making efforts to work on and reach on solutions. This has due connection with teachers giving them detail explanations during the learning of mathematics rather than encouraging the students to work on their own.

e) Factors Negatively Affecting Students' Success in Mathematics

Table 32: Responses of teachers on factors that negatively affect students' success in mathematics

Q.2 (teachers)	What are the factors that negatively affect students' success in mathematics?			
Choices	a) lack of employing varied teaching strategies by teachers	b) lack of employing preferred learning styles and strategies by students	c) both a and b	d)others
No. of respondents	3	5	12	3
Percentage of responses	13%	22%	52%	13%

The majority of these mathematics teachers (52%) agreed that lack of employing different teaching strategies and students' lack of using their own preferred learning styles and strategies negatively affect students' success in mathematics (see Table 32). Corresponding to this finding, Orlich *et al.* (2001) described that the mathematics learning style has a significant influence on students' choice of mathematics learning strategies, and that both learning styles and learning strategies affect learning outcomes.

f) Teachers' Response to Students' Prior Knowledge and Mathematical Background

As indicated in Table 33, 91% of the teachers responded that students' prior knowledge and mathematical backgrounds have greater influence on the students learning and academic achievement. Only a few (9%) of the teachers said that students' prior knowledge did not influence their learning of mathematics.

Table 33: Responses of teachers' on students' prior knowledge and mathematical background

Q.12 (teachers)	Choices	No. of Respondents	Percentage of responses
Do students' prior knowledge and mathematical background have greater influence on their mathematics learning and academic achievement?	a) Yes	21	91%
	b) No	2	9%
	c) I have no idea	-	-

As can be seen in Table 33 the majority of teachers think that students' prior knowledge and mathematical background have greater influence on students mathematics learning and academic achievement. This finding coincided with studies conducted by other researchers like Orlich *et al.* (2001:188) who stated that

Students' cultural and background experiences influence how they understand mathematical concepts and how they respond to and benefit from mathematics instruction. Differences in background, experience, and socio-economic status, culture and language all influence the mathematics learning styles of the students.

The interview data also reflected the same findings. Most of the teachers interviewed reported that students' prior knowledge is limited due to certain factors. One of the interviewees said that the 'students' use of their own natural talent was limited and that their primary level background was not dependable. Students simply sit in class and wait for ready made knowledge. They expect the teachers to give detail explanations on every lesson.' The interviewees also commented that students lack of using their own preferred learning styles and strategies need due attention to improve mathematics instruction in Ethiopia.

4.3 Conclusion

This chapter presented the results of the study that investigated the preferred learning styles and strategies of secondary school students to learn mathematics in Ethiopian context. The study treated the following four major issues:

1. Students' Learning Style and Strategy Preferences to Learn Mathematics,
2. How Teachers' Assist Students to Use Their Preferred Learning Styles & Strategies to Learn Mathematics,
3. The Role of Curriculum in Encouraging Students to Use Their Own Preferred Learning Styles and Strategies, and

4. Major Challenges Students Might Face in Using Their Own Preferred Learning Styles and Strategies

The preferred learning styles and strategies of students were categorized as environmental, emotional, sociological, physiological and psychological to answer the first research question. The following chapter reports the major results, gives recommendations and conclusion to the study.

Chapter 5

Summary of Findings, Recommendations and Conclusion

5.1 Introduction

The purpose of this study was to explore preferred learning styles and strategies of secondary school students and to examine problems that hinder them from using their preferences when learning mathematics. This chapter presents the summary of the findings, recommendations and conclusion of the study.

5.2 Summary of Findings

5.2.1 Students' Learning Style and Strategy Preferences to Learn Mathematics:

- The majority of the students preferred to learn mathematics in a silent than noisy environment, in the mornings than evenings, formal seating arrangement than informal seating arrangements, structured ways of learning mathematics, and mathematical lessons to be supplemented by visual aids during the learning of mathematics.
- Most of the students preferred to work and study mathematics problems with their peers or groups than on their own, to work in groups due to lack of confidence to work on mathematics problems on their own, making graphs and charts to learn mathematics or preferred the visual approach in the learning of mathematics.
- A great majority of the students preferred the detailed explanations on all mathematics problems or topics than getting general highlights or general ideas in the learning of mathematics and preferred lectures and presentation of their teachers. They further expressed that they are not learning mathematics to widen their logical reasoning and to develop their thinking abilities.

5.2.2 How Teachers' Assist Students to Use Their Preferred Learning Styles & Strategies to Learn Mathematics,

On the other hand,

- The majority of the students preferred mathematics teachers who explain mathematics lessons in a clear and sequential order and who explain all mathematics lessons in detail and solve all the problems.

- Most of mathematics teachers were mainly employing autocratic teaching styles in which students do not take part in the learning process. Moreover, they do not allow their students to use their own learning styles and strategies in the learning of mathematics than discussing the mathematics topics repetitively to make their students understand mathematics better. With regard to the types of teaching styles they employ, the interviewed teachers responded that 'presentation, giving assignments and class works and discussions' were reflected as their own preferred style of teaching. They further responded that they didn't assist their students to use their own preferred learning styles and strategies in their teaching of mathematics. The interviewees responded 'a shortage of time after a plasma television's mathematics lessons presentation, only 7 to 10 minutes after presentation, and poor prior mathematical background of students at primary level did not allow them to assist their students to use their own preferred learning styles and strategies in the learning of mathematics.

5.2.3 The Role of Curriculum in Encouraging Students to Use Their Own Preferred Learning Styles and Strategies:

With regards to encouraging students to use their own preferred learning styles and strategies:

- The majority of the students indicated the fact that primary level mathematics curriculum is presented in their mother tongues has helped them to understand mathematics at secondary school level easily.
- Most of the students did not prefer learning mathematics through plasma television; they require brief outlines and concrete presentations, and responded that there is no enough time to check and recheck the answers they found for the problems.
- Many of mathematics teachers also responded that they preferred to teach lessons that deal with facts and real life situations, preferred lecture method and condemn the plasma television presentation since it minimizes their interaction with their students. They further expressed that the preparation of mathematics curriculum they teach is time-bounded and didn't allow them to encourage students to use their own preferred learning preferences in the learning of mathematics.

5.2.4 Major Challenges Students Might Face in Using Their Own Preferred Learning Styles and Strategies

Finally,

- Most of the students responded that they learn mathematics since it is given as a compulsory subject at secondary school level, consider mathematics as a difficult subject and not easily understood, and they do not use their own preferred learning styles and strategies.
- The majority of mathematics teachers responded that teachers lack of using varied teaching strategies and students lack of using their own preferred learning styles and strategies have negatively affected students' success in mathematics. Teachers further noted that students do not use their prior knowledge to learn mathematics.

5.3 Recommendations

The objectives of mathematics should be clearly addressed to the students to know why they learn mathematics. This helps students to have a clear vision and to avoid the prejudice. Students' preferred learning styles and strategies need to be considered from the beginning of mathematics curriculum design up to the implementation stage by concerned stakeholders such as curriculum designers, school administrators and mathematics teachers. School administrators have to consider the preferences of students in order to provide a viable educational environment for students. Mathematics curriculum designers need to consider all the learning approaches that allow students to use their own preferred learning styles and strategies in the learning of mathematics. These learning approaches include revising mathematics course contents as per the learning styles and strategies of students, allowing extra-time to solve mathematical problems and including projects and problems that initiate group work. Mathematics teachers need to promote insightful approaches to learn through the creation of learning environments that students perceive as safe, supportive, and that offer helpful relationship. Teachers also need to present opportunities for exploration, inquiry, and experimentation by providing problems to be solved and matching their teaching styles to the students' preferred learning styles and strategies.

Moreover, mathematics teachers need to help their students develop qualitative conceptions of mathematics learning and help to construct their own meaning in the learning of mathematics rather

than giving detail explanations. Qualitative conceptions of mathematics referred here is to learn mathematics to develop meaning and understanding of mathematics. Since lecturing and telling the same thing over and over again does not assure the learning of students (Manner, 2001), I urge teachers to support their students to learn best through various styles. Teaching strategies and assessment methods employed by mathematics teachers need to be congruent with the students learning preferences. Finally, I would like to advise further research needs to be conducted on the teaching style preferences of mathematics teachers and how it matches with their students' learning styles and strategies.

5.4. Limitations of the Study

It has to be acknowledged that no study can be free of flaws, and there is no exception to this one. Every attempt has been made to make the study valid, reliable and representative, but I still feel that it would have been more appropriate if the samples had been larger than the present one. Financial and time constraints, in fact, played their parts in this case. The sample of the study was limited only to grade 11 students who were enrolled in 2008 academic year and their mathematics teachers. In addition, this study would have been more complete if the views of curriculum developers were incorporated. Regarding tools, the data would have been enriched more through triangulation if classroom observation and group discussion were also included. Due to similar reasons, data gathering was limited only to questionnaires and an interview.

5.5 Conclusion to the Study

The study has identified the preferred learning styles and strategies of secondary school students, the conduciveness of the design of mathematics curriculum and examined the prevailing problems that restrict students from using their own preferences. The assistance students require from their mathematics teachers was also identified. The study has indicated that there is a mismatch between the teaching styles of teachers and the preferred learning styles and strategies of students. Students whose learning styles and strategies matched with their teachers' teaching styles will have greater ease to learn mathematics better than with students whose styles are mismatched (She, 2005). Moreover, it was observed that students were not creating their own knowledge through practice; instead, they were depending on the detail explanations given by their mathematics teachers (plasma television presentation). The plasma television presentation on the other hand has impeded

the interaction of teachers and students and further limited students use of their own preferred learning styles and strategies. When students are taught with methods dissonant from their learning style preferences, they do not succeed in mastering the subject matter as quickly as they could have (Doolan and Honigsfeld, 2000). Matching teaching styles with learning styles and strategies of students is found to be important in maximizing learning. Furthermore, restructuring of mathematics curriculum to make students take part in their own learning is of paramount importance to increase the activities of students in the learning of mathematics. It is further examined that students were not learning mathematics to widen their own logical ability and to develop their creative thinking. Rather, they perceived mathematics as a difficult subject and not easily understood which made them to develop the prejudice. This is the serious issue that requires due attention and needs to be addressed carefully.

On the other side, it is observed that most of these secondary school mathematics teachers view the differences in approaches to learning mathematics as problems inherent in students themselves rather than encouraging their students to learn in their own ways. From the results of the procedures that students were allowed to solve mathematical problems, one can see that most of secondary school mathematics teachers allow their students to follow similar procedures they have shown them to solve other mathematical problems. Similarly, the majority of them responded that they explain mathematical topics using textbooks and give them examples and instruct them to solve other problems in a similar fashion. This emanated from the fact that, most of mathematics teachers follow an autocratic teaching style. On the contrary, it is noted that if students' learning preferences are identified and students are permitted to learn according to their preferences, then their achievement, motivation and interest in school subjects will be enhanced (Renzulli *et al.*, 1998). Moreover, by closely examining students' reflections, teachers can make their approach more comprehensive in its appeal to match diverse learning styles of their students (Prescott, 2001). Therefore, the results of this study have generally shown that, students were not learning mathematics on the basis of their preferred learning styles and strategies. The teachers were practicing autocratic teaching styles and were not allowing students to use their own preferred learning styles and strategies. These imply that the organization of secondary school mathematics curriculum requires reform to accommodate the preferred learning styles and strategies of students.

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4. When a group project is given by mathematics teachers: a) I primarily prefer to work alone and then come to the group to compare my work with group members. b) I prefer to work with the group members to generate ideas within the group c) I don't prefer to work group project.
5. When teachers are presenting mathematical and statistical data in classes: a) I prefer it to be presented in tabular form only. b) I prefer it to be presented in the form of charts or graphs only. c) I prefer it to be presented in the form of tables and charts or graphs d) I have no preferences.
6. When I solve mathematics problems a) I usually work in my ways to the solutions one step at a time. b) I often just see the solutions but then struggle to figure out the steps to get to them. c) I don't like to solve mathematical problems.
7. I prefer when mathematics teachers a) present mathematics lessons in a clear and sequential order. b) Give me an overall picture of the lesson to work it by myself. c) I don't like mathematics.
8. When I start working mathematics problems, I am more likely to a) try to understand the problem first before solving the problem b) start working on the solution before understanding the problem. c) guess the solution of the problem
9. I like mathematics teachers who a) explain mathematics lesson in detail and solve all the problems by themselves. b) Explain only the main points. c) Assist me to use my learning styles and strategies to learn mathematics.
10. I more easily remember a) something I have done. b) Something I saw. c) I have no preference.

Part III. Rating Scale Questions

Please indicate your answer by putting a tick mark (J) in the column of your best choice.

s/n	Elements of learning styles	5 (strongly agree)	4 (agree)	3 (not identified)	2 (disagree)	1 (strongly disagree)
1	I prefer to learn and work mathematics problems in a silent environment					
2	I prefer to learn and work mathematics problems in a noisy environment					
3	I prefer formal ways of seating arrangements in mathematics classes					
4	I prefer informal ways of seating arrangements in mathematics classes					
5	I enjoy studying and working mathematics problems alone by myself (introvert style)					
6	I prefer to study and work on mathematics problems in groups with my peers or in teams (extrovert style)					
7	I prefer to learn mathematics in the morning classes					
8	I prefer to learn mathematics in the afternoon classes					
9	I prefer detail explanations on all of mathematics problems and topics (analytic style)					

10	I prefer general highlighting or general ideas rather than detail explanations on all mathematics problems (global style)					
11	I prefer structured ways during the process of working on mathematical problems					
12	I prefer free choice of working on mathematical problems to explore ones talents and abilities (trial and error)					
13	I can remember best about a subject by listening to a lecture that includes information, explanations and discussion					
14	I prefer to see information written on a blackboard and supplemented by visual aids					
15	I like to work on mathematics problems rather than memorizing their solutions					
16	I require explanations of diagrams, graphs, or visual directions in mathematics classes					
17	I prefer to learn mathematics by listening lessons presented by the teachers					
18	I prefer to learn mathematics through solving different mathematical problems					
19	I enjoy developing and making mathematical graphs and charts to learn mathematics					
20	Lack of using my preferred learning styles have contributed for my achievement in mathematics to be poor					
21	Mathematics teachers' use of preferred teaching styles to help us understand mathematics easily					
22	I learn mathematics to widen my logical reasoning and develop thinking ability					
23	I learn mathematics because it is given as a compulsory subject in my school					
24	The learning of mathematics at primary level in my mother tongue helped me to understand secondary school mathematics easily					
25	I prefer learning mathematics through plasma television (curriculum organization)					
26	For me, mathematics is a difficult subject and I don't understand it easily					

Annex 2: Teachers' Questionnaire

General Instruction

Dear Teacher

The purpose of this questionnaire is to collect information to investigate the learning styles and strategies used by secondary school students in the learning of mathematics. Your participation in completing the questionnaire is extremely useful. Please try to strictly read the questions before giving your responses. Thus, for the closed ended questions given, please choose the answer that best reflects your views from the given alternatives. For the open-ended questions, please write your answers on the blank space provided and even on the back of the paper.

Please read the definition of the following terms since they are essential to respond to the succeeding questions.

1. A style is not the ability but rather it is one's preferred way of using his or her ability.
2. Learning style is a biologically and developmentally determined set of personal characteristics that make identical instruction effective for some and non-effective for others. It is the way that each person begins to concentrate on, process, internalize and retain new and difficult academic information.
3. Learning strategies are specific behaviors that learners use to improve their own learning. It is a specific learning technique used to promote learning, such as observation, guessing, demonstration and group repetition.

Note that you are not required to write your name. Your responses will be kept confidential and anonymous. Thank you for your cooperation.

Part I. Personal profiles

Give appropriate information on your personal background by underlining the letter of your best choice.

1. Sex: (a) male b) female
2. Age: (a) less than 20 years b) 20 to 30 years c) greater than 30 years
3. Educational qualification: (a) Bachelor of Science (BSc.) or Bachelor of Education (BEd.) in mathematics and above b) Diploma c) 12 + Teachers' Training Institute (TTI)
d) others, please specify _____
4. Work experience: (a) less than 5 years b) 6 to 20 years c) greater than 20 years

Part II. Multiple choices

Please give the answer by underlining the letter of your best choice.

1. As a mathematics teacher, I more like to teach a lesson (a) that deals with facts and real life situations. b) that deals with ideas and theories. c) if any, please specify them:
_____.
2. What are the factors that negatively affect students' success in mathematics?
a) lack of employing varied teaching strategies by teachers
b) lack of employing preferred learning styles and strategies by students
c) both a and b d) other factors, please specify them: _____
3. The type of teaching styles you mostly apply in your mathematics classrooms is
a) autocratic b) participatory c) both a and b

4. Do you help your students to use their own learning styles in the process of teaching mathematics? a) Yes b) no c) I have no idea about their learning styles.
5. If your students do not understand mathematical topic under discussion, what measures do you take? a) I skip the topic. b) I discuss the topic repeatedly. c) I allow the students to discuss on the issue by themselves and come up with ideas. d) if others, please mention them: _____.
6. What are your most preferred strategies of teaching mathematics? a) Lecture method
b) project method c) collaborative method
7. Most preferably, how do you motivate your students to participate in the discussion during your mathematics classes? a) By posing the questions, I wait for voluntary hands. b) I randomly call their names and ask to answer c) I will use both techniques mentioned under a and b
8. How do you allow your students to solve mathematical problems? a) I allow them to solve using similar procedures I used to teach them. b) I allow them to work using their own preferred learning styles and strategies. c) I only allow them to work according to the examples given in their textbooks.
9. In most cases, how do you guide your students learn mathematics?
b) I explain mathematical topics using textbooks give them examples and instruct them to solve other problems. b) I discuss mathematical topics with the participation of the classes and encourage them to solve other problems. c) I give them lectures and instruct them to work other mathematical problems on their textbooks. d) All of the above.
10. Does the transmission of mathematics lessons through plasma television encourage students to use their own preferred learning styles and strategies? (a) Yes (b) No c) I have no idea.
11. The preparation of mathematics curriculum for the grade you are teaching is (a) student centered and allows students to use their own learning styles and strategies. (b) time- bounded and no gap to encourage students to use their own preferred learning styles and strategies. (c) I have no idea
12. Does students' prior knowledge and mathematical background have greater influence on their mathematics learning and academic achievement? (a) yes (b) no (c) I have no idea

Annex 4: Letter of Access for Data Collection

Found in attachment since it is PDF file