STUDENTS' LEARNING STYLES AND VIEWS: EFFECT ON HIGHER SECONDARY LEVEL MATHEMATICS ACHIEVEMENT

Kaji Prasad Ghimire

A Dissertation

Submitted to

Tribhuvan University

Faculty of Education

in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy in Mathematics Education

February 2018

This dissertation entitled *Students' Learning Styles and Views: Effect on Higher Secondary Level Mathematics Achievement* has been presented by Kaji Prasad Ghimire on February 4, 2018 and Approved by

………………………………… February 4, 2018

Prof. Dr. Hari Prasad Upadhyay

Dissertation Supervisor

………………………………… . February 4, 2018

Prof. Dr. Siddhi Prasad Koirala

External Examiner

…………………………………… February 4, 2018

Prof. Dr. Ganesh Bahadur Singh

Representative of the Research Committee

……………………………… February 4, 2018

Prof. Krishna Prasad Gautam, PhD

Dean, Faculty of Education , T U

I understand that my dissertation will become part of the permanent collection of any library. My signature below authorizes release of my dissertation to any reader upon request for scholarly purposes.

………………………… February 4, 2018

Kaji Prasad Ghimire,

Degree Candidate

DECLARATION

I hereby declare that this dissertation has not been submitted for candidature to any other degree. The parts of this dissertation have been presented in the following international conferences

1. First International Conference on Transformative Education Research and Sustainable Development (TERSD2016) which was held on October 21-23, 2016 at Dhulikhel, Nepal
2. International Conference on Applications of Mathematics to Nonlinear Sciences (AMNS-2016) which was held on May 26-29, 2016 at Kathmandu, Nepal
3. 9th International Technology, Education and Development Conference (INTED2015) which was held on 2nd-4th March, 2015 at Madrid, Spain
4. 8th annual International Conference of Education, Research and Innovation (ICERI2015) which was held on 16th-18th November, 2015 at Sevilla, Spain.

…………………………

(February 4, 2018)

Kaji Prasad Ghimire,
Degree Candidate

DEDICATION

To my beloved mother late Hari Maya Ghimire

To my lovely country "Nepal" and to all great people of this country

AN ABSTRACT OF THE DISSERTATION OF

Kaji Prasad Ghimire, for the *Degree of Doctor of Philosophy in Mathematics Education* presented on February 4, 2018.

Title: *Students' Learning Styles and Views: Effect on Higher Secondary Level Mathematics Achievement*

Abstract Approved

…………………………………

Prof. Dr. Hari Prasad Upadhyay

Dissertation Supervisor

Mathematics essentially provides the basic skills for human resources. Additionally, it sets the foundation for further education. In this realization, this research investigates the relationship between the grade 11 students' academic achievement in mathematics and their learning styles. It also investigates students' views towards mathematics by gender and academic career plan. In doing so, two hundred forty seven grade 11 students of science stream from two higher secondary schools at Kathmandu Metropolitan City (KMC) were chosen as the participants. A set of 44 forced choice dichotomy items of the Index of Learning Styles (ILS), and 55 views statements, based on view towards mathematics inventory (VTMI) were used at the beginning and at the end of the academic year 2012/13. The learning outcome was based on 50 items of Mathematics Achievement Test (MAT) as constructed by the researcher, which was administered at the end of the academic year along with ILS and views questionnaires. As statistical tool, a descriptive and inferential analysis was employed to examine the relationship between students' beginning and end learning styles. It also examined the students' beginning and end views towards mathematics by gender, and academic groups. Students' changes of learning styles status and

views (positive, balance, or negative) were determined by subtracting the beginning-survey from the end-survey scores.

The findings revealed that the majority of the students tend to be in active, sensing, visual and sequential learning styles. The students' views towards mathematics were slightly positive at the beginning than end. In 100 marks MAT, students obtained mean marks 42.9. However, female students scored slightly higher than their male counterpart. Likewise, the students with negative changes in views scored relatively low in MAT. However, no clear pattern was observed in learning styles and achievement in mathematics. It was also found that the mean achievement score was higher for students with physical group and biology with mathematics. There was significant association between change status of both learning styles and views on MAT by academic groups. As such, learning styles and positive views were important but not sufficient to predict student's success in learning mathematics.

Given that students' learning styles and their views towards mathematics are determining factors for learning mathematics, teachers, thus, are suggested take into account their students' learning styles and views towards mathematics while planning teaching/learning activities in mathematics. Knowing mathematical contents, however, is equally important. Bringing these findings together into account, this study will help other researchers, teachers, students and administrators to gain a better understanding on students' learning styles preferences, and their views on mathematics. Such increased understandings will be helpful for improvement of pedagogical practices related to mathematics studies of higher secondary and pre-university students.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank Tribhuvan University, Nepal for providing me with the opportunity to participate in higher education. I would like to assure that I shall maximize my knowledge and skills to serve my country. I express my heart-felt gratitude to my supervisor Prof. Dr. Hari Prasad Upadhyay, Central Department of Mathematics Education, Faculty of Education, Tribhuvan University for his valuable guidance during the preparation of this study. This extraordinary mentor motivated me in more ways than words can explain.

I am extremely grateful to Dr. Bal Chandra Luitel, Associate Dean, School of Education, Kathmandu University for his guidance, continued support and encouragement. I wish to extend my gratitude to Dr. Russell Gerardo Alpizar-Jara, Director, Department of Mathematics, University of Evora, Portugal for his valuable support when working on international conferences papers and for his guidance in this dissertation writing. It would not have been possible to produce the results of data analysis without his tremendous inputs on this research work. I would like to express my gratitude to Prof Dr Krishna Prasad Gautam, dean, FOE, Prof Dr. Siddhi Prasad Koirala, Prof Dr Arbinda Lal Bhumi for their kind help and valuable inputs. I am grateful to university of Evora and Emmawest2013 for providing me the financial support to work and stay in Evora under D16 mobility program. I am also indebted to Dr. Ze Carlos, Dr. Imme, Teresa and Gabriela from Emmawest2013 (Erasmus mundus) program for their tireless supporting during mobility period in preparing this research work. I must express sincere thanks to Shree Krishna Wagle and Prem Raj Adhikari for language and APA editing. My sincere thanks go to Mr Laxman Acharya and Mr Shyam Acharya for helping me compile data for this study.

Furthermore, I thank all the mathematicians and language experts whose comments and suggestions for the content and language for the mathematics achievement test had been a great one. My special thanks are also due to all the principals, mathematics teachers, school management and students from sample schools for their essential help and cooperation during the collection of research data.

In preparation of this thesis, I have consulted several books, thesis and papers for which I am deeply indebted to the authors and the publications. Many individuals have greatly contributed to complete this thesis; thanks are equally extended to them as well.

Last but not the least, a delightful and warm thanks to my wife Kabita, daughter Anugya, son Nisarga, brother Aseem, sister in law Bunu and other family members for their unconditional love, patience, understanding and support during the entire period of my research.

February 4, 2018 Kaji Prasad Ghimire, Degree Candidate

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ANOVA	Analysis of Variance
ATM	Attitude towards Mathematics
BPEP	Basic and Primary Education Project
CERID	Research Center for Educational Innovation and Development
EDSC	Educational and Developmental Service Center
EIMS	Educational Information Management Section, MOE
FIMS	First International Mathematics Study
GLM	General Linear Model
HSEB	Higher Secondary Education Board
HSSEP	Higher Secondary Schools Enhancement Programm
IEA	Association for the Evaluation of Educational Achievement
ILS	Index of Learning Styles
IOE	Institute of Engineering, TU
IOST	Institute of Science and Technology
KMC	Kathmandu Metropolitan City
MAT	Mathematics Achievement Test
MOE	Ministry of Education, Nepal
MSALT	Michigan Study of Adolescent Life Transition
NASA	National Assessment of Student Achievement
NCTM	National Council of Teachers of Mathematics
SD	Standard Deviation
SEDP	Secondary Education Project
SIMS	Second International Mathematics Study

SLC	School Leaving Certificate Examination
SPSS	Statistical Package for Social Sciences
TIMSS	Third International Mathematics and Science Study
TIMSS	Trends in International Mathematics and Science Study
TU	Tribhuvan University
VTMI	Views towards Mathematics Inventory

CHAPTER I

INTRODUCTION

Advancement of science and technology, engineering and medicine has created greater demand for science studies at higher secondary level, where mathematics is widely acknowledged in enhancing practical, scientific and philosophical knowledge of students. Mathematics studies offer students a mirror to peep into the development of civilization. Mathematical knowledge, in addition, helps them to resolve their practical and philosophical inquires with ease and simplicity as it provides efficient tools and skills for better understanding of the world. Mathematical reasoning, therefore, is one of the most powerful means to organize knowledge and ideas so as to develop new ways of thinking. It is a key gate keeper to initiate further education and employment opportunities, which are remarkable signs of social progress (Middleton, Ricks, Wright, & Grant, 2013). In this relation, Mathematics serves two purposes in particular. First, it enhances the basic skills for human resources; and second, it helps to solve the real-world problems.

Mathematics is defined as the study of numbers, shapes and space using reason, which usually involves special system of symbols and rules for organizing them. Further, mathematics has its own language, tools and mode of operations. It is the science of measurement, quality and magnitude. It is science for logical reasoning and science of abstract form. It is also the numerical and calculation part of human life and their knowledge. It enables man to study relationships between various phenomena in the universe.

One of the focus areas of concern among mathematics educators in this changing and challenging world is the enhancement of student’s performance in mathematics. In Nepal, during the past three decades, mathematics has been a vehicle for raising scientific and technological innovation (Luitel, 2013). The impact of mathematics is much more powerful on the behaviour of individuals. Therefore, its learning outcomes in terms of achievement have gained more attention in recent times. The academic achievement in mathematics is the acquired ability or the degree of competence in mathematics tasks, which are generally measured by standardized tests and expressed in percentage or grade units (Setia, 1991).

Students' low achievement in mathematics has been an issue in Nepal (BPEP, 1995, 1997, 1998; CERID, 1999) as well as in other countries (Webster, 2002; Gonzales & Williams, 2009; Gonzales et al., 2004; Provasnik et al., 2012) For example, 42.09 % SLC examinee failed in mathematics in the year 2013, where 38.79% examinee had failed in the year 2012 (Budhathoki et al., 2014). Grade eight students' overall achievement score in mathematics was 43.0 in 2013 (Metsamuuronen & Kafle, 2013 in NASA, 2013), and the score was just 35.0 out of 100 marks in 2014(EIMS, 2014). The mean SLC score was 37.09 in 2006 (Mathema & Bista, 2006). Likewise, the SLC mean score was 36.4 in 2014 (EIMS, 2014). Likewise, the overall average score in mathematics of grade 11 students was 45.4 in the year 2014 and 49.2 in the year 2013 (Higher Secondary Educational Board [HSEB], 2015). Similarly, grade 12 students' mean score in mathematics was 46.5 and 47.0 in the year 2015 and 2014 respectively (HSEB, 2015). According to TU report (IOST, TU bulletin, 2015) 517 students appeared in the examination of master's in mathematics in the year 2011, where only 30.9% (N=160) passed. Likewise, in the year 2012, 522 students appeared and only15.7% (N=82) passed the examination. Achievement scores, thus, show that students are not performing well as expected by teachers, parents and educators in this subject.

Improving students’ learning mathematics is, therefore, a great concern among teachers, educators, parents and stakeholders. In order to do so, it is necessary to have a better understanding of the factors that influence the students' academic achievement in mathematics (Guardia et al., 2006). It is crucial to know the way students think and learn in order to obtain the good academic performance. In Nepal, it is generally practiced that SLC passed students with comparatively higher score want to join the science and technology streams (Budhathoki et al., 2014). Here, people undertake higher secondary level mathematics as the foundation of mathematical sciences and engineering. This importance given to mathematics, thus, stimulated the researcher to understand the factors affecting success in mathematics.

It is believed that understanding the learning styles of students and managing their learning environments increase their success (Dag & Gecer, 2009; Dunn & Dunn, 1978). Student learning styles, therefore, stand as important concept in the learning process (Caliskan & Kilinc, 2012). Learning styles form a method that enable learners to perceive, to storage, to interact, to acquire, to recall the learning contents, and to respond to the learning environments in different ways (Felder, 1988; Hall, 2008; Jahanbakhsh, 2012; James & Gardner, 1995; Keefe, 1985; Kolb, 1984; McCarthy, 1987).

Everyone has learning ability, but the rate of learning and style varies from individual to individual, which may remain as unique as a signature (Kocakoglu, 2010; Orhun, 2007). Each student plays an integral role in his/her individual learning experiences (Ma & Ma, 2014). These individual differences are important in the learning process. Psychologists refer to this trend as difference in cognitive styles, which help us in explaining how learner differs in cognitive traits like perception or information processing.

Learning generally involves reception and assimilation of new information (Kolb, 1984). Thinker and sensing students, for instance, learn on the base of logic and rules respectively (Jung, 1971). Learning is also an ongoing process that brings changes in the behavior of learner (Dunn & Griggs, 1995; Gagne, 1979). The processing and perceiving approaches of learning take place simultaneously when learners face new information or a new experience (Kolb, 1984). In processing, some learners tend to watch and reflect, while others tend to actively participate. The perceiving step, on the other, may involve gathering all possible information for the solution.

Students learn in many ways as by seeing and hearing; reflecting and acting; reasoning logically and intuitively; memorizing and visualizing; drawing analogies and building conceptual models (Felder, 1996). Learning styles are the composite of characteristics that constitute cognitive, affective, and physiological factors (Keefe, 1979). Learning styles, likewise, are the way in which each learner begins to concentrate on process, where they internalize, absorb and retain new and difficult information (Dunn, 1990).

The learning styles of an individual are not necessarily fixed. They may change over time, and may vary from one subject or learning environment to another based on experience (Orhun, 2007; Felder, 1993). In this reference, learning style signifies an expanding concept of education, which seeks to incorporate cognitive requirements as well as the learner's individual social and physical needs (Dunn & Dunn, 1978). In learning process, some students prefer peers learning rather than learning on their own; and others prefer guided learning rather than to be freely involved in learning activities.

Teaching methods also vary. For example, some teachers prefer to lecture, demonstrate or discuss; some others prioritize applications; and yet other emphasize memory. How much a student learns is dependent upon student's ability as well as the compatibility of personal learning styles and the teachers' teaching styles (Grasha, 1994; Richard, 1993). In this relation, Felder and Silverman (1988) used four dimensions of learning styles:

1) Information processing (active - reflective) based on Kolb (1984) learning styles model. It stresses that active learners tend to retain and understand information best by doing activities, applying and discussing with their peers, while reflective learners remain thinking quietly.

2) Information perceiving dimension (sensing- intuitive) based on Myers-Briggs model. It stresses that sensing learners enjoy learning facts, memorizing, and hands on work, while intuitive learners prefer discovering possibilities and relationships (Myers et al., 1998).

3) Information receiving (visual - verbal) model. This model stresses that visual learners remember best what they see, like from pictures, flow charts and demonstrations, while verbal learners learn best on written words or spoken explanations.

4) Information understanding (sequential - global) model. This model further stresses that sequential learners tend to gain understanding in linear steps, logically from the previous one, while global learners learn in large jumps without seeing connections.

It is, therefore, notable that students, who understand their own learning styles, are likely to be better learners, achieve higher scores, feel greater self- confidence, and exhibit more skills that can be applied in the mathematical problems (Felder, 1996).

Generally, the common learning styles of the students are not in accordance to the usual teaching styles of the lecturers. For instance, students become bored and inattentive in class, perform poorly in examination, get discouraged about the subject matter, and sometimes they shift the stream or drop out from the institute. Similarly, lecturers, who are confronted by low scores of students and their undesirable outcome may sometimes be criticized, where they begin to wonder if they are fit in the profession (Felder, 1993).

It is also observed that individual students' attitudes towards mathematics may affect their careers in the mathematical sciences (Peker & Mirasyedioglu, 2008). Students' tendency to select mathematics courses in college, or career in mathematics related fields, depends on their attitudes towards mathematics (Haladyna, Shaughnessy & Shaughnessy, 1983).

Academic achievement is referred to as the degree or level of success or proficiency attained in some specific area concerning scholastic and academic work (Setia, 1991). In this reference, low achievement in school mathematics education has always been a major concern so as to improve quality of education. Acknowledging it, the relationships between attitudes and achievement in mathematics have been widely studied. Most of those studies have found a positive relationship between attitude and achievement in mathematics (Ma & Kishor, 1997; Reynolds & Walberg, 1992; Saha, 2007).

According to The National Council of Teachers of Mathematics (NCTM, 2000), those who understand Mathematics will have significantly more opportunities and options for their future career. Though students’ beliefs towards mathematics are the result of personal experiences in a classroom (Fleener, 1996; Kalder & Lesik, 2011; Mcleod, 1992), it is notable that attitudes develop and change with time (Gagne, 1979; Mohamed & Waheed, 2011). In reference to it, in the Trends in International Mathematics and Science Study (Mullis et al., 2012) found that students with positive attitudes towards mathematics have higher achievement. Learning styles, attitudes and achievement, thus, are the results of the learning process, which are likely to change over time.

Attitude, a major factor to affect subject choice is also the mental and natural readiness. It doesn't stay the same but changes over time based on students' grade (Gagne, 1979). In general, students' attitudes towards mathematics are governed by their perceptions regarding the usefulness of mathematics, accompanied by the degree of confidence in their ability to learn it. Attitude, thus, is views and images that an individual develops as a result of interaction with different situation (Bennett, 2003). It is almost impossible to offer a precise definition of "attitude towards mathematics", which would be true for all situations (Kulm, 1980). Likewise, there is a lack of common definition of beliefs, whether beliefs are expressions of knowledge or opinion; whether it belongs to cognitive or to the affective domain (McLeod & McLeod, 2002). In this relation, the researcher has decided to redefine the combination of these attitudes and beliefs as views. The views in this study, thus, consists the subscales of value, enjoyment, self-confidence, motivation and belief.

The conceptions, attitudes and expectations of the students regarding mathematics and its learning are considered as significant factors on achievement in mathematics (Borasi & Rose, 1989). As such, it is important to understand how students perceive mathematics, and what variables influence their learning. Students' learning styles and their views towards mathematics come together as factors affecting the learning outcomes, which eventually guides academic aspiration. It emphasizes the necessity to find the strength of the bond among the learning styles, students’ views towards mathematics, and achievement in mathematics based on their academic aspiration and gender.

Statement of the Problem

Throughout the researcher's career as a mathematics teacher of different levels and positions including higher secondary schools in science stream, the researcher has observed that majority of students who hold SLC degree with first division and distinction are enrolled in science program (physics, chemistry, mathematics, biology) of higher secondary level. However, at the end of the academic session, most of their learning outcome in mathematics is not as good as expected, regardless of their higher score in earlier exams at school level. Starting from the enrollment till the end of the academic year, few of them improve; some of them retain the same position and many of them exist with low scores in mathematics. The contextual phenomena here i.e., homogeneous intake and heterogeneous outcome of students has eventually inspired the researcher to conduct this research work.

Going further in this area of study, research shows that as students move through their higher secondary and college studies learning style change significantly, where most of them lose their interest in mathematics (Geiger & Pinto, 1991; Wilkins & Ma, 2003). The researcher’s experience in teaching/learning activities in mathematics, however, have shaped his understanding that many students either loss or gain their interest in mathematics as they experience transition from school to higher levels of education. The researcher has also experienced that the student's preferential focus on the type of information varies individually. In other words, they have different ways of perceiving and understanding information related to mathematics. Students' feelings about mathematics and mathematical learning styles, thus, seemingly affect their interest in studying mathematics.

In the context of Nepal, the low performance (as mentioned above) in mathematics reflects unsatisfactory rate of return on government's and parents' investment in school education. This low learning outcome in the form of achievement at different levels may have relations to different variables. Some of the variables are already identified in various previous investigations. Still, many variables are on the way for further research.

Studies show that students' difficulties in mathematical works are directly related to inappropriate belief they possess about the nature of mathematics, mathematical tasks, and teaching techniques of their teachers (Schoenfeld, 1992). These believes have a strong impact on students' problem solving manner and their approach to learning mathematics (Schoenfeld, 1992). Students' belief about the nature of knowledge, learning styles, and motivational orientation affect their academic achievement in mathematics (Hofer, 1999).

In this reference, present study was an endeavor to understand the relationship among the students' learning styles and students' views about mathematics subject, and learning activities in mathematics achievement based on gender and academic career aspiration plan. The results of this investigation expected insights into the findings of low performance at the higher secondary level, mainly in mathematics, and therefore, the study was to contribute to the enhancement of quality of higher secondary school level mathematics education.

The problem of low achievement in mathematics can be addressed in case affecting variables and their impact on the student' achievement in this subject are identified. Therefore, overall, the present study investigated whether learning styles and students' views affect the higher secondary school students' learning outcomes in mathematics over the time. The implication of findings of this study would help for improvement of mathematics education of higher secondary students.

Rationale of the Study

Mathematical knowledge is important not only as a subject of study. The knowledge and skills in mathematics rather are equally important in the field of science and technology, engineering, navigation, astronomy, computer and other social sciences like education, business and economics. A strong mathematical background is needed for those areas of studies. However, large number of students, who successfully passed in mathematics, their level of achievement, is often found with low level of achievement. This phenomenon has been found in different researches as mentioned in previous headings.

Generally, students have particular ways of interacting and processing the information. Learning style, thus, exists based on individual differences in how students prefer to gather and absorb information; and how they process and organize such information (Felder & Silverman, 1988). It is also notable that learning style is an in-born characteristic, though it is influenced by experience and the environment (Dunn, 1990). The mathematics educators generally believe that students have higher success in mathematics if they have a positive attitude towards the subject (Tapia, 1996). Individual differences in mathematics education, however, have great importance. Such differences become particularly crucial in discipline such as mathematics.

Despite much time and efforts put by students and teachers, the outcome of these efforts is not satisfactory in Mathematics. As such, number of variables need to be studied in order to determine why these students do not perform satisfactorily in mathematics. This understanding also gives space to focus on students' thinking and understanding rather than learning in a repetitive manner (NCTM, 2000). Student difficulties, underachievement, lack of motivation and variation in attitudes are some issues that need to be explored and understood in mathematics education. Therefore, it is crucial that more studies are carried so as to understand the role of learning styles and views in mathematics. It would enable to find out why students have certain learning styles and views about mathematics, and to suggest ways to increase and maintain positive views towards mathematics. Eventually, the quality of mathematics education would increase with the help of such studies.

Mathematics teachers, mathematicians, educators, and parents want to hear their students say things like "mathematics is fun and enjoyable". In bringing this wish into practice, the role of teacher, administrator and parents is to provide each student with the right tools that motivates students to learn. The way of learning varies. For example, some learners are comfortable with theories and abstractions. Likewise, some other prefers facts and observations. Some like active learning while others are inclined towards introspection. Some like visual presentation and yet others prefer verbal description. One learning style is neither superior nor inferior but simply different with different characteristics (Felder & Brent, 2005). In this regard, providing teachers and students with information regarding students' learning styles preferences and their views about mathematics may encourage the students overcome their mathematical knowledge and skills.

Identifying students' preferred way of learning, and finding resources and activities that would make their learning easier is a challenge we face today in mathematics education. Understanding students' way of learning helps teachers to organize their lectures more effectively, which in return is beneficial to both teachers and students. Prior research in this area has identified relationship between students' attitudes towards mathematics, their learning styles, and their achievement in mathematics (Middleton et al., 2013).

In reference to this research gap, this study explored students' learning styles and their views towards mathematics and learning performance in the subject. This research, thus, contributes in adopting effective academic designs or strategies for learning and teaching mathematics among higher secondary school students in Nepal. In addition, the researcher believes that a better understanding of student learning styles and their views about mathematics within classroom context helps teachers and educators to figure out why some students perform better in certain classes with certain approaches.

In this reference, present study has some contributing factors to the practice of teaching and learning mathematics which in a way or others is the rational of the study.

First, this study is based on a theoretical background. The proposed and tested framework model is based on Felder-Silverman (1988) and Tapia (1996). It is expected that this study may contribute to the literature in general by investigating the relationships among several affective and cognitive factors in the context of mathematics education.

Second, the study utilizes the most current, widely validated, and theoretically grounded instruments, Felder-Soloman's index of learning styles (ILS) and views towards mathematics inventory, including Tapia's ATMI to assess students' learning styles and their views towards mathematics.

Third, in the current study, mathematical outcomes variable has not only included mathematics achievement test (MAT) but also students’ willingness to use mathematics in the further study in relation to gender and academic career plan.

Further, the current study is significant in terms of its contribution to the advancement of the analysis procedures of quantitative research in general terms by putting emphasis on students’ learning styles, views and outcomes in mathematics.

Objectives of the Study

The main objective of this study was to explore higher secondary level Science students' learning styles, and their views towards mathematics, focused to investigate the relationship between learning styles, views, and achievement, along with its relationship to gender and academic career aspiration.

The study addressed the following specific objectives focusing on gender and academic aspiration:

1) To explore the learning styles of the students in mathematics.
2) To explore the students’ views towards mathematics.
3) To investigate the relationship between the learning styles and views.
4) To investigate the relationship between the students’ gender and academic aspiration information and achievement in mathematics.
5) To investigate the relationship between learning styles and achievement in mathematics.
6) To investigate the relationship between students’ views towards mathematics and achievement.
7) To examine the relationships among learning styles, views and achievement in mathematics.

Research Questions

The main purpose of this study was to describe and analyze the mathematics learning activities associated with the students' achievement in mathematics at the higher secondary schools in Nepal. Furthermore, the study was carried out with the aim to determine whether or not there was a relation among the students' views of mathematics, their learning styles and achievement in mathematics at higher secondary schools. The collection of information concerning the styles and views about mathematics is a crucial step to address the learning outcomes in mathematics at higher secondary level.

In this concern, present study was to gain insight into how differences in students' views towards mathematics and learning styles relate to learning outcomes in higher secondary mathematics. The main research question, thus, was to investigate the effect of higher secondary school science students' learning styles, their views towards mathematics and mathematics learning, and their achievement in mathematics, based on gender and academic aspiration (continuing mathematics or discontinuing in succeeding grade). In this study, the researcher intended to seek answers to the following research questions:

1. What are the learning styles of higher secondary school students at the beginning and at the end of the academic year?
2. What are the students' views on mathematics and mathematics learning at the beginning and at the end of the academic year?
3. Does relationship exist between learning styles and views towards mathematics?
4. What is the achievement of students in mathematics by gender and academic aspiration?

5. Is there any relationship between the learning styles and mathematics achievement?
6. Is there any relationship between views and mathematics achievement?
7. What type of association exists among the students' learning styles, views, and mathematics achievement?

The Hypotheses

The hypotheses related to the research questions at the 0.05 level of significant are as follows:

Ho: 1 There is no significant difference between beginning learning styles and end learning styles of grade eleven science students.

Ho: 1a There is no significant relationship in the learning styles between beginning and end of students by gender.

Ho: 1b There is no significant relationship in the learning styles between beginning and end of students by academic aspiration.

Ho: 2 There is no significant difference in the students' views towards mathematics with subscale components between beginning and end of grade eleven science students.

Ho: 2a There is no significant difference in the views between beginning and end of students by gender.

Ho: 2b There is no significant difference in the views between beginning and end of students by academic aspiration.

Ho: 3 There is no significant relationship between different dimensions of learning styles and views towards mathematics.

Ho: 4 There is no significant difference on achievement in mathematics of grade eleven science students by

a. gender b. academic aspiration c. gender and academic aspiration

Ho: 5 There is no significant difference of students' achievement in mathematics with different changed/unchanged status of learning styles.

Ho: 5a There is no significant relationship among the students' achievement in mathematics, their gender and changed/unchanged status of learning styles.

Ho: 5b There is no significant relationship among the students' achievement in mathematics, academic aspirations and changed/unchanged status of learning styles.

Ho: 6 There is no significant difference of students' achievement in mathematics with different status of views towards mathematics.

Ho: 6a There is no significant relationship among the students' achievement in mathematics, change status of views and gender.

Ho: 6b There is no significant relationship among the students' achievement in mathematics, change status of views and academic aspiration

Ho: 7 There is no significant effect of students changed/unchanged status of both learning styles and views on achievement in mathematics.

Operational Definitions of Key Terms

Learning Style

The ways in which an individual characteristically acquires, retains, and recalls information are collectively termed the individual’s learning style (Felder & Henrique, 1995).

Learning Styles Dimensions

The Processing information (active-reflective), perceiving information (sensing-intuitive), receiving information (visual-verbal) and understanding information (sequential-global) are learning styles dimensions in Felder and Silverman's learning style model (Felder & Silverman, 1988).

Learning Styles Changed/Unchanged Status

Students' learning style preference either remains in the same domain (unchanged) or shifted (changed) from beginning of the academic session to the end in the same academic year. For example, active to active; active to reflective; reflective to reflective; reflective to active

Views

The functional meaning of views in this study is defined as students’ attitudes (value of mathematics, enjoyment of mathematics, self confidence in mathematics, motivation with mathematics, and belief on the learning/teaching mathematics) towards mathematics.

Views Status

Negative - Students' views towards mathematics in decreasing direction from beginning of the academic year to the end of the academic year.

Balance- Students' views about mathematics remain same from beginning to the end of academic year (unchanged).

Positive - Students’ views towards mathematics in increasing direction from beginning to the end of academic year.

Composite Views

Total views towards mathematics based on subscale (value, enjoyment, self-confidence, motivation, belief) variables (components).

Achievement

The achievement in this study is defined as an indicator of a student's performance in mathematics in terms of the scores obtained by the students in mathematics achievement test prepared by the researcher.

Beginning- Survey

Grade 11 science students initial (pre) survey of learning styles and views towards mathematics at the beginning of the academic year of students' enrollment.

End- Survey

Grade 11 science students' final (post) survey of learning styles and views towards mathematics at the end of the academic year in which they were enrolled.

Higher Secondary Level

According to education system of Nepal, Higher Secondary Level is the academic program between School Leaving Certificate (SLC) and Bachelor's Degree. This program is affiliated with Higher Secondary Education Board (HSEB), Nepal. There is changes in this system after the 8^{th} amendment of Education Act 2071 in 2016.

Demographics

This term incorporates variables like student's gender (male and female) and, academic aspiration career plan (academic group).

Academic Aspiration Career Plan

The variable related to the students' academic career choices for studying science in the succeeding grade:

Physical group- These mathematical sciences students are those who continuing mathematics without biology in grade twelve.

Biology with mathematics group- These indecisive (undecided) students are those who study biology with additional mathematics in grade twelve.

Biological group- These pure biology (non- mathematical sciences) students are those, who study biology without mathematics in grade twelve. These students are terminating mathematics related field in succeeding levels.

Science Students

Those higher secondary level students who undertake physics, chemistry, mathematics and biology/computer at grade eleven and physics, chemistry, mathematics or biology or biology with mathematics at grade twelve under HSEB are science students.

Delimitations of the Study

Due to the limitation of time and resources, this study was delimited to the following aspects:

1. Only the private sector (institutional) higher secondary schools from Kathmandu Metropolitan City (KMC) were considered as population for the study.

2. Only two institutional higher secondary schools, which were running science program, were included. The basic criteria of admission in these institutions included distinction or first division in SLC examination.
3. The present study was delimited to the sample of 247 higher secondary level grade eleven science students, who completed SLC examination either in first division or in distinction from KMC in the academic year 2012/13, enrolled in science program.
4. There are numbers of identified learning styles, but in the present study, only Felder-Silverman learning styles model were considered.
5. To measure the grade eleven science students' learning styles, Felder-Soloman's Index of Learning Styles (ILS) was used.
6. To measure the students’ views towards mathematics, the students' views towards mathematics inventory (VTMI) based on Attitude towards Mathematics (ATM) by Tapia 1996, and the belief towards learning mathematics as developed by researcher were considered.
7. To measure the Mathematics Achievement Test (MAT), MAT as prepared by researcher was used as a research tool.

There were certain reasons for above delimitation. The first one was that the study was basically focused on studying the mean differences. Secondly, it was feasible for the researcher to conduct study in these two higher secondary schools as they were accessible. Thirdly, the financial constraints would not allow the researcher to include all higher secondary schools from KMC. Fourthly, the study was delimited to only grade eleven science students excluding non-science students from other disciplines.

CHAPTER II

REVIEW OF LITERATURES

This chapter reviews the mathematical learning theories, the learning styles models, and students' attitudes and beliefs towards mathematics, in relation to its learning process. Students' demographic information and students' academic achievement studies have also been reviewed. Based on it, the conceptual framework has been primarily sketched so as to link established literature and methodology along with research problem and research questions of this study. Mainly, the chapter is organized into four sections. The first section deals with theoretical and thematic review, second section deals with empirical review, third section discusses on research gap, and fourth section discusses the conceptual model.

Theoretical and Thematic Review on Mathematics Learning

Learning is one of the most important mental functions of human and animal's cognitive system. It leads to the development of new capacities, skills, values, understandings and preferences. It aims to increase individual's experience. Learning is a complex and dynamic process. Learning challenges and empowers individual learner. Each learner approaches learning in different ways. One may define learning as a change in behavior as a result of experience or practice. Some other may hold it as knowledge gained through study. Likewise, yet some other may acknowledge it as a process by which behavior is changed, shaped or controlled. Simply, learning is the individual process of constructing, understanding based on experience from different sources (Pritchard, 2009). Learning is the activity or process of gaining knowledge or skill by studying, practicing, being taught, or experiencing something.

Learning is an individual phenomenon. Learners are expected to take the responsibility for their own learning. The new technology and advancement of information call for students to become lifelong learner. Nevertheless, it is essential that individual student engage in classroom learning (Duncan, 2012).

The cognitive, affective, and psychomotor are the learning domain (Bloom, 1956). In cognitive domain there are six levels moving from simple to complex and from abstract to mental level. Feeling and emotion is affective domain. Psychomotor domain includes physical movement, coordination, and use of the motor-skill areas (Simpson, 1971). Accordingly, Gardner identifies nine intelligences i.e., logical-mathematical, linguistic, bodily-kinesthetic, musical, naturalist, interpersonal, intra-personal, spatial, and existential. An individual may excel in one, two, or three of these but nobody can master them all (Clinchy, 1984).

Grouws (1992) holds that there is no exact definition of learning; how learning takes place; and what components are responsible for learning. Some say that learning is observable changes in behavior, and other say that it is acquiring the new knowledge. According to Thorndike, learning is automatically occurring incremental phenomenon that is associated with use and disuse. More often used information becomes stronger and other goes weaker (Thorndike, 1922).

Mathematical Learning Theories

The research on the brain, its physiology and functional development are closely related to cognitive theory. Processing information is part of brain function (Clinchy, 1984). According to Bruner, learning can be studied independently of the environment and that it takes place within the individual. Learning is an active process in which students develop new ideas based upon their past knowledge. In the learning process, students select and transforms information, formulate hypothesis, and take decisions. As far as instruction is concerned, teacher makes student willing and able to learn (Bruner, 1986, 1990, 1996). In an ecological model, on the other, (Huitt, 2003) focused interaction of the individual with the environment. Likewise, Dewey's theory of learning focused on an individual value of personal experiences along with environmental factors as important in learning (Dewey,1998).

Jean Piaget Theory

The developmental constructivism theorist Jean Piaget pointed out that every normal student is capable of good mathematical reasoning if care and attention is directed to activities of his/her interest. Students' emotional feeling of inferiority in mathematical lessons can be removed by this method. Jean Piaget, a biologist and philosopher was primarily interested to know the development of knowledge in human being. He believed that the cognitive structure and pattern of physical or mental action change through the process of adaptation, assimilation and accommodation. Cognitive development consists of a constant effort to adapt to the environment in terms of assimilation and accommodation. Cognitive development is facilitated by providing activities or situation that engages students. In Piaget theory, mental adaptation is a result how an individual interacts with the environment to gain knowledge.

Two main stages of development are adaptation and cognitive developmental stages. In the adaptive process, the assimilation and accommodation can be accomplished, while cognitive development happens in sequential stages. In assimilation, the learner absorbs new information from the environment into internal cognitive structure. Likewise, in accommodation, the learner modifies internal cognitive structure to conform new information to meet the demands of environments. In these stages, physical, logical-mathematical and social knowledge exists. Learning materials and activities involve the appropriate level of motor or mental operations for a child (Gallagher & Reid, 1981; Piaget, 1970). In this relation, Piaget pointed out that the role of the teacher is that of facilitator and organizer, who creates situation and activities that present a problem to the student. He argued that a student who achieves certain knowledge through free investigation and spontaneous effort will later be able to retain it (Piaget, 1970). In reference to this, a constructivist point of view implies that knowledge is continuously created and reconstructed (Peterson & Knapp, 1993). This understanding accepts teacher's role to one of facilitator (Wadsworth, 1978).

Vygotsky's Theory of Cognitive Development

Vygotsky (1980) emphasized the critical importance of culture and social context for cognitive development. Social interaction is the basis for all learning and development in his theory. Influenced by the Piaget's cognitive theory, Ausubel, Novak, and Hanesian (1978) concluded that learners actively define their past experiences by using internal and cognitive operations. The influencing factors of learning in this regard are what the learner already knows about the subject matter. He considered direct didactic instruction as the most effective way to teach the concepts to the learner. This learning is referred as receptive learning. Processing ideas and preferences for thinking and approaching to work determine how learners learn (Harris, Sadowski, & Birchman, 2005).

Learning theory of mathematics is an attempt to describe and explain behavior in quantitative terms. According to Atkinson, learning is increasing the mean score of the whole class, decreasing the variances, and eventually, maximizing the individual performance. It is possible to develop an optimal instructional strategy for a given individual provided that a detail model of the learning process is available (Atkinson, 1972). In mathematics learning, students need much drill work and practice on right methods and facts to strengthen correct mental bonds (Thorndike, 1922).

Gagne's Theory of Instructions

The professor of Princeton and Florida State University, Gagne's (1979) work is based on intentional or purposeful learning. This learning occurs in schools and training programs. His theory identifies the general human capabilities, which are responsible for behavior changes in learner. Behavior changes confirm that the learning has occurred. Gagne's theory describes the condition under which learning takes place by referring the situation in normal life and school where learning occurs. He focused on the learning outcome of ongoing learning process that brings changes. Gagne examined five major categories of learning as- verbal (being able to state ideas), intellectual skills (having procedural knowledge), cognitive or logical reasoning (having certain technique of thinking, ways of analyzing problems and approaches to solving problems), and attitude (mental state that influence the choices of activities). Likewise, Gagne designed nine instructional events to achieve each of the five learning outcomes. These nine sequential events in order are (1) learner must be receptive, (2) there must be expectancy (informing learners of the objective), (3) there must be prior retrieval,(4) there must be selective perception and preset stimulus material, (5) there must be systematic encoding (providing guidance for the learner), (6) performance must be elicited,(7) feedback and reinforcement must be provided, (8) performance must be assed in the form of information retrieval, and (9) there must be an effort to enhance retention and transfer. All these events are the foundation for instructional design and technology selection in higher education (Gagne, Briggs, & Wagner, 1992; Harris et al., 2005). The learning types for intellectual skills can be organized in a hierarchy, ordered to complexity, based on Gange's Signal Learning, Stimulus Response Learning, Chaining learning, Verbal Association Learning, Discriminations Learning, Concept Formation Learning, Rule Application Learning, and Problem Solving Learning (Upadhayay, Upadhayay, & Luitel, 2014). The primary importance of hierarchy, in this regard, is to identify prerequisites that are to be completed to facilitate learning at each level.

Carl Jung Learning Theory

Early 1900s, Jung characterized the unique personality pattern. His important contribution is to introduce two abilities i.e., introversion and extroversion. According to Jung, different human beings use their mind in different ways. This difference creates differences in individual as well. Active mind involves in perceiving and judging activities. Information taking, perceiving, and organizing the information in mind is judging. Sensing versus intuition is opposite pole of perceiving, whereas thinking versus feeling are two opposite pole of judging. Each individual is involved in one of four functions in daily life, internally as well as externally.

Thinking and feeling are rational or logical functions, whereas sensing and intuition are related to immediate experiences. The function of thinking refers to process of cognitive thought; sensation is perception by means of physical sense organs; feeling is the function of subjective judgment or evaluation; and intuition refers to perception by way of the unconscious. Carl Jung's six abilities as discussed here are used by many psychologist, theorists and educationists in their work (Jung, 1971; Sharp, 1987). For example, Kolb's processing learning styles dimension, which is active experimentation and reflective observation, is similar to Jung's extroversion/introversion dialectics. Likewise, Myers Briggs Type indicator is fully based on Jung's work.

Bloom's Taxonomy

The mental ability of learner is divided into three heading as cognitive, affective and psychomotor (Malone, 2003). Cognitive is concerned with information and knowledge. It is the mental or intellectual thinking behaviors demonstrated by an individual. There is an order of learning at six levels i.e., knowledge, comprehension, application, analysis, synthesis and evaluation. Knowledge is acquired through the application of perception, memory, reasoning and judgment; understanding the meaning is comprehension; using the information is application; breaking down into parts is analysis; synthesis is producing a new whole; and evaluation is judging the value. An individual's emotions, attitudes, appreciations, interests, beliefs and values of some things are affective domain. Likewise, physical activities involving gross or fine motor skills such as coordination, strength, manipulation and speed fall in psychomotor domain (Bloom, 1956; Krathwohl, Bloom, & Masia, 1964).

In addition, an adjusted model of bloom’s taxonomy (1956) cognitive domain was developed by Anderson and Krathwhol (2001) in which the levels five and six (synthesis & evaluation) merged and all the levels became verbs, recommending that mathematical learning is an active process. This is why educationists (for e.g., teachers, trainers, curriculum designers) see the different versions of this cognitive domain model, the new version is gaining wider acceptance overall. The new terms are defined as:

Remember- recognizing, recalling

Understand- interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining

Apply-executing, implementing

Analyze- differentiating, organizing, attributing

Evaluate- checking, critiquing

Create- generating, planning, and producing

In this revised version taxonomy, knowledge is at the basis of these six cognitive process.

The Concept of Learning Styles

Students have various learning styles preferences in the ways they take in and process information. Many researchers, educationists, and psychologists have defined learning styles in terms of individual experiences. Some of these ideas are discussed here. The learning styles in education suggest that instructors need to assess their students learning styles and accommodate the classroom teaching to best fit each student's learning style. Usually, students favor some particular method of interacting with, taking in, and processing information. The studies on such learning styles began in the 1970s and have gained popularity in last four decades (Cassidy, 2004).

It is the way students begin to concentrate on, process, internalize and remember new and difficult academic information. Learning styles, therefore, is unique collection of individual skills and preference that affect the students' way of perceiving, gathering, and processing information in their learning process. Learning style is an approach used by learners to concentrate on, process, internalize, and retain new and difficult information. In this regard, there are five stimuli groups such as environmental, emotional, sociological, physiological and psychological areas. These stimuli do not impact equally on all learners (Dunn & Dunn, 1989; Dunn, 1990)

Felder identified learning styles as (1) information perceive- sensory (sights, sounds and physical sensations) or intuitive (memories, ideas and insight), (2) information received- visual (pictures, diagrams, graphs and demonstrations) or verbal (sounds, written & spoken words, and formulas), (3)Process information- actively (through engagement in physical activity and discussion) or reflective (through introspection), and (4) understanding progress- Sequentially (in a logical progression of small incremental steps) or globally (in large jumps, absorbing materials randomly) (Felder, 1988).

The National Association for Secondary School Principals (NASSP) task force define learning styles as “the composite of characteristics cognitive, affective, and physiological factors that serves as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment” (Keefe, 1985, 1987).

In this reference, the terms learning style and cognitive style are frequently used interchangeably. Cognitive style is an individual’s typical or habitual mode of problem solving, thinking, perceiving and remembering, whereas the term learning style is adopted as the application of cognitive style in learning situation (Riding & Cheema, 1991).

According to Smith, learners learn in different ways and no two learners learn in exactly the same way. Some learn best by seeing, some learn by hearing and others by touching. Knowing preferred learning styles, it helps learner to learn and remember new information. When learners learn, they perceive and think. They also interact with resources, methods and environments. The tendencies and preferences that get from their personal experience bring about their own learning style (Smith, 2012; Maclsaac et al., 2004).

Students have different learning styles features and preferences in the ways they take in and process information. Some students tend to focus on facts, data and algorithms. Others are more comfortable with theories and mathematical models. Some respond strongly to visual forms of information like pictures, diagrams and charts and others get more from verbal form like written and spoken explanation.

Some prefer to learn actively and interactively, and others introspectively and individually (Felder, 1996).

According to Kolb the learner requires abilities as concrete experience verses abstract conceptualization, and active experimentation verses reflective observation. However, many learners develop learning styles that emphasize certain learning abilities over others, which are the result of hereditary, past experiences and the demands of present environments.

Learning styles serve as relatively stable indicators of how students perceive, interact with and, respond within the environment. Also, it describes the particular set of cognitive, affective, and psychological behaviors of learners (Felder, 2010; Keefe, 1979). Conceptually, learning styles explain the way individual absorbs, processes, and retain information. Learning styles, thus, help to support on the idea that student learn in different ways. Learning style theorists suggest that educators and teachers who are aware of their students' learning styles are in a better position to broaden the opportunities for effective learning (De Bello, 1990).

From these ideas on learning styles we can reveal that

i. Learning styles are simply different approaches or ways of learning and making meaning of information.
ii. Individual characteristics influence to learning and studying
iii. Learning styles refer to learners' preferences for some kinds of learning activities over others.
iv. Students who understand their own learning style are likely to be better learners, achieve higher scores, positive towards the subject matter, feel greater self-confidence and exhibit more skills in applying their knowledge in courses.

v. Learning style refers to preferred mode of problem solving, thinking or learning used by an individual.

The concept of learning style, as such, is based in the classification of psychological types. Different learners have different tendency to perceive and process information. Thus, the information processing, perceptual modalities and personality factors are determinants of the learning styles.

Information Processing

Perceiving, organizing, and recalling the information is information processing characteristics. Each individual is unique in terms of sensing, thinking, and retaining information as well as way of solving the problems. Information processing relies on sensation. The way of sensing leads an individual to perceive the source of information. Absence of organization of the information received by senses is incomplete perception. Each individual organizes the information, and remember it when it is needed. Everybody perceives a particular thing, event, or situation, based on the individual life experiences.

Perceptual Modalities

These modalities are based on biological characteristic. In this modality, receiving knowledge and information are related to sensory organs. Visual, auditory, tactile and kinesthetic are perceptual mechanisms. For example, visual learners have their strength in visual description. These learners prefer demonstration for better learning. They feel comfortable in pictorial presentation. Here, teachers need to arrange the seats for better learning. Auditory learners like verbal description since they are good in hearing the lecture and attending the discussions. For them, provision of minimum noises can achieve better learning. The tactile learners, on the other, like to note taking and sketching during the lecture. They do well while providing hands on learning like projects, demonstrations and laboratories work. Similarly, the kinesthetic learners often do best when they involve in solving the problem. These energetic learners want to keep busy while learning. They learn well in excursion and project rather than visual or auditory.

Personality Factors

Personality factors are found different in values, emotions and other aspects of individual. These aspects lead personality patterns. These differences are very much important as they help to estimate the reaction of the person in different situation.

Theories and Models of Learning Styles

There are more than seventy models of learning style (Aina-popoola & Hendricks, 2014). These various models and theories focus on different dimensions and characteristics of learning styles. Learning styles theorists stresses on cognitive processes, personality description, learning processes, and thinking styles of students. Learning styles theories and models are primarily referred to different styles of students, which learners use for the purpose of knowledge gain. These theories and models describe the learning approaches of individual student in different subject and topics. According to (Martini, 1986) there are number of interrelated functions and mutually supportive concepts among different learning theories. Here are some theories and models, which are considered as the most frequently used theories in education research.

1. Curry learning styles model
2. Dunn and Dunn learning style theory
3. Kolb learning style theory
4. VAK/VARK theory
5. Honey and Mumford learning styles

6. The Myer-Briggs Type Indicator
7. Hermon Brain Dominance
8. Canfield Learning styles
9. The Grasha- Riechmann Student Learning Style scales
10. Felder-Silverman Learning Style Model

Curry Learning Styles

Curry defines learning styles as each individual's consistency in perception, thinking, memory and judgment across the conditions. In this model, human learning styles are categorized into three levels. Metaphorically, the cognitive personality factor is the inner layer, information processing style is the middle layer, and instructional format preference is the outer layer of onion (Curry, 1983). In the cognitive personality, the individuals approach to adapting and assimilating information. The intellectual procedure used by individuals in information assimilating is the middle layer, and individuals' preferences of learning environment and activities is the outermost layer.

Dun and Dun Learning Styles

They describe a number of elements that make up a person's learning style. These include environmental elements such as sound, light and temperature; sociological elements such as being peer orientated, team orientated, self-orientated and authority oriented; and the emotional elements which include motivation, persistence, responsibility and structure. In keeping with the elements described above, learners may be classified as auditory learners, visual learners, tactile-kinesthetic learners and analytical or global learners (Dunn & Dunn, 1989; Dunn, 1990).

Kolb's Learning Styles

For Kolb, the four dimensions of learning are: concentrate experience, reflective observation, abstract conceptualization and active experimentation. Based on these, four basic learning style preferences arise as convergent, divergent, assimilation, and accommodation. The component of concrete experience and reflective observation is divergent; the component of abstract conceptualization and reflective observation is assimilator; the component of abstract conceptualization and active experimentation is convergent; and the component of concrete experience and active experimentation is accommodator that defines the learning style. Kolb explains that the environment has an impact on the learner. The environment affects how the learner perceives and processes information. The elements found in Kolb's experiential learning model (Aina-popoola & Hendricks, 2014; Kolb, 1984) are-

Divergent- this type of learners has imaginative ability. They respond to explanation on how the subject matter relates to their experience, interest, and future careers.

Assimilator- This type learner use inductive reasoning and have the ability to create theoretical models.

Convergent- this type of learner has practical application of ideas. These learners excel in a situation where they select a single correct answer to the problem.

Accommodator- this type of learners adapt to new situation easily. They prefer trial and error approach in solving problems. These active learners rely on circumstances information.

Kolb (1984) pointed various subject majors to be associated with these various categories because learning style preferences differed based on under-graduate major. In his analysis, he concluded that student with business majors are accommodators, social sciences are divergent, engineers are convergent, and science and mathematics major are assimilators. These are the approaches, which are not to be taken as exclusive being.

VARK Learning Styles

Fleming's VARK (V-visual; A-aural; R-read and write; K-kinesthetic) and VAK (V-visual, A-auditory, K-kinesthetic) model was designed to help students and other learners to learn more about their own individual learning preferences. Fleming indicated that students learn in different ways. Visual learners prefer graphics, movies, and diagrams while aural learners desire music, discussion, listening lecture, reading and writing. Reading and writing learners learn better from taking notes, reading textbooks and handouts. However, kinesthetic learners desire movements, experiments, hands on activities (Aina-popoola & Hendricks, 2014; Fleming, 2009).

Honey and Mumford Learning Styles

Honey and Mumford's (1992) learning styles instrument is used for identifying the students' learning styles. Like Kolb's inventory they are categorized into four domains. These four domains are activist, reflector, theorist, and pragmatist corresponding with experiencing, reflecting, generalizing, and testing phase of the learning cycle. Learning style may vary according to the situation. Some learners may have one or more stages. This model is behavior model of learning, which focuses on behavioral element, where Kolb's model is information processing model.

In learning situation, Activist- student likes to experience being involved in discussion, project work, team work and problem based learning. These types of learners are creative and extrovert. They feel difficult in passive learning like listening lecture, repetition work and taking concept notes.

Reflector-students are detail oriented, observant, and planer, who evaluates from different perspectives before initiating any action. They find difficulties with inadequate information, time pressure, thinking on their feet, and extrovert activities.

Theorist-students, on the other, adopt a logical, systematic, and analytical approach to problem solving process. They prefer structured and clear purpose; listening to or reading about, and well argued. They like to use their knowledge in complex situation. They are comfortable in questioning and probe assumptions. They find difficult with the situation emphasizing emotions and feelings, and to work together with others with different learning styles. They also find difficulty in open end problems and uncertain situations.

Pragmatist-students, likewise, prefer links between theory and practice. They are comfortable in skills and techniques with practical advantage. They like time management, and prefer to work with credible experts through demonstrations. They prefer working with real problems, realistic case studies, and action plan. They find difficult in chalk and talk, lack of guide lines, discussions without any clear end point, ideas distant from reality, and concepts not in practice.

The Myers- Briggs Type Indicator (MBTI)

The Myer-Briggs Type Indicator popularly known as MBTI is derived from Carl Jung's theory. Jung gave the concept of extraversion/introversion in his theory. Carl Jung's concept is further developed to MBTI as sensing/intuition, thinking/feeling, and judging/perceptive. These dimensions of learning styles measure preferences in how people perceive the world and make decisions. This learning style helps people to understand and appreciate the value and challenges of working and interacting with different personality type.

Extraverted vs introverted: Extravert- students are energized by others. This type of students prefers talking with people and take action. These social persons have ideas and abstract concepts. They can work for a long time without being distracted. However, introvert students energize themselves without interacting with other people. They prefer to work in quite place and they think before they act. For these learners, the impression without expression is worthless.

Sensing vs intuition: Sensing students rely on five senses. They learn through facts and procedures. They are practical detail oriented, realistic, very concrete, and remember the facts. Intuitive learners, on the other, use imagination rather than senses to determine value of information. They focus on meanings and possibilities.

Thinking vs Feeling: Thinkers prefer to take decisions based on logic and rules. They think through and predict the logical consequences of choices. They think in terms of cause and effect. They analyze the information. Their major value is objectivity and fairness in decision making. Feelers like to take decisions based on values and relationships, and do not use logic unnecessarily. These sympathetic people are emotional and humanistic.

Judging vs Perceptive: Judgers set and follow agenda, and planned events, who seek closure even with incomplete data. Perceptive learners, however, can easily be adapted. They are more flexible rather than controlled. They start many task at once but are not capable enough to complete any of them within due time. For them, incomplete tasks and deadlines do not matter (Myers, McCaulley, Quenk, & Hammer, 1998).

Herrmann Brain Dominance Theory

The whole brain concept was developed by Ned Herrmann in 1970s. Herrmann (1991) found the duality of mathematics and science in relation to music and art. He found out that learners learn towards opposing styles of thinking and processing information, and chose the career as a result. Herrmann divided the whole brain functions into four distinct quadrants. Each individual has one or more dominating quadrants. The stronger preference in one quadrant exhibits uncomfortable in thinking and using other quadrants. Each learner has some capabilities in each of the four quadrants and uses them to perform different functions. By understanding our own particular preferences, we can gain powerful insights into why we do the things and why others don't always do what we expect (Herrmann, 1995). According to Herrmann (1991), the four metaphorical quadrants are: A-logical, B-organized, C-interpersonal, and D- imaginative.

Quadrant- A: Thinking of students of this quadrant is analytical, quantitative, factual, logical, rational and critical. This part of the brain is concerned with data analysis, analytical problem solving, and decision making based on facts and reasoning. These types of thinkers are goal oriented. Engineers, computer scientists, lawyers, are strong quadrant A learners.

Quadrant-B: This type of learners are organized, and well planned. These students tend to be step by step method oriented. They are persistent, and disciplined. These students learn by outlining, checklists, taking comprehensive notes, reading instructions, and finding practical knowledge in use. Planers, administrators, and different engineers are of this quadrant.

Quadrant-C: These types of students are innovators, brainstorming, and synthesizer. They prefer holistic approach of problem solving. These sensory and kinesthetic learners have good communication skills and keep good reputation in the society. Teachers, social workers, trainers, nurses have strong quadrant -C preferences. These students are good listeners, enjoy practical works and are respectful in others view.

Quadrant -D: These visual students are humanitarians who prefer group discussion. They are visual, imaginative, spatial, flexible, and intuitive. These learners deal with possibilities, innovations, strategic planning. Research scientists involved in medicine, physics, engineering as well as entrepreneurs, artists have strong quadrant -D preferences (Harris et al., 2005; Lee, 2009)

Canfield Learning Styles

Canfield (1992), an industrial psychologist developed the learning styles inventory scale including four areas like conditions of learning, content, mode, and expectation.

Condition of learning- This type of students need to develop the personal relationships with other students and teachers. They prefer organized and detail content of study. They want to set the objectives and procedures based on their own feedback. These students need to compare their work with others. They enjoy mutual understanding with their teacher. They desire specific information about assignments, rules, and requirements. They like to work independently and determine own study plan. They also like disciplined classroom and well versed instruction.

Areas of Interest- They need to work with numbers and logic, and like to work with words and language. They prefer working in building construction, designing, and equipment operating. They like interviewing, counseling, selling, and helping.

Mode of learning- They prefer listening lecturer, audio, or speeches. They like to read books, articles, and periodical information. They like to interpret diagrams, movies, and laboratory classes (Canfield, 1992; Mohamed & Waheed, 2011).

Grasha-Reichmann Learning Styles

This social interaction learning model was founded by Grasha and Reichmann in 1974. This learning style model defines the personal quality of the student to acquire information, to interact with peers and teachers and to participate in learning experiences. The main aim of this model is to find out the preferences that students have for discussion with the teacher and their classmate. There are six learning styles domain in this model. These six domains are- independent, dependent, competitive, collaborative, avoidant, and participant.

According to Grasha (2002), independent students prefer to work alone and independently with the little guidance of the teachers. They like the assignment that allows them to express their own ideas. They often believe that their ideas are as good as the teacher, and like to study the topics of their interest rather than the one recommended by the teacher and others. Independent students are confident about their ability to learn themselves.

Dependent- students become frustrated when facing new challenges. They prefer specific instructions for assignment with as little ambiguity as possible. They depend on teachers to know what is important for them to learn. They do only the work required in the class, take notes, and do the assigned work as instructed.

Competitive- students are described as doubtful of their peers leading to competition for academic success and recognition. They are motivated to learn so as to outperform their peers. They tend to be group leaders and want to be the first to solve the problem and try to draw the teacher's attention. They are also interested to know how others do the assignment.

Collaborative-students enjoy working harmoniously with their peers in small groups, having discussions, and completing the group work. They feel they can learn by sharing their ideas with peers. They enjoy helping to the classmate with course materials, and study for test with other students. They feel like part of the team.

Avoidant-students tent to have high absenteeism, not enthusiastic about learning materials. They are frequently overwhelmed by class assignment and are not interested in the subject. In their presence in the class, they socialize with peers nearby. They are daydreamer, and study just before the exam. They do not participate in the class activities, and give up anything in the course.

Participative-students are characterized as willing to accept responsibility for self-learning. They are good contributors to the course. They enjoy class activities, discussing with peers and teachers, and completing the assignments. They like to complete all assignments, even additional ones. They prefer teacher who are excellent at analyzing information (Grasha, 2002).

The Felder- Silverman Learning Styles

This learning styles model was developed by Richard Felder and Linda Silverman in 1988. Likewise, Index of Learning Styles (ILS) was developed in 1991 by Felder and Soloman. Felder and Silverman recognized that other theorists have influenced the development of their learning style model. This model combines some of the dimensions based on Jung's theory of psychological type like sensing /intuitive, which is presented in Myers-Briggs Type model. It also involves information processing closely related to concrete experience and abstract conceptualization dimension from Kolb's model like active/reflective (Felder & Spurlin, 2005). Initially, Felder-Silverman constructed this five dimensions model mainly for two reasons: First, to capture the most important learning style differences among engineering students, and second, to provide good foundations for engineering instructors to design a teaching approach that would address the learning needs of all students (Felder & Spurlin, 2005). Initially, they developed five dimensions as information perception (sensing/intuitive), input (visual/auditory), organization (inductive/deductive), process (active/reflective), and understanding (sequential/global). Later they revised it as four dimensions learning styles model removing inductive/deductive and modifying auditory to verbal in previous ones (Felder & Soloman, 2001).

According to International Center for Educators' Learning Styles (ICEL, 2014; Felder & Silverman, 1988) the Felder-Silverman model classifies students' learning preferences into following four learning styles dimensions: information processing (active-reflective); information perceiving (sensing-intuitive); information receiving (visual-verbal); and information understanding (sequential-global).

The active/reflective dimension is related to student's information processing, which transforms it into knowledge. Likewise, the sensing/intuitive dimension distinguishes how each individual student perceives information. The visual/verbal dimension is related to input information. The fourth sequential/global dimension is associated with the information understanding (Felder & Silverman, 1988; Felder & Brent, 2005; Felder & Spurlin, 2005). According to Felder and Spurlin (2005), each of the above dimensions is similar to dimensions of the other learning style models although combination is unique in this Felder-Silverman learning styles model. The Felder-Silverman learning styles model, and students’ characteristics associated with each dimensions are discussed below:

Active and Reflective- Active students understand new information through engagement in physical activity, trying things out, discussing and explaining it to others. They enjoy working in groups and feel hard to learn through lectures. However, reflective students understand new information by examining and manipulating it. They think before they try. They prefer working alone or with one or two close partners. They learn best when provided opportunities to think about the information being presented.

Sensing and Intuitive- Sensing students like to learn new information by their senses. They prefer learning facts, solving problems by standard procedures. They are practical, careful and have patience with details. They prefer data, observation, and hands-on work as well as good in memorizing the facts and experimental work. However, intuitive students learn new information by discovering possibilities and relationships. They prefer translating the words into symbols. They enjoy innovation and grapes new and complicated concepts easily. They are comfortable with abstractions.

Visual and Verbal- Visual students are comfortable with pictures, maps, charts, films visual descriptions, and demonstrations. These types of learners need visual explanation for complex phenomena. They are good observers and stand in opposition of verbal explanations like lectures. They do not learn well in the absence of visual descriptions. In contrast, verbal students prefer written and spoken explanation, oral instructions, and enjoy learning mathematical formula. They are quite comfortable with lengthy lecture and discussions without feeling monotonous. Their sense of hearing gives them good result in exam.

Sequential and Global- Sequential students tend to learn through step by step process. They understand the issues in linear pattern. They follow logical stepwise paths in solving the problems, and their answers are orderly and easy to understand. Nevertheless, big pictures and its interrelationships with interdisciplinary subjects are not in favor of these students. They like materials presented in a steady progression. However, the global learners are synthesizers and thinkers. They are comfortable in systems oriented pattern. They can link the connections based on their holistic perspectives. They learn randomly, where the whole is much greater than its constitute parts. They can solve even complex problems very fast as they focus to the conclusion rather than too many details. They make intuitive leaps and they may be unable to explain how they got the solution. Global students enjoy jumping directly to complex and difficult subject maters (Felder & Brent, 2005; Felder & Silverman, 1988; ICEL, 2014).

Graf et al. (2007) compared the Felder-Silver learning style model with other learning styles models, such as Kolb (1984) and Honey and Mumford (1982) and concluded that the Felder-Silverman model seems to be more appropriate for the use in educational system. Felder and Spurlin (2005) call attention to the proper use and understanding of learning styles models and instruments as:

- learning style dimensions are continuous;
- learning style profiles suggest behavioral tendencies rather than being perfect predictors of behavior;
- learning style preferences are not reliable indicators of learning strengths and weaknesses;
- learning style preferences can be affected by a student’s educational experiences; and
- the point of identifying learning styles is not to label individual students and modify instruction to fit their labels

Felder –Soloman’s Index of Learning Styles

Richard Felder and Barbara Soloman constructed the index of learning styles (ILS) to understand the individual student's preferences of the learning styles dimensions (active-reflective, sensing-intuitive, visual-verbal, and sequential-global) based on Felder-Silver learning styles model. This questionnaire combines personality, learning modality, and cognitive processing of learning styles (Boyd, Murphrey, & Locke, 2004; Duncan, 2012).

The index of learning styles is well investigated and frequently used to identify the learning styles (Duncan, 2012).The validity and reliability of index of learning styles has been established across multiple dimensions. The ILS has been designed for classroom application though useful to know the individual learning preference profile. According to Felder and Spurlin (2005), the use of ILS to assess the learning styles among the students of a class can provide support for instruction. Teachers can formulate the teaching approach that addresses the need of all students, if they know the types of learning styles of each individual in a classroom. In this reference, empirical studies using the index of learning styles concluded that the instrument is suitable and valid for international research (Felder & Brent, 2005).

The Affective Domain

Mcleod (1992) categorized the affective domain into three variables such as beliefs (beliefs about mathematics, beliefs about self as a learner of mathematics, beliefs about mathematics teaching, and belief about the social context of mathematics), attitudes (liking mathematics and enjoyment of solving mathematical problems) and emotion (joy of solving no routine problems). Beliefs play an important role in the development of attitudes and emotions about mathematics. Students' beliefs about mathematics influence the feelings they have about learning mathematics. In this regard, Schoenfeld (1992) pointed out that some commonly held belief can undermine students' problem solving performance.

The cognitive, affective, and psychomotor are the elements of affective domain (Bloom, 1956; Krathwohl et al., 1964). These three interacting fields of human behavior correspond to thinking, feeling, and acting respectively.

Attitudes and beliefs contribute to academic achievement by enhancing the motivation to achieve (Bandura, 1977). Students with the same level of intellectual capability differ in their learning outcomes as a function of their level of attitudes (Schunk, 1989). Attitudinal variables, therefore, are significant indicators of mathematics achievement. Student's interests, attitudes, values and expectancies associates with their educational outcomes as occupations (Carol, 1986)

Attitude and Beliefs towards Mathematics

Large number of studies on attitudes does not have clear definition of this term (Zan & Martino, 2007). The simple and common definition of attitude is an association of positive or negative degree with a certain subject. According to this point of view, the attitude towards mathematics is simply a positive or negative emotional disposition towards mathematics (Haladyna et al., 1983; Mcleod, 1992). Attitude describes as predisposition, or tendency of an individual to respond positively or negatively to some objects, subject, situation, concept or persons (Aiken, 1970). The multiple definition of attitude discusses emotional response, belief regarding the subject, and behavior related to the subject. Based on this view, each individual student's attitude towards mathematics is defined in the complex form as the emotions that each individual associate with mathematics by the individual's belief towards mathematics, in relation to how he or she behave (Hart, 1989). Hence, attitude towards mathematics is the pattern of beliefs and emotions associated with mathematics.

Psychologists define attitude as any strong belief or feeling or any approval or disapproval towards the people or situations. People have favorable or unfavorable attitudes towards other people or the subjects. People favor the things they think are good and helpful to them and oppose the bad things.

The attitudes towards mathematics are defined as general emotional disposition towards the subject mathematics (Haladyna et al., 1983). The positive attitude towards the mathematics is valuable because positive attitude is important school outcome, and learning outcome in term of achievement, which may increase individual student's tendency to elect mathematics courses in high schools and colleges. Attitude possibly may increase one's tendency to select careers related to mathematics and mathematics related courses.

Attitudes and Beliefs Change

Stuart and Thurlow (2000) designed the program to know the changes in beliefs of pre-service elementary school teacher's beliefs about the nature of the mathematics, and teaching learning process. Interviews, examinations, and class writing were used to data collection. The researchers found that students changed their beliefs by the end of the semester course.

Attitudes are a process that changes. When attitudes change, students often do so in response to social influence. Attitude towards mathematics from layman to the mathematician can be influenced by what other persons do or say. Sometimes attitude changes dramatically over the time period. Students who base their attitudes on a careful analysis of the arguments will be more likely to remain this attitude over period of time. However, students remain consistently with this attitude and more resistant to counter opinion than the person who base their attitude on peripheral cues. In a study, for example, people changed their attitudes either by analyzing the peripheral clues or by using the logic of the arguments (Aronson, Wilson, & Akert, 2005).

Student's Attitudes, Beliefs and Achievement

Student's beliefs and attitudes towards the academic subject play a vital role in learning and achievement in that subject. Students' beliefs about mathematics and mathematics learning can have significant impact on their interest in mathematics, their enjoyment of mathematics, and their motivation in mathematics classes (Kloosterman, 2002). Whether a student perceives as strong or weak in a specific subject may be an important factor in their academic achievement. Students develop ideas, feelings, and attitudes towards the academic subject like mathematics over time, and from different sources (Kiamanesh, 2001). Students' beliefs and attitude towards the mathematics teaching and learning play an important role. The learning achievements of students are strongly related to their attitudes and beliefs (Mcleod, 1992; Schoenfeld, 1992). Students' attitudes towards mathematics have positive or negative effect on their learning. Students' feeling, thus, is the crucial factor behind his/her success or failure within the subject. Students may develop either positive or negative attitudes towards mathematics during their educational experiences.

According to Cornell, it is particularly important to foster positive attitudes in mathematics because positive attitudes can allow students to engage in mathematics products (Cornell, 1999). The knowledge of the formation of attitude provides valuable information about the factor contributing to the development of both positive and negative feelings.

Students' beliefs and attitudes towards mathematics affect how the students approach mathematics. If students believe that mathematics is useless and difficult subject then the motivation to spend the time practicing mathematics decline. Belief towards mathematics can also influence confidence, which consequently affect the learning outcome in mathematics in terms of achievement. Hence, the common assumption is that there is relationship between attitude and achievement (Kloosterman, Cougan, & Cougan, 1994).

Empirical Review

This part of literatures review discusses the relationships among the attitudes, beliefs, learning styles, students' demographic and achievement in mathematics.

Studies on Attitudes, Beliefs and Achievement

Kalder and Lesik (2011) investigated the attitudes and beliefs towards the mathematics of secondary pre-service mathematics teachers. The research identified the pre-service teacher with the most positive attitudes and beliefs. The measures regarding confidence, enjoyment, motivation, and beliefs of mathematics lead to conclusion that it is important for teachers of all levels of mathematics to exhibit the positive attitudes and beliefs in order to develop the positive attitude and beliefs to their students towards mathematics. Such attitude is referred to as the affective components, though McLeod acknowledged attitude as one category of the affective domain.

In identifying relation between teachers’ attitude and students’ performance, a study was carried, using attitudes towards mathematics inventory (ATMI) by Tapia and Marsh (2004) based on Fennema-Sherman Attitude Scales (1976), eliminating some questions, which were administered among 293 pre-service teachers (some college students) from northeast United States. The elementary school level teachers were found to hold great impact on the students' attitudes. However, by the time they entered the secondary/higher secondary schools, student’s attitude towards the subject was already ingrained. It also indicated that the secondary students with major mathematics had positive attitudes.

Carter and Norwood (1997) conducted similar study on seven teachers and 158 students. The study reported that the beliefs that teacher hold can also influence their students' beliefs. Researchers found that students of teachers with beliefs that were in the line of the NCTM (2000) standards had significantly different beliefs that lead to success than other students.

Students' attitudes have been linked to achievement (Ma, 1997). However, the nature of the relationship between attitudes and achievement is continuous to be chicken or egg first debate. Attitude and achievement studies in the western countries found that the positive attitude is linked with achievement. However, in Asia or the place where Asian students were participated in the study found that positive attitudes were not always present in students with high achievement scores (Leung, 2002; Ma & Kishor, 1997).

Kottke (2000) found attitudes about mathematics and statistics course and application to chosen academic field of study to be positively correlated with statistical competency and course grades among upper level college students. However, Ma (2003) found that students' attitudes towards mathematics became increasingly more negative during middle school and with the most significant changes among regular mathematics students. It was found that when students reach to the high schools, their attitudes and beliefs towards the social importance of mathematics and nature of mathematics begin to decline. Though, less decline than middle school students. Nevertheless, the beliefs about the nature of mathematics remain relatively stable (Ma & Kishor, 1997; Wilkins & Ma, 2003).

Wilkins and Ma (2003) found that teacher encouragement impact the attitudes towards the mathematics in middle and high school, where peer influence plays a significant role in developing attitudes towards mathematics during high schools. However, teachers are in a key position to positively impact mathematical achievement by designing instruction (Middleton et al., 2013; Wilkins & Ma, 2003). Students' self-confidence has a significant positive correlation with mathematics achievement (Reyes, 1984). In this relation, Fleener (1996) studied high school students' beliefs towards mathematics and concluded that students develop beliefs towards mathematics based on their personal experiences in mathematics classroom.

The Second International Mathematics Study (SIMS) included the self-report items on beliefs about mathematics and mathematics learning. One of the interesting finding was that students tended to see checking answers and memorizing rules and formulae as the very important but least enjoyable aspects of mathematics (Mcleod, 1992) believed that emotions are the outcomes of inconsistency between expected and perceived events. Moreover, most of the research on mathematics learning has overlooked learning by individuals and not by groups. Therefore, students' attitudes toward mathematics, their beliefs about it, and their conceptions of it continue to attract attention of researchers (Grouws, 1992).

Sua (2007) conducted the research work focusing on the attitude and achievement orientations of secondary school students towards the mathematics and science. The research concluded that the attitude and achievement are two important outcomes. In this study 400 secondary school students participated. The research work examined the inter-correlation between attitude and achievement in mathematics based on students' gender, and found that in general their attitude towards mathematics and science both were slightly negative. It was found that female perform well in mathematics than their male counterpart. Meyer and Koehler (1990), however, reported that among secondary school students, when male students have higher achievement they also see mathematics as more useful than female students do.

Kloosterman and Stage (1992) developed an instrument, Indiana Mathematics Beliefs Scales based on modified version of Fennen-Serman mathematics attitude scales. The scale was used to study secondary and higher secondary school students' emotional states, and found that beliefs and attitudes about mathematics are influential on academic achievement (Kloosterman, 2002). Students' perceived beliefs about both the nature of the process and solution of mathematics problems is, thus, a focus of great concern. Students need not to focus on steps in solving the problem but need to think critically. Students of fixed mindset are unable to solve difficult problems, successfully.

Tsai and Walberg (1983) conducted the research on attitude and achievement in mathematics. They found that student's mathematics achievement was dependent on attitude. Furthermore, the attitude was again dependent on the gender of the students.

Ma (1997) investigated the effect of students' attitude on mathematics. The findings indicated reciprocal and not unilateral relationship between mathematics attitude and achievement. Students' feeling of enjoyment was directly affected to mathematics achievement, and perception of mathematics was independent of other attitudinal factors. Likewise, Schofield (1982) found that attitude of the students influence their achievement. However, the other variables like gender of the student, grade level, and type of achievement test were some influencing factors. There was more positive relationship between attitude and achievement in male students than female. Moreover, the effect of attitude grew stronger with successive grade level.

Researchers have studied the students' attitude towards mathematics formation process and noted growing disinterest among high school students in England. They also found that boredom and anxiety were the primary reasons of not taking mathematics at higher level of education (Brown, Brown, & Bibby, 2008). Reynolds and Walberg (1992) investigated the relationship between mathematics achievement and attitude and found that previous attitude had maximum influence on subsequent attitude and achievement. However, the instructional quality also impacts the attitude and achievement. In this regard, (Guay, Marsh, & Boivin ,2003) investigated the relationship between attitude and achievement and concluded that they are bilateral.

McCoy (2005) administered the attitude scales at the beginning and end of the school year among the 107 students of North Caroline state, and concluded that attitude affect the mathematics achievement scores significantly. On the attitude scales, post scores were significantly less positive then the pre-scores (McCoy, 2005 as cited in Bajracharya, 2007).

Academic Career Plan and Gender

Research carried by Buchmann and Dalton (2002) examined the effects of parents and peers attitudes about students’ performance on students' educational aspiration. The study found that peers and parents impact educational aspirations in US. It also found that academic career plan are largely determined by the types of school, student attendance and interpersonal effects. The academic aspiration also depends on the structural features of the educational system in which the students operate.

Girls doing better in mathematics than their boy counterparts are found less interested in mathematics as they reach higher secondary school. Girls are poorly represented in mathematics, engineering, and physical sciences. However, girls have good representation in nonmathematical field. The Michigan study of adolescent life transition (MSALT) found that parents' are the significant influencing factor on their children's career choices. What the parents' expect from their daughter's ability in mathematics and science influence the daughter's own perceptions based on which they choose the possible major in college. The values girls hold can affect their decision to engage in certain tasks that fit with their believe system and personal goals. From the influence of the gender role, girls may end up avoiding the field they perceive is competitive. However, male students continue to accept traditionally male dominate subjects like mathematics, physics and engineering. Female students' professionals still dominate the careers that involve social field like medicine, education, and the field which consume too much time. When considering careers, girls have to balance their values to decide what they focus on. Female students react very quickly on their failure and success in comparison to their male counterparts. Female students tend to change college majors when their scores slip (Bleeker, 2002; Wingfield, Battle, Keller, & Eccles, 2002).

In Nepal, mathematics is basic prerequisite for engineering. Here, applicant should have completed 10+2 or equivalent with at least 200 full marks in mathematics (IOE, TU 2012). The students of biological sciences study 100 full marks mathematics course of grade eleven. In this level, mathematics and physics are considered hard subjects by majority of the students. The poorer students' tendency is to leave these subjects. The minimal differences are observed in male and female achievement in mathematics and science until high school. However, the achievement gap begins to occur during the adolescence. All students basically have to learn same subjects at high schools and grade eleven sciences in Nepal. It is only in the later year where students start getting some choices whether or not they focus on subjects like mathematics.

Learning Styles and Career Plan

Nasser and Carifio (2006) conducted the international research work to understand the learning styles of 109 male students and 90 female students at the University of Lebanon. In this study, the Felder and Soloman's index of learning styles was used and the results indicated the significant differences. Majority of the students were in the visual and active learning styles domain. Engineering, business, and economics students' scores were higher in active and visual learning styles, while science major students scored high in intuitive, sequential and visual. Architecture students were more visual. However, communication major scored high in active and sensing. Humanities and social sciences students were more in visual and active learning styles. Likewise, Blowe and Price (2012) conducted a study to investigate academic performance of Career and Technical Education (CTE) completers and non-CTE completers in the commonwealth of Virginia. The findings of the study revealed that CTE completers had significantly higher mathematics pass rates and higher cohort graduation rates than those of their counterparts.

Learning Styles and Gender

There are number of factors that affect the learning styles. Dunn and Griggs (1995) identified some factors that affect learning styles such as gender, age, and culture. The students' gender plays important role in learning styles preferences. So, one needs to consider the gender when identifying learning style preferences. The gender can influence learning outcomes. Various studies showed that there is a difference in terms of students' gender. As such, gender is considered as one of the determining variables in learning styles variables. In this relation, Wehrwein, Lujan, and DiCarlo (2007) also studied the learning styles preferences of male and female students of physiology using VARK learning style model, and found the significant differences between them. Lincoln and Rademacher (2006) studied the differences between 33 male students and 66 female students based on VARK model and found that there was significant difference between male and female students’ learning styles.

Learning Styles and Achievement

Jahanbakhsh (2012) investigated the relationships between learning styles of high school girls' students and their academic achievement focusing on their major. In this study 350 students participated, where Felder and Solomon Index of Learning Styles (ILS) was used for data collection. The study found that there was significant correlation between the students' academic achievement in science and mathematics major and their sensing/intuitive learning styles dimensions. However, other major students' academic achievement was significantly correlated with the active/reflective and sequential global learning styles.

Adnan et al. (2013) conducted the study to examine the learning styles preferences and mathematics learning outcomes in terms of achievement among 362 high performance school students. In this survey method, the ILS of 44 items questionnaire was administered. There, the achievement scores were based on participants' final year examination grade. The data were analyzed using descriptive and inferential statistics including t-test and Pearson correlation. The findings of this study revealed that majority of the students approached to mild learning style among active, sensing, visual and sequential. The study concluded that there is a significance difference between genders based learning style of visual, verbal, sequential and global. Furthermore, there was positive relation between active and reflective learning style and mathematics achievement.

Prajapati, Dunne, Bartlett, and Cubbidge (2011) used the ILS to investigate the influence of learning styles on academic performance. In this study, 213 non-graduate and graduate optometry students participated. Among these national and international students, there were 63% female. The study found that the majority of optometry students had balanced learning styles, and their academic performance was not influenced by the learning styles. However, the academic performance was influenced by their enrolment category. This study also revealed that the usual teaching methods of teachers need not be altered as the majority of students were of balanced learning styles. The balanced learning styles students adapt the usual teaching styles.

Kulac, Sezik, Asci, and Gurpinar (2013) performed the research work to investigate correlations among learning styles, academic achievement and gender of medical students in preclinical years. In this study, Grasha-Reichmann Students Learning Styles Scales, along with final exam scores and passing grades were used for data collection and analysis. The study found that female students with competitive and collaborative learning styles scored significantly higher than male students. Likewise, students with competitive learning styles scored higher academic achievement than other counterparts. This study also revealed gender difference in favor of female students' achievement.

Attitude and Learning Styles

Middleton et al. (2013) conducted the research work to investigate whether difference exists between learning style and attitudes about mathematics based on gender and race. In this study 384 undergraduate and graduate students enrolled in institution of higher education in the United States. The index of learning styles and attitudes towards mathematics inventory were administered for the data collection. The study suggested that science, technology, engineering, or mathematics (STEM) majors have more positive attitudes towards mathematics. It also found the influence of gender in both the learning styles and attitudes towards mathematics (Peker & Mirasyedioğlu, 2008). Further, the study found that convergent learners have significantly higher attitude about mathematics than the assimilators.

Changes in Learning Styles

Barris et al. (1985) conducted the study using the learning styles inventory to determine whether college students change their learning styles preferences over their college experiences. They found decreased preferences for teacher-structured learning and an increased preference to student structured learning. Similarly, Pinto et al. (1994) used the Kolb learning styles inventory to assess the learning styles preferences among 178 under graduate from business majors students in a three year longitudinal study (sophomore, junior and senior year of college), and found that learning styles may exhibit some degree of change over the course of a students' college career. Furthermore, students showed increased preferences for active experimentation as they progressed though their educational aspiration plan from sophomore to senior.

Personal Characteristics and Mathematics Learning

Personal characteristics involve students’ internal and external characteristic variables. The gender and students' academic career plan are some of the personal characteristic variables. Students’ personal characteristics correlate up to 0.8 with achievement (Bloom, 1956).

A number of studies have demonstrated the effect of gender difference on the learning and found that male students were higher achiever than their female counterparts (Berthelot et al, 2001). An experiment carried out by Lalithamma (1975; cited in Setia, 1991) on 732 pupils of class nine found that there was significant difference in the performance of boys and girls in mathematics. The difference was in the favor of boys. Likewise, Johnson (2000) concluded a research on academic achievement among public elementary school students and suggested that girls perform better in reading and writing subjects while boys perform better on the more analytical subjects of mathematics and science.

The investigation based on research over the last decades as undertaken by Schwartz and Hanson (1992) has shown that males and females have different classroom experiences because they approach learning differently for teachers tend to treat them differently. Girls' mathematics achievement in the elementary grades is equal to that of boys but gradually decreases in the middle schools. It suggests that the decline of female achievement is the result of strong pattern of socialization rather than the gender differences in mathematics ability. Research found that mathematics achievement had significant positive correlation with intelligence, and girls had higher mathematical achievement than boys. In yet another study, similar investigation was made on gender effects in learning abilities, which found that females performed higher than males (Setia, 1991).

Dutt (1989) conducted a study by taking a sample of 128 grade five students (64 boys and 64 girls) and found that gender did not account for the differential achievement in mathematics. Kulkarni (1970) and Nayar (1971) conducted a research work and reported that boys achieved higher than girls did. Kimball (1989 as cited in Rahaman, 2003) investigated that female students generally achieved higher in the class but their scores in the standard examination were lower than male counterparts. In a similar study, More and Smith (1987) compared the mathematics achievement of young men and women aged between fifteen and twenty-two and reported that male performed better than female in the arithmetic reasoning and mathematics knowledge test.

Center for Educational Innovations and Development (CERID,1999) studied on Assessment of Learning Achievement of Lower Secondary Children and reported that the factors like gender of student were highly significant in the students' achievement in mathematics. CERID (1999) reported that the achievement on mathematics of Tharu students was lower than that of the students of non –Tharu communities, and the achievement of Tharu girls was found to be higher than that of Tharu boys. The first International Association for the Evaluation of Educational Achievement (IEA) implemented mathematics study project in different countries and found that gender was related to mathematics achievement in almost all countries, where boys scored higher than the girls in all levels (National Council of Teachers of Mathematics NCTM, 1995). Nevertheless, the gender difference was negligible with respect to the achievement in mathematics (Mullins, Martin, Gonzalez, & Chrostowski, 2003).

Studies on Achievement in Mathematics

The main aim of this part is to briefly highlight the information about the international and national level achievement studies in general, and mathematics in particular. It is also to bring into light the similar research works done by different researchers.

International Achievement Studies in Mathematics

More attention appears to have been paid to international study in mathematics. In this regard, the IAE carried out the First International Mathematics Study (FIMS), where mean scores were below 50%. There, majority of students scored below 40%. There, low scores occurred at the senior level. The attitudes of younger children (13 years old) were more positive to mathematics than the senior students.

The Second International Mathematics Study (SIMS, 1976-1989) investigated mathematics education at three levels i.e., curricular intentions, implemented curriculum, and student achievement. Students' performance was measured and reported separately for five areas i.e., Arithmetic, Algebra, Geometry, Measurement, and Statistics. The study also replicated the finding of FIMS. It incorporated the relationships between the output and input measures of mathematics education. This study reported that middle school students performed the best in Arithmetic and worst in Geometry. At the middle school level, girls tended to outperform boys in computational skills and Algebra. Boys, on the other, performed better in Geometry and Measurement. Teachers used whole class instructional techniques, relying heavily on prescribed textbooks with no different types of assignments and instructions (NCTM, 1992).

The Third International Mathematics and Science Study (TIMSS) investigated middle school grades and found that majority of the participating countries performed above the international average. In most countries, gender differences were lower in mathematics. In almost every country, the majority of students agreed that they did well in mathematics. Similarly, the major findings of TIMSS (2003) stressed that the countries where TIMSS was under work were seen to have increased mathematics achievement of grade eight students over the eight years' period from 1995 to 2003 (Mullis et al., 2003).

Research Studies on Achievement in Nepal

Research Center for Education Innovations and Development (CERID, 1985) conducted a study among the grade five students and identified that majority of students' secured less than 45% marks in mathematics. BPEP (1997) conducted the study "The effect of new curriculum on the achievement of grade four students". This study revealed that the mathematics achievement was just 28%. Similarly, Basic and Primary Education Project (BPEP ,1998) investigated the effect of new curriculum on the achievement of grade five students, and concluded that the mathematics achievement was just 26.58%. In the same line, Educational Development Service Centre (EDSC, 1999) conducted a research on "National Assessment of Grade Five Students" in Mathematics. The overall mean performance in mathematics was 27.25 and the SD was 17.08. There, the mean scores of boys and girls were 29.56 and 24.64 respectively EDSC (1997).

A study entitled "Assessment of Learning Achievement of Lower Secondary Children (grade 6&8) was launched by CERID/SEDP in the year 1999. In this study, students' personal characteristics and school-related variables were included in order to find out the factors contributing the grade six and grade eight student's achievement in mathematics. Out of other sub-factors, gender was the factor that significantly affected students' achievement in mathematics.

A study entitled "The effect of new curriculum on the achievement of grade five students" was carried out by BPEP in the year 1998. In this study, the household characteristics, student's characteristics, school characteristics and teacher's characteristics were included. The achievement of students' in the various components of mathematics was studied. This study report revealed that the student's achievement scores in mathematics were very poor i.e. below 30%, not even the required pass marks. Similar type of study among the grade four students was conducted by BPEP in the year 1997, which concluded that the achievement score in mathematics among the grade four students was 23.42%, which was very poor and least among the other subjects.

EDSC/BPEP (1999) carried out a study "National Assessment of Grade Five Students". Here, it studied factors affecting student's achievement such as school-related factors, student- related factors, and teacher-related factors. Furthermore, the study acknowledged gender as significant factor. There, the national-level achievement score of grade five students in mathematics was 27.25%, which was significantly poor.

CERID (1982) carried out a research work on "Achievement Level of Primary School". The main aim of this study was to determine the achievement level of primary school students. This study reported that the main scores in arithmetic tests were 43.5%, which was least among the other subject areas. This study investigated the component -wise scores in arithmetic. Based on the result, it concluded that boys were better than girls in Arithmetic. There was no significant difference in respect to the students living in remote or non-remote areas.

CERID/MOE/SEDP (1999), likewise, conducted a research on lower secondary children and concluded that the mean and SD of achievement scores of grade eight student in mathematics were 28.87 and 19.63 respectively. Similarly, the mean and SD in mathematics of grade eight students of central region were 32.35 and 21.56 respectively. The mean achievement score of grade eight students in mathematics of Kathmandu was found 24.45 out of 50 marks with standard deviation

7.96. There, male students scored 25.45 and their female counterpart scored 23.45 (Ghimire, 2006). Furthermore, the mean achievement score of grade eight students in mathematics was 44.64 with standard deviation 10.16 in total 100 marks from Kathmandu valley (Bajracharya, 2007). In all cases, the mean achievement score in mathematics was below 50 out of 100 marks.

Gap in the Research

This part of the study discusses the gap identification from the reviewed literature. In Nepal, majority of researches has been conducted on lower level of school education (primary, lower secondary and secondary) but not in higher secondary and higher education. This study, thus, could play an important role to fulfil the gap of researches in mathematics between secondary and higher secondary levels of school education of Nepal.

It was very important to understand the origin of negative attitude and beliefs. In relation to this, there were many research works carried on the beliefs and attitudes about mathematics, where constructs of different questionnaire like self-concept, confidence, anxiety, self-efficacy, and beliefs about the usefulness of mathematics were used. The literature supported the idea that teachers, peers, and parents play an important role in influencing attitudes and beliefs. Teachers can improve their students' attitudes and beliefs about mathematics through verbal counseling, encouragement, technology based instruction, and projects focus on students' work. Majority of the research work pertaining to attitudes and beliefs focused to measure learning outcome in terms of achievement. As such, the ATM (Tapia & Marsh,2004) was broken into four subscales components like value, enjoyment, self-confidence, and motivation. These sub-scales wouldn’t measure teachers' role in learning mathematics, so belief about learning mathematics was needed in the instruments.

The researcher, based on the above discussed literature, found that there was a gap of linkage between learning styles and attitudes in different level of education system. There was also a gap between higher secondary school students' gender and their academic career plan (selection of subject of studies). Further, it was also found that there was a gap between beginning and end survey of students' learning styles, beliefs and attitudes based on academic career aspiration plan and gender. Mainly, there was a gap in the research linking an association among the change of learning styles, change of attitudes, students' gender, academic aspiration, and learning outcome in mathematics. It approached researcher with basic understanding that students' awareness of their learning styles preferences and their opinion towards the subject can lead to improving students' learning outcome and performance in mathematics.

Summary

As noted in the review of literature, the purpose of many studies was simply to identify students’ learning styles preferences. Learning styles preferences were related to demographic variables such as age, gender, race/ethnicity, employment, and work experiences. Academic achievement was also related to learning styles. Moreover, mathematics education research works stressed that students’ difficulties with mathematics learning could be related to the types of beliefs they hold about the nature of mathematics (Hofer, 1999; Schoenfeld, 1992). Similarly, students’ views on the usefulness of mathematics influences their engagement with the task and academic performance. Furthermore, attention to learning styles and learner diversity enhance motivation to learn. When students’ motivation increases, larger learning gains are also achieved.

The Fennema-Sherman mathematics attitude scales were developed in 1976, and used over the last 30 years. This popular instrument has been used to evaluate students of various backgrounds, gender, and academic levels. Many researchers have distinguished that each individual student processes and learn new information in different ways. It is in line to the body of past research works, which focused differences in the ways individual perceives and processes information ((Felder & Silverman, 1988; Husch, 2001). The result of the literature review confirmed that the Felder-Soloman's Index of Learning Styles (ILS) and Tapia's Attitude towards Mathematics (ATM) were the best tools for generating the independent variables for this research work. So far as researcher’s knowledge is concerned, no studies were found that examined higher secondary students’ learning styles and views towards mathematics in Nepalese context. This study, thus, aimed to provide evidence regarding how students’ views about mathematics promote their achievement. In addition, this study attempted to examine the relations of students’ views related to mathematics and students’ learning styles on their achievement in mathematics based on gender and academic career aspiration plan.

Theoretical Framework

Learning styles determine how an individual perceives, processes and understands information. Students exhibit different approaches to learning (Felder, 1988). Different kind of learning styles theories and models has different learning methods. These learning styles theories and models have been discussed in literature review chapter of this study. As Felder-Silverman learning styles theory (model) was suitable for assessing and studying the mathematical learning pattern in school and college students, this study employed the Felder-Silverman (1993) learning style dimensions as a theoretical referral to the theme of the study. These dimensions are based on psychology theories (Jung, 1971) and learning theories (Kolb, 1984). The Felder and Silverman (1988) learning styles has four dimensions of learning preferences: active-reflective, sensing-intuitive, visual-verbal, sequential-global. The Felder-Soloman's (1999) index of learning styles is based on Felder-Silverman (1993) learning styles theory, which assesses students' learning style (Felder & Soloman, 2001).

This study has also focused on the theory that an individual's attitude affects the way they view, pursue, and achieve within the subject of mathematics. Various studies have focused on attitudes and mathematics (Fennema & Sherman, 1976; Tapia & Marsh, 2004; Kloosterman, 2002) and found that there is a correlation between attitude towards mathematics, achievement in mathematics, and future aspirations in majoring in mathematics (Greenwood, 1997; Turner 1981). Tapia and Marsh (2004) describe Fennema's theory as the belief, where performance in mathematics is an interaction of attitudes that occur during the learning task. A focal point of the research on attitudes towards mathematics has been on and around the interaction of gender and attitudes towards mathematics.

Students' attitude towards mathematics has been found as contributing variable to their success in mathematics (Mata et al., 2012). The definition of attitude towards mathematics, however, is not same in all situations (Middleton et al. 2013). Therefore, the working definition of attitudes and beliefs in this study is "views towards mathematics". Views are related to value, enjoyment, self-confidence, motivation and belief.

Conceptual Framework of the Study

The aim of this section is to set an appropriate framework to address the research questions mentioned in the first chapter, based on review of literature as discussed in this chapter. The framework of this study was grounded in the premise that students' learning styles and views towards mathematics are equally important variables to be considered by teachers and educators in designing courses and delivery of lessons.

There has been no common conceptual framework for different learning style theories (Dunn & Griggs, 1995). In this study, Felder and Silverman (1988) model of learning styles served as the theoretical construct. This theory states that students' learning styles can be described as students' preference on how they receive and process information. This study emphasizes certain characteristics of learning styles that are illustrated by higher secondary science students. Since learning styles can be learned over time (Grasha, 2002), it may be useful to teach these styles to students throughout the course. Identifying the common characteristics of learning styles of student population can enhance the learning potential in mathematics for more students. If a particular learning style is found to be a contributing factor for higher secondary school students' learning of mathematics, they could be encouraged to use and develop this learning style for better performance in mathematics course.

In second half of twentieth century, many researchers focused on affect as an important field of study of teaching and learning in mathematics education. These studies discussed the psychology and cognitive aspects of affect and its uses in mathematics education (Belbase, 2013). Fennema (1989), in this regard, investigated the influence of beliefs on achievement in mathematics. The extensively used attitude measure was the mathematics attitude scales (Fennema & Sherman, 1976), which constituted values, beliefs, confidence, anxiety in mathematics, and disposition in problem solving. There has been critique regarding the researches on attitude in terms of theoretical and methodological consideration, where they are charged as driven by statistical method rather than the theory (Mcleod, 1987).

The attitude towards mathematics inventory (ATMI) was developed by Tapia (1996) based on Fennema & Sherman (1976) which does not consist ‘beliefs’. The separation of belief is difficult in carrying research on attitude (Mcleod, 1992; Pepin 2011). It is because, attitude is positive or negative degree of emotional disposition towards mathematics (Haladyna et al., 1983; Mcleod, 1992), which is recognized in terms of an emotional response, the beliefs about the mathematics, and the behavior regarding the mathematics (Hart, 1989). Thus, in this study, the views towards mathematics including attitude and belief were considered in the conceptual framework.

This dissertation focuses on the theories in which the learners' views affect the way they perceive the subject, and learning outcome within that subject. It is in line with numerous prior studies, which focused that there is an association between mathematical achievement, future aspirations in majoring in mathematics, gender, and students' attitude about mathematics (Fennema & Sherman, 1976; Tapia & Marsh, 2004). There has been different research documenting the difficulties of students in doing well in mathematics. Some studies suggest that students avoid taking advanced mathematics because of these difficulties associated to this subject (Walker & McCoy, 1997).

The research on mathematical attitude focused on its gender, academic achievement and pursuance in mathematics found that gender is the significant factor (Gardner, 1975). According to Dunn, Dunn and Price (1979), each student learns through complex set of reactions, feeling and previously established knowledge. The learning process is conceived as environmental, emotional, sociological and physiological. The focus on how individuals learn is the basic for the learning styles models. It is a comprehensive approach to the identification of how individuals prefer to learn during educational activities.

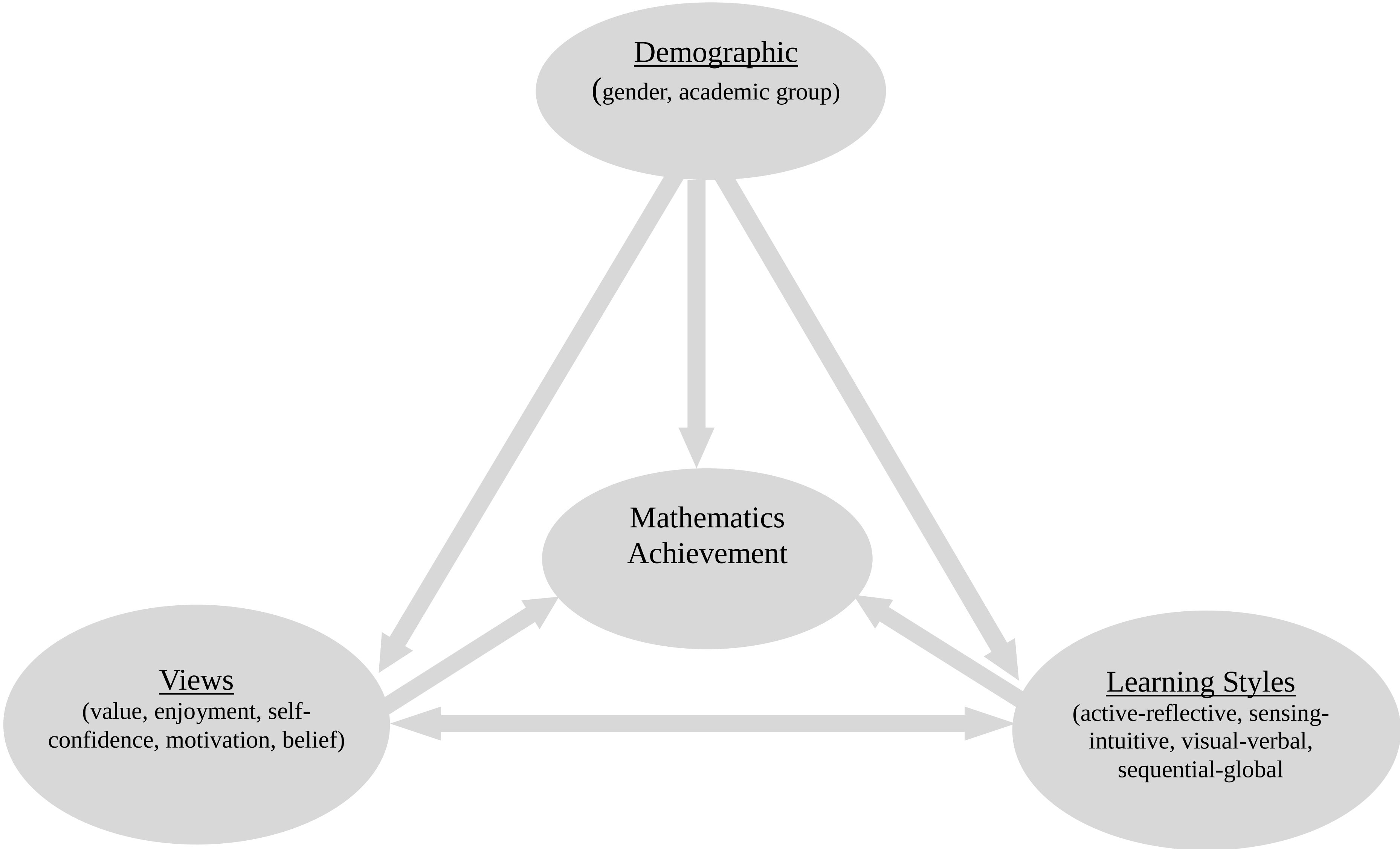
Research has found positive relationship between attitude and achievement in mathematics. However, there is an insufficient research that investigates the relationship between attitudes towards mathematics, belief about mathematics, and learning styles. The investigation of these variables is vital to understand the relationship between attitude, belief, learning styles and achievement in mathematics. Few studies in this area have provided mixed findings (Middleton et al., 2013).

According to Bruner (1973) three key variables of learning are a) nature of the learner b) the nature of the knowledge to be learned, and c) the nature of the learning process (Malone, 2003). Keefe (1987) described three dimensions of personal styles in learning as cognitive styles (information processing to include the way one encodes, process, store, retrieves and decodes information), affective styles (personality dimensions to include attention, motivation, interests, and emotions) and physiological styles (including gender behavior, and physical environmental conditions). Depending on the ideas and aspects of the meaning of learning style another term such as cognitive style is often used in similar context (Graf, 2007). The cognitive style is considered as the learning style. Physiological style, on the other, is related with the information of gender and academic career aspiration plan. TheWalberg (1992) model of educational productivity identified some key factors that relate students' affective, behavioural and cognitive development. These factors were further classified into three groups i.e., students' personal variables, instructional variables, and environmental variables (Reynolds & Walberg, 1992). In this study, students' personal variables are focused. More specifically, the demographic is based on Walberg's (2004) education productivity model, views is based on Tapia's (1996) model, and learning style is based on Felder-Silverman (1988) model.

The conceptual framework for this study is, thus, based on above conceptual analysis and past research, which is based in the literature of learning styles theory and affective domain and their possible influence on students' achievement in mathematics. The student's learning styles and students' views towards mathematics has been considered as the independent variables, and the achievement score in mathematics has been considered as the dependent variable. Students' view included the value of mathematics, enjoyment of mathematics, self-confidence with mathematics, motivation of mathematics and belief about teaching/learning mathematics. Besides these components, students' gender, academic career aspiration plan, continuing or discontinuing mathematics in succeeding grade has been incorporated. Mainly, the research work has been depended on affective domain and Felder's learning styles model based on gender and academic aspiration. Researcher has considered demographic as the nature of learner; learning styles and views as the nature of learning process; and the mathematical knowledge as the nature of learning outcome in mathematics.

The conceptual framework presented in the figure below summaries the relationship between the variables, and student learning outcomes in terms of achievement in mathematics. This represents a simplified conceptual model for describing these relationships including beginning and end survey. The model presented in Figure 2.1 suggests that the students' learning styles, students' views and demographic information can directly affect the students' learning outcomes as academic achievements in mathematics. Likewise, the model reflects an association of demographics (gender and academic aspiration) with learning styles and views towards mathematics. The model also shows the relaionship between learning styles and views towards mathematics.

Figure 2.1. Conceptual Framework Model



CHAPTER III

METHODOLOGY

This chapter presents the details of separate headings such as research design, population, sample, instruments, data collection procedure, and statistical analyses. Besides, several other practical factors and issues that need to be considered while making a choice of methodology are addressed here. These include the type of information required, the purpose of the study, outcomes for the data, the acquired mastery over quantitative techniques of the research, time and resource constraints, and the sample from the population.

Design of the Study

In this study, quantitative survey design was used. The quantitative research allows numeric data to be condensed into manageable forms. The statistical procedures for data analysis ensure that the information are presented and interpreted in an accurate and informative form. Since the survey method provides quantitative or numeric description of trends, attitudes, or opinions of a population by studying the sample from that population, researchers may generalize the results from the sample to the population (Fraenkel, Wallen, & Hyun, 2012). In this beginning at end survey design, researcher surveyed the same sample of individual students at two times during the course of the survey (Creswell, 2009). As the researcher was studying the same sample students, he explored the changes in their feeling and behavior during the academic session. The loss of same sample (individual students) from beginning to the end of academic year is frequent (Fraenkel, Wallen, & Hynn, 2012).

The first purpose of this non-experimental survey research was to understand the learning styles and students' views towards the mathematics of higher secondary school science students in Nepal by gender and academic aspiration (physical group students, biology with additional mathematics students and biology without mathematics students-biological group). Secondly, it sought to determine if there was any relationship between learning styles, views about mathematics, gender, academic aspiration, and learning outcomes in terms of academic achievement.

As such, the beginning-end test survey design was adopted to find association among learning styles and views about mathematics with subscale components. The results of beginning test-end test exhibited that beginning test establish students' prior learning styles and views on mathematics at the beginning of the academic session (first week of academic year), while end tests measured students' learning styles, and views on mathematics including achievement test in mathematics at the end of the course by gender and academic aspiration. The change of learning styles and views over time can affect mathematics achievement of grade eleven science students.

This study employed mainly the quantitative (single group beginning test and end test) approach in the research process (Creswell, 2009). There were reasons behind the choice of quantitative methodology. First, the prior studies suggested that quantification of the data is possible. Second, the model had a clear set of research hypotheses to be tested. Third, the technological advances and availability of computer aided software program such as Statistical Package for Social Sciences (SPSS) would make easy in handling large amount of data.

The variables in this study were students' achievements in mathematics, the learning styles, and students' views about the mathematics, gender and academic aspiration career plan (academic group). In this study, the learning styles, views towards mathematics and demographics (gender, academic group) of students were independent variables and the students’ achievement was dependent variable and (see Appendix 19).

Population

The population refers the entire mass of observations, from which a representative sample is chosen for the collection of the data. This study aimed to find out the relationships of higher secondary school science students' learning styles, their views towards mathematics, and achievement in mathematics by gender and academic aspiration. In this regard, the target population of the study was grade eleven science students admitted in academic year 2012/13 in higher secondary schools affiliated to higher secondary education board (HSEB), Nepal. For the study sample, researcher selected the higher secondary schools running science program (with number of students not less than 150) from Kathmandu Metropolitan City (KMC) of Kathmandu district. The present study was delimited to institutional (non-government aided i.e. private) schools. Therefore, the population of this study was the grade 11 science students studying mathematics in the academic year 2012/13 from institutional higher secondary schools at Kathmandu Metropolitan City.

Sample and Sampling Procedures

Sample

Sampling permits the investigation of smaller group viewed as to be representative of the larger population (Wiersma & Jurs, 2005). The benefit of research sample is that, if the findings are derived from a random sample of an entire population, the research outcomes are applicable to the entire population from which the sample was derived (Allen, 2001). The sampling of the total population can be done in different ways. One can use any probability sampling plan at each stage of a multistage plan, and the plan can be different at each stage. Investigators can select a sample by using combination of different sampling method (Cohen & Manion, 1994).

The random sampling of population is identified as a basis for generalizing research findings to the study population from which the sample was drawn. Usually, the stratified sampling is used to divide the population into important categories relevant to the researcher interest. The stratified random purposeful sampling is a combination of sampling strategies, where sub strata (groups or classes) are chosen based on specified criteria, and a sample of cases is then selected within those subclasses (Fraenkel, Wallen, & Hyun, 2012; Mertens, 2014).

In practice, stratified random sampling along with other more complex sampling techniques are employed to reduce some of the logistical costs associated with collecting information from the sample (Fraenkel, Wallen, & Hyun, 2012; Agresti & Finlay, 2008). When the population is large and widely dispersed, gathering a random sample poses administrative problems (Cohen & Manion, 1994). The true random sampling in social research is extremely difficult to achieve (Shulman, 1981).

Sampling in this study had to ensure representative sample of grade 11 science students who enrolled in higher secondary schools (Appendix 20) with mathematics course during the academic year 2012/2013 in the KMC of the Kathmandu district. As such, the selection of research sample for this particular research work was first stratified sampling, and then convenient sampling, followed by random stratified sampling among higher secondary schools in the KMC of the Kathmandu district.

Since the purpose of this baseline and end line survey study was to investigate the learning achievement in mathematics of those students who passed the SLC examination with first division and distinction, students from the two institutional higher secondary schools were selected as sample students. This study did not include students from public schools and the schools under the third strata (with less than 150 students). It was because these schools would not limit their admissions to first division and distinction holders. In addition, the proportion of students by gender (male=65.18% and female=34.82%) from sample schools were nearest to the targeted population. According to HSEB, there were 13427 (male=67.64% and female=32.36%) students enrolled in grade 11 science in 104 higher secondary schools in the year 2012/13 from Kathmandu district (HSEB, 2015).

Similarly, another reason for selecting these students was their ability to understand the survey tools and MAT, which were in English language. In general, majority of students from public higher secondary schools are not expected to have as much competency in English language, where Nepali is the default medium of instruction in these schools.

Two higher secondary schools (one school with more than 300 students, and other with less than 300 but more than 150 students), in which the minimum criteria for admission in science was first division in SLC examination (see Appendix 20) were considered. Students' enrollment in these schools was from different corner of Nepal. These schools were selected by using stratified sampling method from more students schools strata (more than 300 students), and medium number of students strata (number of students from 150 to 300). Randomly, four sections from first strata school (more than 300 students) and three sections from second strata (students more than 150 and less than 300) were selected. In the beginning survey, targeted number of students were 320, the participated number of students were 296. All students from randomly selected sections participated in the survey. Regarding the students' demographic information (gender and academic information for group selection), and their identity code like section and roll number, students who participated in the beginning and end survey were asked to fill up as indicated at the top of the survey instrument. Two students’ personal information was incomplete, so, 294 students were included. The forty-seven students total of 294, who participated in the initial (first or pre) survey were not present in the final (end or post) survey. These numbers of students were not considered in the study.

Thus, this study surveyed on 247 higher secondary level science students enrolled in the academic year 2012/13.These students participated in the Index of Learning Styles (ILS) and students' views towards mathematics survey during the first week of the class commence, and again participated for the mathematics achievement test (MAT), ILS and views towards mathematics questionnaire at the last regular class session, one week prior to the grade eleven course completion. In these two surveys, there was one academic year gap.

Sampling Procedure

In the random stratified sampling process, the following steps were involved.

1. Categorized the higher secondary schools running science program in the year 2012/13 affiliated to HSEB.
2. All the higher secondary schools running science program from Kathmandu Metropolitan City were considered and numbers of science students from each school were listed.
3. All the institutional (no government aid received) higher secondary schools with science program from KMC were listed.
4. These institutional higher secondary schools running science program were categorized into three strata: first strata schools with more than 300 grade eleven science students; the second strata schools with more than 150 and less

than 300 grade eleven science students; and third strata schools with number of grade eleven science students less than 150.

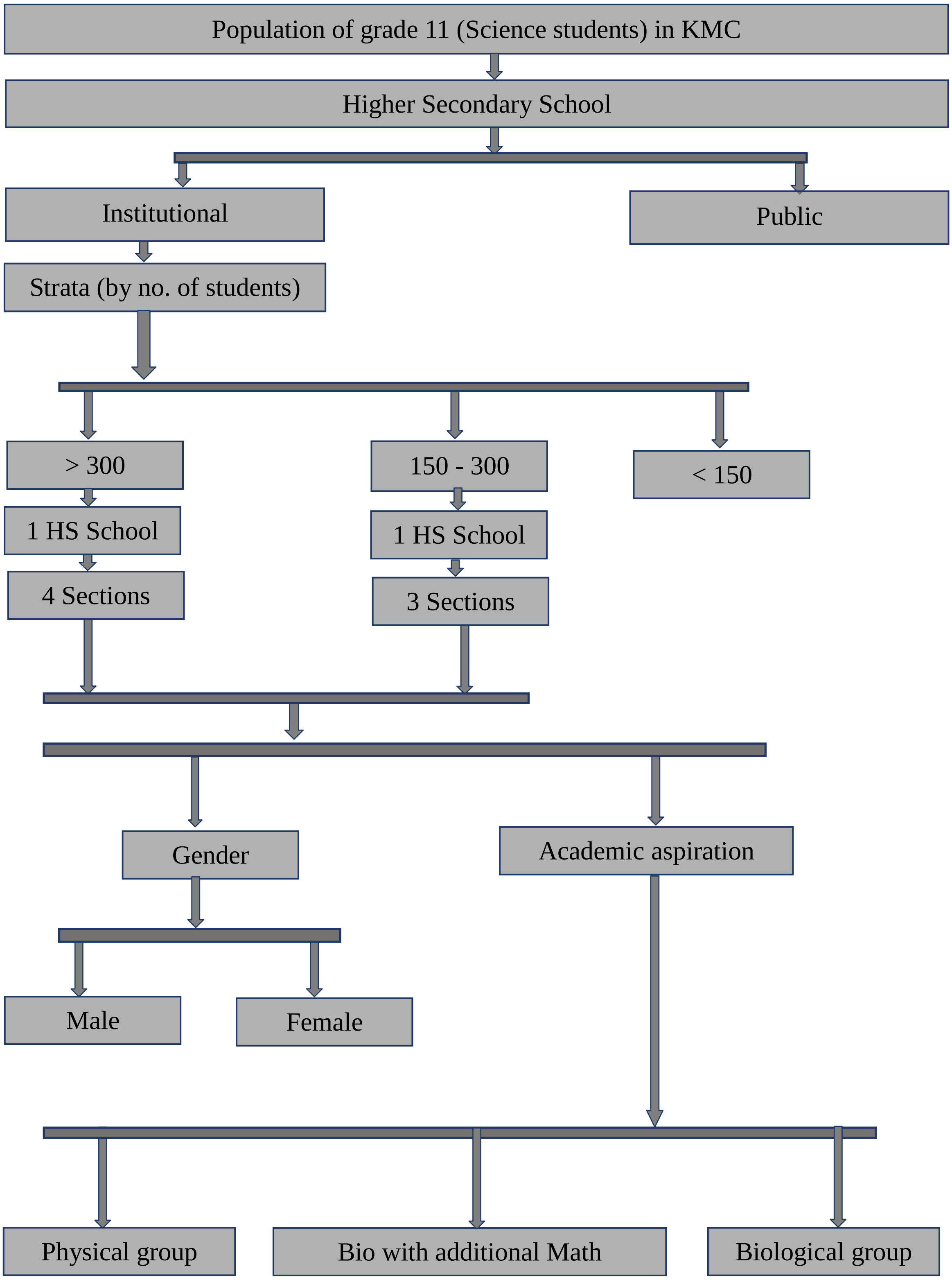
5. There were 13 higher secondary schools in the first strata, and other thirteen in the second strata, altogether 26 schools were considered (see Appendix20).
6. All the grade 11 science students enrolled in these 26 schools were study population.
7. It was decided to select two schools; one from first strata, and another from second strata so that the total number of students about 250.
8. Researcher approached and explained to these higher secondary schools management for the purpose of study with the letter provided from the Dean office, Faculty of Education but could not find the positive responses from all higher secondary schools.
9. Then, researcher proceeded for convenient sample, one from first strata and another from second strata.
10. Randomly, four sections (about 50 students in one section) were selected from one school of first strata, and three sections (about 40 students in one section) from another school of second strata.
11. All the students from respective sections were selected at the beginning and only those students who were participated in the beginning survey were selected for the end survey.
12. The same instruments (ILS and VTMI) with MAT were administered among the same students as a beginning survey at the last regular session, one week prior to the formal completion of the courses.
13. There were 144 (male 87, female 57) students from first strata school and 103 (male 64, female 29) students from second strata school, who participated in

the MAT at the end of the session as well as both the surveys of ILS and VTMI at the beginning of the session, and at the end of the academic year. The total 247 students were participated.

14. Finally, the sample size of this study was 247 students, who completed grade 11 mathematics courses.

The figure 3.1 below is summary of the sampling procedure.

Figure 3.1. Schematic Diagram of Sampling in Selecting Schools



Tools for Data Collection

The purpose of this study was to examine whether the learning styles and students' views towards mathematics remain stable or change overtime relative to their gender and academic aspirations career plan. This study was also to investigate the relation of learning styles and views on achievement in mathematics. In doing so, following instruments were used for data collections, which are discussed below:

1. Student's Demographic Information (gender, academic aspiration career plan)
2. Felder-Soloman's Index of Learning Styles (ILS)
3. Views towards Mathematics Inventory (VTMI): Likert Scale Questionnaire
4. Mathematics Achievement Test (MAT) developed by researcher

Demographic Information

The demographic information to know the gender and academic aspiration career plan (academic group) of the higher secondary science students were obtained along with the tools ILS and VTMI at the beginning and at the end of academic session. In this study, the academic aspiration is career choice in study of science subject like continuing mathematics-physical group, biology with additional mathematics, biology without mathematics-biological group in succeeding grade i.e. grade 12)

The Felder-Soloman's Index of Learning Styles (ILS)

This inventory was initially developed to determine the learning styles of engineering students, and now is used not only in science, engineering and medicine, but also with students across other majors (Graf, 2007). The index of learning styles (ILS) is appended in appendix 2. In this study, ILS contained four dimensions. These dimensions (or domains) were; Active-Reflective (also known as processing dimension), Sensing-Intuitive (known as perceiving dimension), receiving Visual-Verbal (known as receiving dimension) and understanding Sequential-Global (known as understanding dimension).

Teachers of science and technology based discipline apply the ILS instrument (Felder & Soloman, 2001) based on the Felder & Silverman (1988) learning style model in their respective classes. This instrument can be administered to determine and explain the students' learning styles preferences. Dee, Nauman, Livesay, and Rice (2002) studied the learning styles of 255 university students and found Cronbach's Alpha ranged within the interval 0.54 to 0.72. This study also found the excellent reliability on test-retest results of ILS in different measurements over time. The study, thus, concluded that the ILS instrument was an acceptable tool for measuring students' learning styles (Zywno, 2003).

According to Felder and Spurlin (2005), published reliability and validity tests of the ILS showed significant at 0.05 level of confidence interval. Test-retest correlation coefficient found positive relationships. This instrument also indicated strong construct validity in identifying and predicting learning style preferences of students of different disciplines (Felder & Spurlin, 2005). On cross validation of the ILS, Graf (2007) found that the ILS tool was reliable in technology enhanced learning environments. In relation to it, Felder and Spurlin (2005) reported that the Cronbach's Alpha was greater than criterion value of 0.5.

The reliability and validity were established again in Nepali context. In Nepali context, for the revalidation, this 44 items index of learning styles was piloted among 50 students in a higher secondary school at ward 32 of KMC, which had similar setting with the actual research school to evaluate its effectiveness. Cronbach's alpha of piloting for the overall ILS scale was 0.52. The four learning styles dimensions' internal consistency reliabilities value was ranged from 0.42 to 0.55 (see Appendix 8). It was sufficient for the study (Tuckman 1999; Pornsakulvanich et al., 2012).

Each dimension of learning styles was measured by randomly arranged 11 items (see Appendix 22). The instrument used a forced choice format which had two options of 'a' and 'b'.

The first option 'a' referred for first category and 'b' for second category of each learning dimension. For example, in processing domain 'a' was for active and 'b' for reflective. For analyzing the responses, researcher coded each answer of 'a' as quantity 1, and each answer of 'b' as quantity 0. Each respondent's learning styles was determined by summing up scores of the style in each dimension. The difference of the totals within the dimension was determined. Learning styles domain with the higher score corresponded to the preferred style (see Appendix 9).

For each category of learning style dimensions, the scores indicated the inclination between active verses reflective; sensing verses intuitive; visual verses verbal and sequential verses global. Moreover, researcher subtracted the total of each beginning learning styles dimensions from the corresponding end total to find the changed or unchanged learning styles from initial and final survey. Changes may occur in the same category of learning styles domain or from first category to second and vice versa. These changed or unchanged learning styles were defined as learning style changed/unchanged status.

Learning Style Changed/Unchanged Status

Learning style status (change-unchanged) were determined by comparing the total scores of beginning and end survey for each end (score either one side or opposite) of the learning styles. If the score was more than five out of total eleven in each beginning and end survey than the students' preferences would remain same (unchanged). If the students' scored more than five in beginning survey but less than five in the end, it would indicate change status of learning styles from beginning to end (Appendix 9). This scoring system generated four categories for each of the four learning style dimensions. For example, for the active-reflective dimension, the four categories were: active-active (same in both, active in beginning and active in end), active-reflective (active in beginning but reflective in end), reflective-reflective (reflective in both beginning and end), and reflective-active (reflective in beginning but active in end). The detail is in Table 3.1.

Table 3. 1

The Category of Changed/Unchanged Status of Learning Styles

Learning Style dimensions	Changed/Unchanged Status			
Processing(Act/Ref)	Act-Act	Act-Ref	Ref-Ref	Ref-Act
Perceiving (Sen/Int)	Sen-Sen	Sen-Int	Int-Int	Int-Sen
Receiving (Vis/Ver)	Vis-vis	Vis-Ver	Ver-Ver	Verb-Vis
Understanding (Seq/Glo)	Seq-Seq	Seq-Glo	Glo-Glo	Glo-Seq

Act- Active; Ref- Reflective; Sen- Sensing; Int-Intuitive; Vis-Visual; Ver-Verbal; Seq-Sequential; Glo-Global

Views towards Mathematics Inventory (VTMI)

This likert scales questionnaire survey contained the attitudes towards mathematics and students' belief about learning mathematics. The tool attitudes towards mathematics by Tapia (1996) were modified version of (Fennema & Sherman, 1978) mathematical attitudes and belief test scales.

For this study, researcher adapted the Attitudes towards Mathematics Inventory (ATMI), which consisted of 40 items (from 1 to 40) that measured four subscales variables namely value, enjoyment, self-confidence and motivation (Tapia

& Marsh, 2004). The constructed 15 (from 41 to 55) items Likert scales questionnaires survey for students' belief about learning mathematics were incorporated with ATMI to form the students' views towards mathematics inventory (VTMI) (see Appendix 3).

For this study, researcher gathered information of beginning and end views of students towards mathematics. All students were inquired about their views, at the beginning and at the end of academic year of grade 11 science, using Views towards Mathematics Inventory (VTMI), which measured five subscales namely value, enjoyment, self-confidence, motivation (Tapia & Marsh, 2004) and belief.

The validity and reliability of the ATMI was established for high school and college students (Tapia & Marsh, 2002, 2004). The researcher piloted this 40 items questionnaire among the 100 higher secondary level grade twelve science students, who completed the grade eleven courses in the academic year 2012 for the validation in Nepali context. The result of this piloted survey found the Cronbach's coefficient Alpha 0.91. Researcher utilized this Cronbach's coefficient Alpha in this pilot study and found a strong internal consistency, where Alpha ranged from 0.90 to 0.91(see Appendix 6). As such, it could be used confidently for this study. As this instrument (ATMI) would not measure belief, researcher developed a belief subscale as well. The validity and reliability of belief has been established.

This belief scales was based on Fennema and Sherman (1978) and Kumar (2011), where necessary modification, revision, and addition of the items were made to know the students' belief about mathematics learning. Initially, a belief questionnaire of 25 statements were prepared and distributed among the group of higher secondary level science students. The final try out consisting of 22 statements, and necessary adjustments from the previous set, were administered among 100 grade

12 science students from conveniently sampled higher secondary school running science program, situated at Batisputali (see Appendix 5). The Cronbach's Alpha for all the items varied from 0.84 to 0.86 (see Appendix 6). The corrected items' total correlation was less than 0.16 and more than 0.90, which were rejected for the beliefs subscale of the views. Finally, 15 positive and negative items statements were accepted. The final form of views consisted 55 items statements (see Appendix 3).

This research utilized these 55 items views towards mathematics inventory (VTMI). The entire VTMI was a Likert type scale with 5 for strongly agree response, 4 for agree, 3 for neutral, 2 for disagree and 1 for strongly disagree. 39 items were positively arranged (e.g., mathematics is a very worthwhile and necessary subject). Conversely, 16 items questions were negatively arranged (e.g., mathematics makes me feel uncomfortable). For these items, the scale was reversed i.e., 5 for strongly disagree, 4 for disagree, 3 for neutral, 2 for agree and 1 for strongly agree. The composite views score was the total of these rating. Therefore, higher scores indicated more positive views towards mathematics. The sum of all statements of each respondent showed his/her total views scores on the scale. Then, the possible maximum score was 275 and minimum score was 55. The higher score on the scale reflected more positive views towards mathematics and vice versa.

There were five subscales components of the views towards mathematics inventory (VTMI) addressing value, enjoyment, self-confidence, motivation and beliefs. Each and every subscale components did not have equal number of response items: 10 statements measured the value of mathematics; 10 statements items assessed the enjoyment of mathematics; 15 items statements measured self-confidence with mathematics; 5 items were used to assess the motivation towards the mathematics, and 15 items statements measured the students' beliefs about the mathematics (see

Appendix 23). For comparison, the mean of scores of each subscales variables of VTMI were determined. The beginning and end composite view scores were computed for each student.

The researcher determined the students' changed scores of the composite views across the academic year. Researcher also determined whether there was a relationship between gender, academic aspiration, and views about mathematics.

VTMI Components

According to Tapia and Marsh (2004) the subscale variables are described as:

Value: The value was designed to measure students' views regarding the usefulness, relevance, and worth of mathematics in their daily life now and then

Self-confidence: This subscale component was to assess students' confidence and self-concept of their performance in mathematics.

Enjoyment: The enjoyment of the category was constructed to measure the degree to which students enjoy working in mathematics and mathematics classes (Ma & Kishor, 1997; Thorndike, 1922).

Motivation: Motivation subscale category was constructed to measure interest in mathematics, and desire to pursue studies in mathematics.

Belief: Belief subscale component was designed to measure students' learning mathematics in the class and outside as well as their feelings about teacher and mathematics teaching.

Views Status

Changes in views' scores from the students were determined by subtracting the beginning views scores from the end views scores. The total views changes (changed/unchanged) were categorized into three statuses i.e., positive, balance and negative, which was carried out on the basis of mean scores plus minus one standard deviation (Daniel & Russell, 2012). A positive status would indicate that a student's scores of views towards mathematics increased from the beginning to the end of grade 11, whereas, a negative status would indicate that a student´s views decreased. A balance status would indicate that changes in student's views were not sufficiently drastic, and therefore, were considered to remain stable.

The Mathematics Achievement Test (MAT)

This constructed test consisted of 50 multiple choice questions of each of two marks totaling 100 from grade 11 prescribed mathematics curriculums, which covered Algebra, Calculus, Trigonometry, and Coordinate Geometry (see Appendix 4).

Developing the Mathematics Achievement Test

Since the purpose of the study was to study the achievement level of grade 11 students in mathematics, a standardized mathematics achievement test was required to measure the achievement level of the student in the subject. As there was no readymade standardized test available, it was necessary to develop a MAT. For this study, a mathematics achievement test (MAT) for higher secondary level grade 11 students based on the mathematics curriculum 2010 of higher secondary education board (HSEB)/ MOE/ Nepal, was developed by the researcher himself. The development of MAT was done by adopting the standard procedure. As it was necessary to be familiar with the prescribed course of study before constructing the test, the mathematics curriculum prepared by HSEB for higher secondary level (grade 11), and the reference books prescribed by the HSEB available in the market published by private publishers were studied.

Necessary guidelines from the specific grid and model questions prepared by HSEB and the test papers used in the previous examinations were taken into consideration. Based on it and following the specific learning outcomes, the test was developed for students of higher secondary level (grade 11). The instructional objectives defined by the curriculum were considered as the learning outcomes of the students. Thereafter, critical analysis of the prescribed curriculum, reference books, specific grid and other materials related to higher secondary level mathematics for grade 11 students in Nepalese context for the preparation of MAT was carried out. Moreover, four major areas of mathematics such as Trigonometry, Calculus, Algebra and Coordinate Geometry were covered in achievement test. The numbers of test items were selected proportionally from each area of contents. The total 150 teaching hours are provided for grade 11 mathematics curriculum. Teaching hour for Algebra is 78 hours, Trigonometry is 12 hours, Coordinate Geometry is 22 hours, and calculus is 38 hours (Mathematics Curriculum HSEB, 2010). Three hours nationwide external examination of 100 full marks and 35 pass marks is provisioned for grade 11 mathematics courses (see Appendix 11).

At the various levels of cognitive domain, a preliminary draft of mathematics achievement test (MAT) for grade 11 students, containing of 75 multiple choice items corresponding to the content area was prepared after consulting supervisor, teachers and specialists including the instructions for responding to the test items. Items were graded in the ascending order of difficulty.

Preliminary Tryout

Fairly computer typed first blueprint of 75 items was given to five mathematics education experts, five higher secondary school mathematics teachers who were involved in teaching grade 11 mathematics, and a language expert to find out the gross defects in language, appropriateness of the distracters, complexity and coverage of the contents. With their opinion, necessary modifications, deletion and addition in items were made. Thus, a test booklet containing 72 items was typed and photocopied.

To check the language ambiguity, appropriateness of the options, distracters and items, and time required from students' point of view, a draft of such 72 items was given to a group of 50 students of grade twelve, who had completed grade eleven mathematics courses in the previous academic year from an assessable higher secondary school at KMC. It was aimed to find out the level of difficulty as well as the vagueness, if any, in the construction of items as well as the tentative time estimation. It was performed in a convenient higher secondary school, running science program in Kathmandu valley. Items analysis and distracters analysis were done based on the responses of these students. Again, necessary corrections in language, instructions, and distributions of distracters were made on the basis of these students' observations. In this way, the 60 items were finalized for the final tryout.

Final Tryout

For the purpose of final tryout of Mathematics Achievement Test (MAT), hundred sets of items (topic-wise allocation of items included in the booklet shown in the Appendix 10) booklets were prepared. The items were tried out in the mid-week of the month June 2012 on hundred students of grade twelve science students, who had completed and appeared the grade eleven mathematics examinations from one of the sampled higher secondary school with similar setting at Battisputali, Kathmandu. Before answering the questions, students were requested to read the instructions.

Necessary oral instructions for answering were also given. They were also asked to answer all the questions. No time was fixed for the final tryout, but the students were asked to finish the paper as early as they could. The time taken by students who completed and submitted first and last were kept in the record.

Correcting the answer sheet, it was found that four students had not completed all the questions; hence they were not included in the sample. Therefore, only 96 students' answer sheets were selected for item analysis. The average time taken to solve all the items in the test was near about one hour.

Scoring of the Test (Final Tryout)

The answer sheets were scored with the help of scoring key. One score was assigned to each correct response. The total score obtained by a student was the total number of their correct response.

Item Analysis of the Test

The item analysis of achievement test was primarily done to find out ambiguities, clues, ineffective distracters and technical defects that might have been overlooked during test construction. While modifying and eliminating items, it was ensured that no important concept was removed out.

Difficulty Value of the Items

The difficulty value of each of the item was computed for final tryout of the test. As the tryout sample was small, the researcher constructed the frequency distribution of each item based on the responses of these 96 students. An item analysis chart (see Appendix 12) was prepared. The first row of the chart indicated the responses of different students for the first item; the second row indicated the responses of different students for second item and so on. The total number of correct responses in the first row showed the total number of students responding correctly to the first item. The total number of correct responses in the second row showed the total number of students responding correctly to the second item. Similarly, total number of correct responses in each of the remaining sixty rows showed the total number of students responding correctly to each of the remaining sixty items respectively.

Discriminative Value of the Items

The ninety-six students for the final tryout were arranged in descending order of their scores. The student getting the higher scores was ranked first. The student getting next higher score was ranked second. Continuing the process, the student getting lowest scores was ranked ninety fourth. After arranging the students in descending order of their scores, they were classified in three groups. The first group consisted of high scorer, where there were 26 students, which was 27% of total students. The second group consisted of next 44 students, which formed middle 46% of the total students. Likewise, the third group consisted of the remaining 26 students from lower group, which was 27% of the total students. In order to find out the discriminative value of various items, the two groups higher and lower consisting of top 27% of students and bottom 27% of the students were compared. Hence, the total number of students out of top 26 and bottom 26, who responded each of the items correctly, was calculated. This discriminative value of each item of final tryout has been presented in appendix 13.

Final Form of the Mathematics Achievement Test (MAT)

On the basis of item analysis, only those items were selected whose difficulty values were in the interval 0.30 (30%) and 0.70 (70%), and the discriminative values in the interval 0.22 to 0.70. The items whose difficulty values lay in the intervals 0.25 to 0.30 and 0.70 to 0.80, and the discriminative values in the intervals 0.15 to 0.22 and 0.70 to 0.75 were modified. In this way, the item number 21, and 52 were modified. The items whose difficulty values and discriminative values lie beyond the above-mentioned interval were not selected. Likewise, the item numbers 4, 27, 34, 38, 48 were dropped, and the item numbers 8, 15, 23, 42, 45 were not included in the mathematics achievement test. Items were proportionately from the areas covering Trigonometry, Calculus, Algebra and Coordinate Geometry of higher secondary level (grade 11) mathematics. Moreover, the selected items varied in difficulty values. There was no item which was either too easy, or too difficult. The time limit of the text was fixed on the basis of the time taken (about 50 minutes) by the majority of students. The final form of the achievement test has been put in the Appendix 4.

Scoring of the Mathematics Achievement Test (MAT)

For scoring of the mathematics achievement test, a score key was developed. A score of two was assigned for each correct response. The total score obtained by a student was the total number of his correct responses (see Appendix 14).

Reliability of MAT

Reliability refers to the consistency and accuracy of the measurement or scores. According to (Singh, 1986) reliability is the property of the test scores. The internal consistency reliability indicates the homogeneity of the test. The most common method of estimating internal consistency reliability is the split half method in which the test is divided into two halves. The common way is odd-even method. In this method, all odd numbered items (like 1, 3, 5, 7, …) constitute one part of the test and all even (like 2, 4, 6, 8, …) constitute another part of the test. Each examinee, thus, receives two scores: the number of correct responses on all odd numbered items constitutes one score, and the number of correct responses on all even numbered items constitutes another score for the same examinee. In this way, two sets of scores were obtained. Upadhyay (2001) referring to Tuckman (1975) suggests that published tests require test reliabilities of 0.85 or above while teacher made tests are usually considered with reliabilities of 0.60 or above. Sixty items mathematics achievement test were equally divided into two halves and used Rulon and Flanagan formula. In this study, the internal consistency reliability was calculated by the Rulon Formula and Flanagan Formula (see Appendix 24). Both these formulas provide the reliability of the total test score.

The reliability coefficient of the items using Rulon Formula was found 0.91, and the reliability coefficient of the items using Flanagan Formula was found 0.92. Thus, the Rulon Formula and the Flanagan Formula yielded almost all the same coefficient of the reliability, which automatically checked the accuracy of the computation.

Content Validity

The validity of the test refers to that quality of a test, which requires the test to accurately measure what it claims to measure. It is not a statistical concept; rather it is a logical concept. It is concerned with the relevance of the contents of the items, individually as well as whole. Singh (1998) has said that content validity involves essentially the systematic examination of the test content to determine whether it covers a representative sample.

To determine the suitability of the items, pre-pilot test was held on the draft of the test items. The draft of the test was provided to the mathematics teachers. The mathematics teachers accepted the tests as competent tests for testing skills and abilities of the students. It was also observed that the tests were good enough to be used. Teachers also reported that the tests were better than the tests they used in the schools. Likewise, the draft test items were given to the group of subject experts in the subject matter. The experts agreed with the investigator on effectivity of test items. The validity of the test was established by expert judgment.

Areas of Item

In total, there was 150 teaching hours; trigonometry- 12 hours, algebra -78 hours, coordinate geometry -22 hours, and calculus -38 hours. One test item was finalized for three teaching hours' time period. There were 50 items, out of which 4 items from Trigonometry, 13 items from Calculus, 26 items from Algebra and 7 items from coordinate Geometry were included in the mathematics achievement test. The topic wise allocation of items (specific grid) is appended in the Appendix 11.

Student's Demographic Information

The population was stratified into three academic carrier aspiration groups i.e., physical group (physical sciences), biology with additional mathematics (indecisive), and biological group (pure biology without mathematics-non-mathematical sciences). The demographic information was developed in order to obtain detailed information on students' roll number, section, (name- option), SLC compulsory mathematics score and variables including gender, and their academic career plan like continuing mathematics in the succeeding grade, biology with additional mathematics, and biology without mathematics. This information was collected along with survey tools at the beginning and at the end of the academic year (see Appendix 1).

Data Collection Procedure

After construction of Mathematics Achievement Test (MAT), Student's Views towards Mathematics Inventory (VTMI), and adapting Index of Learning Styles (ILS), the next step was to administer these instruments upon the grade 11 science students' of two higher secondary schools (one from first strata and one from the second strata) at the beginning and at the end of the academic year. The researcher consulted the school administration/principals, and explained in details the purpose of the study, and sought permission. Likewise, the subject teachers were approached on the same day and were requested to render their cooperation in the administration of the test. On the assigned day, the researcher went to the class with higher secondary mathematics teachers.

Students who had not participated in the beginning of the academic session were not allowed to take part in the mathematics achievement test including index of learning styles (ILS), and views towards mathematics inventory (VTMI). The purpose of the test taking and survey questionnaire was made clear to them. They were assured that the test results and their views towards mathematics and learning styles information including gender and academic career aspiration were to be used in research purpose only. They were also informed that the test results would not affect their status in their respective sections. Further, they were asked to answer the questions freely and fearlessly without discussing among themselves. The subject teachers helped the researcher in maintaining a sound environment while taking the test.

Before distributing the test, the researcher and the subject teachers explained the students how to give their responses. At the time of administration of the test, the researcher and the subject teachers took special care to ensure that every participating student was following the language and instruction. If any item was not clear, it was explained by researcher. The time given for completing the questionnaire (learning styles and views) at the beginning of the session was forty minutes. The time for academic achievement in mathematics test (MAT) at the end of the session was one hour thirty minutes (50 minutes for MAT, 20 minutes for ILS and 20 minutes for VTMI) including the time for students' views and learning styles questionnaires. The data collection work was completed in the beginning of the new session within the first week and last week of the completion of academic year 2012/13.

Scoring Procedure

Scoring of the MAT was done with the help of self-prepared scoring key. The total scores on MAT were the number of correct responses (see Appendix14). Scoring key of the views (Appendix 7) and learning styles (Appendix 9) were based on the literature performed. Taking into consideration, the scores obtained by the students, it was divided into three categories (positive, balance, negative) based on changed (increased or decreased the views score from beginning to end of academic session) /unchanged (either the views score unchanged or changed within one standard deviation from the mean) views towards mathematics, and four categories (status) based on each learning style dimensions.

Statistical Techniques Used

The descriptive statistics was used for mean, standard deviation, and coefficient of correlations. The mean and standard deviation (SD) of the scores of male and female students of Mathematics (physical group), Biology with additional Mathematics (indecisive group), and Biology with no Mathematics (biological group) were calculated separately. The correlations coefficient between beginning and end surveys of views and learning styles were calculated under the descriptive statistics. The inferential statistics was computed for statistically significant association among the variables. The chi-square, analysis of variance (ANOVA) and t-score were used to analyze the data using the statistical package for social sciences (SPSS) version 20. The information obtained from questionnaire forms were converted into quantitative data.

Procedure of Data Analysis

The raw data were gathered from the answer sheets and questionnaires, and then entered into computer using SPSS programs for carrying out detailed analyses.

The data analyses covered both descriptive and inferential statistics. To analyze the data according to the purpose of the study, data analyses were carried out at several stages in the following sequence.

- The frequency distributions and percentage distribution of students were computed with respect to gender and academic career aspiration.
- The computation of beginning and end learning styles preferences of students based on gender and academic aspiration were performed.
- The mean scores and standard deviation (SD) of beginning and end views towards mathematics with subscale components were computed.
- The computation of students' views towards mathematics based on gender and academic aspiration were performed.
- Beginning and end learning styles total and difference into different domain focused to gender and academic aspiration career plan were computed.
- The data analysis was involved in computation of learning styles changed/unchanged status based on gender and academic aspiration.
- Beginning and end views total and differences based on gender and academic career aspiration plan were computed.
- The data analysis was involved in the computation of changed/unchanged status of views based on gender and academic aspiration.
- The mean and standard deviation of mathematics achievement test (MAT) with respect to gender and academic aspiration were computed.
- The correlation coefficients between beginning and end views towards mathematics with subscale components were computed.
- The correlation coefficients between beginning and end learning styles dimensions were computed.

- The correlation coefficient between learning styles and views by beginning and end were computed.

The mean, SD, percentage, frequency, and correlations were computed in the above cases. Similarly, t-test, chi-square, one-way ANOVA, and General Linear Model (2-way ANOVA) were computed to see the significance of the differences in the learning styles, views, and achievements of the students in different samples. Analysis of relations between students' achievement and the attributing factors related with demographics, views (positive, balance, negative), and learning styles changed/unchanged status were processed using simple statistical rule.

Research Questions, Data Type, Data Source and Statistics Involved

The following Table 3.2 is the outline of research questions, statistical measure and data sources.

Table 3.2

Statistical Applications Tools for this Quantitative Research Questions

Research Questions	Statistical Applications	Data Source
What are the learning styles of higher secondary school students at the beginning and end of the academic year?	Frequency, Percentage Correlations, Chi-square	Felder-Soloman's Inventory of Learning Styles (ILS) , Demographic
What are the students' views on mathematics and mathematics learning at the beginning and end of the academic year?	Frequency, Percentage, Mean, SD, Correlations, t-test, ANOVA	VTMI based on M. Tapia's, ATMI , Demographic
Does relationship exist between learning styles and views towards mathematics?	Correlations	ILS, VTMI
What is the achievement of students in mathematics by gender and academic aspiration?	Frequency, Percentage, Mean, SD, ANOVA	MAT, Demographic
Is there any relationship between the learning style and mathematics achievement?	Frequency, Mean, SD, ANOVA	ILS, MAT, Demographic
Is there any relationship between views and mathematics achievement?	Frequency, Mean, SD, ANOVA	VTMI, MAT, Demographic
What type of association exists among the students' learning styles, views, and mathematics achievement?	Frequency, Mean, SD, ANOVA	ILS, VTMI, MAT,

Summary

This chapter described the methodology that was used to conduct and analyze the data in this study. The research was survey research in nature with a quantitative analysis of data. The purpose of this study was to understand the relationship among the learning style preferences, views, and achievement in mathematics of the higher secondary school students. In this relation, specially, this chapter described the process of examining the beginning and end learning style preferences, beginning and end views, and academic achievement between the gender and academic aspiration in the sample. It aimed to correlate beginning and end survey results, categorizing the learning styles and views changed/unchanged status.

Data analysis consisted of descriptive statistics of the mean, standard deviation, and percentage of the groups and inferential statistics such as t-test, chi-square, and analysis of variance. The study employed the use of Felder-Soloman's 44 items index of learning styles and 55 items views about mathematics questionnaire. These inventories were administered in the beginning of the academic year 2012/13. The researcher-made 50 items mathematics achievement test was used near the end of academic year along with ILS and VTMI. The data were collected from 247 grade 11 science students by gender and academic aspiration. The collected data were analyzed using SPSS for PC.

CHAPTER IV

RESULTS ANALYSIS AND INTERPRETATION

The purpose of this study was to examine the learning styles and the views towards mathematics of higher secondary school students (SLC level compulsory mathematics mean score 87.91 with SD 10.03 of sample students) in grade 11 mathematics course. The study focused on (1) Learning styles dimensions (active-reflective, sensing-intuitive, visual-verbal, sequential-global), (2) views (with subscale components as value, enjoyment, self-confidence, motivation, belief), (3) academic achievement in mathematics, and (4) students' gender and academic aspiration. The mathematics achievement test (MAT) was dependent variable. Students' learning styles, views towards mathematics, and demographic (gender and academic groups like physical group, biology with additional mathematics and purely biological group) were independent variables of this study. The quantitative methods were used to measure these variables and their associations. For this purpose, data regarding the gender, academic career aspiration, learning styles, students' views towards mathematics and achievement test in mathematics of grade 11 science students were collected from two higher secondary schools running science program in Kathmandu metropolitan city. The statistical analysis of the data and obtained results has been reported in this chapter.

Before applying parametric test, the data were analyzed using descriptive statistics to get the initial insights for further data analysis procedures. The descriptive statistics were used to explore those learning styles, views and achievement in mathematics that have led to the development of inferential statistics. So, this chapter has two stages. In the first stage, descriptive statistics has been employed, which is followed by inferential statistics in the second stage.

The first stage sought to determine the extent to which grade 11students' learning styles and views changed during the academic year in mathematics course. This stage also examined the correlation between students' beginning and end learning styles and views towards mathematics. Mainly, this stage addressed research questions 1, 2, 3, and 4. The second stage, likewise, dealt with the significant associations among the dependent and independent variables. This inferential statistics stage addressed the research questions 5, 6, and 7.

Table 4.1

Distribution of Participants by Gender and Academic Aspiration

	Academic aspiration (academic group)				
	Physical	Biology with Math	Biological	Total	Percentage
Male	96	43	22	161	65.2
Female	8	55	23	86	34.8
Total	104	98	45	247	
Percentage	42.1	39.7	18.2		100%

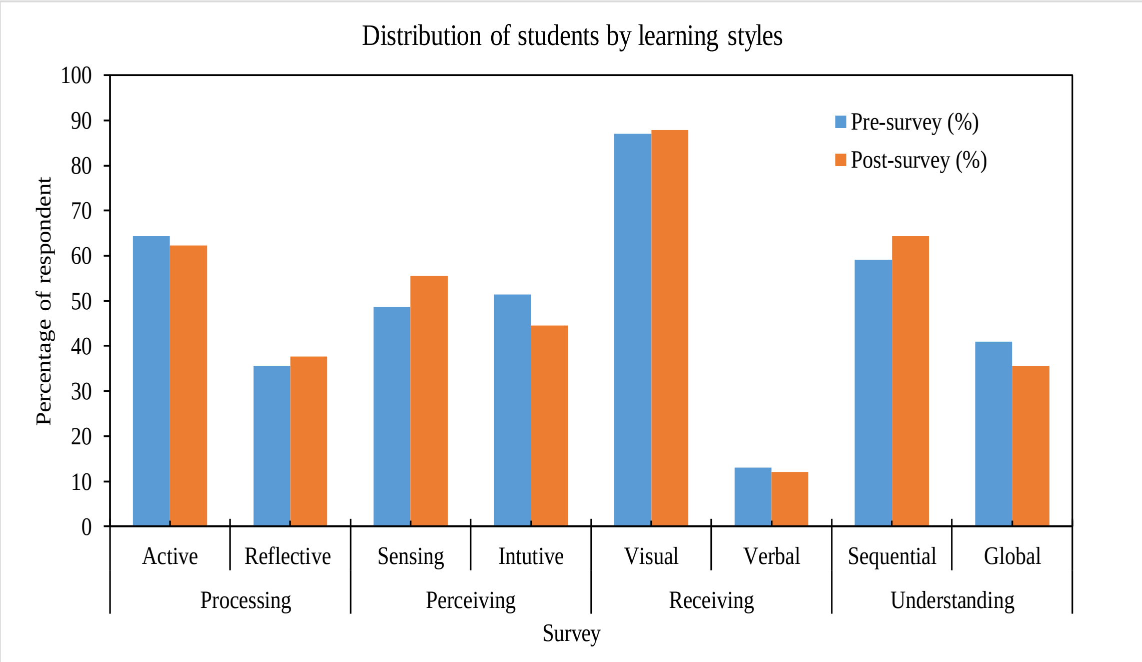
Table 4.1 shows that 247 higher secondary level grade 11science students were involved in this study. These students participated in the study at the beginning and end of the academic year. In terms of gender, 65.18% (N=161) of the students were male, and 34.82% (N=86) of them were female. In terms of academic aspiration career plan, 42.1% (N=104) of the students took the mathematical sciences (physical group), 39.7% (N=98) of them took biology with additional mathematics, and 18.2% (N=45) of them were non-mathematical students (biological group).

Learning Styles and Demographic Information

This section discusses the students' beginning and end learning styles and their association by gender and academic aspiration (group).

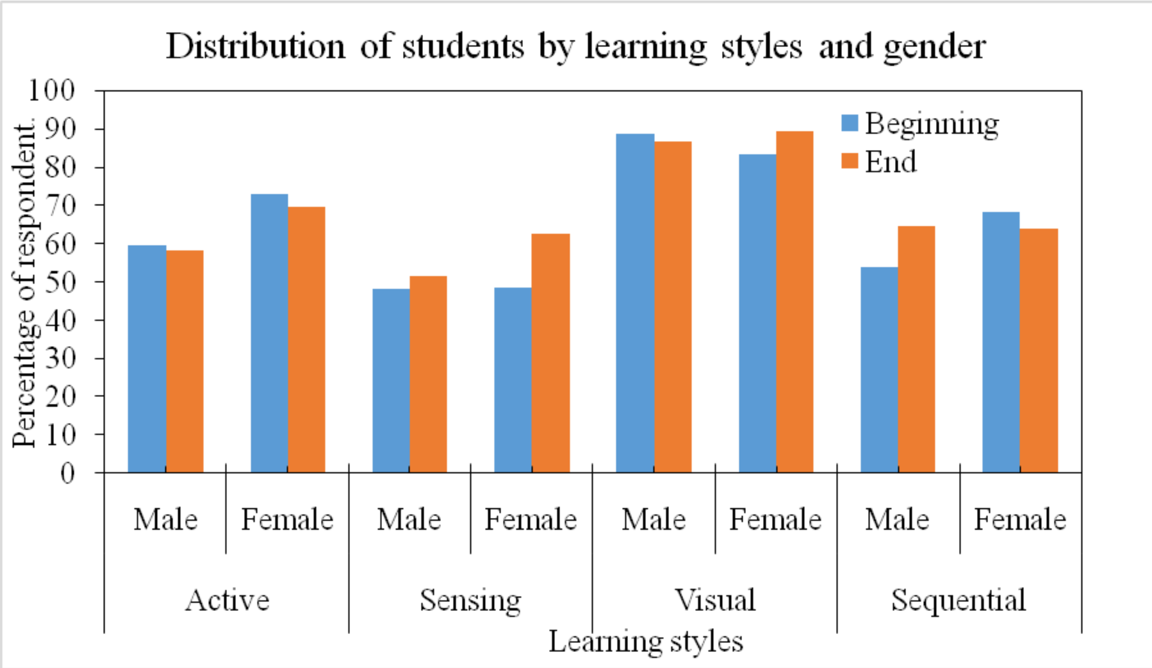
Figure 4.1 Distribution of Students by Learning Styles

Figure 4.1 shows variation in students' learning styles from beginning to the end of academic year in perceiving (sensing-intuitive) and understanding (sequential-



global) dimensions. However, small changes occurred in processing (active-reflective) and receiving (visual-verbal) learning styles. Majority of the students were in active (beginning 64.4%, end 62.30%), visual (beginning 87%, end 87.90%) and sequential (beginning 59.10%, end 64.40%). The pattern, thus, indicated that the percentage distribution of active learning style slightly decreased from beginning to end. However, there was slight increment in other learning styles from beginning to end. Figure 4.1 showed the overall distribution of learning styles, which in showing distribution of learning styles with respect to gender, is extended to figure 4.2 below

Figure 4.2. Distribution of Students' Learning Styles by Gender



The Figure 4.2 shows that the majority of the female students were active in both beginning (73.3%) and end (69.8%) survey compared to their male counterparts. In sensing learning styles, the female students increased from beginning (48.8%) to end (62.8%). In sequential learning style domain, the male students increased from beginning (54.0%) to end (64.4%), while female students decreased from beginning (68.6%) to end (64.0%).There, majority of the students (both male and female) in both beginning and end study were in visual learning styles domain. Figure 4.1 showed the overall distribution of learning styles. Regarding the distribution of learning styles by academic aspiration, it was extended to figure 4.3.

Figure 4.3. Distribution of Students' Learning Styles by Academic Aspiration

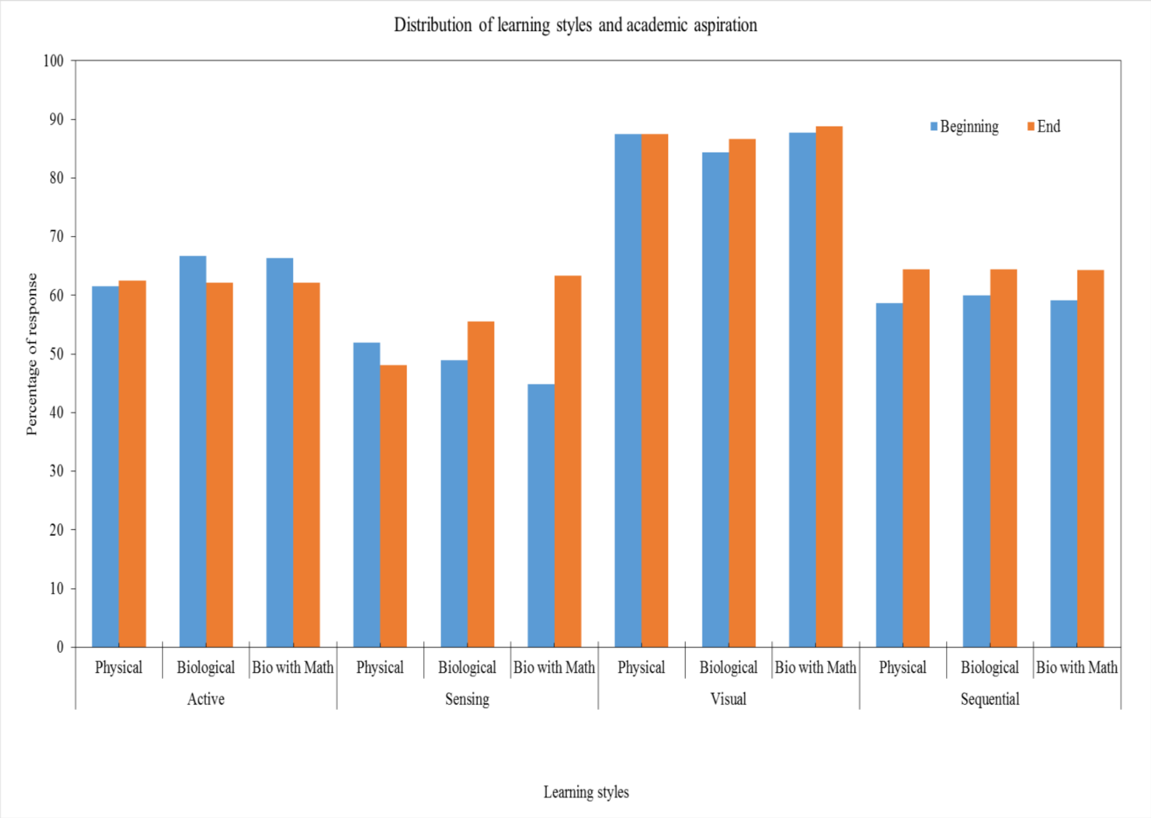


Figure 4.3shows that physical group students decreased from beginning to end in the active, sensing and visual learning styles domain while increased in sequential. Likewise, biology with mathematics group students decreased from beginning (66.3%) survey to end (62.2%) in active learning styles domain, while increased in sensing from beginning (44.9%) to end (63.3%). Biological group students decreased from beginning to end in active (66.7% to 62.2%) and increased from beginning to end in sensing (48.9.0% to 55.6%), and sequential (60% to 64.4%) learning styles domain.

The Table 4.2 below examined the relationships between beginning and end learning style dimensions.

Table 4.2

Correlation between Beginning and End Learning Styles

Learning Styles	End Active	End Sensing	End Visual	End Sequential
Beginning Active	0.41*			
Beginning Sensing		0.37*		
Beginning Visual			0.50*	
Beginning Sequent				0.26*

* *indicates the significant of correlation*

Table 4.2 shows that there was positive correlation between the beginning and end corresponding learning style dimensions. There was higher correlation in visual learning style(r=0.50) followed by active learning style (r=0.41) and lower correlation in sequential learning style dimension (r=0.26). All were significant at 5%. The study revealed that grade 11 science students' learning style preferences within the interval of one academic year were in the same directions.

Table 4.3 below, similarly, presents the overall cross distribution of beginning and end learning style dimensions. This table also measured the statistically significant association among the beginning and end learning styles dimension.

Table 4.3

Distribution of overall Beginning and End Learning Styles and chi-square analysis

Learning styles				N	χ^2	df	p-value
		End					
		active	reflective				
Beginning	active	113	46	159	14.46	1	0.00
	reflective	41	47	88			
	Total	154	93	247			
		End					
		sensing	intuitive				
Beginning	sensing	83	37	120	17.74	1	0.00
	intuitive	54	73	127			
	Total	137	110	247			
		End					
		visual	verbal				
Beginning	visual	198	17	215	27.94	1	0.00
	verbal	19	13	32			
	Total	217	30	247			
		End					
		sequential	global				
Beginning	sequential	106	40	146	10.55	1	0.00
	global	53	48	101			
	Total	159	88	247			

Table 4.3 shows that the calculated chi-square value in the active-reflective learning styles dimension was 14.46 and the degree of freedom (2-1) x (2-1)=1. It indicated that this was significant at 0.05 probability level (chi-square=14.46, df=1, p=0.00). Similarly, the chi-square value for sensing-intuitive learning styles dimension was 17.74, for visual-verbal learning styles dimension was 27.94 and sequential-global learning styles dimension was 10.55 with one degree of freedom. In each case the probability level was p=0.00. Therefore, there was a statistically

significant change between the beginning and end learning style for each dimension active-reflective; sensing-intuitive; visual-verbal; and sequential-global. Therefore, the null hypothesis Ho:1"There is no significant difference in the learning styles between beginning and end of grade 11 science students" failed to accept.

Tables 4.4 and table 4.5 below are extension of table 4.3 above. It presents the cross distribution of beginning and end ILS survey, which measured participants' learning style preferences by gender and academic aspiration. This table revealed the significant or no significant association between beginning and end learning style preferences.

Table 4.4a

Analysis of beginning and End Active -Reflective Learning Style by Gender

Gender			End		χ^2	df	P-value
			active	reflective			
Male	Beginning	act	67	29	12.73	1	0.00
		ref	27	38			
Female	Beginning	act	46	17	1.18	1	0.27
		ref	14	9			

Table 4.4a shows that the test statistic was partially significant: χ^2 (1) =12.73, p=0.00. Therefore, the null hypothesis Ho: 1a "There is no significant relationship in the learning style (active-reflective) between beginning and end of students by gender" was partially failed to reject.

There was statistically significant association between beginning and end survey of active- reflective learning styles with respect to male students. However, the female students' association between beginning and end survey was not statistically significant (p=0.27).

The result, thus, indicated that there was more consistency in active-reflective learning styles among the female students from beginning to the end of the academic year in comparison with male students.

Table 4.4b

Analysis of Beginning and End Sensing-Intuitive Learning Style by Gender

Gender			End sensing	End intuitive	χ^2	df	p-value
Male	Beginning	sensing	51	27	11.59	1	0.01
		intuitive	32	51			
Female	Beginning	sensing	32	10	6.31	1	0.00
		intuitive	22	22			

Table 4.4b shows that the test statistic was statistically significant: $\chi 2$ (1) =11.59 p=0.012 for the male students, and $\chi 2$ (1) =6.31 p=0.00for female students. Therefore, the null hypothesis Ho: 1a “There is no significant relationship in the learning style (sensing-intuitive) between beginning and end survey of students by gender” was failed to accept.

There was statistically significant association between beginning and end survey of sensing- intuitive learning styles with respect to the gender of the students. The table 4.4b shows that there was no consistency in sensing-intuitive learning styles among higher secondary school science students from beginning to the end of the academic year. Clearly, it was observed that changes occurred in sensing-intuitive learning styles within the academic year.

Table 4.4c

Analysis of Beginning and End Visual-Verbal Learning Style by Gender

Gender			End		χ^2	df	p-value
			visual	verbal			
Male	Beginning	visual	131	12	24.4	1	0.00
		verbal	9	9			
Female	Beginning	visual	67	5	5.85	1	0.01
		verbal	10	4			

Table 4.4c indicated that the test statistic was statistically significant: $\chi2$ (1) =24.40 and p=0.00 for the male students and for the female students: $\chi2$ (1) =5.85 and p=0.016. Therefore, the null hypothesis Ho: 1a "There is no significant relationship in the learning style (visual-verbal) between beginning and end survey of students by gender" was failed to accept. There was statistically significant association between beginning and end survey of visual-verbal learning styles with respect to the gender of the students.

This result, thus, indicated that there was no consistency in visual-verbal learning styles among higher secondary school science students from beginning to the end of the academic year. Clearly, it was observed that changes occurred in visual-verbal learning styles within the academic year.

Table 4.4d

Analysis of Beginning and End Sequential-Global Learning Style by Gender

Gender			End		χ^2	df	P-value
			sequential	global			
Male	pre	sequential	65	22	8.47	1	0.00
		global	39	35			
Female	pre	sequential	41	18	2.5	1	0.11
		global	14	13			

Pre- Beginning

Table 4.4d shows that the test statistic was statistically significant: $\chi2$ (1) =8.47, p=00 for the male students. Therefore, the null hypothesis "There is no significant relationship in the learning style (sequential-global) between beginning and end survey of students by gender" was partially failed to accept.

There was statistically significant association between beginning and end survey of sequential-global learning styles with respect to male students. However, the female students' association between beginning and end survey was not statistically significant (p=0.11). The Table 4.4d also shows that there was lower consistency in sequential-global learning styles among higher secondary school male science students in comparison with their female counterpart from beginning to the end of the academic year. Clearly, it was observed that changes occurred in sequential-global learning styles within the academic year among the male students. It was also observed that the tendency of female students remained in the same sequential and global learning style dimension throughout the academic year.

Table 4.5a

Analysis of Beginning and End Active-Reflective Learning Style by Academic Aspiration

Academic aspiration			End		$\chi2$	df	P-value
			active	reflective			
Physical	pre	act	45	19	4.33	1	0.03
		ref	20	20			
Bio with Math	pre	act	48	17	11.06	1	0.00
		ref	13	20			
Biological	pre	act	20	10	0.76	1	0.38
		ref	8	7			

Pre- beginning

Table 4.5a shows the statistical chi-square analysis to test association of beginning and end active-reflective learning styles of students. The physical and biological with mathematics academic aspiration groups of students was observed to have statistically significant association between beginning and end survey of active - reflective learning styles, $\chi2$ (df=1) =4.33and p=0.03 for physical group students and

$\chi2$ (df=1) =11.06, p=0.00 for biological with mathematics groups of students. Therefore, the null hypothesis Ho: 1b “There is no significant relationship in the learning style (active-reflective) between beginning and end survey of students by academic aspiration” was partially failed to accept.

However, there was no significant association between beginning and end survey for purely biological group students on the active-reflective learning styles (p=0.38). It, thus, indicated that the changes in active-reflective learning styles occurred among the physical group and biology with mathematics group of students, while there was a consistency among biological group of students.

Table 4.5b

Analysis of Beginning and End Sensing-Intuitive Learning Style by Academic Aspiration

Academic aspiration			End sensing	End intuitive	$\chi2$	df	p-value
Physical Group	pre	sen	33	21	7.64	1	0.00
		int	17	33			
Bio with Math	pre	sen	34	10	6.74	1	0.00
		int	28	26			
Biological Group	pre	sen	16	6	5.14	1	0.02
		int	9	14			

Pre- beginning

Table 4.5b shows the statistical chi-square analysis to test for association of beginning and end sensing-intuitive learning styles of students. The physical group, biological with mathematics and biological group all three-academic aspiration group of students was observed to have statistically significant association between beginning and end survey of sensing -intuitive learning styles, $\chi2$ (df=1) =7.64 and p=0.00 for mathematical students; $\chi2$ (df=1) =6.74 and p=0.00 for biological with mathematics students; and $\chi2$ (df=1) =5.14 and p=0.02 for biological group students. Therefore, the null hypothesis Ho: 1b “There is no significant relationship in the learning style (sensing-intuitive) between beginning and end survey of students with respect to academic aspiration" was failed to accept. It indicated that there was no consistency in sensing-intuitive learning styles among higher secondary school science students from beginning to the end of the academic year based on academic aspiration. Clearly, it was observed that changes occurred in sensing-intuitive learning styles within the academic year.

Table 4.5c

Analysis of Beginning and End Visual-Verbal Learning Style by Academic Aspiration

Academic aspiration		End visual	End verbal	$\chi 2$	df	P- value
Physical	vis	85	6	23.22	1	0.00
	ver	6	7			
Bio with Math	vis	78	8	2.60	1	0.10
	ver	9	3			
Biological	vis	35	3	6.25	1	0.00
	ver	4	3			

Table 4.5c shows the statistical chi-square analysis to test for association of beginning and end visual-verbal learning styles of students. The physical and biological academic aspiration group of students was observed to have a statistically significant association between beginning and end survey of visual-verbal learning styles, $\chi 2$ =23.22 and p=0.00 for physical; and $\chi 2$ = 6.25 and p=0.01 for biological group. However, there was no significant association between beginning and end surveys on the visual-verbal learning styles for biology with mathematics academic aspiration group of students at 5%. Therefore, the null hypothesis "There is no significant relationship in the learning style (visual-verbal) between beginning and end survey of students by academic aspiration" is partially failed to accept.

It indicated that there was more consistency in visual-verbal learning styles among biology with mathematics group of higher secondary school science students compared to physical and purely biological group of students from beginning to the end of the academic year. Clearly, it revealed that changes occurred in visual-verbal learning styles within the academic year based on academic aspiration.

Table 4.5d

Analysis of Beginning and End Sequential-Global Learning Style by Academic Aspiration

Academic aspiration			End sequential	End global	χ2	df	p-value
Physical Group	Beginning	seq	47	14	10.26	1	0.00
		glo	20	23			
Bio with Math	Beginning	seq	41	17	2.54	1	0.11
		glo	22	18			
Biological Group	Beginning	seq	18	9	0.15	1	0.70
		glo	11	7			

Table 4.5d shows the statistical chi-square analysis to test association of beginning and end sequential-global learning styles of students. The physical group of students was observed to have statistically significant association between beginning and end survey of sequential-global learning styles, χ2 (df=1) =10.26, p=00. Therefore, the null hypothesis Ho: 1b “There is no significant relationship in the learning style (sequential-global) between beginning and end survey of students by academic aspiration” was partially failed to accept.

However, biology with mathematics and purely biology groups of students had no statistically significant association at 0.05 level of significance, where between beginning and end surveys of sequential-global learning styles, the result for biology with mathematics was χ2 (df=1) =2.54, p=0.01, and for purely biological group students was χ2 (df=1) =0.15; p=0.70.The table 4.5d indicated that more changes of sequential-global learning styles dimension occurred in the physical group students compared to biology with mathematics and biological group of students. The more consistency was observed among the biological group students in sequential-global learning styles within the academic year. The above tables 4.3, 4.4 and 4.5 showed the learning style preferences.

Figure 4.4 below shows the category of changed unchanged overall distribution of students' with respect to learning style domains.

Figure 4.4. Overall Distribution of Changed/Unchanged Status of Learnig Styles

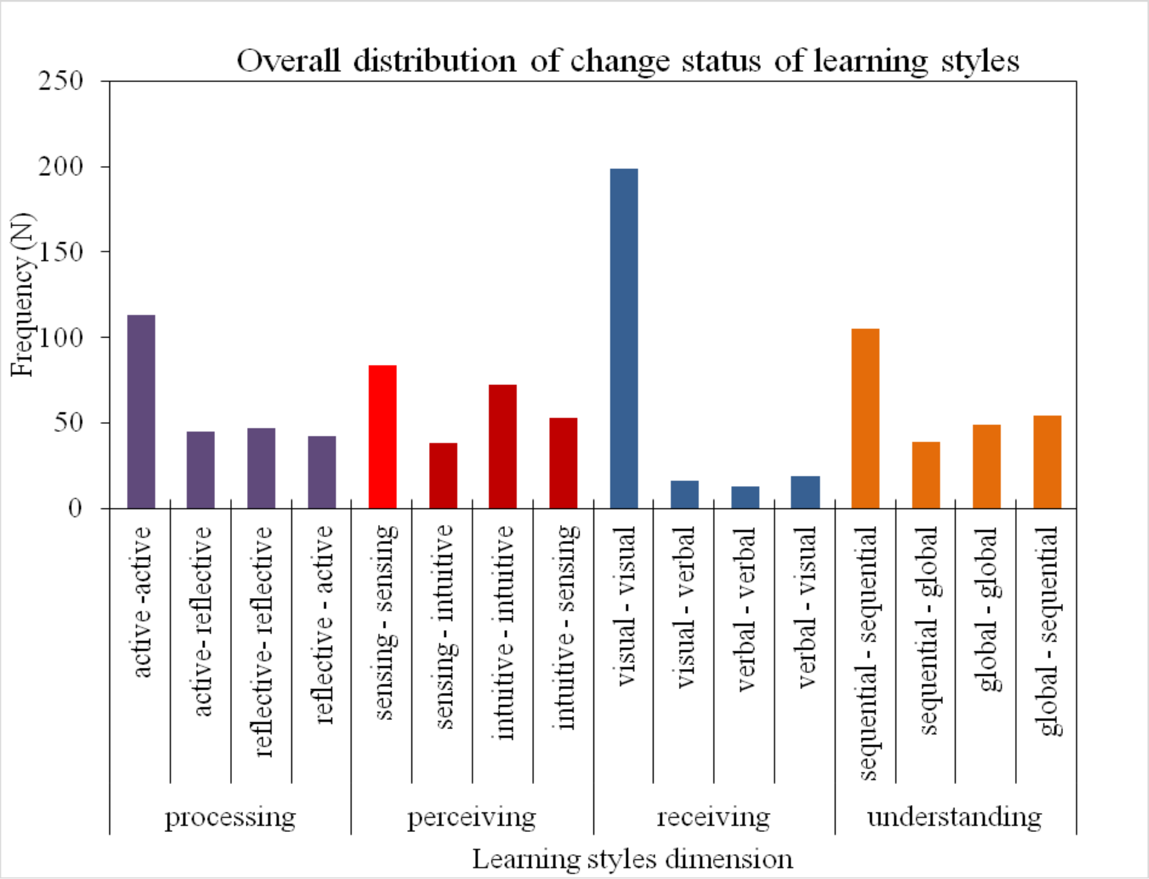


Figure 4.4 shows that the majority of the students did not change their learning styles from beginning to end surveys, showing that they were predominantly visual (80.6%); active (45.7%); sequential (42.5%) and sensing (34.0%) out of total of 247 students. The Figure also indicated that there was tendency of students to remain in the same learning styles preferences.

Figure 4.5 and Figure 4.6 below display the distribution of male and female students' change unchanged learning style status and students' academic aspiration.

Figure 4.5. Distribution of Change Status of Learning Styles and Gender

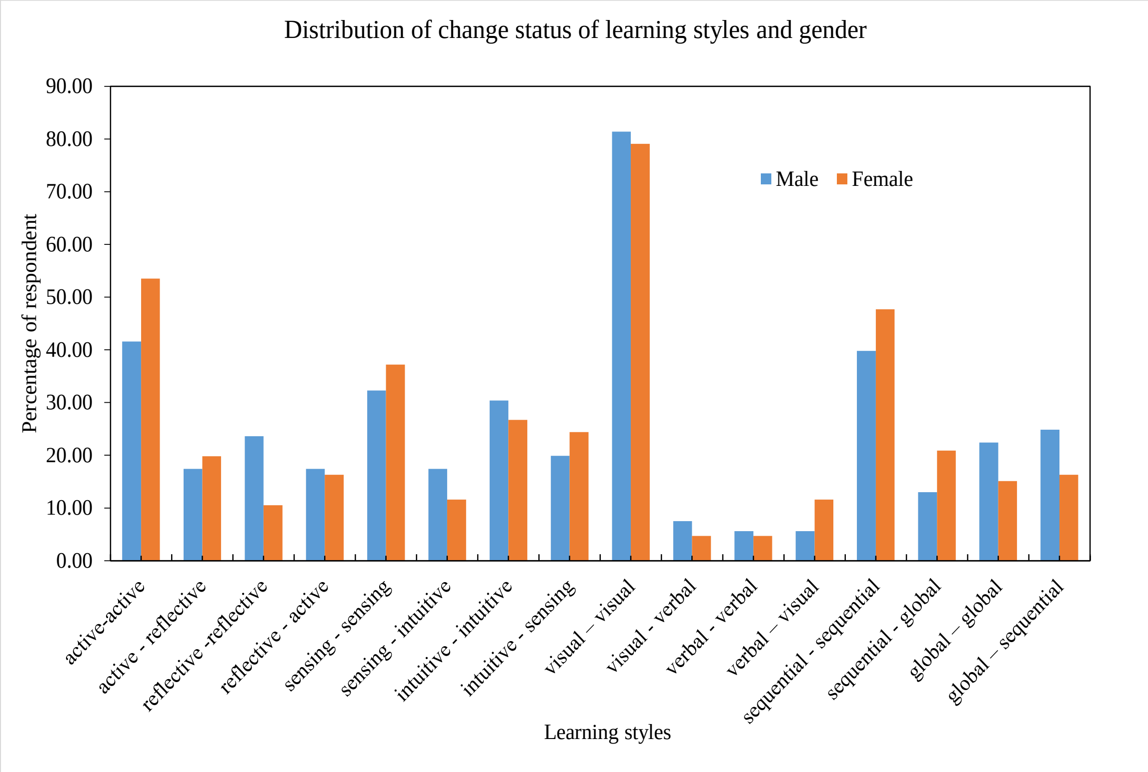


Figure4.5 shows that in active-reflective learning styles dimension, majority of both male and female students were in active to active domain from beginning to end. However, in reflective learning style domain 23.6% of male remained at reflective to reflective. 17. 4% male and 11.6% female students shifted from sensing to intuitive. Likewise, 19.9% male and 24.4% female shifted from intuitive to sensing. Interestingly, majority of students were in the same learning style domain from beginning to end survey. In visual/verbal dimension, majority of both male and female were in visual to visual learning style domain.

In sequential-global dimension, 47.7% female students were in sequential to sequential, while 39.8% male were there. Similarly, 24.84% male, and 16.3% female shifted from global to sequential.

Figure 4.6. Distribution of Changed/Unchanged Status of Learning Styles by Academic Aspiration Group

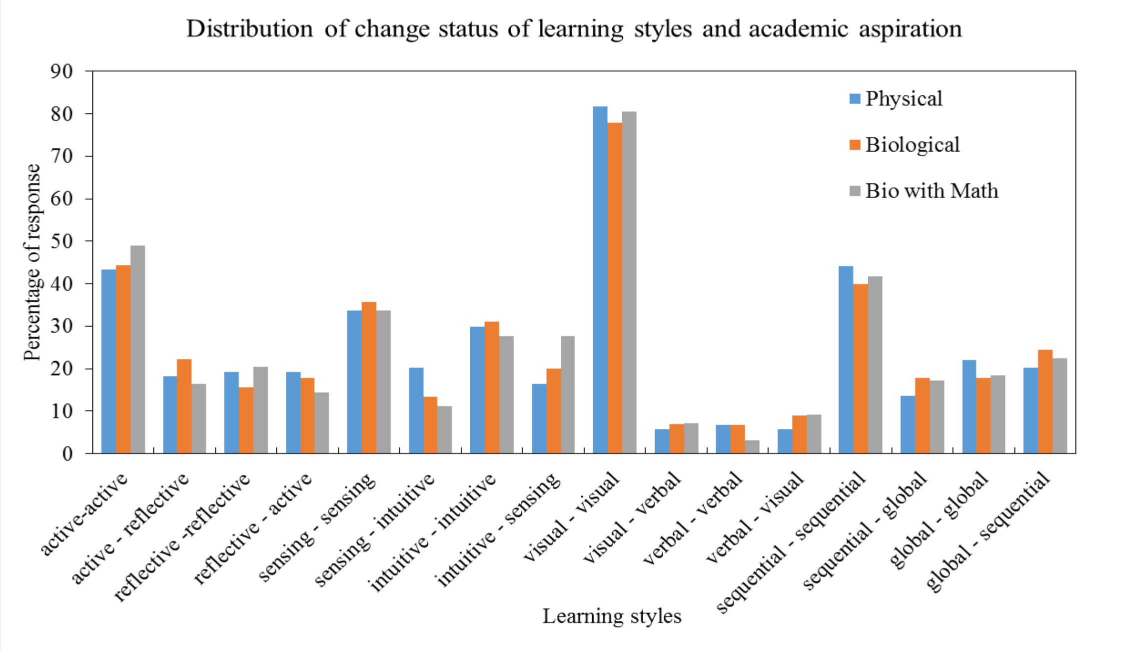


Figure 4.6 shows that the pattern of physics, biological and bio with additional mathematics group of students were decreased from reflective to active learning style by 22.2%, 18.3%, and 14.3% respectively. From active to reflective pattern, it increased from biological (22.7%), physical (18.3%), and biology with additional mathematics (16.3%). In the sensing-intuitive learning styles dimension, the pattern of shifted learning styles were decreased from physical group (20.2%), biological group (13.3%),and biology with mathematics group (11.2%) while in intuitive to sensing it was increased in ordered from physical group (16.3%), biological (20.0%), and biology with mathematics (27.6%).

In visual-verbal learning styles, majority of physical group, biological group and biology with mathematics group students were in the visual domain both in beginning and end survey. In sequential-global learning styles, the pattern of shift of learning styles from sequential to the global was physical group 13.5%, biology with additional mathematics 17.3%, and biological 17.8%. It increased from global to the sequential as physical group (20.2%), biology with additional mathematics (22.5%), and biological group (24.4%).

Views towards Mathematics and Demographic Information

This section discusses the students' beginning and end views and their association by gender and academic aspiration (group). Table 4.6below, addresses the research question 2. This table sought to find out the beginning and end views of mathematics as perceived by the higher secondary school science students. The views questionnaire comprised 55 items based on 5-point likert scale with a total score of 275, measuring their views towards mathematics. The result below demonstrates that all the students had positive views based on their views score with subscale components.

Table 4.6

Distribution of Views with Subscale Components and Mean Scores

Views with subscales	No of items	Survey	N	Mean	SD	Mean of each item
Value	10	Beginning	247	43.5	4.0	4.4
		End	247	42.9	4.6	4.3
Enjoyment	10	Beginning	247	40.5	6.1	4.1
		End	247	39.1	6.8	3.9
Self-confidence	15	Beginning	247	58.1	9.5	3.9
		End	247	57.2	10.5	3.8
Motivation	5	Beginning	247	18.6	3.5	3.7
		End	247	18.0	3.6	3.6
Belief	15	Beginning	247	60.8	5.7	4.1
		End	247	54.5	8.6	3.6
Total views	55	Beginning	247	221.6	24.4	4.0
		End	247	211.7	28.9	3.9

Table 4.6 shows descriptive statistics, computed for students' total views scores, where their scores on each of the five view subscale components were measured on each individual survey item. The standard deviation of each subscale components and total views were also measured. These measures included mean, standard deviation, and mean of each item. Students' beginning survey scores and end

survey scores were most positive for value of mathematics, with the mean score of each item of beginning survey 4.4 and end survey 4.3. The mean low score of each item in motivation were with beginning survey 3.7 and end 3.6. The mean score of each item in belief variable varied more from beginning score 4.1 to end 3.6, where mean of beginning total item was 4.0 and end was 3.9. However, the standard deviation varied more from beginning to end in subscales component belief. The mean views score was 221.6 with standard deviation 24.4 in beginning survey, and mean views score 211.7 with standard deviation 28.9 in the end survey. This table 4.6 also revealed that there were slightly positive beginning and end views with subscale components towards the mathematics. However, end views scores were less than the beginning views score. In each item mean ranged from 3.6 to 4.4. This descriptive analysis investigated that the views towards mathematics scores were lower from beginning survey to end survey.

To test the relationship between beginning and end views with subscale components, the paired sample t- test was computed, and so as the results are displayed in Table 4.7.

Table 4.7

Analysis of Beginning and End Views with Subscale Variables. Paired Samples Test (N=247)

Pairs	Paired Differences	Mean	SD	t	df	P-value
1	end value total - beginning value total	-0.62	4.58	-2.11	246	0.03
2	end enjoy total –beginning enjoyment total	-1.36	5.56	-3.86	246	0.00
3	end self conf total –beginning total	-0.92	9.66	-1.50	246	0.03
4	end motivation total - beginning total	-0.64	3.59	-2.79	246	0.00
5	end belief total - beginning belief total	-6.32	8.47	-11.7	246	0.00
6	end views total - beginning views total	-9.83	24.58	-6.29	246	0.00

beg- beginning; self conf- self confidence

The paired t-test was used to compare the means of the survey at the beginning and at the end (Table 4.7). The study measured each subject at the beginning and at the end of the academic year. The paired comparison t- test measured whether the means of beginning scores and the end scores of views with subscale components of two surveys differed significantly. The survey results revealed that the t score in value toward mathematics was 2.11 with 246 degree of freedom; results were significant at the 0.05 probability level (2 tailed). Likewise, the score on end survey was found to be significantly lower than score on beginning survey (t=2.11, df=246, p=0.03). The t-test for the mean scores of beginning enjoyment and end enjoyment were found significantly difference at probability level 0.05. The mean score on end survey was lower than the mean score on beginning survey of enjoyment subscale component of views (t=3.86, df=246, p=0.00). It was found that the mean of beginning survey and mean of end survey difference significantly at probability level 0.05 on self-confidence subscale component of views, (t=1.50, df=246, p=0.03). A paired sample t- test indicated that scores were significantly higher for the beginning survey than for the end survey of motivation subscale (t= 2.79, df=246, p=00). The paired comparison t- test revealed that scores were significantly higher for the beginning survey than for the end of belief subscale (t=11.72, df=246, p=00). A pair samples t -test was conducted to evaluate whether beginning views total mean score were higher or end views total mean score. The results indicated that the beginning mean score was higher than end mean score, significant at .05 level of probability (t=6.29, df=246, p=0.00).

Hence, there was no sufficient evidence to accept the null hypothesis Ho:2 “There is no significant relationship in the students' views with subscale components between at the beginning and at the end survey of grade eleven science students”. It was found that there was significant difference between beginning and end survey of views with subscales. Therefore, mean comparisons between beginning and end subscale views showed that mean beginning scores were statistically higher ($p<0.05$) than the mean end scores for all subscales.

To test the relationships between beginning and end views with subscale components, the correlations were computed, where results are displayed in Table 4.8. The detail correlations are appended in Appendix 21.

Since there was positive correlations between each subscale components and composite views in both beginning and end surveys, it shows that views only is sufficient in further analysis.

Table 4.8

Correlation between Beginning and End for Each Subscale Components and Composite Views

Views components	Correlation (beginning and end)	Composite Beginning views	composite End views
value	0.44	0.69	0.69
enjoyment	0.63	0.90	0.91
self-confidence	0.54	0.92	0.91
motivation	0.50	0.81	0.79
belief	0.36	0.81	0.82

Table 4.8 shows that there were positive correlations between beginning and end survey scores for each subscale components, it shows that views only is sufficient in further analysis. Also, as expected, there were positive correlations between beginning-subscales and overall beginning views, and between end subscales and overall end views. All correlations were significant at 5%. The correlation between beginning and end composite views was 0.59. Table 4.8above indicated the overall views score. To analyze mean scores difference between male and female students, the analysis of t- test was computed and displayed in the Table 4.9 below.

Table 4.9

Differences in beginning-Test and End-Test of Views Score by Gender

Gender	N		Begin ning Views	End views	Mean Differenc e	S D of Difference	t	df	P-value
Male	161	Mean S D	223.71 22.33	214.92 25.84	-8.79	25.38	0.9 1	245	.36
Female	86	Mean S D	217.56 27.54	205.77 33.14	-11.76	23.02			

In general, beginning and end views scale for both male and female exhibited positive trends towards mathematics. Table 4.9 shows that the beginning-views mean scores were higher than the end-views mean scores. The results also showed that male student's views score towards mathematics decreased from the beginning (mean= 223.71; SD=22.33) to the end of the academic year (mean= 214.92; SD=25.84). This table also revealed that female students' overall views towards mathematics decreased from beginning (mean= 217.53; SD=24.39) to the end of the academic year (mean =205.77; SD=33.14). However, female students' mean difference between beginning to end (M=-11.76) was more than the male students' mean difference (M=-8.79).

The independent sample t- test revealed that non-significant difference in students' views towards mathematics between male and female was found, *t* (df=245) =0.91; *p*=0.36. Therefore, there was no sufficient evidence to reject the null hypothesis Ho: 2a "there is no significant relationship in the views between beginning and end survey of students by gender" at 0 .05 level of significant. It, thus, indicated that there was no statistical significant differences between the views mean scores of male and female students obtained by male and female higher secondary science students within the academic year.

To analyze mean score among the academic aspiration group of students, the analysis of variance was computed and displayed in Table 4.10.b

Table 4.10

Analysis of Differences in Beginning-Test and End-Test Views Score by Academic Aspiration

Academic Aspiration	N		Beginning Views	EndViews	Mean Difference	S D of Difference
Physical Group	104	Mean S D	222.71 21.49	218.34 23.53	-4.37	24.12
Bio with Math	98	Mean S D	227.13 23.24	213.71 28.54	-13.42	21.69
Biological Group	45	Mean S D	206.78 27.56	192.16 32.59	-14.62	29.26

ANOVA

Diff end beginning views

	Sum of Squares	df	Mean Square	F	p-value
Between Groups	5400.97	2	2700.49	4.6	0.01
Within Groups	143177	244	586.79		
Total	148578	246			

The study divided the participants into three groups, i.e., physical, biology with additional mathematics and biological, based on academic career aspirations plan. In general, beginning and end views scale for all three academic aspiration groups exhibited positive trends towards mathematics. Table 4.10 showed that the beginning-views mean scores were higher than the end-views mean scores in all cases. The results also showed that the range of views score varied from 227.13 with standard deviation 23.24 (bio with math students- beginning survey) to 192.16 with standard deviation 32.59 (biological students- end survey). The differences of mean end views minus mean beginning views scores were -4.37, -13.42, and -14.62 for the physical, biology with mathematics, and biology without mathematics groups respectively.

A statistical significant difference in views scores between physical, biology with mathematics, and purely biology students were found, F (2, 244) =4.60, p=.01. Therefore, the null hypothesis (Ho: 2b) "there is no significant relationship in the views between beginning and end survey of students with respect to academic aspiration" failed to accept at .05 level of significant. The result indicated that there was statistical significant difference in mean scores obtained by different academic aspiration group of higher secondary science students within the academic year.

Tables 4.6, 4.7, 4.8 and 4.10 summarize the descriptive and inferential statistics for overall beginning and end views mean score and their relationships of all participant students by gender and academic aspiration. In addition, the views changed –unchanged status was divided into three categories (positive, balance, negative). Data were analyzed using inferential statistics. The chi-square was used to determine the association of views changed/unchanged status and gender (Table 4.11). Table 4.12displays the association of views changed/unchanged status and students' academic aspiration. It shows that there was significant association between views changed-unchanged status and students' academic aspiration.

Table 4.11

Distribution of Students on Views Change Status by Gender

views change status	Gender		Total	$\chi2$ -value	df	P-value
	Male	Female				
Positive	25	11	36			
Balance	114	62	176	0.39	2	0.82
Negative	22	13	35			
Total	161	86	247			

Table 4.11 shows that majority of the students male, N=114(70.8%) and female, N=62; (72.1%) were in the balance status. Male (N=25) students were more positive compared to female (N=11; 12.8%). However, in total positive and negative status, students were almost equal (positive= 14.6% and negative=14.2%). The students in the balance status group were (N=176) 71.3%, which was almost as expected. The results revealed that there was no statistically significant association of the distribution at 5% (p=0.82).

Table 4.12

Distribution of Students on Views Change Status by Academic Aspiration

	Academic aspiration group			Chi-square test			
Views Status	Physical	Bio with Math	Biological	N	χ^2-value	df	P-value
Positive	22	8	6	36			
Balance	73	76	27	176	14.46	4	0.00
Negative	9	14	12	35			
Total	104	98	45				

Table 4.12 shows the joint distribution of student's view status and academic aspiration. According to the classification, 71.3% (N=176) of the students remained in the balanced group, 14.6% (N=36) changed from lower to higher mean scores

(positive group), and 14.2% (N=35) changed from higher to lower mean score views (negative group). It was noted that physical academic career aspiration students were mainly classified as balanced and positive, while the majority of the biology with mathematics or Biological (non-mathematical) academic carrier aspiration students were classified mainly in the balanced or negative groups. The calculated chi-square value was 14.46 with the degree of freedom 4 and p value 0.00. Therefore, there was a statistically significant association between views status and academic aspiration of the students.

Learning Styles and Views towards Mathematics

In addition, to check whether there was relationship between learning styles and views towards mathematics, a correlation analysis of the beginning-test and end-test of learning style dimensions and views towards mathematics were conducted. The following table shows the correlation between learning styles and views in both at the beginning and at the end survey.

Table 4.13

Descriptive Statistics and Correlation Analysis Between Views and Learning Styles

Beginning learning styles and beginning views		Mean	SD	Correlation	P-value
Pair 1	Beginning views	221.6	24.39	0.04	0.55
	Beginning active	6.01	1.63		
Pair 2	Beginning views	221.6	24.39	-0.08	0.21
	Beginning sensing	5.29	1.91		
Pair 3	Beginning views	221.6	24.39	-0.02	0.79
	Beginning visual	7.73	1.96		
Pair 4	Beginning views	221.6	24.39	-0.06	0.31
	Beginning sequential	5.95	1.77		

end learning styles and end views		Mean	SD	Correlation	P-value
Pair 1	End views	211.7	28.86	0.06	0.38
	End active	6.13	1.91		
Pair 2	End views	211.7	28.86	-0.13	0.14
	End sensing	5.68	1.89		
Pair 3	End views	211.7	28.86	0.06	0.13
	End visual	8.23	2.00		
Pair 4	End views	211.7	28.86	-0.04	0.54
	End sequential	6.02	1.7		

No of students, N=247

In Table 4.13, the correlations coefficient analysis was made to identify if trends existed in the relationship between the views (beginning and end) scale and learning styles dimensions (beginning and end). The table 4.13 showed that the strength of association between the beginning views and beginning learning styles as well as the association between end views and end learning styles was very low, and that the correlations coefficient was statistically not significant. From the correlation table, it is seen that there was no correlation between learning styles and views in both at the beginning and at the end survey.

Therefore, no statistical evidence existed to reject the null hypothesis (Ho: 3) "there is no significant relationship between different dimension of learning styles and views" at 0.05 level of significant. The result indicated that there was no statistical significant difference between the views and learning styles.

Achievement in Mathematics and Demographic Information

This section discusses the students' achievement in mathematics and their association by gender and academic aspiration (group).

Tables 4.14 and 4.15 summarized and analysed the data from the mathematics achievement test. The MAT scores were presented by students' demographic. Table 4.14 indicated that female students performed better in MAT compared to male. As displayed in table 4.15 below, analysis of variance reported the significant difference in MAT score with respect to academic aspiration. The difference was in favour of biology with mathematics group of students.

Table 4.14

Analysis of Mathematics Achievement Test Score by Gender

Gender	N	Mean	SD	F-value	P-value
Female	86	44.65	13.57	2.18	0.14
Male	161	42.00	13.45		
Total	247	42.92	13.52		

As displayed in Table 4.14, one way ANOVA was used to data analysis in order to compare the mean of achievement test score of mathematics between male and female students. The calculated F- ratio was 2.18. This was not significant at 0.05 level of probability. This revealed that the difference in the mean scores obtained by male (M=41.99; SD=13.45) and female (M=44.65; SD=13.58) students were not statistically significant: F (1, 245) = 2.18; p= 0.14 >0.05. However, the female students' obtained higher score than their male counterpart in mathematics achievement test. Therefore, there was no sufficient evidence to reject the null hypothesis (Ho: 4a) "there is no significant difference on achievement in mathematics of grade eleven science students by gender".

Table 4.15

Analysis of Mathematics Achievement Score by Academic Aspiration

Academic Aspiration	N	Mean	SD	F-value	P-value
Physical	104	43.30	12.9	8.35	0.00
Bio with Math	98	45.67	15.0		
Biological	45	36.04	8.0		

As displayed in Table 4.15descriptive and inferential statistics (one way ANOVA) was used for data analysis in ordered to compare the mean of achievement test scores of mathematics among different academic career aspiration groups (physical, biology with mathematics, biological) of students. It was found that the mean score in mathematics achievement test of biology with additional mathematics students were 45.67 with standard deviation 15.02, followed by physical group students whose mean score was 43.30 with standard deviation 12.9. However, the score obtained by biological group students was lower with mean 36.04 and standard deviation 8.0. The calculated F- value was 8.35. This is significant at 0.05 level of probability. This revealed that the difference in the mean scores obtained by different academic aspiration group of students were statistically significant: $F(2, 244) = 8.35$; $p= 0.00$. However, mean mathematics achievement test score was 42.92, which is below the average marks with standard deviation 13.5. Therefore, there was no sufficient evidence to accept the null hypothesis (Ho: 4b) "there is no significant difference on achievement in mathematics of grade eleven science students by academic aspiration".

A two- way ANOVA was conducted that examined the effect of gender and academic aspiration on achievement in mathematics. There was statistically significant interaction between the effects of gender and academic aspiration on achievement in mathematics, F (5,241) =4, p=.00. The Table 4.16 and Figure 4.7 below indicated that female score was higher than male. However, females' score declined from physical group to biology with mathematics group, whereas male students' score in MAT inclined from physical to biology with mathematics group.

Table 4.16

Two-way ANOVA of Gender and Academic Aspiration on Achievement in Mathematics

Gender	Academic aspiration	Mean	SD	N
	Biological Group	37.8	7.63	23
Female	Physical Group	47.8	14.64	8
	Bio with additional Mathematics	47.1	14.54	55
	Biological Group	34.2	8.23	22
Male	Physical Group	42.9	12.87	96
	Bio with additional Mathematics	43.9	15.60	43

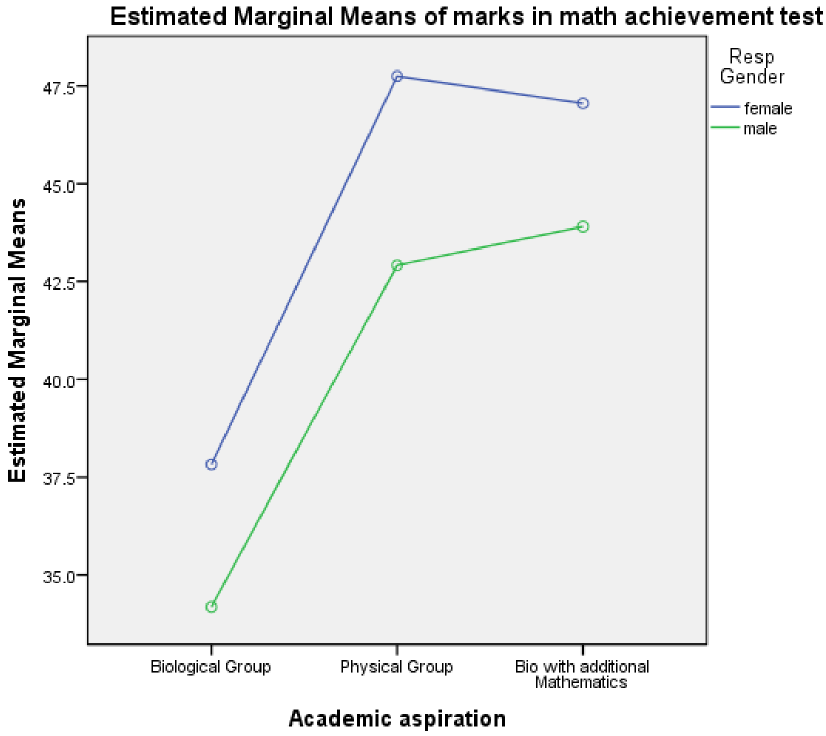
Tests of Between-Subjects Effects

Dependent Variable: Marks in Mathematics Achievement Test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	3445.34[a]	5	689.07	3.99	0.00
Intercept	242040.59	1	242040.59	1403	0.00
Gender * Academic aspiration	3445.34	5	689.07	3.99	0.00
Error	41575.88	241	172.51		
Total	499920	247			
Corrected Total	45021.22	246			

[a]*R Squared = .077 (Adjusted R Squared = .057)*

Figure 4.7. Interaction Effects of Gender, Academic group and Views



As shown in Table 4.16 and Figure 4.7 in the table titled "Two-way ANOVA of gender and academic aspiration on achievement in mathematics" represented the mean for every possible combination of the independent variables. There, female students of physical group academic aspiration scored higher (M=47.75; SD=14.64) and biological group male students scored lower (M=34.18; SD=8.23). The second part, titled "Tests of Between-Subjects Effects, "presented the main result of ANOVA. Here, the corrected model represented the results of F test for the overall model. The calculated F value was 3.99. This was statistically significant (p=0.00). The other results showed interaction between gender and academic aspiration on achievement score. The interaction between gender and academic aspiration, denoted as Gender * Academic aspiration, had a calculated F value of 3.99 and was statistically significant difference at p=0.00. It revealed that the interaction effects of an academic aspiration and gender on achievement in mathematics was statistically significant. Therefore, the null hypothesis (Ho: 4c) "there is no significant difference on achievement in mathematics of grade eleven science students by gender and academic aspiration" was not accepted.

Learning Styles and Mathematics Achievement

This section discusses the students' learning style status and their association by gender and academic aspiration (group). To examine whether there was effect of changed/unchanged status of learning style preference on achievement in mathematics, the descriptive and inferential statistics (two- way analysis of variance) was used. Table 4.17 indicated that there was no statistically significant difference on mean of achievement score in mathematics by learning styles status.

Table 4.17

ANOVA Test of Learning Styles Changed/Unchanged Status and Mathematics Achievement Test Scores

Learning style status	N	Mean	S D		Sum of Squares	df	Mean squares	F	p-value
Act-act	113	43.26	13.88	Between Groups	706.42	3	235.47	1.29	0.27
Act-ref	45	40.40	13.22						
Ref-ref	47	45.62	12.55	Within Groups	44314.8	243	182.37		
Ref-act	42	41.67	13.79						
Sen-sen	84	41.07	13.03	Between Groups	1031.92	3	343.98	1.90	0.13
Sen-int	38	47.21	14.67						
Int-int	72	43.36	12.82	Within Groups	43989.29	243	181.03		
Int-sen	53	42.15	14.05						
Vis-vis	199	42.45	13.71	Between Groups	905.84	3	301.95	1.66	0.17
Vis-ver	16	48.50	11.94						
Ver-ver	13	38.92	11.00	Within Groups	44115.38	243	181.55		
Ver-vis	19	45.79	13.60						
Seq-seq	105	43.47	12.66	Between Groups	158.94	3	52.98	0.29	0.83
Seq-glo	39	41.74	10.74						
Glo-glo	49	41.92	14.88	Within Groups	44862.28	243	184.62		
Glo-seq	54	43.59	15.77						

Act-active; Ref- Reflective; Sen-Sensing; Int- Intuitive; Vis-Visual; Ver- Verbal; Seq-Sequential; Glo- Global

Active-reflective: The table 4.17 shows that the mean scores of academic achievements of the students whose learning styles remained in active (43.26) and reflective (45.62) was greater than the students whose learning styles changed from active to reflective (40.40) and reflective to active (41.67). A significance difference was not found in mathematics achievement score for active-reflective learning style status, F (3, 243) =1.29, p=0.27.

Sensing-intuitive: Researcher found that there was a variation on the mathematics achievement scores in this learning dimension. Students whose learning styles shifted from sensing to intuitive scored higher (47.21), followed by intuitive to intuitive (43.36), and lower (41.07) for sensing to sensing. A difference in mathematics achievement score for sensing-intuitive learning style status was not found statistically significant, F (3, 243) =1.90, p=0.13.

Visual-verbal: In this dimension of learning styles, mathematics achievement score varied from 38.92 to 48.50. Those students who shifted from visual to verbal obtained higher scores. Students from verbal to verbal scored less. A difference in mathematics achievement score for visual-verbal learning style status was not found statistically significant, F (3, 243) =1.66, p=0.17.

Sequential-global: It was found that there was no drastic change of mathematics achievement scores in this learning style dimension. However, mathematics scores were slightly higher (mean=43.47) for sequential to sequential and for global to sequential (mean=43.59) learning style. A difference in mathematics achievement score for sequential-global learning style status was not found statistically significant, F (3, 243) =0.28, p=0.83.

ANOVA was used to analyse data in order to compare different group of students and achievement score in mathematics, where F ratio was calculated. Table

4.17 shows no statistically significant differences in mathematics achievement among learning styles status at significant level of 5%. Therefore, the null hypothesis (Ho: 5) "there is no significant difference of students' achievement in mathematics with different changed/unchanged status of learning style" was failed to reject.

To examine whether there was effect of changed-unchanged status of learning styles preference related to gender on achievement in mathematics, the descriptive and inferential statistics (two- way analysis of variance) were used. The tables 4.18a to 4.18d indicated that there was no statistically significant difference on mean of achievement score in mathematics by learning styles changed/unchanged status with respect to gender.

Table 4.18a

Two-way ANOVA of Changed/Unchanged Status of Active- Reflective Learning Style and MAT Score by Gender.

Changed/unchanged status	Gender	frequency N	Mean	SD
active-active	M	67	41.79	14.13
	F	46	45.40	13.37
active-reflective	M	28	37.93	12.00
	F	17	44.47	14.50
reflective-reflective	M	38	46.53	12.50
	F	9	41.78	12.67
reflective-active	M	28	40.36	13.28
	F	14	44.30	14.92

Tests of Between-Subjects Effects

Dependent Variable: Mathematics Achievement Test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	1820.776[a]	7	260.11	1.44	0.19
Intercept	312225.822	1	312225.82	1727.30	0.00
active-reflective status * Gender	1820.776	7	260.11	1.44	0.19
Error	43200.439	239	180.76		
Total	499920	247			
Corrected Total	45021.215	246			

[a]*R Squared = .040 (Adjusted R Squared = .012)*

Table 4.18a presents descriptive statistics on students' change of learning styles across the four phases based on gender. The results showed that male students who remained in reflective learning style domain from beginning survey to the end obtained higher MAT mean scores (mean=46.53 and SD=12.67). It was followed by female students who remained in the active learning style from beginning to end survey with the mean MAT scores (mean= 45.40 and SD=13.37). However, the male students who changed their learning styles domain either from active to reflective or from reflective to active achieved low MAT scores. There was variation with the female students in phase changed and unchanged of learning styles from beginning to end survey. This revealed that male students with unchanged learning style domains scored higher than changed. Further, phase unchanged status of female students were not associated with higher achievement scores in mathematics.

A two-way ANOVA was conducted that examined the effect of gender and active-reflective learning style changed/unchanged status. There was not a statistically significant interaction between the effects of gender and learning style (active-reflective) status, $F(7, 239) = 1.44$; $p = 0.19$.

Table 4.18b

Two-way ANOVA of Changed/Unchanged Status of Sensing-Intuitive Learning Styles and MAT Score by Gender

Changed/unchanged status	gender	frequency N	mean	SD
sensing-sensing	M	52	39.96	13.74
	F	32	42.88	11.76
sensing-intuitive	M	28	45.79	14.56
	F	10	51.20	15.00
intuitive-intuitive	M	49	42.90	12.29
	F	23	44.35	14.13
intuitive-sensing	M	32	40.56	13.48
	F	21	44.57	14.89

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	1652.75	7	236.11	1.3	0.25
Intercept	377096.90	1	377096.9	2078.15	0.00
sensing/intuitive status * Gender	1652.75	7	236.11	1.3	0.25
Error	43368.46	239	181.46		
Total	499920	247			
Corrected Total	45021.21	246			

[a] *R Squared = .037 (Adjusted R Squared = .008)*

Table 4.18b presents descriptive statistics on students' change of sensing-intuitive learning styles across the four categories based on gender. The results showed that male students who were intuitive at the end survey but had been intuitive or sensing at the beginning survey scored higher in MAT score compared to those male students who were sensing at the end survey. This table also revealed that the female students who were sensing at the beginning survey but shifted to the intuitive at the end survey scored higher in MAT (mean=51.2 and SD=15), while those female students who remained in the sensing learning style scored low 42.8 with standard deviation 11.76.

A two-way ANOVA was conducted that examined the effect of gender and sensing-intuitive learning style status. There was not a statistically significant interaction between the effects of gender and learning style (sensing-intuitive) status, $F(7, 239) = 1.30$; $p = 0.25$on achievement in mathematics.

Table 4.18c

Two-way ANOVA of Changed/Unchanged Status of Visual-Verbal Learning Styles, and MAT Score by Gender

Changed/unchanged status	gender	frequency N	Mean	SD
visual-visual	M	131	41.71	13.80
	F	68	43.88	13.51
visual-verbal	M	12	47.17	12.01
	F	4	52.50	12.48
verbal-verbal	M	9	38.67	9.20
	F	4	39.50	16.03
verbal-visual	M	9	42.44	13.70
	F	10	48.80	13.47

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	1395.690[a]	7	199.38	1.09	0.36
Intercept	135565.817	1	135565.82	742.69	0.00
visual/verbal status * Gender	1395.69	7	199.38	1.09	0.36
Error	43625.525	239	182.53		
Total	499920	247			
Corrected Total	45021.215	246			

[a]*R Squared = .031 (Adjusted R Squared = .003)*

Table 4.18c presents descriptive statistics on students' change of visual verbal learning styles across the four phases based on gender. The results showed that male students who changed in the learning style domain from beginning survey to the end obtained higher MAT mean scores (visual to verbal, mean=47.17 and verbal to visual=48.8) with SD= 12.67. The female students who changed their learning styles domain either from visual to verbal (mean=52.5) or from verbal to visual (mean=48.8) achieved higher MAT scores. This revealed that male and female students with unchanged learning style domains were with lower scores than changed.

A two-way ANOVA was conducted that examined the effect of gender and visual-verbal learning style status. There was no statistically significant interaction between the effects of gender and learning style (visual-verbal) status, F (7, 239) =1.09; p=0.36 on achievement in mathematics.

Table 4.18d

Two-way ANOVA of Changed/Unchanged Status of Sequential-Global Learning Style, MAT Score by Gender

phase change learning styles	Gender	frequency N	Mean	SD
sequential – sequential	M	64	42.38	13.01
	F	41	45.17	12.05
sequential- global	M	21	40.67	9.68
	F	18	43.00	12.02
global-global	M	36	40.78	13.61
	F	13	45.08	18.18
global –sequential	M	40	43.15	15.84
	F	14	44.86	16.11

Tests of Between-Subjects Effects

Dependent Variable: Mathematics Achievement Test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	613.78	7	87.68	0.47	0.85
Intercept	345830.86	1	345830.87	1861.26	0.00
sequential/global status * Gender	613.78	7	87.68	0.47	0.85
Error	44407.43	239	185.81		
Total	499920	247			
Corrected Total	45021.21	246			

[a] *R Squared = .014 (Adjusted R Squared = -.015)*

Table 4.18 d presents descriptive statistics on students' change of sequential global learning styles across the four categories based on gender. The results showed that female students obtained slightly higher MAT scores who remained in the same sequential to sequential (mean=45.17) as well as global to global (45.08) learning style domain from beginning survey to the end compared to those female students who shifted from sequential to global and global to sequential. The male students who changed or unchanged their learning style domain either from sequential to global or from global to sequential observed variation in MAT scores. This revealed that female students with unchanged learning style domains scored higher than changed. Further, phase unchanged status of male students were not associated with higher achievement scores in mathematics.

A two-way ANOVA was conducted that examined the effect of gender and sequential-global learning style status. There was no statistically significant interaction between the effects of gender and learning style (sequential-global) status, $F(7, 239) = 0.47$; $p = 0.85$on achievement in mathematics.

Therefore, there was no sufficient evidence to reject the null hypothesis (Ho: 5a) "there is no significant relationships among the students' achievement in mathematics, their gender and changed/unchanged status of learning styles".

To examine whether there was effect of changed/unchanged status of learning styles preference related to academic aspiration on achievement in mathematics, the descriptive and inferential statistics (two- way analysis of variance) were used. The table 4.19a to table 4.19d indicated that there was statistically significant difference on mean of achievement score in mathematics by learning styles status with respect to academic aspiration.

Table 4.19a

Two-way ANOVA of Active-Reflective Learning Style and MAT score by Academic Aspiration

Changed/unchanged status	academic aspiration	frequency N	Mean	SD
	Physical	45	41.0	12.7
active - active	Biological	20	36.9	6.54
	Bio with Math	48	48.0	15.67
	Physical	19	40.2	10.54
active- reflective	Biological	10	36.0	10.07
	Bio with Math	16	43.4	17.20
	Physical	20	49.2	10.90
reflective-reflective	Biological	7	36.9	8.71
	Bio with Math	20	45.1	14.02
	Physical	20	45.5	15.93
reflective -active	Biological	8	33.3	9.19
	Bio with Math	14	41.0	10.81

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	4849.25	11	440.84	2.58	0.00
Intercept	309007.36	1	309007.37	1807.65	0.00
Academic aspiration* active/reflective status	4849.25	11	440.84	2.58	0.00
Error	40171.95	235	170.95		
Total	499920	247			
Corrected Total	45021.21	246			

[a] R Squared = .108 (Adjusted R Squared = .066)

Table 4.19a shows that biology with additional mathematics academic aspiration group students scored higher in mathematics achievement test, who remained in the same phase of learning styles (active to active, mean=48.0 and reflective to reflective, mean =45.10) from beginning to end survey compared to those students who shifted their learning styles domain (active to reflective, mean=43.4 and reflective to active, mean=41.0).The biological students exhibited same pattern as biology with mathematics group of students. The physical students who were in the same reflective to reflective learning style scored higher (mean=49.20 with SD=10.9) and least (mean=40.21) in active to reflective. This result pointed out that students whose learning styles remained unchanged were good in mathematics than those who changed. However, there was no consistency among the physical group students.

A two-way ANOVA was conducted that examined the effect of academic aspiration and active-reflective learning style status. There was a statistically significant interaction between the effects of academic aspiration and learning style (active-reflective) status on achievement in mathematics, F (11, 235) =2.58; p=0.00.

Table 4.19b

Two-way ANOVA of Sensing-Intuitive Learning Style and MAT score by Academic Aspiration

Changed/unchanged status	Academic	frequency N	mean	SD
	Physical	35	40.9	12.3
sensing - sensing	Biological	16	36.0	9.9
	Bio with math	33	43.6	14.5
	Physical	21	46.0	12.3
sensing- intuitive	Biological	6	40.0	8.6
	Bio with math	11	53.4	19.3
	Physical	31	42.7	11.9
intuitive-intuitive	Biological	14	35.2	6.6
	Bio with math	27	48.2	14.2
	Physical	17	45.6	16.6
intuitive -sensing	Biological	9	34.6	6.0
	Bio with math	27	42.4	13.6

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	4708.38	11	428.04	2.5	0.00
Intercept	334750.53	1	334750.54	1951.4	0.00
Academic aspiration * sensing-intuitive status	4708.38	11	428.04	2.5	0.00
Error	40312.82	235	171.54		
Total	499920	247			
Corrected Total	45021.21	246			

[a.]R Squared = .105 (Adjusted R Squared = .063)

Table 4.19b indicates that biology with additional mathematics academic aspiration group students scored higher (sensing to intuitive, mean=53.45, and intuitive to intuitive, mean=48.22) in mathematics achievement test who were intuitive in the end survey and either intuitive or sensing in the beginning survey. Regarding the physical group, students who changed their learning style scored higher in mathematics achievement test compared to those who remained in the same learning style domain. However, biological students were not associated in the clear pattern from beginning to end survey regarding the mathematics achievement test scores.

A two-way ANOVA was conducted that examined the effect of academic aspiration and sensing-intuitive learning style on achievement in mathematics. There was a statistically significant interaction between the effects of academic aspiration and learning style (sensing-intuitive) status on achievement in mathematics, F (11, 235) =2.50; p=0. 00.

Table 4.19c

Two-way ANOVA of Visual-Verbal Learning Style and MAT score by Academic Aspiration

Changed/unchanged status	Academic aspiration	N	Mean	SD
visual - visual	Physical	85	42.92	13.07
	Biological	35	36.34	7.96
	Bio with math	79	44.66	15.60
visual- verbal	Physical	6	51.00	13.84
	Biological	3	36.67	3.06
	Bio with math	7	51.43	10.37
verbal-verbal	Physical	7	40.00	8.79
	Biological	3	28.00	5.29
	Bio with math	3	47.33	13.32
verbal -visual	Physical	6	51.00	13.84
	Biological	4	39.00	11.37
	Bio with math	9	49.56	13.48

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	4030.53	11	366.41	2.1	0.02
Intercept	128717.99	1	128717.99	737.94	0.00
Academic aspiration* Visual- verbal status	4030.53	11	366.41	2.1	0.02
Error	40990.68	235	174.43		
Total	499920	247			
Corrected Total	45021.21	246			

[a.] R Squared = .090 (Adjusted R Squared = .047)

Table 19.c indicates that majority of students (physical, biology with mathematics, biological) were in visual to visual learning style domain from beginning survey to the end survey. Regarding the biology with mathematics academic aspiration students' scores, it was slightly higher in mathematics achievement test of those who changed their learning style domain from beginning to the end compared to biology with mathematics academic aspiration group students. Physical group academic aspiration students who shifted their learning style domain from beginning to end scored higher (mean=51.0) in MAT compared to physical

group students who remained in the same phase of learning style. Biological academic aspiration students who were verbal in both at the beginning and at the end survey scored low (mean=28).

A two-way ANOVA was conducted that examined the effect of academic aspiration and active-reflective learning style changed/unchanged status. There was a statistically significant interaction between the effects of academic aspiration and learning style (visual-verbal) status on achievement in mathematics, F (11, 235) =2.10; p=0.02.

Table 4.19d

Two-way ANOVA of Sequential-Global Learning Style and MAT score by Academic Aspiration

Changed/unchanged status	Academic	N	Mean	SD
sequential – sequential	Physical	46	45.61	14.41
	Biological	18	39.11	5.83
	Bio with math	41	42.98	12.44
sequential- global	Physical	14	40.14	11.81
	Biological	8	38.00	5.66
	Bio with math	17	44.82	11.29
global-global	Physical	23	43.39	11.14
	Biological	8	28.25	9.88
	Bio with math	18	46.11	17.74
global-sequential	Physical	21	40.19	12.10
	Biological	11	35.27	8.21
	Bio with math	22	51.0	18.74

Tests of Between-Subjects Effects

Dependent Variable: Mathematics Achievement Test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	5103.14	11	463.92	2.73	0.00
Intercept	320154.954	1	320154.95	1884.77	0.00
Academic aspiration * Sequential/ global status	5103.14	11	463.92	2.73	0.00
Error	39918.07	235	169.86		
Total	499920	247			
Corrected Total	45021.21	246			

[a.] R Squared = .113 (Adjusted R Squared = .072)

Table 4.19d indicates that physical academic aspiration group students scored higher in mathematics achievement test who remained in the same category of learning style (sequential to sequential, mean=45.61 and global to global, mean =43.39) from beginning to end survey compared to those students who shifted their learning style domain (sequential to global and global to sequential).The biology with mathematics academic aspiration students exhibited different pattern from beginning to end survey in mathematics achievement test score, which varied from 42.98 to 51. Regarding the biological academic aspiration students, those who were sequential at the beginning to end survey obtained slightly higher MAT score, while other biological students scored low.

A two-way ANOVA was conducted that examined the effect of academic aspiration and sequential-global learning style status. There was a statistically significant interaction between the effects of academic aspiration and learning style (sequential-global) status on achievement in mathematics, $F(11, 235) = 2.73$; $p = 0.00$.

Therefore, there was no sufficient evidence to accept the null hypothesis (Ho: 5b) "there is no significant relationships among the students' achievement in mathematics, academic aspiration and changed/unchanged status of learning styles.

Views towards Mathematics and Achievement

This part discusses the students' views status and their association by gender and academic aspiration (group).

To determine whether a relationship existed between students' views towards mathematics and achievement in mathematics, a descriptive and inferential (one-way ANOVA) statistics were performed. Table 4.20 below displays that there was statistically significant difference in mathematics mean achievement score among the changed/unchanged status of views towards mathematics.

Table 4.20

ANOVA for Views Change Status and MAT score

Marks in math achievement test						
Category of views status	N	Mean	SD			
Negative change	35	36.17	8.86			
Balance	176	44.55	14.18			
Positive change	36	41.5	11.98			
Total	247	42.91	13.53			

		Sum of Squares	df	Mean Square	F	p-value
marks in math achievement test * view change status	Between Groups (Combined)	2131.607	2	1065.8	6.06	0.00
	Within Groups	42889.608	244	175.78		
	Total	45021.215	246			

Table 4.20 shows that majority of students who were in balance category of views scored higher (M=44.55; SD=14.18) in mathematics achievement test, which was followed by positive category (M=41.50, SD=11.98). The negative view category students scored lower (M=36.17; SD=8.86). The total mean score was 42.9 (SD=13.5), which indicated that average achievement score was below 50. In general, the students with positive views changes scored higher than those students with negative changes. This result pointed that views change status and mathematics achievement scores were significantly different. This result supports the findings of Kalder and Lesik (2011).

The one-way ANOVA was conducted to examine whether there were statistically significant difference among the students in the different category of views (change-unchanged) status. The results revealed that there was statistically significant mean differences among negative, balance, and positive students, F (2,244) =6.06, p=0.00. Therefore, there was no sufficient evidence to accept the null hypothesis (Ho: 6) "there is no significant difference of students' achievement in mathematics with different status of views towards mathematics".

To examine whether a relationship exists between views status and gender on achievement in mathematics, descriptive statistics and two- way analysis of variance was performed. Table 4.21 below indicates that there was statistically significant difference on mean of achievement score in mathematics by views status with respect to gender.

Table 4.21
Two-way ANOVA for Change Status of Views and MAT score by Gender.

status change category	Gender	N	mean	SD
Positive	M	25	41	11.14
	F	11	42.7	14.21
Balance	M	114	43.4	14.33
	F	62	46.6	13.79
Negative	M	22	35.7	8.91
	F	13	36.9	9.08

Tests of Between-Subjects Effects
Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	2576.28	5	515.26	2.93	0.01
Intercept	218194.26	1	218194.26	1238.9	0.00
Views status * Gender	2576.28	5	515.26	2.93	0.01
Error	42444.92	241	176.12		
Total	499920	247			
Corrected Total	45021.21	246			

[a.] R Squared = .057 (Adjusted R Squared = .038)

Table 4.21 shows that balance category female students obtained higher score (mean=46.61 and std dev=13.79) in mathematics achievement test followed by balance category male students (mean=43.42). In positive change status, female students scored higher than male. However, in negative views change status, male students scored lower compared to their female counterpart. The mathematics achievement test scores varied from 35.73 to 46.61.

The two-way ANOVA was run to analyze the interaction effect of gender and views change status on achievement in mathematics. The interaction between gender and views status (Views status*Gender) had a calculated F value of 2.93. There was a significant difference in mean mathematics achievement test scores (p=0.01). This revealed that the effect of gender on achievement in mathematics significantly varied by views status (change/ unchanged category).

Therefore, there was no sufficient evidence to accept the null hypothesis (Ho: 6a) "there is no significant relationship among the students' achievement in mathematics, views status and gender".

To examine whether a relationship existed between views status and academic aspiration on achievement in mathematics, descriptive statistics and two- way analysis of variance was performed. The table 4.22 below indicates that there was statistically significant difference on mean of achievement score in mathematics by views status with respect to academic aspiration.

Table 4.22

Two-way ANOVA for Change Status of Views, and MAT score by Academic Aspiration

view change status	Academic aspiration	N	Mean	SD
Negative change	Biological	12	37.17	6.18
	Physical	9	36.89	8.43
	Bio with Mathematics	14	34.86	11.22
Balance	Biological	27	35.48	8.44
	Physical	73	44.55	13.31
	Bio with Mathematics	76	47.76	15.32
Positive change	Biological	6	36.33	10.54
	Physical	22	41.73	12.98
	Bio with Mathematics	8	44.75	9.85

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	5423.19[a]	8	677.9	4.07	0.00
Intercept	193813.2	1	193813.2	1165	0.00
Views status * Academic aspiration	5423.19	8	677.9	4.07	0.00
Error	39598.03	238	166.38		
Total	499920	247			
Corrected Total	45021.22	246			

[a.] R Squared = .120 (Adjusted R Squared = .091)

Table 4.22 shows that the mean scores of the students' achievement in mathematics ranged from 34.9 to 47.8, based on views changes status and academic aspiration. The students from biology with additional mathematics, whose views towards mathematics remained unchanged from beginning to the end of the academic year (balance), scored higher (47.8) than the students with positive (44.8) views change, and much higher than the students with negative views change (34.9).

Interestingly, students with negative views, who did not want to study mathematics, scored more than the students who wanted to continue mathematics in higher studies.

The two-way ANOVA was run to analyze the interaction effect of academic aspiration and views change status on achievement in mathematics. The interaction between academic aspiration and views status (Views status*Academic aspiration) had a calculated F value of 4.07. This revealed that the effect of academic aspiration on achievement in mathematics significantly varied by views status (change-unchanged category). There, a significant interaction between academic aspiration and views status was found, $F(8, 238) = 4.07$ and $p=0.00$.

Therefore, there was no sufficient evidence to accept the null hypothesis (Ho: 6b) "there is no significant relationship among the students' achievement in mathematics, views status and academic aspiration".

Learning Style, Views towards Mathematics and Achievement

This section discusses the association of students' learning styles, their views and academic achievement in mathematics.

To determine whether a relationship exists between views status and learning style status on achievement in mathematics, a descriptive statistics and two-way analysis of variance was performed. The table 4.23a to 4.23d indicates that there was statistically significant difference on mean of achievement score in mathematics by views status and learning style changed/unchanged status.

Table 4.23a

Two-way ANOVA in Comparison of Active -Reflective Learning Style, Views Change Status and MAT Score

active reflective status	view status	N	mean	SD
active – active	Positive	14	40.1	11.38
	Balance	86	45.1	14.49
	Negative	13	34.3	6.92
active- reflective	Positive	3	44.0	9.17
	Balance	37	42.1	13.09
	Negative	5	26.0	6.48
reflective – reflective	Positive	10	43.8	11.49
	Balance	28	47.8	14.17
	Negative	9	41.6	6.62
reflective – active	Positive	6	39.3	18.18
	Balance	32	42.7	13.78
	Negative	4	37.0	6.00

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

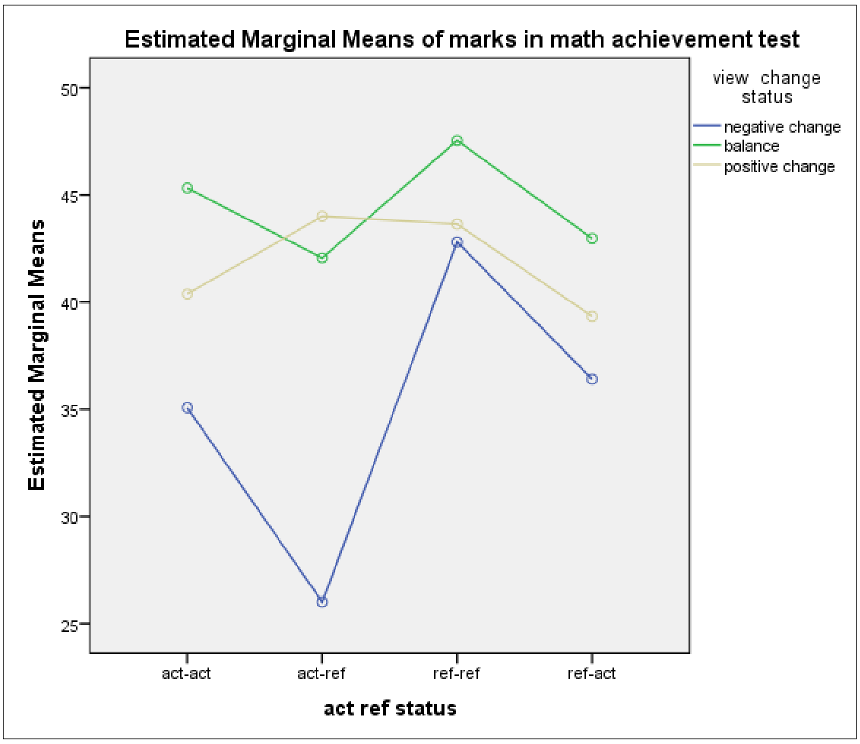
Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	3812.78[a]	11	346.62	1.98	0.03
Intercept	177215.17	1	177215.17	1010.61	0.00
Views status * active/reflective status	3812.78	11	346.62	1.98	0.03
Error	41208.44	235	175.355		
Total	499920	247			
Corrected Total	45021.22	246			

a. R Squared = .085 (Adjusted R Squared = .042)

Table 4.23a and Figure 4.8a show that the effects of active reflective learning style and students' views changed status on their academic achievement in mathematics ranged from 26.0 to 47.75. It was found that students whose learning style and views remained unchanged obtained higher scores compared to changed status of active and reflective learning style, and change of views towards the mathematics from beginning to the end of the academic year.

A two-way ANOVA was run to examine the effects of different category of views status and different category of active-reflective learning style status on achievement in mathematics. There was a significant two-way interaction, F (11,235) =1.98; p=0.03. Therefore, the research hypothesis (Ho: 7) "there is no significant effect of students changed/unchanged status of active-reflective learning styles and views status on mathematics achievement" was not retained.

Figure 4.8a. Interaction Effect of Active-Reflective Learning Style and Academic



Aspiration on MAT score

Table 4.23b

Two-way ANOVA in Comparison of Sensing-Intuitive Learning Style, Views Change Status and MAT score

sensing intuitive status	view status	N	Mean	SD
	Positive	8	48.0	10.2
sensing - sensing	Balance	64	41.2	13.8
	Negative	12	36.0	7.4
	Positive	3	49.3	1.1
sensing- intuitive	Balance	32	48.1	15.4
	Negative	3	36.0	8.7
	Positive	14	40.3	11.3
intuitive - intuitive	Balance	49	45.2	13.6
	Negative	9	38.2	7.7
	Positive	8	34.0	14.2
intuitive - sensing	Balance	38	46.0	13.0
	Negative	7	30.6	9.4

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	4330.43[a]	11	393.68	2.27	0.01
Intercept	193958.3	1	193958.3	1120.16	0.00
Views status * sensing/intuitive status	4330.43	11	393.68	2.27	0.01
Error	40690.79	235	173.15		
Total	499920	247			
Corrected Total	45021.22	246			

[a.] R Squared = .096 (Adjusted R Squared = .054)

Table 4.23b and Figure 4.8bshows effects of sensing-intuitive learning style and students' views changed status on their academic achievement in mathematics, which ranged from 30.57 to 49.33. The students whose learning style at the beginning survey was sensing, and whose views towards mathematics changed in positive direction scored higher in mathematics achievement test. However, students whose views towards mathematics unchanged from beginning to the end while changed in sensing-intuitive learning style scored higher than the students of unchanged sensing-intuitive learning style and balance category of views. It also indicated no clear pattern on changed status of learning style and negative direction views status. This result indicated that there was a significantly differences in the mean mathematics achievement scores, changed learning style and changed views status.

A two-way ANOVA was run to examine the effects of different category of views status and different category of sensing-intuitive learning style status on achievement in mathematics. There was a significant two-way interaction, $F(11,235) = 2.27$; $p=0.01$. Hence, there was no sufficient evidence to accept the null hypothesis "there is no significant effect of students change status of learning style (sensing-intuitive) and status of views on mathematics achievement".

Figure 4.8b. Interaction effect of sensing-intuitive learning style and academic aspiration on MAT score

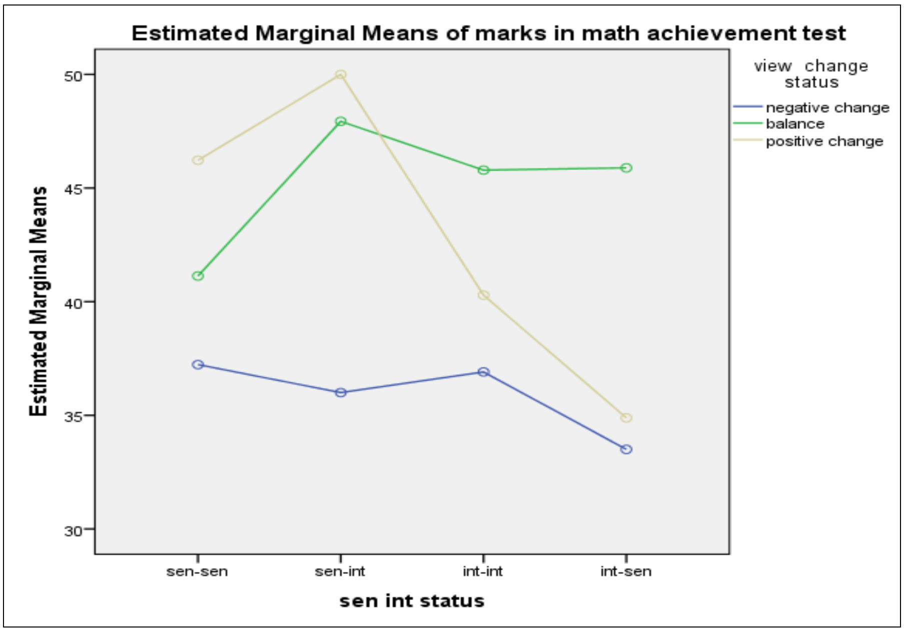


Table 4.23c

Two-way ANOVA in Comparison of Visual-Verbal Learning Style, Views Change Status and MAT Score

visual verbal status	view status	N	Mean	SD
	positive	26	41.2	12.3
visual - visual	balance	151	43.8	14.2
	negative	22	35.0	8.7
	positive	3	53.3	9.2
visual- verbal	balance	7	54.9	11.4
	negative	6	38.7	7.0
	positive	0		
verbal - verbal	balance	8	41.8	12.3
	negative	1	36.0	
	positive	0		
verbal - visual	balance	17	47.7	13.0
	negative	2	30.0	5.6

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	3910.02[a]	10	391	2.25	0.01
Intercept	96233.08	1	96233.08	552.43	0.00
Views status * visual/verbal status	3910.02	10	391	2.25	0.01
Error	41111.19	236	174.2		
Total	499920	247			
Corrected Total	45021.22	246			

[a.] R Squared = .087 (Adjusted R Squared = .048)

Table 4.23c and Figure 4.8c shows that majority of the students were in the visual to visual learning style and Balance (unchanged) views towards mathematics from beginning to the end of the academic year. In different status, they obtained the mathematics achievement scores ranked from 30 to 54.86. Visual to verbal learning style students of balance and positive views status scored higher than verbal to visual.

A two-way ANOVA was run to examine the effects of different category of views status and different category of visual-verbal learning style status on achievement in mathematics. There was a significant two-way interaction, $F(11,235) = 2.25$; $p=0.01$. Hence, there was no sufficient evidence to accept the null hypothesis "there is no significant effect of students change status of learning styles (visual-verbal) and status of views on mathematics achievement".

Figure 4.8c. Interaction Effect of Visual-Verbal Learning Style and Academic Aspiration on MAT score

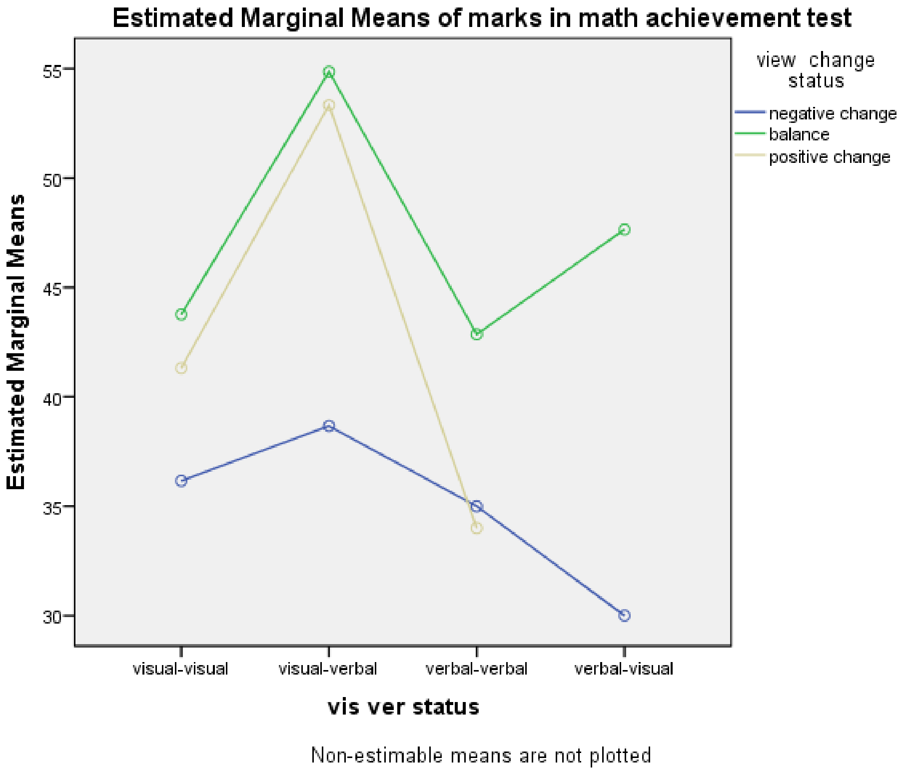


Table 4.23d

Two-way ANOVA in Comparison Of Sequential-Global Learning Style, Views Change Status and MAT score

sequential global status	view status	N	Mean	SD
sequential - sequential	Positive	19	44.1	12.59
	Balance	75	44.2	13.02
	Negative	11	37.1	8.78
sequential- global	Positive	4	39.5	11.82
	Balance	30	42.4	11.16
	Negative	5	39.6	8.65
global - global	Positive	5	31.6	8.88
	Balance	36	45.4	15.37
	Negative	8	32.5	7.07
global - sequential	Positive	5	42.8	12.13
	Balance	42	45.4	16.62
	Negative	7	33.1	7.82

Tests of Between-Subjects Effects

Dependent Variable: Mathematics achievement test

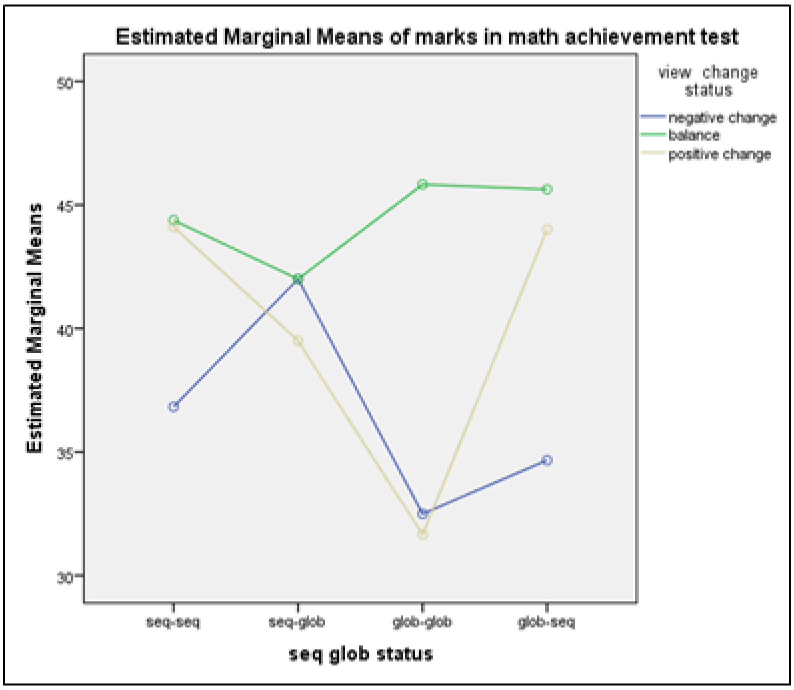
Source	Type III Sum of Squares	df	Mean Square	F	P-value
Corrected Model	3530.21[a]	11	320.93	1.82	0.05
Intercept	194310.22	1	194310.22	1100.55	0.00
Views status * Sequential/global status	3530.21	11	320.93	1.82	0.05
Error	41491.01	235	176.56		
Total	499920	247			
Corrected Total	45021.22	246			

a. R Squared = .078 (Adjusted R Squared = .035)

Table 4.23d and Figure 4.8d shows that the effects of changed status of sequential- global learning style and changed status of students' views towards mathematics on achievement in mathematics ranked from 31.60 to 45.44. Students who were in the global learning style domain in the beginning and their views unchanged from beginning to the end of the academic year scored higher in mathematics achievement test followed by positive views status students. The negative direction category students who were whether changed learning style or unchanged scored low in mathematics achievement test.

A two-way ANOVA was run to examine the effects of different category of views status and different category of sequential-global learning style status on achievement in mathematics. There was a significant two-way interaction, F (11,235) =1.82; p=0.05. Therefore, there was no sufficient evidence to accept the null hypothesis "there is no significant effect of students change status of learning styles (sequential-global) and status of views on mathematics achievement".

Figure 4.8d. Interaction Effect of Sequential-Global Learning Style and Academic Aspiration on MAT Score



The outline of null hypothesis is listed below

Table 4.24

Outline of Results of Hypothesis Testing

Results of Null Hypothesis Testing at 5% Level of Significance			
Number	Null Hypothesis	Decision	Table No
Ho:1	There is no significant difference between beginning learning styles and end learning styles of grade eleven science students.	Rejected	4.3
Ho:1a	There is no significant relationship in the learning styles between beginning and end of students by gender.	Partially Rejected	4.4
Ho:1b	There is no significant relationship in the learning styles between beginning and end of students by academic aspiration.	Partially Rejected	4.5
Ho:2	There is no significant difference in the students' views towards mathematics with subscale components between beginning and end of grade eleven science students.	Rejected	4.7
Ho:2a	There is no significant difference in the views between beginning and end of students by gender.	Accepted	4.9
Ho:2b	There is no significant difference in the views between beginning and end of students by academic aspiration.	Rejected	4.10
Ho:3	There is no significant relationship between different dimensions of learning styles and views towards mathematics.	Accepted	4.13
Ho:4a	There is no significant difference on achievement in mathematics of grade eleven science students by gender	Accepted	4.14
Ho:4b	There is no significant difference on achievement in mathematics of grade eleven science students by academic aspiration.	Rejected	4.15
Ho:4c	There is no significant difference on		

	achievement in mathematics of grade eleven science students by gender and academic aspiration	Rejected	4.16
Ho:5	There is no significant difference of students' achievement in mathematics with different changed/unchanged status of learning styles.	Accepted	4.17
Ho:5a	There is no significant relationship among the students' achievement in mathematics, their gender and changed/unchanged status of learning styles.	Accepted	4.18
Ho:5b	There is no significant relationship among the students' achievement in mathematics, academic aspirations and changed/unchanged status of learning styles.	Rejected	4.19
Ho:6	There is no significant difference of students' achievement in mathematics with different status of views towards mathematics.	Rejected	4.20
Ho:6a	There is no significant relationship among the students' achievement in mathematics, change status of views and gender.	Rejected	4.21
Ho:6b	There is no significant relationship among the students' achievement in mathematics, change status of views and academic aspiration	Rejected	4.22
Ho:7	There is no significant effect of students' changed/unchanged status of both learning styles and views on achievement in mathematics.	Rejected	4.23

CHAPTER V

SUMMARY, DISCUSSIONS, AND CONCLUSION

The primary purpose of this chapter is to present precisely the overall picture of the study. In doing so, this chapter consists three sections. The first section relates the foundational background of the study. The second section explains the research findings and examines the conclusions derived from the findings of this study. Likewise, the third section discusses the implications and recommendations of this research.

Summary of the Study

Learning mathematics has become an essential part of each student's overall development. The advancement of science and technology, which has its base in mathematics, adds ease to adjust in this technologically driven world. Therefore, enrollment and success of students in science and technology, engineering, and mathematical sciences, has always been the focus area of mathematics education research.

It has been the concern of teachers, parents, educators, and stakeholders that their students and children perform well in mathematics. In this respect, many teachers are convinced that their students need to have positive views on the subject. They also acknowledge the role of learning styles for their academic success in mathematics (Abidin, Rezaee, Abdullah, & Singh, 2011). The learning styles are collection of modalities that determine how an individual process, perceives, receives, and understands information. These modalities are major factors that impact students' educational outcomes (Felder & Silverman, 1988; Torres, 1994).

Students process and learn new knowledge in different ways and have different learning styles preferences (Felder & Silverman, 1988; Honey & Mumford, 1992; Kolb, 1984). According to Dunn and Dunn (1989), learning style refers to each student's concentration on the mental processes, the internalization, and the retention of new and difficult information. Felder and Spurlin (2005) further say that some students prefer to learn by active participation, whereas others like to sit back and reflect on ideas or theories; some prefer to note making whereas others prefer to use diagrams or pictures. These differences are termed as learning styles. It is very important to know such learning styles of the students in order to help them to succeed (Hodges, 1988).

In fact, despite the importance of mathematics, some learners perceive that it is abstract, boring and not very much practical. These beliefs influence the students' mathematical performance, teaching of mathematics, and the area where mathematics education occur (Mcleod, 1992).In this line, some studies support that many students develop negative attitudes about mathematics in their academic career. Likewise, negative beliefs about themselves prevent students from improving the learning of mathematics (Chapman, 1988).

Different studies have found that there is a positive relationship between attitudes and achievement in mathematics (Ma & Kishor, 1997; Reynolds & Walberg, 1992; Saha, 2007). Literature stress that individuals’ attitudes towards mathematics may affect their careers in the mathematical sciences (Peker & Mirasyedioğlu, 2008). Students' tendency to select or reject mathematics courses in college, thus, depends on their attitudes towards mathematics. Likewise, their career related to mathematical science eventually depends on their success level in this area of knowledge (Ignacio, Nieto, & Barona, 2006; Clark, 1999; Haladyna et al., 1983).

The researches on the affective domain in mathematical sciences were limited to inquiring attitudes about mathematics for a long time. However, the scope has been extended to incorporate the study of beliefs (Mcleod, 1992). Attitude is linked to the views and images that the individual develops as a result of interaction with different situations (Bennett, 2003). It was, thus, important to investigate how students internalize learning mathematics, and how they develop positive or negative views towards the subject, which potentially may led to success/failure in attaining mathematics achievement. In this consideration, the researcher decided to redefine the combination of these attitudes and beliefs further as the views consisting on the subscales of value, enjoyment, self-confidence, motivation and belief.

The term views in this study referred to individual's image of themselves with respect to how each student perceives and values their learning of mathematics. Views are the descriptors of the affective domain in mathematics related to attitudes and beliefs. It had important place in this study as the purpose behind this study was to investigate the affecting factors in the success of mathematics learning, with the intension of promoting positive views among the students. As such, the study focused on students' views towards mathematics, and the role of their learning styles in influencing their academic performance in this subject**.**

In reference to it, this study brought into light the learning styles of students and their views towards mathematics. These are the determining factors of achievement in this subject. Therefore, this study offers educators and teachers the insight into understanding the importance of students' learning styles and their views towards this subject.

The sample under study consisted of 247 higher secondary level science students enrolled in the academic year 2012/13. All these students had completed their grade eleven mathematics courses from the two higher secondary schools running science program in Kathmandu metropolitan city, Nepal. These students participated in the Index of Learning Styles (ILS) and students' views towards mathematics survey during the first week of the class commence, and participated for the mathematics achievement test (MAT), ILS and views questionnaire at the last week of grade eleven course completion. Different instruments such as ILS, VTMI, and MAT were used for the data collection.

Felder-Solomon's Index of Learning Styles (ILS)

This study used the Felder and Silverman (1988) model of learning styles. The model emphasized four different dichotomous method of learning as:

i. Active-reflective (active learners prefer to do things, and reflective learners prefer to think through).

ii. Sensing-intuitive (sensing learners are concrete practical, and intuitive learners are innovative and conceptual).

iii. Visual-verbal (visual learner prefers pictures and diagrams, where verbal prefers written and spoken information).

iv. Sequential-global (sequential learners prefer to be orderly linear, but global learners are holistic system thinkers).

This 44 items index of learning styles was piloted among 50 science students who had completed their grade eleven mathematics course. Cronbach's alpha of the piloting for the overall ILS scale was 0.52. Each dimension of learning styles was measured by 11 items with two choices either a or b. The first option 'a' referred for first category and 'b' for second category of each learning dimension. Each respondent's learning styles was determined by totaling up the score in each dimension. The difference of the totals within the dimension was determined.

Learning styles domain with the higher score corresponded to the preferred style. Moreover, researcher subtracted the total of each beginning learning styles dimensions from the corresponding end total to find the changes status of learning styles before and after survey. Changes occurred in the same category of learning styles domain, or from first category to second and vice versa.

In order to measure students' views towards mathematics, 40 items Attitude towards Mathematics instrument (ATMI) by M Tapia (Tapia & Marsh, 2004) and 15 items belief subscale component as constructed by researcher were used. This forty items ATMI would measure four subscales namely value, enjoyment, self-confidence and motivation (Tapia & Marsh, 2002). As this instrument (ATMI) would not measure beliefs, researcher developed belief- scale based on (Fennema & Sherman, 1978; Kumar,2011) with necessary modification, revision and addition of the items as experienced by the researcher to know the students' belief about mathematics learning/teaching.

The validity and reliability of the ATMI have been established for high school and college students (Tapia & Marsh, 2002, 2004). The researcher piloted this 40 items questionnaire among the 100 higher secondary level grade twelve science students who completed the grade 11 courses in the academic year 2012.The result of this piloted survey found the Cronbach's coefficient Alpha 0.91. The final try out of belief subscale of views consisting of 22 statements, and necessary adjustments from the previous set, were administered among 100 science students from KMC. The Cronbach's Alpha for all the accepted 15 positive and negative statements belief items varied from 0.84 to 0.86. The final form of views contained the 55 items statements (value- 10 items, enjoyment-10 items, self-confidence-15 items, motivation-5 items and belief-15 items).

The entire Views towards Mathematics Inventory (VTMI) proceed through Likert type scale. The possible responses on each statement of the views (value, enjoyment, self-confidence, motivation, and belief) scale were assigned as 5, 4, 3, 2,1 for strongly agree, agree, neutral, disagree and strongly disagree respectively for positive statements and vice versa for negative statements. The sum of all statements of each respondent showed his/her total views scores on the scale. The possible maximum score was 275 and minimum score was 55. The higher score on the scale reflected more positive views towards mathematics and vice versa. The differences of the scale between beginning and end were calculated subtracting beginning score from the end.

This constructed test consists of 50 multiple choice questions of each of 2 marks totaling 100 from grade eleven prescribed mathematics curriculum which covered Algebra, Calculus, Trigonometry, and Coordinate Geometry. Since there was no ready-made standardized test available, it was necessary to develop a MAT for grade eleven students based on the mathematics curriculum 2010 of higher secondary education board, Nepal. The researcher developed this final instrument after initially considering 75 multiple choice items in various cognitive domains of mathematics content area, and after consulting teachers and specialists. The final try out of the test consisting of 60 items was administered among 100 grade twelve science students who completed grade 11 mathematics courses.

After construction of Mathematics Achievement Test (MAT), and adapting Views towards Mathematics Inventory (VTMI) and Index of Learning Styles (ILS), the next step was to administer these tools upon the grade eleven science students' of two higher secondary schools at the beginning and end of the academic year in the KMC. Students were asked to tick on gender (male or female) they belong to at the beginning survey as well as at the end. Students were also asked to tick on the option from their academic career aspiration plan (physical group biology with mathematics and biological group) at the end survey.

Students who didn't participate at the begging of the academic session were not allowed to take part in the mathematics achievement test, learning styles index and views at the end of the academic year. In doing so, the purpose of the test taking and survey questionnaire was made clear to them. The data collection work was completed at the beginning of the new session within the first week and last week of the completion of academic year 2012/13. Between these two surveys, there was one academic year gap.

The data were analyzed using basic descriptive statistics including the mean, standard deviation, frequencies, percentage and correlation. The inferential statistics like t-test, chi-square and ANOVA were analyzed for statistical significant test. The statistical package for social sciences (SPSS ver. 20) was used.

Summary of Major Findings

Following are summary of the findings based on ordered of research questions and hypotheses.

1. The participants in this study were 161 males (65.2%) and 86 females (34.8%) totalling 247students.
2. The distribution of the students according to career aspiration was- physical group 104 (42.1%), biology with additional mathematics 98 (39.7%), and biological group 45 (18.2%).
3. Regarding the learning styles, majority of the students were active (64.4% at the beginning and 62.3% at the end), visual (87.0% at the beginning and 87.9% at the end), sequential (59.1% at the beginning and 64.4% and at the

end). In sensing learning style, there were 48.6% students at the beginning and 55.5% at the end.

4. There were positive correlations between the beginning and the corresponding end learning style dimensions varying from 0.26 to 0.50. The results were significant at 0.05 level of probability.
5. There was significant association between learning styles status of beginning- and end-survey at the 0.05 level of significance.
6. There was a significant association between learning styles status (changed/ unchanged) and beginning-end surveys when examined by gender category. This association was not significant for female students in active/reflective (p=0.27) and sequential/global (0.11) learning styles.
7. There was a significant association between learning styles status (changed/ unchanged) and beginning-end surveys when examined by academic aspiration category. This association was not significant for biological group students in active/reflective (p=0.38) and sequential/global (p=0.70) learning styles. The results also revealed that this was not significant for biology with mathematics students in sequential/global learning style (p=0.11).
8. The mean score of each item of 10 items value subscale of views in the beginning survey was 4.4 and the end survey was 4.3. In the 10 items enjoyment subscale of views, the mean score of each item at the beginning was 4.1, while at the end survey it was 3.9.In the 15 items self-confidence subscale, the mean score of each item at the beginning was 3.9 followed by 3.8 at the end. In 5 items motivation subscale, the mean score of each item in beginning survey was 3.7 followed by 3.6 in end survey. Likewise, the belief sub scale of views contained 15 items. The mean score of each item at the

beginning was 4.0 and at the end it was 3.6. However, the mean score of each item of composite views in beginning survey was 4.0 followed by the mean score of each item of end survey with 3.8. In all cases, the mean scores declined from beginning to end survey, although overall scores reflected positive views.

9. As expected, there was a high degree of positive correlations between each subscale components and the composite views, ranging from 0.69 to 0.92. The researcher also found positive correlations between beginning- and end surveys composite views (r=0.59).

10. There was significant difference between the mean score of beginning- and end-composite views (p=0.00). It was also found that there were significant differences between the mean scores for all subscale components from beginning survey to the end.

11. There was no statistically significant difference in views score changes (from beginning to end) between male and female students (p=0.36).

12. There were statistically significant changes in views scores from beginning- to end surveys based on academic aspiration (physical, biology with mathematics, biological) (p=0.01).

13. There was no statistically significant association between the learning styles and views towards mathematics in both beginning- and end-survey by correlations coefficient.

14. In 100 marks MAT, students obtained mean marks 42.9. There was no statistically significant difference in mean MAT scores between male and female students (p=0.14). However, female students scored higher (mean=44.7) than their male counterparts (mean=42.0).

15. Based on academic aspiration, physical group students scored 43.3 in MAT; biology with mathematics group students scored 45.7; and purely biological group students scored 36.0. Difference between mean scores in MAT of these three groups of students was found significant (p=0.00). The results revealed that students who were in biology with mathematics group scored higher in MAT score than those biological group students.
16. There was interaction effect of gender and academic aspiration on the academic achievement in mathematics. This interaction effect was statistically significant (p=0.00).
17. In change status of active-reflective learning styles, students mean mathematics achievement test scores varied from 40.4 (active-reflective) to 45.6 (reflective-reflective).In change status of sensing-intuitive learning styles dimension, the mean MAT scores varied from 42.0 (sensing-sensing) to 47.2(sensing-intuitive). However, in visual-verbal learning styles dimension, students scored 38.92 (verbal-verbal) to 48.5 (visual-verbal). Finally, in sequential-global learning style dimension, the mean MAT scores varied from 41.7 (sequential-global) to 43.6 (global-sequential). There was no significant mean difference of MAT scores based on learning styles status.
18. There was no statistically significant difference in the mean MAT scores based on change and unchanged status of learning style dimensions by gender.
19. There were statistically significant differences in the mean MAT scores based on change and unchanged status of learning style dimensions by academic aspiration.

20. The distributions of participating students in different categorical status of views were: 14.6% students in positive views change status, 71.3% students in balance status, and 14.2% students in negative changed status.
21. The male students in balance status of views were 70.8% while female students were 72.1%. The male students in positive status were 15.5% and female students in positive status were12.8%. There was no statistically significant association in this distribution of students in different views status category at 0.05 with respect to gender.
22. The physical group students in balance status of views were 73(70.2%) while biology with mathematics group of students in balance status was 76 (77.6%). The biological group of students in negative status of views were 12 (26.7%). There was statistically significant association between views status category and academic aspiration at (p=0.00).
23. The students in balance category of composite views scored 44.6 in MAT. The mean MAT score of positive views changed category students was 41.5. Likewise, the mean MAT score of negative view changed status group of students was 36.2. There was statistical significant difference in mathematics achievement score and views change/unchanged status (p=0.00).
24. The female students who were in the balance category of views scored higher (mean=46.6) in MAT while the male students of negative category scored the lower (mean=36.9). There was statistically significant difference in mean of MAT scores between views status and gender (p=0.01).
25. The students of balance category in views and biology with mathematics academic career aspiration scored higher (mean=47.8) in MAT. However, biological students of balance category scored the lower (mean=34.9). There

was statistically significant difference in mean of MAT score between views status and academic aspiration (p=0.00).

26. In active-reflective learning styles dimensions and views status, students obtained the mean of MAT scores ranged from 34.3 (active-active and negative) to 47.8 (reflective-reflective and balance).There were statistically significant difference in the academic achievement scores in mathematics between views status (change/unchanged) and active-reflective learning style status (change/unchanged) (p=0.03).

27. In sensing/intuitive learning styles dimensions and views status, students obtained the mean of MAT scores that ranged from 30.8 (intuitive -sensing and negative) to 49.3 (sensing-intuitive and positive). There were statistically significant difference in the academic achievement scores in mathematics between views status and sensing-intuitive learning style status (p=0.01).

28. In visual-verbal learning style dimension and views status, students obtained the mean of MAT scores that ranged from 30.0 (verbal-visual and negative) to 54.9 (visual-verbal and balance). There were statistically significant difference in the academic achievement scores in mathematics between views status and visual-verbal learning style status (p =0.01).

29. In sequential-global learning style dimension and views status, students obtained the mean of MAT scores that ranged from 31.6 (global-global and positive) to 45.44 (global-global and balance). There were statistically significant difference in the academic achievement scores in mathematics between views status (change- unchanged) and sequential-global learning style status (p= 0.05).

Discussions

The receiving information (visual-verbal) learning styles domain displayed the most varied results with regards to both gender and academic aspiration in both beginning and end survey. In terms of gender, numbers of male students' preferring active learning style were much higher than the female students. The study indicated that higher secondary level male students prefer to learn in groups, where they can discuss about learning materials. On the other, female students' preferring sequential learning style were higher than their male counterparts in beginning survey. This indicated that the female students do not see the whole picture in learning process; they follow linear stepwise paths in finding solutions. The biology with additional mathematics group of students displayed varied results with sensing learning style in beginning and end survey, which was higher in end survey. It indicated that the preferences of both males and females at the beginning of the course were theories and their meanings. In course duration, however, they develop their learning approaches to be more practical and details. One interesting finding was that each of the beginning and end learning style dimensions had overall significant associations. It is difficult to trace the real reason for this change. However, a possible reason may be a sudden change in the higher secondary school system, which seems more rigorous and higher in standard than what the students were used to in secondary schools.

As expected, higher secondary school science students had overall positive views towards mathematics, either in beginning of the academic year or at the end of the course. This finding supports the idea that high expectancy for success in mathematics shows positive achievement behaviors. The overall views towards mathematics appeared to have significantly higher mean score in the beginning-survey in almost all subscale components. The possible reasons may be that at the end of the academic year, students get exhausted and sometimes get discouraged. This discouragement may result to some extent the less positive response.

Likewise, as expected, majority of the students remained in the same learning style status and balance category of views towards mathematics changed status from beginning to the end of the academic session. The current study disclosed that the mean achievement score of female students in mathematics achievement test was slightly higher than their male counterparts. However, the mean score was below 50 in totaling 100 marks. Female students in Nepalese society spend most of their time at home than males. Therefore, they have plenty of time to study and can complete the assignment which is likely to contribute to score slightly higher. The academic aspiration differences in mathematics achievement test, is not in favor of biological group (nonmathematical sciences) of students.

Learning styles do not necessarily remain fixed in individual; it changes over time (Marriott, 2002; Zeegers, 2001). In this relation, the current study indicated that there was significant interaction effect of overall change-unchanged learning style status and academic aspiration on achievement in mathematics. Additionally, this study investigated the significant difference of mean scores of mathematics achievement test based on views category (changed/unchanged status) with respect to gender and academic aspiration.

One reason for these differences may be the consistency of student’s views towards mathematics from the beginning to the end of academic year. Another reason may be that the greater determination and motivation of students to work harder in order to be success in mathematics keeping the learning style preferences compatible to learning environment.

This study revealed that majority of the higher secondary school science students' preferences of learning styles were active, sensing, visual, and sequential in both beginning and end survey. However, more females were in active compared to their male counterparts. This study also showed that, on average, more females were on the dimension related to sensing learning styles, whereas male tended to prefer intuitive approaches to learning mathematics. These findings of this study are supported by Pallapu (2009), who had used the index of learning styles to examine the learning styles preferences of 346 college students in US. Berry and Settle (2011) distinguished the learning styles preference of 180 college students. In both studies, the participants showed similar learning styles preferences. The majority of the students showed preferences for active, sensing, visual, sequential learning styles domain. Likewise, Philbin, Meier, Huffman, and Boverie (1995) had investigated the differences in learning styles between men and women of 72 subjects of various ethnic groups, and found significant relationship.

This study observed that the students' views towards mathematics were in positive direction (greater than 3 for each item in likert scale) in both beginning and end surveys. However, mean views score decreased from beginning survey to the end survey. The male students had slightly higher score in overall views compared their female counterparts. These findings of this study are in the line of study of Norton and Rennie (1998) who had found that the students' attitudes towards mathematics was less positive in senior grades; and overall, male students had more positive attitudes than female students, which is in line to the findings of Mcleod (1992) and Middleton et al. (2013).

Similarly, this study found no significant relationships between learning styles and views towards mathematics. In doing so, this finding supports the results of Orhun (2007).

In terms of achievement and gender, this current study found no statistical significant differences of mean score in mathematics achievement test between male and female students. This finding supports the results of Ajai and Imoko (2015); Mubeen, Saeed, and Arif (1996); Setia (1991). The results of this study on learning styles and achievement in mathematics is also supported by the findings of Adnan et al. (2013; Jahanbakhsh (2012); Prajapati et al. (2011). In this relation, this study found that higher the mean score in views towards mathematics, more the mean score on academic achievement in mathematics. This positive correlation supported the findings of Cornell (1999) and Ma and Kishor (1997).

The current study was conducted to assess whether there were differences in learning styles and views towards mathematics with respect to gender and academic career aspiration plan. It was also to investigate the relationship that exists between beginning and end survey of learning styles and views among higher secondary school science students. In doing so, as stated earlier, data were collected from 247 grade 11science students, which was limited in two higher secondary schools from Kathmandu. It was further proceed with 44 items Felder-Soloman index of learning styles, 55 items views towards mathematics questionnaire and 50 items mathematics achievement test. The relationships among the variables; learning styles, views about mathematics, mathematics achievement test, gender and academic aspiration of higher secondary level students were limited.

The first research question was: What are the learning styles of higher secondary school level science students at the beginning and at the end of the academic year? The data related to this question can be seen in figures4.1- 4.6 and tables 4.2- 4.5. Likewise, the table 4.3 indicated the significant association between beginning and end overall learning styles dimension. When looking at the individual groups such as gender and academic aspiration, it becomes clear that some groups prefer a particular learning style. More female students were in active and sensing learning styles as well as more biology with mathematics group of students were in sensing learning style.

The second Research Question was: What are the students' views on mathematics and mathematics learning at the beginning and end of the academic year? The data related to this research question can be seen in table 4.6-4.12. The participant students had a mean of composite views survey score of beginning=4.0 and end=3.9 on the 5 point likert scale, with a score of 1 representing the most negative views, a score of 3 representing a neutral position, and a score of 5 representing the most positive views. Therefore, the mean composite score reflected the views that were slightly higher above the neutral position. From table 4.7, the significant difference between beginning and end survey of views with subscale were observed.

The third Research Question was: Does relationship exists between learning styles and views towards mathematics? The data related to this research question can be seen in the table 4.13. There were no significant correlations between learning styles and composite views.

Fourth Research Question was: What is the achievement of students in mathematics by gender and academic aspiration? The data related to this research question can be seen in the tables 4.14, 4.15, and 4.16 and figure 4.7. The findings suggested that there were no statistically significant relationships between students' gender and academic achievement in mathematics. Study also showed that there were significant difference of mean achievement score in mathematics and academic aspiration (physical, biology with additional mathematics, and biological). However, biology with additional mathematics students scored higher and non-mathematical sciences students scored least.

The fifth Research Question was: Is there any relationship between the learning styles and mathematics achievement? The data related to this research question can be seen in tables 4.17, 4.18, and 4.19. The research found that there was no significant effect of learning styles (changed/unchanged status) on achievement in mathematics as well as non-significant interaction effect of learning styles changed/unchanged status and gender on achievement in mathematics. However, there was a significant interaction effect of learning styles status (changed/unchanged) and academic aspiration on achievement in mathematics.

The sixth Research Question was: Is there any relationship between the views and mathematics achievement? The data related to this research question can be seen in tables4.20, 4.21 and 4.22. Significant relationships were found between views status (positive, balance, and negative) and mean academic achievement score in mathematics. Additionally, there was significant interaction effect of gender and views status on academic achievement in mathematics. However, the two-way analysis of variance found significant interaction effect of views status and academic aspiration on achievement score in mathematics.

The seventh Research Question was: What types of association exists among the students' learning styles, views and academic achievement in mathematics? The data related to this research question can be seen in the tables 4.23 and figures 4.8a, 4.8b, 4.8c, 4.8d. The table 4.23 showed that there was significant interaction effect of views status and learning styles status on achievement score in mathematics.

The check list of research questions, table numbers, and figure numbers are added in appendix 16. The table 4.1 showed the distribution of students' gender and academic aspiration. Table 4.4 indicated partially significant association between beginning and end learning styles with respect to gender, and table 4.5 showed that there was significant association between beginning and end learning styles and academic aspiration. Table 4.8 showed significant correlations between beginning and end composite views with subscale components. Table 4.9 indicated no significant differences of views score with respect to gender, whereas table 4.10 pointed the significant difference of views mean score with respect to academic aspiration. Table 4.11 indicated no significant association between views status and gender. In addition, table 4.12 showed that there was significant association between students' views status and their academic aspiration.

Talking about country context, Nepal is a developing country, which has to identify and follow new trends that may help it to move ahead. The progress is to be seen in all walk of our lives. As such, it has to make major changes in educational system, which is one of the effective tools that help nation to achieve its aims. Students, teachers and concerned authority are supposed to do their best to bring up effective, productive, prospective, and qualified manpower. Experience shows that learning mathematics with additional skills is very important in the world market. However, learning mathematics requires variety. Knowing the students, their likes, dislikes, ways of learning, may facilitate learning cycle to be much more effective. Besides knowing the learning style preferences, students need to be aware of the meanings of their learning styles. In doing so, students gain confidence in their strengths and develop diverse strategies for coping with the challenging situations. The findings of this study, as such, is useful not only for understanding the students' views and learning styles but also in helping them to find mathematics as easier, more practical, and more enjoyable.

Discussions with Speculations

The majority of female students preferred an active learning style. This study supports that the higher secondary science female students learn by trying things out and working with others. They appear to be more interested in communicating with others and prefer to learn by doing work in groups. In group, they can discuss the materials they need to learn. The preferred learning style of higher secondary science male students was intuitive. This study supports that the intuitive learners prefer to learn abstract materials like theories and derivations. They are able to discover further possibilities and innovative approaches. In this context, male students studying science course seek to be studying either technical subject like engineering or mathematics related pure science courses. On the other, the female science students seek to continue their studies either in medical related field or nonmathematical related courses. This study supports that both the male and female students' have trend of further study in science and technology. However, more male students prefer engineering and female prefer medical sciences. In informal discussions, the image about the mathematics of more male students was positive while the image about mathematics of more female students was less positive. This study supports the ideas that students with positive feeling and enthusiasm join higher secondary science courses which are the phase change of one school system from secondary school to the different school system of higher secondary. There, they need to go familiar with the new system and make some changes in their feelings about the subjects, career, and teachers. These reasons may change students' views towards mathematics.

The average of achievement score in mathematics was below 50 out of 100.The reasons for low performance may be due to gap in secondary level mathematics curriculum and higher secondary level mathematics curriculum. Other reasons may be differences in teachers' teaching techniques between secondary and higher secondary schools as well school management system and peer interactions. There is provision of extra (additional) mathematics for biological students at grade twelve. Those biological students who pass with additional mathematics are eligible for both mathematical related sciences and nonmathematical related courses. It may be the reason that students who were in biology with additional mathematics group scored higher in mathematics achievement test. In this study, female students performed slightly higher mean mathematics achievement score than their male counterparts. The reason may be that equally capable female students with competitive academic results from non-gender bias family background were enrolled in grade eleven science courses. Students with unchanged views or change in positive direction scored higher, which may be due to consistency in their views about the subject mathematics and learning mathematics. Students with views towards mathematics in decreasing direction and academic career plan nonmathematical sciences (biological group) scored lower in MAT. This may be due to the fact that they may not be unaware about the importance of the subject mathematics and not interested in doing more practice in mathematics.

Majority of the students were in visual learning style, which indicated that these students remember best what they have taught through diagrams, sketches, flow charts and pictures. The study indicated that students scored more in achievement test who changed their visual learning styles to the verbal followed by verbal to verbal. The reasons may be that teachers' focus on either oral or written explanations. In doing so, students who would easily adapt to any teaching techniques may score higher. This study found that students' learning styles may exhibit some degree of change over the one academic year of higher secondary level grade eleven. This investigation supports the study of Pinto et al. (1994) on learning styles of under graduate business major college students.

Limitations of the Study

Like other research studies, this study also has some limitations. Every attempt has been made to make this research valid, reliable and representative. However, due to financial and time constraints, the sample size of this study was relatively smaller. The data for this study came from self-reported survey conducted at two different times. In the beginning of the academic year, students' learning styles and views towards mathematics could be elaborated as they would feel that they understood the materials in mathematics. Likewise, this study was conducted in a classroom setting, and therefore, on the data collection day some students might have been absent. These absent students might have had different learning styles and views towards mathematics than those who participated in the survey. Likewise, some participating students may have deliberatively chosen to give their preferred opinion rather than their actual practices when they answered the survey. Some other students might have answered thoughtlessly to finish the survey quickly. In MAT, students might have guessed the answer. Some students might also have discussed among the peers before answering and this might have influenced their answers. The sample of the study was limited only to grade 11 science students who were admitted in 2012/2013 academic year. Similarly, the sample was limited to the science students of two higher secondary schools in the KMC from Kathmandu district. This does not mean that other schools were not appropriate for the study, but the selected schools represented the students from all corners of KMC as well Kathmandu district and different parts of the country Nepal. These two schools may not be the best epresentation of the student population. The truthfulness of the students is another limitation. This study would have been stronger if the interviews with groups of participant students were incorporated through triangulation for additional qualitative approach. Further, English not being the native language for students, responding the survey in English may have been yet another limitation.

Conclusion

Overall, the learning styles, views, gender and field of study are determining factors, which potentially influence academic achievement in mathematics. Students' learning styles would vary according to gender, type of program attended, and their views. Notably, the students need to have the mathematics skills and knowledge not only to succeed in an increasingly competitive world economy but also to succeed in life. Even though most of the mathematics teachers follow an autocratic teaching technique, it is actually more efficient, if the students' learning styles preferences are identified and they are taught according to their learning preference. Such practise will enhance their interest and achievement in mathematics. Compared with students who take mathematics in the succeeding grades, the students who don't are the ones with lower achievement in mathematics.

In this reference, the exposure of better perspective towards mathematics helps students to develop positive views towards mathematics; and therefore, promotes their learning ability and performance in mathematics achievement. Students with different learning styles dimension do not differ in their overall views. The gender difference has no impact on the learning styles and views towards mathematics of higher secondary science students in Nepal.

Further, the positive view towards mathematics is at medium level. It shows that there is still possible room for improvement. However, it is interesting to know that despite the lower achievement of higher secondary science students in mathematics, the views of these students in this study are fairly positive. It suggests that the concerned authority needs to bridge the gap between secondary level curriculum and higher secondary curriculum in mathematics. Teachers should take into account their students learning styles while deciding their teaching method.

Implications

Several implications emerge from the findings of this study. First, the study come with the idea that in order to assess higher secondary level science students' learning styles, the index of learning styles (Felder & Soloman, 2001), and views towards mathematics inventory (Tapia & Marsh, 2004) can also be used in similar other research works in this area of knowledge. Second, the results of this study extends knowledge in the field of learning styles in the Nepalese context, as most of the earlier investigation are carried out only in the context of developed countries. In addition, it adds knowledge of views (beginning and end without treatment) in the body of literature in the field of learning domain. As this study suggests, after understanding the learning styles of students, teachers can be encouraged to teach their students and promote the positive views towards mathematics. It is because the current study and other related studies in this area acknowledges that a positive view towards mathematics enables the students to retain the information much longer; it enables them apply it more efficiently and effectively. Academic achievement in mathematics can be enhanced through providing learning environments that match students' learning styles (Zhang, 2004). The positive relation between students' views and students' achievement in mathematics demonstrated that the views play a major role in student learning. It is, therefore, important and imperative for students to develop positive views towards mathematics and make mathematics interesting and appealing. This may go a long way to help students develop positive views towards mathematics; learn it without any suppression; and hence improve students' academic achievement in mathematics.

Further, as the finding of this study suggests, knowing the students' learning styles and views towards the mathematics can improve the mathematics education of higher secondary level schools and pre-university. Identifying students' preferred way of learning, and finding resources and activities make their learning easier. Understanding students’ way of learning helps teachers to organize their lectures more effectively, which in return is beneficial to both teachers and students. Studying the relationships of learning styles and views on academic achievement in mathematics is expected to achieve following educational implications:

- if learning styles is a significant factor, then education techniques can enforce certain learning techniques that is necessary for success.

- knowing students' learning styles and views about mathematics can also provide teachers, curriculum designers, educators, book writers, education leaders with information for better performance in mathematics.

- the information of learning styles and views can also provide valuable suggestions in regard to whether students are best suited for the instructional mode.

This research provides the empirical evidence of students learning styles, and their views on achievement in mathematics by gender and academic career interest among higher secondary level science students in Nepal .The finding suggests that in addition to using learning styles assessment to enhance achievement in mathematics, it is very important to promote their views about mathematics. The study also sheds light on achievement in mathematics and suggests that academic career choices are more important for success in mathematics compared to gender. These findings have implications for improvement of mathematics education of higher secondary science students in Nepal and other countries. The findings are significant for identifying appropriate techniques, which teachers can apply to facilitate efficient learning. Likewise, the understanding of the importance of students' learning styles and their views towards mathematics contribute to a better and systematic learning/ teaching in classroom activities.

Recommendations

In spite of the fact that the concept of learning styles has been part of the body of the international education research for more than three decades (Dunn et al., 2008), it is not well known in the Nepali education contest. Therefore, the government of Nepal needs to introduce the idea of the learning styles among the educators, teachers, and principals so that they can learn to understand the students' learning styles. Understanding the students' learning styles, teachers may enable them to adjust their teaching techniques to meet the needs of students.

Although the views of the students towards mathematics were in the positive direction, their achievement scores are not as satisfactory as expected. It may be caused by other factors like future scopes in job careers, facilities available in the schools, students' personal characteristics, and environment. The concern authority should pinpoint the problems and need to take the necessary measures.

This study in general recommends that the responsible bodies need to work on capacity building, especially for the teachers, providing the facilities in the schools as well as the improvement of the environment within schools and outside.

In the mathematics teaching process, instead of traditional way, altering the teaching methods is recommended to accommodate the learning style preference (Felder, 1996). Acknowledging it, based on the findings of this study, it further recommends to:

1. Give students the opportunity for active cooperation on at least some assignments in consideration of the active learning style students.
2. Provide balance, concrete and conceptual information to facilitate the sensing and intuitive students.
3. Teach new concepts to which the students can relate in terms of individual's personal and career experiences rather than memorize (intuitive learners).
4. Make liberal use of visuals to aid the visual students.
5. Provide the balance structured teaching techniques that support students with sequential learning style.
6. Present the materials to the global learners based on their prior knowledge and experiences.

The study further recommends that, first, teachers need to understand the learning styles of their students' to make mathematics teaching effective, and to enhance students learning readiness. Second, the students need to be aware of their learning styles, and implement it to enhance their learning capabilities in higher secondary mathematics. Third, in the line of transformation from classical to the technology age, this change makes call for the shift of teaching from teacher-centered to student-centered. This eventually would be helpful in developing positive views of students towards mathematics, which as this study suggests, is another important factor for student engagement in this subject. It advocates for participatory approaches in mathematics class.

Recommendations for Future Research

The study was limited only to two higher secondary schools running science programs with students more than 150 from Kathmandu Metropolitan City out of twenty six schools. Regardless of survey, conducting similar studies by using other methods such as observation and interview or focus group discussion are recommended.

The findings of this study suggest that:

1. There is a need to extend it further beyond this geographical boundary to prove the relationship established by this study.
2. The independent variables such as teachers' views towards mathematics and their learning styles may be taken up.
3. The independent variables such as teachers' expectation from student in mathematics learning may be taken up.
4. The study could be extended by including the teaching styles of teachers and investigate if there is a match or mismatch of the learning styles in mathematical sciences at higher secondary level.
5. There is a need to extend the learning style instruments other than Felder-Soloman's index of learning styles in higher secondary level mathematics and other sciences.
6. The relationships among the variables views about the mathematical sciences, learning styles and achievement of students need to extend on ethnicity, socio-economic status and culture.

7. It may be interesting to replicate this study in larger population; also follow up studies may be undertaken to establish the validity of findings of the present study.
8. The study could be extended over a period of two academic years of higher secondary level.
9. This study could also be extended by comparing between the science and non-science students.
10. The study could be extended to bachelor's students of science and technology, engineering, and medicine.
11. The study could be extended to secondary level and higher secondary level students from public school.

REFERENCES

Abidin, M. J. Z., Rezaee, A. A., Abdullah, H. N., & Singh, K. K. B. (2011). Learning styles and overall academic achievement in a specific educational system. *International Journal of Humanities and Social Science*, *1*(10), 143–152.

Adnan, M., Lee Abdullah, M. F. N., Ahmad, C. N. C., Puteh, M., Zawawi, Y. Z., & Maat, S. M. (2013). Learning style and mathematics achievement among high performance school students. *World Applied Sciences Journal*, *28*(3), 392-399.

Agresti, A., & Finlay, B. (2008). *Statistical options for the social sciences* (4th ed.). London: Prentice Hall.

Aiken, L. R. (1970). *Attitudes toward mathematics*. Retrieved from http://www.jstor.org/stable/1169746?seq=1#page_scan_tab_contents

Aina-popoola, S., & Hendricks, C. S. (2014). Learning styles of first-semester baccalaureate nursing students : A literature review. *Institute for Learning Styles Journal*, *1*, 1–10.

Ajai, J. T., & Imoko, B. I. (2015). Gender differences in mathematics achievement and retention scores: A case of problem-based learning method. *International Journal of Research in Education and Science*, *1*(1), 45–49.

Allen, J. (2001). *Sociology of education: Possibilities and practices*. Melbourne: Cengage Learning.

Anderson, L., & Krathwohl, D. A. (2001). *Taxonomy for learning, teaching and assessing: Arevision of bloom's taxonomy of educational objectives*. New York: Longman.

Aronson, E., Wilson, T. D., & Akert, R. M. (2005). *Social psychology* (5th ed.). New Delhi, India: Pearson Education International.

Atkinson, R. C. (1972). Ingredients for theory of instruction. *American Psychologist*, *27*(10), 921–931.

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1978). *Educational psychology: A cognitive view* (2nd ed). New York, NY: Rinehart & Winton

Bajracharya, I. K. (2007). *Determinants of achievement status of grade VIII students in mathematics* (Unpublished doctoral dissertation). Tribhuvan University, Kathmandu.

Bandura, A. (1977). Self-efficacy:Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. http://doi.org/10.1037/0033-295X.84.2.191

Barris, R., Kielhofner, G., & Bauer, D. (1985). Educational experience and changes in learning and value preferences. *OTJR: Occupation, Participation and Health*, *5*(4), 243–256.

Belbase, S. (2013). Images, anxieties, and attitudes toward mathematics. *International Journal of Education in Mathematics Science and Technology*, *1*(4), 230–237.

Bennett, J. (2003). *Teaching and learning science*. New York, NY: Continuum.

Berry, T., & Settle, A. (2011). Learning style differences. *International Journal of Education Research, 6*(1), 1–8.

Berthelot, J. M., Ross, N., & Tremblay, S. (2001). Factors affecting grade 3 student performance in Ontario: A multilevel analysis. *Education Quarterly Review*, *7*(4), 25.

Bleeker, M. M. (2002). *Pernets influence on maths and science career plans.* Biennial Meeting of the Society for Research on Adolescence, New Orleans, LA.

Bloom, B. (1956). *Taxonomy of education objectives, hand book I: Cognitive domain*. New York, NY: McKay.

Blowe, E. H., & Price, T. (2012). Career and technical education: Academic achievement and graduation rates of students in the commonwealth of Virginia. *Sage Open*, *2*(3), 1–13. http://doi.org/10.1177/2158244012455437

Borasi, R., & Rose, B. J. (1989). *Journal writing and mathematics instruction on JSTOR*. Retrieved from http://www.jstor.org/stable/3482313?seq=1#page_scan_tab_contents

Boyd, B. L., Murphrey, T. P., & Locke, D. (2004). Evaluating the scope of learning style instruments used in studies. *Journal of Southern Agricultural Education Research*, *54*(1), 124–133.

Basic and Primary Education Project [BPEP]. (1995). *Basic and primary education introductory booklet*. Kathmandu: Author.

BPEP. (1997). *Basic and primary education introductory booklet*. Kathmandu: Author.

BPEP. (1998). *Basic and primary education introductory booklet*. Kathmandu: Author.

Brown, M., Brown, P., & Bibby, T. (2008). “I would rather die”: Reasons Given by 16-year-olds for not Continuing their Study of Mathematics. *Research in Mathematics Education*, *10*(1), 3–18. http://doi.org/10.1080/14794800801915814

Bruner, J. (1986). *Actual minds, possible worlds* (The Jerusalem-Harvard lectures). Cambridge, MA: Harvard University Press.

Bruner, J. (1990). *Acts of meaning*. Cambridge: Harvard University Press.

Bruner, J. S. (1996). *The culture of education*. London, UK: Harvard University Press.

Bruner, J. (1973). *The relevance of education*. New York, NY: Norton.

Buchmann, C., & Dalton, B. (2002). Interpersonal influences and educational aspirations in 12 countries: The importance of institutional context. *Sociology of Education*, *75*(2), 99–122.

Budhathoki, C. B., Khatri, H. B., Shrestha, D., Rana, B. K., Sigdel, T. P., Panta, K., & Thapa, S. W. (2014). *Status of SLC dropouts and identifying ways to engaging students in co-curricular activities*. Kathmandu: Authors.

Calıskan, H., & Kılınc, G. (2012). The relationship between the learning styles of students and their attitudes towards social studies course. *Procedia - Social and Behavioral Sciences*, *55*, 47–56.

Canfield, A. A. (1992). *Canfield learning styles inventory manual*. Torrance: Western Psychological Services.

Carol, K. (1986). Gender research and education. *American Psychologist, 41*(10), 1161–1168.

Carter, G., & Norwood, K. S. K. . (1997). The relationship between teacher and student beliefs about mathematics. *School Science and Mathematics*, *97*(2), 62–67.

Cassidy, S. (2004). Learning styles: An overview of theories, models, and measures. *Educational Psychology*, *24*(4), 429–444.

Centre for Research (2015). *Statistical bulletin*. Kathmandu: Tribhuvan University.

CERID. (Research center for educational innovation and development)(1999). *Assessment of learning achievement of lower secondary children*. Kathmandu: Author.

CERID (1985). *A study of effectiveness of primary education*. Kathmandu: Author.

CERID (1998). *Performance level of grade v students.* Kathmandu: Author.

CERID (1982). *Achievement study of primary school children.* Kathmandu: Author.

Chapman, J. W. (1988). Learning disabled children's self-concepts. *Review of Educational Research*, *58*(3), 347–371.

Clark, J. V. (1999). *Minorities in science and math*. Retrieved from http://files.eric.ed.gov/fulltext/ED433216.pdf

Clinchy, B. M. (1984). Frames of mind:The theory of multiple intelligence. *The Journal of Education*, *166*(2), 199–205.

Cohen, L., & Manion, L. (1994). *Research method in education* (4th ed.). London, UK: Routledge.

Cornell, C. (1999). I hate math!: i couldn't learn it, and i can't teach it!. *Childhood Education*, *75*(4), 225–230. http://doi.org/10.1080/00094056.1999.10522022

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). New Delhi, India: Sage publication.

Curry, L. (1983). *An organization of learning styles theory and constructs*. Retrieved from http://files.eric.ed.gov/fulltext/ED235185.pdf

Dağ, F., & Geçer, A. (2009). Relations between online learning and learning styles. *Procedia - Social and Behavioral Sciences*, *1*, 862–871.

Daniel, F. C., & Russell, K. S. (n.d.). *Making sense of the social world methods of investigation*. New Delhi: Sage Publication.

De Bello, T. C. (1990). Comparison of eleven major learning styles models: Variables, appropriate populations, validity of instrumentation, and the research behind them. *Reading, Writing, and Learning Disabilities*, *6*(3), 203–222.

Dee, K. C., Nauman, E. A., Livesay, G. A., & Rice, J. (2002). Research report: Learning styles of biomedical engineering students. *Annals of Biomedical Engineering*, *30*(8), 1100–1106. http://doi.org/10.1114/1.1512677

Dewey, J. (1998). *Experience and education*. New York, NY: Kappa Delta Pi.

Duncan, O. M. C. (2012). *An examination of the learning styles of brazilian senior high school students attending public and private schools in a metropolitan area of Brazil*. Auburn University, USA.

Dunn, R., Honigsfeld, A., Doolan, L. S., Bostrom, L., Russo, K., Schiering, M. S., … Tenedero, H. (2008). Impact of learning-style instructional strategies on students' achievement and attitudes: Perceptions of educators in diverse institutions. *The Clearing House*, *82*(3), 135–140.

Dunn, R. S. (1990). Understanding the Dunn and Dunn learning styles model and the need for individual diagnosis and prescription. *Reading, Writing, and Learning Disabilities*, *6*(3), 223–247.

Dunn, R. S., & Dunn, K. J. (1978). *Teaching students through their individual learning styles: A practical approach*. Reston: Reston Publishing Company.

Dunn, R. S., & Dunn, K. J. (1989). *Learning style inventory (LSI)*. Lawrence, KS: Price Systems.

Dunn, R. S., Dunn, K. J., & Price, G. E. (1989). *Learning style inventory (LSI)*. Price Systems, Incorporated, Lawrence.

Dunn, R. S., & Griggs, S. A. (1995). *Multiculturalism and learning style: Teaching and counseling adolescents*. London, UK: Greenwood Publishing Group.

Dutta, S. (1989). Effectiveness of inductive strategies of teaching mathematics on achievement and attitude of students in relation to sex and intelligence. *Asian Journal of Psychology and Education*, *22*, 34–58.

EDSC (1997). *National achievement level of grade three students*. Kathmandu: Author.

EDSC (1999). *National achievement level of grade five students*. Kathmandu: Author.

EIMS (Educational Information Management Section) (2014).*Nepal education in figures at a glance.* Kathmandu: Author.

Felder, R. M. (1988). How students learn: Adapting teaching styles to learning styles. *Proceedings: Frontiers in Education Conference*, 489–493.

Felder, R. M. (1993). Reaching the second tier: Learning and teaching styles. *College Science Teaching*, *23*(5), 286–290.

Felder, R. M. (1996). Matter of style. *ASEE Prism*, *6*(4), 18–33.

Felder, R. M. (2010). *Are leraning styles invalid? (Hint:No*. Retrieved from http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/LS_Validity(On-Course).pdf

Felder, R. M., & Brent, R. (2001). Effective strategies for cooperative learning. *Journal of Cooperation & Collaboration in College Teaching*, *10*(2), 65–75.

Felder, R. M., & Brent, R. (2005). Understanding student differences. *Journal of Engineering Education*, *94*(1), 57–72.

Felder, R. M., & Henrique, E. R. (1995). Learning and teaching styles in foreign and second language education. *Foreign Language Annals*, *28*(1), 21-31.

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education*, *78*(7), 674–681.

Felder, R. M., & Soloman, B. A. (2001). Learning styles and stratgies. Retrieved from http://?www2.?ncsu.?edu/?unity/?lockers/?users/?f/?felder/?public/?ILSdir/?styles.?htm

Felder, R. M., & Soloman, B. A. (2007). *Learning styles and strategies*. Retrieved from http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm

Felder, R. M., & Spurlin, J. (2005). Applications, reliability and validity of the index of learning styles. *International Journal of Engineering Education*, *21*(1), 103 –

112.

Fennema, E. (1989). *The study of affect and mathematics: A proposed generic model for research in affect and mathematical problem solving*. New York, NY: Springer.

Fennema, E., & Sherman, J. A. (1976). Fennema-Sherman mathematics attitudes scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics Education*, *7*(5), 324–326.

Fennema, E., & Sherman, J. A. (1978). Sex-related differences in mathematics achievement and related factors : A further study. *Journal for Research in Mathematics Education*, *9*(3), 189–203.

Fleener, M. J. (1996). Scientific world building on the edge of Chaos: High school students' beliefs about mathematics and science. *School Science and Mathematics*, *96*(6), 312–320.

Fleming, N. D. (2009). *VARK: A guide to learning styles*. Research and statistics. Retrieved from h ttp://www. vark-learn. com/english/page. asp

Fraenkel, J. R., Wallen, & Hyun, N. E. (2012). *How to design and evaluate research in education.* New York, NY: McGraw Hill.

Gagne, R. M. (1979). *The condition of learning* (3rd ed.). New York, NY: Holt Rinehart and Winston.

Gagne, R. M., Briggs, L., & Wagner, W. (1992). *Principle of instructional design* (4th ed.). TX: Fort Worth.

Gallagher, J. M., & Reid, D. K. (1981). *The learning theory of Piaget and Inhelder*. Monterey, CA: Brooks.

Gardner, P. L. (1975). Science curricula and attitudes to science: A review. *Australian Science Teachers Journal*, *21*(2), 23-40.

Geiger, M.A., & Pinto, J. K. (1991). Changes in learning style preference during a three- year longitudinal study. *Psychological Reports, 69*(3), 755-762.

Ghimire, K. P. (2006). *Factors affecting lower secondary level students' achievement in mathematics*. Kathmandu University School of Education, Lalitpur.

Gonzales, P., Partelow, L., Pahlke, E., Lerner, R., Jocelyn, L., Kastberg, D., & Williams, T. (2004). *Highlights from the trends in international mathematics and science study (TIMSS) 2003*. Kathmandu: National Center for Education Statistics.

Gonzales, P., & Williams, T. (2009). *Highlights from TIMSS 2007: Mathematics and science achievement of U.S. fourthand eighth-grade students in an international context*. National Center for Education Statistics. Retrieved from http://ies.ed.gov/pubsearch/pubsinfo.asp?pubid=2009001

Graf, S. (2007). *Advanced adaptivity in learning management systems by considering learning styles*. Vienna University of Technology website: http://doi.org/10.1109/WI-IAT.2009.271

Graf, S., Viola, S. R., Leo, T. & Kinshuk, J. (2007). In depth analysis of the Felder-Silverman learning style dimensions. *Journal of Research on Technology in Education*. *40*(1), 79-63

Graf, S., & Kinshuk, Liu, T.C. (2009). Coping with mismatched courses: Students' behaviour and performance in courses mismatched to their learning styles. *Educational Technology Research and Development*, *57*(6), 739–752.

Grasha, A. F. (1994). A matter of style: The teacher as expert, formal authority, personal model, facilitator, and delegator. *College Teaching*, *42*(4), 142–149.

http://doi.org/10.1080/87567555.1994.9926845

Grasha, A. F. (2002). *Teaching with style: A practical guide to enhancing learning by understanding teaching and learning styles*. Pittsburgh, PA: Alliance.

Greenwood, L. (1997). *Psychological and contextual factors influencing mathematics achievement.* Paper presented at the 1997 Australian Association for Research in Education Annual Conference in Brisbane.

Grouws, D. A. (1992). *Handbook of research on mathematics teaching and learning*. NewYork, NY: National Council of Teachers of Mathematics (NCTM).

Guardia, J., Freixa, M., Peró, M., Turbany, J., Cosculluela, A., Barrios, M., & Rifà, X. (2006). Factors related to the academic performance of students in the statistics course in psychology. *Quality and Quantity*, *40*, 661–674.

Guay, F., Marsh, H. W., & Boivin, M. (2003). Academic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology*, *95*(1), 124–136. http://doi.org/10.1037/0022-0663.95.1.124

Haladyna, T., Shaughnessy, J. M., & Shaughnessy, J. M. (1983). A causal analysis of attitude toward mathematics. *Journal for Research in Mathematics Education*, *14*(1), 19–29.

Hall, M. (2008). The effect of cooperative learning groups and competitive strategies on math facts fluency of boys and girls. *The Effects of Learning Strategies*, 1-28.

Hannula, M. S. (2002). Attitude towards mathematics: Emotions, expectations and values. *Educational Studies in Mathematics, 49*(1), 25–46.

Harris, L. V. A., Sadowski, M. S., & Birchman, J. A. (2005). A comparison of learning style models and assessment instruments for university graphics educators. *Engineering Design Graphics Journal*, *70*(1), 6–14.

Hart, L. E. (1989). *Describing the affective domain: Saying what we mean in affect and mathematical problem solving*. New York, NY: Springer.

Herrmann, N. (1991). The creative brain. *The Journal of Creative Behavior*, *25*(4), 275–295.

Herrmann, N. (1995). *The creative brain: Insights into creativity, communication, management, education and self-understanding*. Lake Lure, NC: The Ned Herrmann Group.

Hodges, S. A. (1988). Individual learning styles of student nurses, their teachers and ward sisters. *Journal of Advanced Nursing*, *13*(3), 341-344. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/3417928

Hofer, B. K. (1999). Instructional context in the college mathematics classroom: Epistemological beliefs and student motivation. *Journal of Staff, Program & Organization Development*, *16*(2), 73–82.

Honey, P., & Mumford, A. (1992). *The manual of learning styles*. Maidenhead: Peter Honey.

HSEB. (2015). *Report of the office of the controller of the examination*. Bhaktpur: Author.

Huitt, W. (2003). A transactional model of the teaching/learning process. *Educational Psychology Interactive*. Retrieved from http://www.edpsycinteractive.org/materials/tchlrnmd.html

Husch, D. S. (2001). *An investigation of the relationships between learning styles, personality temperaments, mathematics self-efficacy, and post-secondary calculus achievement*. University of Tennessee, Knoxville.

ICEL. (2014). *International center for educators' learning styles*. Retrieved from https://eiclsresearch.wordpress.com/

Ignacio, N. G., Nieto, L. J. B., & Barona, E. G. (2006). The affective domain in mathematics learning. *International Electronic Journal of Mathematics Education*, *1*(1), 16–32.

IOE (2012). *Institute of engineering entrance information bulletin*. Kathmandu: IOE,TU.

Jahanbakhsh, R. (2012). Learning styles and academic achievement: A case study of Iranian high school girl's students. *Procedia - Social and Behavioral Sciences*, *51*, 1030–1034.

James, W. B., & Gardner, D. L. (1995). Learning styles: Implications for distance learning. *New Directions for Adult and Continuing Education*, 67, 19–31.

Johnson, R. M. (2000). *Gender differences in mathematics performance: Walberg's educational productivity model and the NELS:88 Database*. New Orleans, LA.

Jonassen, D. H., & Grabowski, B. L. (1993). *Handbook of individual differences, learning, and instruction*. New Jersey: Lawrence Erlbaum Associates.

Jung, C. G. (1971). *Psychological types* (Vol. 6). Princeton: Princeton University Press.

Kalder, R. S., & Lesik, S. A. (2011). A classification of attitudes and beliefs towards mathematics for secondary mathematics pre-service teachers and elementary pre-service teachers: An exploratory study using latent class analysis. *IUMPST: The Journal*, *5*.

Keefe, J. W. (1979). *Learning styles: An overview in NASSP's student learning styles: Diagnosing and prescribing programs.* Reston: National Association of Secondary School Principles.

Keefe, J. W. (1985). Assessment of learning style variables: The NASSP task force model. *Theory Into Practice*, *24*(2), 138-144.

Keefe, J. W. (1987). *Learning style theory and practice*. Reston: National Association of Secondary School Principles.

Kiamanesh, A. R. (2004, May). *Factors affecting Iranian students' achievement in mathematics*. In First IEA International Research Conference, Cyprus.

Kloosterman, P. (2002). Beliefs about mathematics and mathematics learning in the secondary school: Measurement and implications for motivation. In *Beliefs: A Hidden Variable in Mathematics Education?* (pp. 247–269). New York, NY: Springer.

Kloosterman, P., Cougan, M. C., & Cougan, M. C. (1994). Students ' beliefs about learning school mathematics. *The Elementary School Journal*, *94*(4), 375–388.

Kloosterman, P., & Stage, F. K. (1992). Measuring beliefs about mathematical problem solving. *School Science and Mathematics*, *92*(3), 109–115.

Kocakoglu, M. (2010). Determining the learning styles of elementary school (1st-8th grade) teachers. *International Online Journal of Education and Science, 2*(1), 54–64.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Kottke, J. L. (2000). Mathematical proficiency, statistics knowledge, attitudes toward statistics, and measurement course performance. *College Student Journal*, *34*(3), 334-339.

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). *Taxonomy of educational objectives: Handbook II affective domain*. New York, NY: David McKay.

Kulac, E., Sezik, M., Asci, H., & Gurpinar, E. (2013). Learning styles, academic achievement, and gender in a medical school setting. *Journal of Clinical and Analytical Medicine.*, *6*(5), 1–4.

Kulm, G. (1980). *Research on mathematics attitude in research in mathematics education*. Reston, VA: NCTM.

Kumar, R. (2011). *Research methodology*(3rd ed.). New Dehi, India: Sage publication.

Lee, M. (2009). *Utilizing the index of learning styles (ILS) in a technology-based publishing program* (Doctorial dissertation). University of Phoenix.

Leung, F. K. S. (2002). Behind the high achievement of east asian students. *Educational Research and Evaluation*, *8*(1), 87–108. http://doi.org/10.1076/edre.8.1.87.6920

Lincoln, F., & Rademacher, B. (2006). Learning styles of ESL students in community colleges. *Community College Journal of Research and Practice*, *30*(5-6), 485–500.

Luitel, B. (2013). Mathematics as an impure knowledge system: Symbiosis, (W)Holism and synergy in mathematics education. *International Journal of Science and Mathematics Education*, *11*, 65–87.

Ma, V. J., & Ma, X. (2014). A Comparative analysis of the relationship between learning styles and mathematics performance. *International Journal of STEM Education*, *1*(3), 1–13.

Ma, X. (1997). Reciprocal relationships between attitude toward mathematics and achievement in mathematics. *Journal of Educational Research*, *90*(4), 221–229.

Ma, X. (2003). Effects of early acceleration of students in mathematics on attitude and anxiety toward mathematics: The developmental perspective. *The Teachers College Record*, *105*(3), 438–464.

Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for*

Research in Mathematics Education, *28*(1), 26–47.

Maclsaac, M., Estey, N., MacDonald, S.R., & Case, E. (2004). *Understanding learning styles.* Ottawa, Ontario: Canadian Child Care Federation.

Malone, S. A. (2003). *Learning about learning*. London, UK: Charted Institute of Personnel and Development (CIPD) Home Publishing.

Mandler, G. (1989). *Affect and learning: Causes and consequences of emotional interactions*: *affect and mathematical problem solving*. New York, NY: Springer.

Marriott, P. (2002). A longitudinal study of undergraduate accounting students' learning style preferences at two UK universities. *Accounting Education*, *11*(1), 43–62.

Martini, M. (1986). *An analysis of the relationship (s) between and among computer-assisted instruction, learning style perceptual preferences, attitudes, and the science achievement of seventh grade students in a suburban*. Retrieved from https://www.researchgate.net/publication/234792562_

Mata, M. L., Monteiro, V., & Peixon, F. (2012). *Attitudes towards mathematics: effects of individual, motivational, and social supportfactor.* Child Development research.

Mathema, K. B, & Bista, M. B. (2006). *Study on student performance in SLC main report*. Ministry of Education and Sports, Education Sector Advisory Team, Kathmandu.

McCarthy, B. (1987). *The 4MAT System: Teaching to learning styles with right/left mode techniques*. London: Excel.

Mcleod, D. B. (1987). *A constructivist approach to research on attitude toward mathematics.* Proceedings of the 11th International Conference of the International Group for the Psychology of Mathematics Education, 133–139.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. *Handbook of research on mathematics teaching and learning*, 575-596.

McLeod, D. B., & McLeod, S. H. (2002). Synthesis–beliefs and mathematics education: Implications for learning, teaching and research. In G. C. Leder, E. Pehkonen, and G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education* (pp.115-123). Dordrecht, Netherlands.

Mertens, D. M. (2014). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*. Londan: Sage Publications.

Metsamuuronen, J., & Kafle, B. R. (2013). *Where are we now? Students achievement in Mathematics, Nepali and Social Studies in 2011*. Kathmandu: NASA.

Meyer, M. R. & Koehler, M. S. (1990). *International influences on gender differences in mathematics.* New York, NY: Teacher College.

Middleton, K., Ricks, E., Wright, P., & Grant, S. (2013). Examining the relationship between learning style preferences and attitudes toward mathematics among students in higher education. *Institute of Learning Styles Journal*, *1*, 1–15.

MMP (2013). *Bloom's revised taxonomy: Mathematics.* Wiconsin: The Milwaukee Mathematics Partnership, University of Wiconsin.

Mohamed, L., & Waheed, H. (2011). Secondary students' attitude towards mathematics in a selected school of Maldives. *International Journal of Humanities and Social Science*, *1*(15), 277–281.

Mubeen, S., Saeed, S., & Arif, M. . (1996). *Attitude towards mathematics and academic achievement in mathematics among secondary level boys and girls*. The annual meeting of the mid south educational research association (Nov 6-8), Tuscaloo SA, AL.

Mullins, V. S., Martin, O. M., Gonzalez, E. J., & Chrostowski, S. J. (2003). *Timss 2003 international mathematics report.* IEA's Third International Mathematics and Science Study, Chestnut Hil, MA.

Mullis, I. V. S., Martin, M. O., Minnich, C. A., Stanco, G. M., Arora, A., Centurino, V. A. S., & Castle, C. E. (2012). Education policy and curriculum in mathematics and science. In *TIMSS 2011 encyclopedia* (Vol.1). Chestnut Hill, MA: International Study Center, Boston College.

Myers, I. B., McCaulley, M. H., Quenk, N. L., & Hammer, A. L. (1998). *MBTI manual: A Guide to the development and use of the Myers-Briggs type indicator* (Vol. 3). Palo Alto, CA: Consulting Psychologists Press.

Nasser, R. N., & Carifio, J. M. (2006). Learning styles and the selection of majors among lebanese youth. *Mediterranean Journal of Educational Studies, 11*(2), 53-61.

NASA (2015). Report on national assessment of students achievement 2013. *Grade 8: mathematics, nepali and science.* Education Review Office, MOE. Nepal.

NCTM. (1992). *National council of teachers of mathematics.* Reston, VA: NCTM.

NCTM. (1995). *Assessment standards for school mathematics*. Reston, VA: NCTM.

NCTM. (2000). *Standards for school mathematics*. Reston, VA: NCTM.

Norton, S. J., & Rennie, L. J. (1998). Students' attitudes towards mathematics in single-sex and coeducational schools. *Mathematics Education Research Journal*, *10*(1), 16–36.

Orhun, N. (2007). An investigation into the mathematics achievement and attitude towards mathematics with respect to learning style according to gender. *International Journal of Mathematical Education in Science and Technology*, *38*(3), 321–333.

Pallapu, P. (2009). *An exploratory study of undergraduate students' learning styles*. Auburn University, Auburn, Albama.

Peker, M., & Mirasyedioğlu, Ş. (2008). Pre-service elementary school teachers' learning styles and attitudes towards mathematics. *Eurasia Journal of Mathematics, Science & Technology Education*, *4*(1), 21–26.

Pepin, B. (2011). Pupils' attitudes towards mathematics: A Comparative study of Norwegian and English secondary Students. *The International Journal on Mathematics Education, 43,* 535-546.

Peterson, P. L., & Knapp, N. F. (1993). *Understanding learner's understandings*. Michigan State University: Center for the Learning and Teaching of Elementary Subjects.

Philbin, M., Meier, E., Huffman, S., & Boverie, P. (1995). A survey of gender and learning styles. *Sex Roles*, *32*(7/8), 485–494.

Piaget, J. (1970). *Science of education and the psychology of the child*. New York: Orion.

Pinto, J. J. K., Geiger, M. A., & Boyle, E. J. E. (1994). A three-year longitudinal study of change in student learning styles. *Journal of College Student Development*, *35*(2), 113–119.

Pornsakulvanich, V., Dumrongsiri, N., Sajampun, P., Sornsri, S., John, S. P., Sriyabhand, T., … Jiradilok, S. (2012). An analysis of personality traits and learning styles as predictors of academic performance. *ABAC Journal*, *32*(3), 1–19.

Prajapati, B., Dunne, M., Bartlett, H., & Cubbidge, R. (2011). The influence of learning styles, enrolment status and gender on academic performance of optometry undergraduates. *Ophthalmic and Physiological Optics, 31*(1), 69–78.

Pritchard, A. (2009). *Ways of learning: Learning theories and learning styles in the classroom*. London: Routledge.

Provasnik, S., Kastberg, D., Ferraro, D., Lemanski, N., Roey, S., & Jenkins, F. (2012). *Highlights from TIMSS 2011: Mathematics and science achievement of U.S. Fourth and eighth-grade students in an international context*. Washington, DC: National Center for Education Statistics.

Rahman, H. M. (2003). *A study of achievement in mathematics of grade eight students different ethnic groups of Nepal* (Unpublished doctoral dissertation). University of Lucknow, Lucknow.

Reyes, L. H. (1984). Affective variables and mathematics education. *The Elementary School Journal*, *84*(5), 558–581.

Reynolds, A. J., & Walberg, H. J. (1992). A process model of mathematics achievement and attitude. *Journal for Research in Mathematics Education, 23*(4), 306–328.

Reynolds, A. J. & Walberg, H. J. (1992). A structural model of high school mathematics outcomes. *The Journal of Educational Research*, *85*, 150-158.

Richard, M. F. (1993). Reaching the second tier: Learning and teaching styles in college science education. *Journal of College Science Teaching*, *23*(5), 286–290.

Riding, R., & Cheema, I. (1991). Cognitive styles: An overview and integration. *Educational Psychology*, *11*(3-4), 193–215.

Saha, S. (2007). A study of gender attitude to mathematics, cognitive style and achievement in mathematics. *Experiments in Education*, *35*(6), 8-18.

Schoenfeld, A. H. (1992). *Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics*. Retrieved from http://cimm.ucr.ac.cr/ojs/index.php/eudoxus/article/download/177/312

Schofield, H. L. (1982). Sex, grade level, and the relationship between mathematics attitude and achievement in children. *Journal of Educational Research*, *75*(5), 280–284. http://doi.org/10.1080/00220671.1982.10885395

Schunk, D. H. (1989). Self-efficacy and cognitive achievement: Implications for students with learning problems. *Journal of Learning Disabilities*, *22*, 14–22.

Schwartz, W., & Hanson, K. (1991). Equal mathematics education for female students. In *Striving for excellence: The national education goals* (pp. 70–71). Washington, DC.

Setia, S. (1991). *Socio psychological and educational factors of differential learning rate in modern mathematics at the senior secondary stage* (Doctoral Thesis). Punjab University, Panjab.

Sharp, D. (1987). *Personality types: Jung's model of typology* (Vol. 31). Toronto, Canada: Inner city books.

Shulman, L. S. (1981). Disciplines of inquiry in education: An overview. *Educational Researcher*, *10*(6), 5–23. http://doi.org/10.3102/0013189X010006005

Simpson, E. (1971). *Educational objectives in the psychomotor domain*. Retrieved from https://books.google.com.np/books?id=rM-mtgAACAAJ

Singh, A. K. (1986). *Tests, measurements and research methods in behavioural sciences*. New Delhi, India: Bharati Bhawan

Smith, C. (2012). *Sensory learning styles: Visual, auditory and kinesthetic learning styles.* Retrieved from http/www.whitebelt.org

Stuart, C., & Thurlow, D. (2000). Making it their own: Preservice teachers' experiences, beliefs, and classroom practices. *Journal of Teacher Education*, *51*(2), 113–121.

Sua, T. Y. (2007). Attitudes and achievement orientations of students towards learning of science and mathematics in English. *Kajian Malaysia*, *25*(1), 15–39.

Tapia, M. (1996). *The attitudes toward mathematics instrument.* In Annual Meeting of the Mid-South Educational Research Association (November 6-8), Tuscaloosa, AL.

Tapia, M., & Marsh, G. E. (2002). *Confirmatory factor analysis of the attitudes toward mathematics inventory*. http://eric.ed.gov/?id=ED471301

Tapia, M., & Marsh, G. E. (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly*, *8*(2), 16–22.

Thorndike, E. L. (1922). *The psychology of arithmetic*. London: Macmillan.

Torres, R. M. (1994). Learning styles of students in a college of agriculture. *Journal of Agriculture Education*, *35*(4), 61–66.

Tsai, S. L., & Walberg, H. J. (1983). Mathematics achievement and attitude productivity in junior high school. *The Journal of Educational Research*, *76*(5), 267–272.

Tribhuvan University (TU). (2015). *Statistical Bulletin.*Centre for Research.Kathmandu. Author.

Tuckman, B. W. (1999). *Conducting educational research* (5th ed.). New York, NY : Harcourt Brace College Publishers.

Turner, N. D. (1981). Twenty year later: High school students who showed promise in mathematics. *The American Mathematical Monthly*, *99*(6), 432-435.

Upadhayay, H. P., Upadhayay, M. P., & Luitel, S. (2014). *Exploratory teaching mathematics*. Kathmandu: Sukunda Pustak Bhawan.

Upadhyay, H. P. (2001). *Effect of constructivism on mathematics achievement of grade v students in Nepal* (Unpublished doctoral dissertation). Panjab University, Chandigarh.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. London: Harvard University Press.

Wadsworth, B. J. (1978). *Piaget for the classroom teacher*. London: Addison-Wesley.

Walberg, H. J. (2004). Improving educational productivity: An assessment of extent research. *The LSS Review*, *3*(2), 11-14.

Walker, E. N., & McCoy, L. P. (1997). Students' voices: African Americans and mathematics. *Multicultural and Gender Equity in the Mathematics Classroom: The Gift of Diversity*, 34–35.

Webster, B. J. (2002). *Modeling mathematics achievement: An Australian study of learning environments in education.* Curtin University of Technology, Australia.

Wehrwein, E. A., Lujan, H. L., & DiCarlo, S. E. (2007). Gender differences in learning style preferences among undergraduate physiology students. *Advances in Physiology Education*, *31*(2), 153–157.

Wiersma, W., & Jurs, S. G. (2005). *Research methods in education: An introduction* (8th ed.). New York NY: Pearson Education.

Wilkins, J. L. M., & Ma, X. (2003). Modeling change in student attitude toward and beliefs about mathematics Jesse. *The Journal of Educational Research*, *97*(1), 52–63.

Wigfield, A., Battle, A., Keller, L. B., & Eccles, J. S. (2002). Sex differences in motivation, self-concept, career aspiration, and career choice: Implications for cognitive development. *Biology, Society, and Behavior: The Development of Sex Differences in Cognition*, 93-124.

Zan, R., Martino, P. D, & Matematica, D. (2007). Attitude toward mathematics: Overcoming the positive / negative dichotomy. *TMME Monograph*, *3*, 157–168.

Zeegers, P. (2001). Approaches to learning in science: A longitudinal study. *British Journal of Educational Psychology*, *71*, 115–132.

Zhang, L. (2004). Predicting cognitive development, intellectual styles, and personality traits from self-rated abilities. *Learning and Individual Differences*, *15*, 67–88. http://doi.org/10.1016/j.lindif.2004.08.001

Zywno, M. S. (2003). A contribution to validation of score meaning for felder-soloman's index of learning styles. *Engineering Education*, 1–16.

APPENDICES

Appendix 1

Student's Demographic Information

Directions:

Dear students, your response will be kept secret and will be used only for research study and not for any other purpose. So, please feel free to give true facts.

I: at the beginning of the academic session

Name: .... (Optional)

Class: ………….. Section: ....Roll No: …………..

Gender: Male: …………. Female: …………...

SLC Score: Compulsory Math: ………….. (Optional)

II: At the end of the academic session

Name: .... (Optional)

Class: ………….. Section: ....Roll No: …………..

Academic aspiration (group selection in grade 12):

1. Mathematical sciences (Physical group)………
2. Biological sciences with additional mathematics …………..
3. Non mathematical (pure biological group)……..

Appendix 2

Index of Learning Styles

DIRECTIONS:

Please choose only one answer for each question. If both “a” and “b” seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I

a) try it out. **b)** think it through.

2. I would rather be considered

a) realistic. **b)** innovative.

3. When I think about what I did yesterday, I am most likely to get

a) a picture. **b)** words.

4. I tend to

a) understand details of a subject but may be fuzzy about its overall structure.

b) understand the overall structure but may be fuzzy about details.

5. When I am learning something new, it helps me to

a) talk about it. **b)** think about it.

6. If I were a teacher, I would rather teach a course

a) that deals with facts and real life situations.

b) that deals with ideas and theories.

7. I prefer to get new information in

a) pictures, diagrams, graphs, or maps.

b) written directions or verbal information.

8. Once I understand

a) all the parts, I understand the whole thing.

b) the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to

a) jump in and contribute ideas.

b) sit back and listen.

10. I find it easier

a) to learn facts. **b)** to learn concepts.

11. In a book with lots of pictures and charts, I am likely to

a) look over the pictures and charts carefully.

b) focus on the written text.

12. When I solve math problems

a) I usually work my way to the solutions one step at a time.

b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken

a) I have usually gotten to know many of the students.

b) I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer

a) something that teaches me new facts or tells me how to do something.

b) something that gives me new ideas to think about.

15. I like teachers

a) who put a lot of diagrams on the board.

b) who spend a lot of time explaining.

16. When I'm analyzing a story or a novel

a) I think of the incidents and try to put them together to figure out the themes.

b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to

a) start working on the solution immediately.

b) try to fully understand the problem first.

18. I prefer the idea of

a) certainty. **b)** theory.

19. I remember best

a) what I see. **b)** what I hear.

20. It is more important to me that an instructor

a) lay out the material in clear sequential steps.

b) give me an overall picture and relate the material to other subjects.

21. I prefer to study

a) in a study group. **b)** alone.

22. I am more likely to be considered

a) careful about the details of my work.

b) creative about how to do my work.

23. When I get directions to a new place, I prefer

a) a map. **b)** written instructions.

24. I learn

a) at a fairly regular pace. If I study hard, I'll "get it."

b) in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first

a) try things out.

b) think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to

a) clearly say what they mean.

b) say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember

a) the picture.

b) what the instructor said about it.

28. When considering a body of information, I am more likely to

a) focus on details and miss the big picture.

b) try to understand the big picture before getting into the details.

29. I more easily remember

a) something I have done. **b)** something I have thought a lot about.

30. When I have to perform a task, I prefer to

a) master one way of doing it.

b) come up with new ways of doing it.

31. When someone is showing me data, I prefer

a) charts or graphs.

b) text summarizing the results.

32. When writing a paper, I am more likely to

a) work on (think about or write) the beginning of the paper and progress forward.

b) work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to

a) have “group brainstorming” where everyone contributes ideas.

b) brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone

a) sensible. **b)** imaginative.

35. When I meet people at a party, I am more likely to remember

a) what they looked like.

b) what they said about themselves.

36. When I am learning a new subject, I prefer to

a) stay focused on that subject, learning as much about it as I can.

b) try to make connections between that subject and related subjects.

37. I am more likely to be considered

a) outgoing. **b)** reserved.

38. I prefer courses that emphasize

a) concrete material (facts, data).

b) abstract material (concepts, theories).

39. For entertainment, I would rather

a) watch television. **b)** read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are

a) somewhat helpful to me. **b)** very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,

a) appeals to me. **b)** does not appeal to me.

42. When I am doing long calculations,

a) I tend to repeat all my steps and check my work carefully.

b) I find checking my work tiresome and have to force myself to do it.

43. I tend to picture places I have been

a) easily and fairly accurately.

b) with difficulty and without much detail.

44. When solving problems in a group, I would be more likely to

a) think of the steps in the solution process.

b) think of possible consequences or applications of the solution in a wide range of areas.

Appendix 3

Views toward Mathematics Inventory (VTMI)

Instructions: This inventory consists of statements about your views toward mathematics. There are no correct or incorrect responses. For each statement indicates the extent to which you agree with the statement, where Strongly Disagree (SD), Disagree (D), Unsure (U), Agree (A), Strongly Agree (SA). Students are advised to read each statement carefully and circle or tick the best response.

Item No	Statements	Responses
1	Mathematics is a very worthwhile and necessary subject.	SD D U A SA
2	I want to develop my mathematical skills.	SD D U A SA
3	Mathematics helps develop the mind and teaches a person to think.	SD D U A SA
4	Mathematics is important in everyday life.	SD D U A SA
5	Mathematics is one of the most important subjects for people to study.	SD D U A SA
6	Math courses would be very helpful no matter what I decide to study	SD D U A SA
7	I can think of many ways that I use math outside of school.	SD D U A SA
8	I think studying advanced mathematics is useful.	SD D U A SA
9	I believe studying math helps me with problem solving in other areas.	SD D U A SA
10	A strong math background could help me in my professional life	SD D U A SA
11	I get a great deal of satisfaction out of solving a mathematics problem	SD D U A SA
12	I have usually enjoyed studying mathematics in school	SD D U A SA
13	I like to solve new problems in mathematics.	SD D U A SA
14	I would prefer to do an assignment in math than to write an essay	SD D U A SA

15	I really like mathematics	SD	D	U	A	SA
16	I am happier in a math class than in any other class.	SD	D	U	A	SA
17	Mathematics is a very interesting subject.	SD	D	U	A	SA
18	I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.	SD	D	U	A	SA
19	I am comfortable answering questions in math class	SD	D	U	A	SA
20	Mathematics is dull and boring.*	SD	D	U	A	SA
21	Mathematics is one of my most dreaded subjects.*	SD	D	U	A	SA
22	When I hear the word mathematics, I have a feeling of dislike.*	SD	D	U	A	SA
23	My mind goes blank and I am unable to think clearly when working with mathematics.*	SD	D	U	A	SA
24	Studying mathematics makes me feel nervous.*	SD	D	U	A	SA
25	Mathematics makes me feel uncomfortable.*	SD	D	U	A	SA
26	I am always under a terrible strain in a math class.*	SD	D	U	A	SA
27	It makes me nervous to even think about having to do a mathematics Problem*	SD	D	U	A	SA
28	I am always confused in my mathematics class.*	SD	D	U	A	SA
29	I feel a sense of insecurity when attempting mathematics.*	SD	D	U	A	SA
30	Mathematics does not scare me at all.	SD	D	U	A	SA
31	I have a lot of self-confidence when it comes to mathematics	SD	D	U	A	SA
32	I am able to solve mathematics problems without too much difficulty	SD	D	U	A	SA
33	I expect to do fairly well in any math class I take	SD	D	U	A	SA
34	I learn mathematics easily.	SD	D	U	A	SA
35	I believe I am good at solving math problems.	SD	D	U	A	SA
36	I am confident that I could learn advanced mathematics	SD	D	U	A	SA
37	I plan to take as much mathematics as I can during my education	SD	D	U	A	SA
38	The challenge of math appeals to me.	SD	D	U	A	SA
39	I am willing to take more than the required amount of	SD	D	U	A	SA

	mathematics.					
40	I would like to avoid learning mathematics.*	SD	D	U	A	SA
41	I have been interested in mathematics since school	SD	D	U	A	SA
42	I have not been doing well in mathematics*	SD	D	U	A	SA
43	My teachers give me encouragement to work harder in math	SD	D	U	A	SA
44	My mathematics teachers spark my interest in math	SD	D	U	A	SA
45	My teachers want me to understand the content of mathematics	SD	D	U	A	SA
46	My teachers don't explain why mathematics is important*	SD	D	U	A	SA
47	The teaching techniques of my teachers help me to understand the concepts in mathematics	SD	D	U	A	SA
48	My teachers do not understand my problems and difficulties in math *	SD	D	U	A	SA
49	I do a lot of group work in the mathematics class	SD	D	U	A	SA
50	I don't believe 'drills and practice' is one of the best way of learning mathematics*	SD	D	U	A	SA
51	Mathematics is considered as one of the difficult subjects*	SD	D	U	A	SA
52	Mathematics enables men to understand the world better	SD	D	U	A	SA
53	The teaching in my mathematics class is not interactive*	SD	D	U	A	SA
54	In mathematics, I can be creative and discover things myself	SD	D	U	A	SA
55	Learning mathematics must be an active process	SD	D	U	A	SA

- Negative statement

Appendix 4

Mathematics Achievement Test (MAT)

Instruction:

The test paper has been prepared based on mathematics curriculum of grade eleven. This test will be used only for research purpose. The marks so obtained do not influence the school results. Students are advised to read each question carefully and tick (√) one of the best answers.

1. Which of the following is empty set?

a. {x: x>1 and x<1} b. {x: x+3 =3} c. {ϕ} d. {x: x ≥1 and x≤1 }

2. If x is real then which of the following is correct?

a. $|x| > 0$ b. $|x| < 0$ c. $|x| = 0$ d. $|x| \geq 0$

3. Which of the following is logically equivalent proposition of $p \Leftrightarrow q$?

a. $(p \wedge q) \vee (p \vee q)$ b. $(p \Rightarrow q) \wedge (q \Rightarrow p)$

c. $(p \Rightarrow q) \vee (q \Rightarrow p)$ d. $(p \wedge q) \Rightarrow (q \vee p)$

4. R is a relation from {11, 12, 13) to {8, 10, 12} defined by y = x – 3. Then, R^{-1} is?

a. {(8, 11), (10, 13)} b. {(11, 8), (13, 10)}

c. {(10, 13), (8, 11), (12, 10)} d. {(11, 8), (12, 10), (13, 12)}

5. Which is the function f: [0, 2] ∈ R defined by $f(x) = x^2$?

a. one to one function b. onto function

c. one to one and onto both d. neither

6. Which is the domain of $f(x) = \sqrt{9 - x^2}$?

a. (–3, 3) b. [–3, 3]

c. $x \leq -3$ or $x \geq 3$ d. $x \geq 9$

7. About which of the following line, the curve $y = x^2$ is symmetrical?

a. y axis b. x axis c. the line y = x d. the line x+ y = 0

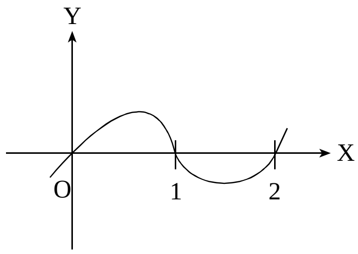
8. Which of the following function represents the given graph?

a. $f(x) = x(x +1) (x + 2)$

b. $f(x) = x(x-1) (x -2)$

c. $f(x) = (x - 1) (x - 2) (x - 3)$

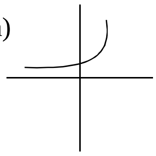
d. $f(x) = (x+1)(x + 2) (x +3)$



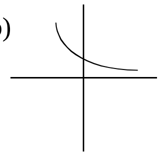
9. Which of the following graph represents the

function: $f(x) = \left(\frac{1}{2}\right)^x$?

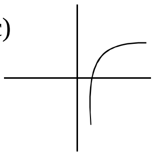
(a)



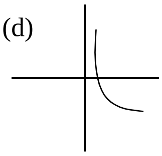
(b)



(c)



(d)



10. **When the function f(x) becomes an odd function?**

    a. $f(x) = -f(x)$ b. $f(x) = f(-x)$

    c. $f(-x) = -f(x)$ d. $f(-x) = f(x)$

11. **Which one is the general solution of tan 3θ = 1?**

    a. $n\pi + \frac{\pi}{4}$ b. $\frac{n\pi}{3} + \frac{\pi}{12}$ c. $n\pi$ d. $n\pi \pm \frac{\pi}{4}$

12. **Which of the following interval satisfied $\cos^{-1}(\cos x) = x$?**

    a. $x \in R$ b.x $\in [0, \pi]$ c. $x \in [-1, 1]$ d. $[-\pi, \pi]$

13. **If acos A = bcos B, then ΔABC is?**

    a. Isosceles only b. Right angled only

    c. Equilateral d. Right angled or Isosceles

14. **If the sum of first n even natural numbers is equal to k times the sum of first n odd natural numbers, then what is the value of k?**

    a. $\frac{1}{n}$ b. $\frac{n-1}{n}$ c. $\frac{n+1}{2n}$ d. $\frac{n+1}{n}$

15. **If second terms of a GP is 2 and sum of its infinite terms is 8, then what is its first term?**

    a. 4 b. 2 c . $\frac{1}{2}$ d. $\frac{1}{4}$

16. **Which progression is it, if it has non zero equal numbers?**

    a. AP only b. AP and GP only

    c. AP, GP and HP d. AP and HP only

17. **If $n \in N$ then $10^{2n-1} + 1$ is divisible by?**

    a. 3 b. 7 c. 11 d. 15

18. **Which of the following is true?**

a. Every scalar matrix is an identity matrix   b. Every identity matrix is scalar matrix

c. Every diagonal matrix is an identity matrix   d. A square matrix whose each element is 1 is an identity matrix

If $A=\begin{bmatrix} 1 & 2 \\ 0 & 0 \end{bmatrix}$ and $B=\begin{bmatrix} -2 & 0 \\ 1 & 0 \end{bmatrix}$ then,

a. AB = BA = 0   b. AB = 0, BA ≠ 0

c. BA = 0, AB ≠ 0   d. AB ≠ 0, BA ≠ 0

19. If each element of a 3x3 matrix is multiplied by 3, then the determinant of the newly formed matrix is?

a. 3|A| b. 9 |A| c. 27|A | d. $|A|^3$

20. The system of equations 2x + y =4, 3x+2y=2 and x +y = -2 have?

a. unique solution   b. no solution

c. infinite numbers of solution   d. two solution

21. The system of equations 2x + y = 5; 4x + 2y = 10 are?

a. Consistent and Independent   b. Inconsistent and Independent

c. Consistent and dependent   d. Inconsistent and dependent.

22. The system of equations AX=B of 3 equations in 3 unknowns has a unique solution if

a. |A|≠0   b. |A|≠0, (adjA) B=0

c. |A|=0, (adjA) B=0   d. |A|=0,(adjA)B≠0

23. The value of (cos40° + i sin40°) (cos50° + i sin50°) is equal to?

a. –1   b 1   c. –i   d. i

24. If $x - iy = \sqrt{\dfrac{1-i}{1+i}}$ then

a. x + y = 1   b. x – y = – 1

c. $x^2 + y^2 = 1$ d. $x^2 - y^2 = -1$

26. If w is a cube root of unity, then value of $(1+w)^3-(1+w^2)^3$ *is*

a. –2   b. 9

c. 2   d. 0

27. Ram was asked his age by Shyam. Ram said, "The number you get when you subtract 25 times my age from twice the square of my age will be thrice your age". If age of Shyam is 14, then what is the Ram's age?

a. 14 b. 28 c. 21 d. 25

28. If α and β are roots of equation $x^2 + x - 3 = 0$ then value of $\alpha - \beta$ is equal to?

a. $\sqrt{13}$ b. $-\sqrt{13}$ c. $\pm\sqrt{13}$ d. 13

29. If the equation $x^2 - (k + 4)x + (4k + 1) = 0$ has equal roots then,

a. $k = 6$ b. $k = 2$ c. $k = 6$ or 2 d. $k = \pm 6$

30. The points (a, 0), (0, b) and (1, 1) are collinear if ,

a. $a + b = ab$ b. $a - b = ab$

c. $b - a = ab$ c. $a + b + ab = 0$

31. If three lines $3x - y = 2$, $5x + ay = 3$ and $2x + y = 3$ are concurrent, then a is equal to?

a. 2 b. 3 c. –1 d. –2

32. What is the equation of the straight line passing through the point (3, 2) and perpendicular to the line $y = x$?

a. $x - y = 5$ b. $x - y = 1$

c. $x + y = 1$ d. $x + y = 5$

33. If the pair of lines $x^2 - 2pxy - y^2 = 0$ and $x^2 - 2qxy - y^2 = 0$ be such that each pair bisects the angles between other pair , then

a. $p + q = 1$ b. $pq = -1$

c. $pq = 1$ d. $p - q = 1$

34. What is the coordinates of the center of a circle passing through (0, 0), (3, 0) and (0, 5)?

a.(3, 5) b. (5, 3) c. (3/2, 5/2). d. $\left(\frac{-3}{2}, \frac{-5}{2}\right)$

35. What is the equation of the tangent at the point (3, –2) to the circle $x^2 + y^2 = 13$?

a. $3x + 2y = 13$ b. $3x – 2y + 13 = 0$

c. $2x + 3y = 0$ d. $3x – 2y – 13 = 0$

36. If the line $2x – y + k = 0$ is a diameter of the circle $x^2 + y^2 + 6x – 6y + 5 = 0$, then k is equal to?

a. 9 b. 6 c. 3 d. 1

37. The limiting value of $\lim_{x\to 0} \frac{\sin x^0}{x}$ is?

a. 1 b. $\frac{\pi}{180}$ c. x d. π

38. Let f(x) = $\begin{cases} 1 + x, & x > 0 \\ x, & x \leq 0 \end{cases}$, then the function f(x) at x = 0 is?

a. continuous b. discontinuous c. undefined d. indeterminate

39. If f(x) = x log x what will be the value of f' (1)?

a. 1 b. 0 c. -1 d. $\frac{1}{2}$

40. If e^{xy} =xy, then dy/dx is equal to?

a. $\frac{y}{x}$ b. $\frac{-y}{x}$ c. $\frac{x}{y}$ d. xy

41. The area bounded by the curves $y = x^2$ and $y = 2x$ is?

a. $\frac{4}{3}$ b. $\frac{3}{4}$ c. 4 d. 3

42. What is the integral of ∫x cos x dx ?

a. x sin x + c b. sin c + cos x

c. x sin x + cos x + c d. sin x + x cos x + c

43. **The diameter of a circle is increasing at the rate of 1 unit/sec. When its radius is π, the rate of increase of its area in sq. unit/sec is?**

a. $2\sqrt{\pi}$ b. $\sqrt{2\pi}$ c. $\frac{1}{\sqrt{2\pi}}$ d. $\frac{1}{2\sqrt{\pi}}$

44. A stone projected vertically upward moves under the action of gravity alone and its motion is described by $x = 49t - 4.9t^2$. The stone will attain the maximum height after, how many seconds in the air?

a.5 sec b.4 sec c.3 sec d.2 sec

45. The maximum value of xy subject to x + y = 8 is equal to?

a. 20 b. 8 c. 12 d. 16

46. The condition for the point of inflection of a curve y = f(x) is?

a. $f'(x) = 0$ b. $f'(x) > 0$

c. $f''(x) = 0$ d. $f''(x) > 0$

47. If $2+\sqrt{3}\,i$ is a root of $x^2+px+q=0$ where p & q are real then (p, q) is equal to?

a. (7, 4) b. (-4, 7) c. (-4,7i) d. (4i, -7)

48. If t=secx & m=tanx then which is true?

a. $\frac{dm}{dx}=1+tm+m^2$ b. $\frac{dm}{dx}= tm$

c. $\frac{dt}{dx}=1+tm+m$ d. $\frac{dt}{dx}= tm$

49. Which of the following condition need not be satisfied for the function f(x) to be a continuous function?

a. f(a) is defined b. f(x) is differentiable at a

c. $\lim_{x \to a} f(x)$ exists d. $\lim_{x \to a} f(x) = f(a)$

50 If $\int_{\frac{\pi}{2}}^{a} \sin x\, dx = \frac{1}{2}$ then what is the value of a?

a. $\frac{-\pi}{2}$ b. $\frac{-2\pi}{3}$ c. $\frac{2\pi}{3}$ d. $\frac{-\pi}{3}$

Appendix 5

ATMI (M Tapia) and Beliefs (Final Try-Out)

	Statements	Responses				
1	Mathematics is a very worthwhile and necessary subject.	SD	D	U	A	SA
2	I want to develop my mathematical skills.	SD	D	U	A	SA
3	Mathematics helps develop the mind and teaches a person to think.	SD	D	U	A	SA
4	Mathematics is important in everyday life.	SD	D	U	A	SA
5	Mathematics is one of the most important subjects for people to study.	SD	D	U	A	SA
6	Math courses would be very helpful no matter what I decide to study	SD	D	U	A	SA
7	I can think of many ways that I use math outside of school.	SD	D	U	A	SA
8	I think studying advanced mathematics is useful.	SD	D	U	A	SA
9	I believe studying math helps me with problem solving in other areas.	SD	D	U	A	SA
10	A strong math background could help me in my professional life	SD	D	U	A	SA
11	I get a great deal of satisfaction out of solving a mathematics problem	SD	D	U	A	SA
12	I have usually enjoyed studying mathematics in school	SD	D	U	A	SA
13	I like to solve new problems in mathematics.	SD	D	U	A	SA
14	I would prefer to do an assignment in math than to write an essay	SD	D	U	A	SA
15	I really like mathematics	SD	D	U	A	SA
16	I am happier in a math class than in any other class.	SD	D	U	A	SA
17	Mathematics is a very interesting subject.	SD	D	U	A	SA
18	I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.	SD	D	U	A	SA
19	I am comfortable answering questions in math class	SD	D	U	A	SA

20	Mathematics is dull and boring.*	SD	D	U	A	SA
21	Mathematics is one of my most dreaded subjects.*	SD	D	U	A	SA
22	When I hear the word mathematics, I have a feeling of dislike.*	SD	D	U	A	SA
23	My mind goes blank and I am unable to think clearly when working with mathematics.*	SD	D	U	A	SA
24	Studying mathematics makes me feel nervous.*	SD	D	U	A	SA
25	Mathematics makes me feel uncomfortable.*	SD	D	U	A	SA
26	I am always under a terrible strain in a math class.*	SD	D	U	A	SA
27	It makes me nervous to even think about having to do a mathematics Problem*	SD	D	U	A	SA
28	I am always confused in my mathematics class.*	SD	D	U	A	SA
29	I feel a sense of insecurity when attempting mathematics.*	SD	D	U	A	SA
30	Mathematics does not scare me at all.	SD	D	U	A	SA
31	I have a lot of self-confidence when it comes to mathematics	SD	D	U	A	SA
32	I am able to solve mathematics problems without too much difficulty	SD	D	U	A	SA
33	I expect to do fairly well in any math class I take	SD	D	U	A	SA
34	I learn mathematics easily.	SD	D	U	A	SA
35	I believe I am good at solving math problems.	SD	D	U	A	SA
36	I am confident that I could learn advanced mathematics	SD	D	U	A	SA
37	I plan to take as much mathematics as I can during my education	SD	D	U	A	SA
38	The challenge of math appeals to me.	SD	D	U	A	SA
39	I am willing to take more than the required amount of mathematics.	SD	D	U	A	SA
40	I would like to avoid learning mathematics.*	SD	D	U	A	SA
41	I have been interested in mathematics since school	SD	D	U	A	SA
42	I have not been doing well in mathematics*	SD	D	U	A	SA
43	My teachers give me encouragement to work harder in math	SD	D	U	A	SA
44	My mathematics teachers spark my interest in math	SD	D	U	A	SA
45	I still remember very well my good mathematics teachers	SD	D	U	A	SA

46	My teachers want me to understand the content of mathematics	SD	D	U	A	SA
47	My teachers don't explain why mathematics is important*	SD	D	U	A	SA
48	The teaching techniques of my teachers help me understand the concepts in mathematics	SD	D	U	A	SA
49	My teachers do not understand my problems and difficulties in mathematics *	SD	D	U	A	SA
50	My teachers want me to enjoy learning	SD	D	U	A	SA
51	My teachers assign several homework problems	SD	D	U	A	SA
52	I do a lot of group work in the mathematics class	SD	D	U	A	SA
53	I don't believe 'drills and practice' is one of the best way of learning mathematics*	SD	D	U	A	SA
54	Mathematics provide foundation for applied sciences	SD	D	U	A	SA
55	Mathematics is a way of thinking using symbols and equations	SD	D	U	A	SA
56	Mathematics is considered as one of the difficult subjects*	SD	D	U	A	SA
57	Mathematics enables men to understand the world better	SD	D	U	A	SA
58	The teaching in my mathematics class is mostly lecture oriented	SD	D	U	A	SA
59	Trying to solve until the correct answer, makes mathematics easy to understand	SD	D	U	A	SA
60	The teaching in my mathematics class is not interactive*	SD	D	U	A	SA
61	In mathematics, I can be creative and discover things myself	SD	D	U	A	SA
62	Learning mathematics must be an active process	SD	D	U	A	SA

Appendix 6

Item Analysis of ATMI (M Tapia) and Beliefs (Final Try-out)

Item No	Item total correlation	Cronbach's Alpha	Item No	Item total correlation	Cronbach's Alpha
1	0.25	0.91	21	0.54	0.91
2	0.17	0.91	22	0.63	0.90
3	0.23	0.91	23	0.57	0.90
4	0.35	0.91	24	0.36	0.91
5	0.14	0.91	25	0.50	0.91
6	0.19	0.91	26	0.55	0.91
7	0.22	0.91	27	0.47	0.91
8	0.33	0.91	28	0.53	0.91
9	0.32	0.91	29	0.45	0.91
10	0.23	0.91	30	0.28	0.91
11	0.28	0.91	31	0.42	0.91
12	0.40	0.91	32	0.33	0.91
13	0.72	0.90	33	0.47	0.91
14	0.47	0.91	34	0.43	0.91
15	0.67	0.90	35	0.48	0.91
16	0.42	0.91	36	0.55	0.91
17	0.58	0.90	37	0.55	0.91
18	0.54	0.91	38	0.33	0.91
19	0.64	0.90	39	0.43	0.91
20	0.60	0.90	40	0.37	0.91
41	0.25	0.66	52	0.21	0.66 (R)
42	0.29	0.65	53	0.42	0.64 (R)
43	0.33	0.65	54	0.06	0.67
44	0.60	0.62	55	-0.27	0.70
45	-0.25	0.68 (R)	56	0.48	0.63
46	0.31	0.65	57	0.23	0.66
47	0.45	0.63	58	-0.28	0.71 (R)
48	0.35	0.65	59	-0.09	0.69 (R)
49	0.60	0.62	60	0.74	0.62
50	0.01	0.68 (R)	61	0.46	0.64
51	0.03	0.68 (R)	62	0.16	0.67

R= Rejected

Appendix 7

Specimen Scoring Key for VTMI

Item No	Response				
	SD	D	U	A	SA
1	1	2	3	**4**	5
2	1	2	3	4	**5**
3	1	2	3	**4**	5
4	1	2	3	**4**	5
5	1	2	3	4	**5**
6	1	2	3	4	**5**
7	1	2	**3**	4	5
8	1	2	**3**	4	5
9	1	**2**	3	4	5
10	1	2	**3**	4	5
11	1	2	3	**4**	5
12	1	2	3	4	**5**
13	1	2	3	**4**	5
14	1	2	3	**4**	5
15	1	2	3	4	**5**
16	1	**2**	3	4	5
17	1	**2**	3	4	5
18	1	2	**3**	4	5
19	1	2	3	**4**	5
20	5	**4**	3	2	1
21	5	**4**	3	2	1
22	5	**4**	3	2	1
23	5	4	**3**	2	1
24	5	**4**	3	2	1
25	**5**	4	3	2	1
26	**5**	4	3	2	1
27	**5**	4	3	2	1
28	**5**	4	3	2	1
29	5	**4**	3	2	1
30	1	**2**	3	4	5
31	1	2	3	**4**	5
32	1	2	3	4	**5**
33	1	2	3	4	**5**
34	1	2	3	**4**	5
35	1	2	3	**4**	5
36	1	2	3	4	**5**
37	**1**	2	3	4	5

38	1	**2**	3	4	5
39	**1**	2	3	4	5
40	5	**4**	3	2	1
41	**1**	2	3	4	5
42	5	4	**3**	2	1
43	1	2	3	4	**5**
44	1	2	3	**4**	5
45	1	2	3	**4**	5
46	**5**	4	3	2	1
47	1	2	3	**4**	5
48	**5**	4	3	2	1
49	1	2	**3**	4	5
50	5	**4**	3	2	1
51	5	**4**	3	2	1
52	1	**2**	3	4	5
53	5	4	3	2	**1**
54	1	**2**	3	4	5
55	1	**2**	3	4	5

NB: Bold indicates the response scale towards the item

Total score: 4x1+8x2+7x3+21x4+15x5= 200

Appendix 8

Reliability Statistics of ILS (Final Try-Out)

Learning style	Item total correlation	Cronbach's Alpha	No of items	Cronbach's Alpha (total)
Active /reflective	0.16	0.55	4	0.52
Sensing/sensing	0.33	0.43		
Visual/verbal	0.32	0.44		
Sequential/global	0.36	0.42		

Appendix 9

Learning Styles Questionnaire Scoring Sheet

1. Place a "1" in the appropriate spaces in the table below (e.g. if you answered "a" to

   Question 3, put a "1" in Column "a" by Question 3).

2. Add up the columns and write the totals in the indicated spaces.

3. For each of the four scales, subtract the smaller total from the larger one. Write the difference (1 to 11) and the letter (a or b) with the larger total.

Active/Reflective			**Sensing/Intuitive**			**Visual/Verbal**			**Sequential/Global**		
Q	a	b	Q	a	b	Q	a	b	Q	a	b
1			2			3			4		
5			6			7			8		
9			10			11			12		
13			14			15			16		
17			18			19			20		
21			22			23			24		
25			26			27			28		
29			30			31			32		
33			34			35			36		
37			38			39			40		
41			42			43			44		

Total (add up each column)

Active/Reflective			**Sensing/Intuitive**			**Visual/Verbal**			**Sequential/Global**		
Q	a	b	Q	a	b	Q	a	b	Q	a	b

Larger – Smaller + Letter of Larger (see below*)

**Example*:* If total was 3 for a and 8 for b: 8 – 3 = 5, b is letter of larger so we write 5b.

Appendix 10

Mathematics Achievement Test (Final Tryout)

To every question there are four probable answers. Only one answer is correct.

Tick (√) the correct one.

1. Which of the following is empty set?

a.{x: x is a real number and $\mathbf{x^2-1=0}$ } b. {x: x is a real number and $\mathbf{x^2+1=0}$ }

c. {x: x is a real number and $\mathbf{x^2-9=0}$ } d. {x: x is a real number and $\mathbf{x^2=x+2}$ }

2. If x is real then

a. $|x| > 0$ b. $|x| < 0$ c. $|x| = 0$ d. $|x| > 0$ or 0

3. The logically equivalent proposition of $p \Leftrightarrow q$ is

a. $(p \wedge q) \vee (p \vee q)$ b. $(p \Rightarrow q) \wedge (q \Rightarrow p)$

c. $(p \Rightarrow q) \vee (q \Rightarrow p)$ d. $(p \wedge q) \Rightarrow (q \vee p)$

4. Truth table for the statement $p \wedge (\sim q)$ is

a.

p	q	~q	p ∧ ~q
T	T	F	F
T	F	T	T
F	T	F	F
F	F	T	F

b.

P	q	~q	p ∧ ~q
T	T	F	F
T	F	T	T
F	T	F	T
F	F	T	F

c.

p	q	~q	p ∧ ~q
T	T	F	F
T	F	T	T
F	T	F	F
F	F	T	T

d.

P	q	~q	p ∧ ~q
T	T	F	T
T	F	T	T
F	T	F	F
F	F	T	T

5. R is a relation from {11, 12, 13) to {8, 10, 12} defined by y = x – 3. Then, R^{-1} is

a. {(8, 11), (10, 13)} b. {(11, 8), (13, 10)}

c. {(10, 13), (8, 11), (12, 10)} d. {(11, 8), (12, 10), (13, 12)}

6. The function f: [0, 2] → R defined by f(x) = x^2 is

a. one to one function b. onto function

c. one to one and onto both d. neither

7. The domain of f(x) = $\sqrt{9 - x^2}$ is

a. (–3, 3) b. [–3, 3]

c. $x \le -3$ or $x \ge 3$ d. $x \ge 9$

8. Determine whether the functions of f & g are inverse of each other

a. f(x)=3x &g(x)= x/3 b. f(x)=3x &g(x)= x

c. f(x)=2x-1 &g(x)= x/2+1 d. f(x)= x^2 &g(x)= $\sqrt{x}$

9. The curve y = x^2 is symmetrical about

a. y axis b. x axis c. the line y = x d. the line x+ y = 0

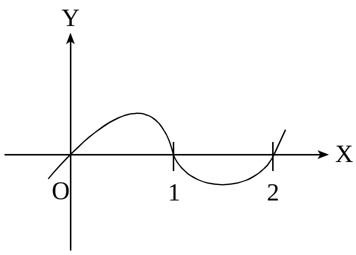
10. Figure alongside is the graph of the function

a. f(x) = (x –1) (x – 2)

b. f(x) = x(x–1) (x –2)

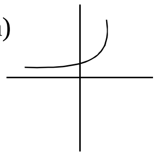
c. f(x) = (x – 1) (x – 2) (x – 3)

d. f(x) = (x + 1) (x +2)

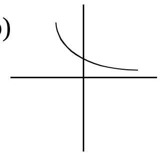


11. The graph of the function f(x) = $\left(\frac{1}{2}\right)^x$ is

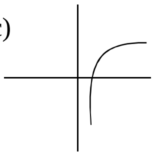
(a)



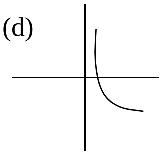
(b)



(c)



(d)



12. The function f(x) is an odd function if

a. f(x) = –f(x) b. f(x) = f(–x)

c. f(–x) = –f(x) d. f(–x) = f(x)

13. The general solution of tan 3θ = 1 is

a. $n\pi + \frac{p}{4}$ b. nπ/3+π/12 c. $n\pi$ d. $n\pi \pm \frac{p}{4}$

14. cos^{-1}(cos x) = x is satisfied by

a. x ∈ R b.x ∈[0,π] c. x ∈ [–1, 1] d. [–π, π]

15. If (a + b + c) (b + c – a) = 3bc, then

a. A = 45° b .B = 45° c. A = 60° d. C = 60°

16. If acosA = bcosB, then ΔABC is

a. isosceles only b. right angled only

c. equilateral d. right angled or isosceles

17. If the sum of first n even natural numbers is equal to k times the sum of first n odd natural numbers, then k is

a. $\frac{1}{n}$ b. $\frac{n-1}{n}$ c. $\frac{n+1}{2n}$ d. $\frac{n+1}{n}$

18. If second terms of a GP is 2 and sum of its infinite terms is 8, then its first term is

a. 4 b. 2 c. $\frac{1}{2}$ d. $\frac{1}{4}$

19. Non zero equal numbers are in

a. AP only b. AP and GP only

c. AP, GP and HP d. AP and HP only

20. If $n \in N$ then $n^3 + 2n$ is divisible by

a. 2 b. 3 c. 4 d. 6

21. If A is any matrix, then

a. matrix A is a set b. matrix A is a number c. matrix A is a set of numbers

d. matrix A is an arrangement of numbers in rectangular array

22. If $A = \begin{bmatrix} 1 & 2 \\ 0 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & 0 \\ 1 & 0 \end{bmatrix}$ then,

a. $AB = BA = 0$ b. $AB = 0, BA \neq 0$

c. $BA = 0, AB \neq 0$ d. $AB \neq 0, BA \neq 0$

23. $\begin{vmatrix} \sin q & \cos q \\ \cos q & -\sin q \end{vmatrix}$ is equal to

a. -1 b. 1 c. $-\cos 2\theta$ d. $\cos 2\theta$

24. If each element of a 3x3 matrix is multiplied by 3, then the determinant of the newly formed matrix is

a. $3|A|$ b. $9|A|$ c. $27|A|$ d. $|A|^3$

25. The system of equations 2x + y =4, 3x+2y=2 and x +y = -2 have

a. unique solution b. no solution

c. infinite numbers of solution d. two solution

26. The system of equations 2x + y = 5; 4x + 2y = 10 are

a. Consistent and Independent b. Inconsistent and Independent

c. Consistent and dependent d. Inconsistent and dependent

27. If a square matrix A has a column of zeroes then the determinant of A is

a. 0 b. 1 c. -1 d. -2

28. The system of equations AX=B of 3 equations in 3 unknowns has a unique solution if

a. $|A| \neq 0$ b. $|A| \neq 0$, (adjA) B=0 c. $|A|=0$, (adjA) B=0 d. $|A|=0$,(adjA)$B \neq 0$

29. The value of (cos40° + i sin40°) (cos50° + i sin50°) is

a. –I b i c. –1 d. 1

30. If $x - i\,y = \sqrt{\frac{1-i}{1+i}}$ then

a. $x + y = 1$ b. $x - y = -1$

c. $x^2 + y^2 = 1$ d. $x^2 - y^2 = -1$

31. If ω is a cube root of unity, then value of $(1 + \omega)^3 - (1 + \omega^2)^3$ is

a. –2 b. 0 c. 2 d. 9

32. Ram was asked his age by Shyam. Ram said, " The number you get when you subtract 25 times my age from twice the square of my age will be thrice your age". If age of Shyam is 14, then the age of Ram is

a. 21 b28 c. 14 d. 25

33. If α and β are roots of equation $x^2 + x - 3 = 0$ then value of $\alpha - \beta$ is

a. $\sqrt{13}$ b.$-\sqrt{13}$ c. $\pm\sqrt{13}$ d. 13

34. The condition for polynomial equation $ax^2 + bx + c = 0$ to be quadratic is

a. $a > 0$ b. $a < 0$

c. $a \neq 0$ d. $a \neq 0, b \neq 0$

35. If the equation $x^2 - (k + 4)\,x + (4k + 1) = 0$ has equal roots then

a. $k = 6$ b. $k = 2$ c. $k = 6$ or 2 d. $k = \pm 6$

36. The points (a, 0), (0, b) and (1, 1) are collinear if

a. $a + b = ab$ b. $a - b = ab$

c. $b - a = ab$ c. $a + b + ab = 0$

37. Three lines $3x - y = 2$, $5x + ay = 3$ and $2x + y = 3$ are concurrent then a is

a. 2 b.3 c. –1 d. –2

38. The length of the perpendicular from the origin to the line

$\frac{x}{3} - \frac{y}{4} = 1$ is

a. $\frac{11}{5}$ b. $\frac{5}{12}$ c. $\frac{12}{5}$ d. $\frac{-5}{12}$

39. The equation of the straight line passing through the point (3, 2) and perpendicular to the line $y = x$ is

a. $x - y = 5$ b. $x + y = 5$

c. $x + y = 1$ d. $x - y = 1$

40. If $x^2 - 2pxy - y^2 = 0$ and $x^2 - 2qxy - y^2 = 0$ bisect angles between each other, then

a. $p + q = 1$ b. $pq = -1$

c. $p^2 + pq + q^2 = 0$ d. $p - q = 1$

41. A circle passes through (0, 0), (3, 0) and (0, 5). The coordinates of its center is

a. (3, 5) b. (5, 3) c. (3/2, 5/2). d. $\left(\frac{-3}{2}, \frac{-5}{2}\right)$

42. The general equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ represents a circle if

a. $a = b, c = 0$ b. $a = b, h = 0$

c. $f = g, h = 0$ d. $f = g, c = 0$

43. Equation of the tangent at the point (3, –2) to the circle $x^2 + y^2 = 13$ is

a. $3x + 2y = 13$ b. $3x - 2y + 13 = 0$

c. $2x + 3y = 0$ d. $3x - 2y - 13 = 0$

44. If the line 2x – y + k = 0 is a diameter of the circle

$x^2 + y^2 + 6x - 6y + 5 = 0$, then k is equal to

a. 9 b. 6 c. 3 d. 1

45. The symbol $x \rightarrow a$ stands for

a. x > a or x < a b x = a c. x = a or x $\neq$ a d. x $\neq$ a

46. The limiting value of $\lim_{x \to 0} \frac{\sin x^0}{x}$ is

a. 1 b. $\frac{\pi}{180}$ c. x d. π

47. Let f(x) = $\begin{cases} 1 + x, & x > 0 \\ x, & x \leq 0 \end{cases}$, then the function f(x) at x = 0 is

a. continuous b. discontinuous

c. undefined d. indeterminate

48. The derivative of f(x) is defined as the limit of $\frac{f(x+\Delta x) - f(x)}{\Delta x}$ where

a. $\Delta x = 0$ b. Δx approaches zero

c. Δx is divisible by 0 d. Δx is multiple of 0

49. If f(x) = x log x, f' (1) will be

a. –1 b. 0 c. 1 d. $\frac{1}{2}$

50. $\frac{dy}{dx}$ When $e^{xy} = xy$ is

a. $\frac{y}{x}$ b. $\frac{-y}{x}$ c. $\frac{x}{y}$ d. xy

51. The area bounded by the curves $y = x^2$ and y = 2x is

a. $\frac{4}{3}$ b. $\frac{3}{4}$ c. 4 d. 3

52. Integrate $\int$ tanxdx

a. logsinx + c b. logsecx +c

c. logcotx+ c d. logtanx + c

53. If $\int_{\frac{\pi}{2}}^{a} \sin x\, dx = \frac{1}{2}$ then a is

a. $\frac{-\pi}{2}$ b. $\frac{-2\pi}{3}$ c. $\frac{2\pi}{3}$ d. $\frac{-\pi}{3}$

54. The diameter of a circle is increasing at the rate of 1 unit/sec. When its radius is π, the rate of increase of its area in Sq. unit/sec is

a. $2\sqrt{\pi}$ b. $\sqrt{2\pi}$ c. $\frac{1}{\sqrt{2\pi}}$ d. $\frac{1}{2\sqrt{\pi}}$

55. A stone projected vertically upwards moves under the action of gravity alone and its motion is described by $x = 49t - 4.9t^2$. The stone will it attains a maximum height after

a. 5 sec b.4 sec c. 3 sec d. 2 sec

56. The maximum value of xy subject to x + y = 8 is

a. 20 b. 16 c. 12d. 8

57. The condition for the point of inflection of a curve y = f(x) is

a. $f'(x) = 0$ b. $f'(x) > 0$

c. $f''(x) = 0$ d. $f''(x) > 0$

58. If $2+\sqrt{3}i$ is a root of $x^2+px+q=0$ where p & q are real then (p, q) is

a. (7, 4) b. (-4, 7) c. (-4,7i) d. (4i, -7)

59. If t=secx &m=tanx then which is true?

a dm/dx=1+tm+ m^2 b.dm/dx=tm c.1+tm+m d. dt/dx= tm

60. To prove a function f(x) is continuous which from the following need not be satisfy:

I. f(a) is define **II. f(x) is differentiable at a**

III. $\lim_{x\to a} f(x)$ exists **IV. $\lim_{x\to a} f(x) = f(a)$**

a. I only b. II only

c. I & II only d. IV only

Appendix 11

Topic wise Allocation of Items (specific grid) of Mathematics Achievement Test (MAT)

Area	Content (units)	No of Teaching Hours	Items No	No of Questions	Total Marks
Algebra	Sets, Real Number and Logic	10	1,2,3	3	6
	Relations, Functions and Graphs	12	4,5,6, 7	4	8
	Curve Sketching	10	8,9,10	3	6
	Sequence & Series and Mathematical Induction	12	14, 15,16, 17	4	8
	Matrices and Determinants	8	18, 19,20	3	6
	System of Linear Equations	8	21, 22,23	3	6
	Complex Numbers	12	24,25,26,47	4	8
	Polynomial Equations	8	27,28,29	3	6
Trigonometry		10	11,12,13	3	6
Coordinate Geometry	Straight Lines and Pair of Lines	12	30,31,32, 33	4	8
	Circle	10	34,35,36	3	6
Calculus	Limits and Continuity	10	37,38,49	3	6
	The Derivatives	8	39,40,48	3	6
	Application of Derivatives	12	43,44,45,46	4	8
	Antiderivative and its Applications	10	41,42,50	3	6
Total		150		50	100

Appendix 12

Difficulty Value of MAT Items

The number of correct responses and difficulty value of items for final tryout of mathematics achievement test (No of Participants, N=96)

Item Number	Number of students giving correct responses	Difficulty Value P	Remarks
1	43	0.45	A
2	55	0.57	A
3	50	0.52	A
4	18	0.19	C
5	45	0.47	A
6	47	0.49	A
7	52	0.54	A
8	38	0.40	NI
9	54	0.56	A
10	62	0.65	A
11	60	0.63	A
12	51	0.53	A
13	42	0.44	A
14	46	0.48	A
15	31	0.32	NI
16	63	0.66	A
17	55	0.57	A
18	46	0.48	A
19	51	0.53	A
20	47	0.49	A
21	74	0.77	M
22	49	0.51	A
23	55	0.57	NI
24	56	0.58	A
25	63	0.66	A
26	60	0.63	A
27	78	0.81	C
28	63	0.66	A
29	63	0.66	A
30	59	0.61	A
31	61	0.64	A
32	57	0.59	A
33	54	0.56	A
34	77	0.80	C
35	56	0.58	A
36	55	0.57	A
37	62	0.65	A
38	18	0.19	C
39	47	0.49	A

40	61	0.64	A
41	46	0.48	A
42	66	0.69	NI
43	48	0.50	A
44	51	0.53	A
45	62	0.65	NI
46	50	0.52	A
47	58	0.60	A
48	77	0.80	C
49	59	0.61	A
50	43	0.45	A
51	44	0.46	A
52	74	0.77	M
53	46	0.48	A
54	64	0.67	A
55	38	0.40	A
56	40	0.42	A
57	45	0.47	A
58	62	0.65	A
59	53	0.55	A
60	47	0.49	A

A=Accepted C= Cancelled M=Modified NI= Not Included

Appendix 13

Discriminative Value of MAT Items

Discriminative value along with item number, for the higher group and the lower group, for final tryout of mathematics achievement test (No of Participants, N=96)

Item No	Number of correct responses		Discriminative value	Remarks
	upper group N=26	Lower group N=26		
1	21	10	0.42	A
2	23	9	0.53	A
3	19	7	0.46	A
4	9	5	0.15	C
5	13	2	0.42	A
6	14	2	0.46	A
7	22	9	0.50	A
8	23	9	0.54	NI
9	15	6	0.35	A
10	13	4	0.35	A
11	18	8	0.38	A
12	21	8	0.50	A
13	24	11	0.50	A
14	23	5	0.69	A
15	24	7	0.65	NI
16	19	3	0.61	A
17	17	7	0.39	A
18	19	3	0.62	A
19	21	5	0.62	A
20	22	8	0.54	A
21	25	7	0.69	M
22	16	5	0.42	A
23	21	8	0.50	NI
24	11	2	0.34	A
25	22	6	0.62	A
26	20	7	0.50	A
27	23	4	0.73	C
28	12	3	0.35	A
29	15	4	0.42	A
30	18	5	0.50	A
31	22	9	0.50	A
32	23	11	0.46	A
33	17	7	0.38	A
34	23	4	0.73	C
35	20	5	0.57	A
36	22	8	0.54	A
37	24	7	0.65	A

38	12	8	0.15	C
39	20	8	0.46	A
40	17	5	0.46	A
41	16	5	0.42	A
42	14	4	0.38	NI
43	23	5	0.69	A
44	19	7	0.46	A
45	20	10	0.38	NI
46	22	7	0.57	A
47	20	5	0.58	A
48	24	5	0.73	C
49	18	5	0.50	A
50	15	6	0.35	A
51	17	8	0.34	A
52	22	4	0.69	M
53	21	11	0.38	A
54	13	3	0.38	A
55	16	7	0.34	A
56	22	7	0.58	A
57	18	4	0.54	A
58	20	4	0.62	A
59	13	2	0.43	A
60	14	4	0.38	A

0

A= Accepted R= Rejected NI=Not Included M=Modified

Appendix 14

MAT Scoring Key

Test item No	Correct choice	Test item No	Correct choice	Test item No	Correct choice	Test item No	Correct choice	Test item No	Correct choice
1	d	11	b	21	a	31	d	41	a
2	d	12	b	22	c	32	d	42	c
3	b	13	d	23	a	33	c	43	d
4	a	14	d	24	d	34	c	44	a
5	a	15	a	25	c	35	d	45	d
6	b	16	c	26	d	36	a	46	c
7	a	17	c	27	a	37	b	47	b
8	b	18	b	28	c	38	b	48	d
9	b	19	b	29	c	39	a	49	b
10	c	20	c	30	a	40	b	50	c

Appendix 16

Check list of Research Questions, Tables and Figures

RQ No	Research Questions	Tables No	Figures No
1	What are the learning styles of higher secondary school students at the beginning and end of the academic year?	4.2, 4.3, 4.4a-4.4d, 4.5a-4.5d	4.1, 4.2, 4.3, 4.4, 4.5, 4.6
2	What are the students' views on mathematics and mathematics learning at the beginning and end of the academic year?	4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	
3	Does relationship exists between learning styles and views?	4.13	
4	What is the achievement of students in mathematics by gender and academic aspiration?	4.14, 4.15, 4.16	4.7
5	Is there any relationship between learning styles status (changed/unchanged) and mathematics achievement?	4.17, 4.18a-4.18d, 4.19a-4.19d,	
6	Is there any relationship between views (status) and mathematics achievement?	4.20, 4.21, 4.22	
7	What type of association exists among the students' learning styles, views and mathematics achievement?	4.23a-4.23d	4.8a-4.8d

Appendix 17

Grade XI Mathematics Course Contents

Unit 1: Sets, Real Number System and Logic 10 hrs

Sets: Sets and set operations, Theorems based on set operations.

Real Number System: Real numbers, Field axioms, Order axioms, Interval, Absolute value. Geometrical representation of the real numbers.

Logic: Introduction, statements, Logical connectives, Truth tables, Basic laws of logic.

Unit 2: Relations, Functions and Graphs 12 hrs

Relations:

Ordered pair, Cartesian product, Geometrical representation of Cartesian product, relation, Domain and range of a relation, Inverse of a relation.

Functions:

Definition, Domain and range of a function, Functions defined as mappings, Inverse function, Composite function, functions of special type (Identity, Constant, Absolute value, Greatest integer), Algebraic (Linear, quadratic and cubic), Trigonometric, Exponential logarithmic functions and their graphs.

Unit 3: Curve Sketching 10 hrs

Odd and even functions, Periodicity of a function, symmetry (about x-axis, y-axis and origin) of elementary function. Monotonocity of a function, Sketching graphs of polynomial functions $\left(\frac{1}{x}, \frac{x^2-a^2}{x-a}, \frac{1}{x+a}, x^2, x^3\right)$, Trigonometric, exponential, logarithmic functions (Simple cases only)

Unit 4: Trigonometry 10 hrs

Inverse circular functions, Trigonometric equations and general values, properties of a triangle (sine law, Cosine law, tangent law, Projection laws, Half angle laws), the area of a triangle. Solution of a triangle (simple cases)

Unit 5: Sequence and Series, and Mathematical Induction12 hrs

Sequence and Series:

Sequence and series, type of sequences and series (Arithmetic, Geometric, Harmonic), Properties of Arithmetic, Geometric, and Harmonic sequences, A.M., G.M. And H.M.

Relation among A.M., G.M. and H.M., Sum of infinite geometric series.

Mathematical Induction:

Sum of finite natural numbers, Sum of the squares of first n - natural numbers, Sum of cubes of first n – natural numbers. Intuition and induction, principle of mathematical induction.

Unit 6: Matrices and Determinants 8 hrs

Matrices and operation on matrices (Review), Transpose of a matrix and its properties, Minors and Cofactors, Adjoint, Inverse matrix. Determinant of a square matrix, properties of determinants (Without proof) upto 3×3.

Unit 7: System of Linear Equations 8 hrs

Consistency of system of linear equations, solution of a system of linear equations by Cramer's rule, Matrix method (row - equivalent and Inverse) upto three variables.

Unit 8: Complex Number 12 hrs

Definition of a complex number. Imaginary unit, Algebra of complex numbers, Geometric representation of a complex number, Conjugate and absolute value (Modulus) of a complex numbers and their properties. Square root of a complex number, Polar form of a complex number, product and Quotient of complex numbers. De Moivre's theorem and its application in finding the roots of a complex number, properties of cube roots of unity.

Unit 9: Polynomial Equations 8 hrs

Polynomial function and polynomial equations, Fundamental theorem of algebra (without proof), Quadratic equation Nature and roots of a quadratic equation, Relation between roots and coefficients, Formation of a quadratic equation, Symmetric roots, one or both roots common.

Unit 10: Co-ordinate Geometry 12 hrs

Straight line: Review of various forms of equation of straight lines, Angle between two straight lines, condition for parallelism and perpendicularity, length of perpendicular from a given point to a given line, Bisectors of the angles between two straight lines.

Pair of lines: General equation of second degree in x and y, condition for representing a pair of lines, Homogeneous second degree equation in x and y, Angle between pair of lines, Bisectors of the angles between pair of lines.

Unit 11: Circle **10 hrs**

Equation of a circle in various forms (Centre at origin, centre at any point, general equation of a circle, circle with a given diameter), Condition of Tangency of a line at a point to the circle, Tangent and normal to a circle.

Unit 12: Limits and Continuity **10 hrs**

Limits of a function, Indeterminate forms, Algebraic properties of limits (without proof), Theorem on limits of algebraic, Trigonometric, Exponential and logarithmic functions $\lim_{x\to a}\frac{x^n - a^n}{x - a}$, $\lim_{x\to 0}\frac{\sin x}{x}$, $\lim_{x\to 0}\frac{e^x - 1}{x}$, $\lim_{x\to 0}\frac{\log(1 + x)}{x}$

Continuity of a function, Types of discontinuity, Graph of discontinuous function.

Unit 13: The Derivatives **8 hrs**

Derivative of a function, Derivatives of algebraic, trigonometric, exponential and logarithmic functions by definition (simple forms), Rules of differentiation. Derivatives of parametric and implicit functions, Higher order derivatives.

Unit 14: Applications of Derivatives **12 hrs.**

Geometric interpretation of derivative, Monotonocity of a function, Interval of monotonocity**,** Extrema of a function, Concavity, Points of inflection, Derivative as rate measure.

Unit 15: Antiderivatives and its Applications **10 hrs**

Antiderivative, Integration using basic integrals, Integration by substitution and by parts method, the definite integral, The definite integral as an area under the given curve, Area between two curves.

Appendix 18

Permission Letters

Date: Mon, 10 Sep 2012 15:12:19 -0400
Subject: Re: permission
From: felder@ncsu.edu
To: kp_ghimire@hotmail.com
Dear ILS user:
You have raised one of several frequently asked questions about the Index of Learning Styles. You will find a response at
http://www.ncsu.edu/felder-public/ILS-faq.htm
You may also find it helpful to consult the ILS home page,
http://www.ncsu.edu/felder-public/ILSpage.html
Regards,
Richard Felder
Richard M. Felder
Hoechst Celanese Professor Emeritus of Chemical Engineering
N.C. State University
http://www.ncsu.edu/effective_teaching
From: mtapia@berry.edu
To: kp_ghimire@hotmail.com
Subject: RE: permission
Date: Wed, 26 Sep 2012 22:46:07 +0000
Dear KP,
You have permission to use the Attitudes Toward Mathematics Inventory (ATMI) in your dissertation. If you have any question, please do not hesitate to ask me.
Please let me know of the findings in your study.
Sincerely,
Martha Tapia
Martha Tapia, Ph.D.
Associate Professor
Department of Mathematics and Computer Science
Berry College
P.O. Box 49501
Mount. Berry, Georgia 30149-5014

Appendix 19

Variables used in the Study

Independent Variables (IVs)

1. Learning Styles (Felder-Soloman) four dimensions

    i. Active-Reflective ii. Sensing-Intuitive

    iii. Visual-Verbal iv. Sequential-Global

2. Views with Subscale Variables

    i. Value ii. Enjoyment iii. Self-confidence

    iv. Motivation v. Belief

3. Gender i. Male ii. Female

4. Academic Career Aspiration

    i. Mathematical Sciences

    ii. Undecided (Biology with additional Mathematics)

    iii. Nonmathematical Sciences

Dependent Variable (DV)

Mathematics Achievement Test (MAT)

Appendix 20

List of Higher Secondary Schools

S No	Name of the higher secondary school	Address	No of students
1	**National School of sciences H S school**	**Lainchaur, Kathmandu**	**866**
2	Trinity International H S school	Dillibazar, Kathmandu	850
3	V S Niketan H S school	Minbhawan, Kathmandu	331
4	Pentagon Intl H S school	Tinkune, Kathmandu	658
5	Goldengate Int H S school	Battisputali, Kathmandu	685
6	Southwestern State H S school	Basundhara, Kathmandu	235
7	Ambition academy H S school	Puranu Baneshwar, Ktm	230
8	Kathmandu Barsha H S school	Subidhanagar, Tinkune, Ktm	442
9	Xavier Int H S school	Kalopul, kathmandu	286
10	New Summit H S school	Puranu Baneshwar, Ktm	173
11	Nobel Academy H S school	Naya Baneshwar, kathmandu	191
12	Himalayan White house Int H S S	New Baneshwar, Kathmandu	389
13	NASA Int H S school	Tinkune, Kathmandu	306
14	Kathmandu Model H S school	Bagbazar, Kathmandu	679
15	The Times H S school	Dillibazar, Kathmandu	173
16	Kathmandu Bernhardt H S school	Balkhu, Kathmandu	265
17	Nepal Mega College	Babarmahal, Kathmandu	271
18	**NIC H S school**	**Dillibazar, Kathmandu**	**157**
19	Canvas Int H S school	Dhapasi, Kathmandu	174
20	Capital H S school	Koteshowar, Kathmandu	458
21	Liverpool Int H S school	Naya Baneshowar,Ktm	466
22	Takshashila academy H S school	Bishalnagar, Kathmandu	154
23	Bridgewater Int H S school	Sinamangal,Kathmandu	182
24	St Xavier's College	Maitighar, Kathmandu	517
25	Everest Florida H S school	Shantinagar, Kathmandu	608
26	Morgan Int H S school	Basundhara, Kathmandu	289

Source-HSEB 2015

Appendix 21

Correlations among subscale variables and composite views of beginning and end

	End value	End enjoyment	End self-confidence	End motivation	End belief	composite end views
Beginning value	0.44	0.37	0.28	0.28	0.26	0.37
Beginning enjoyment	0.33	0.63	0.50	0.45	0.41	0.56
Beginning self-confidence	0.29	0.60	0.54	0.41	0.40	0.57
Beginning motivation	0.33	0.51	0.37	0.50	0.34	0.47
Beginning belief	0.31	0.43	0.33	0.35	0.36	0.43
composite Beginning views	0.39	0.63	0.51	0.47	0.43	0.59

Appendix 22

No of items for ILS Dimension

Dimension	Items	Total
Active and Reflective	1,5,9,13,17,21,25,29,33,37,41	11
Sensing and Intuitive	2,6,10,14,18,22,26,30,34,38,42	11
Visual and Verbal	3,7,11,15,19,23,27,31,35,39,43	11
Sequential and Global	4,8,12,16,20,24,28,32,36,40,44	11
Total		44

Appendix 23

No of items for VTMI

Views components	Items	Total
Value	1,2,3,4,5,6,7,8,9,10	10
Enjoyment	11,12,13,14,15,16,17,18,19,20	10
Self-confidence	21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	15
Motivation	36,37,38,39,40	5
Belief	41,42,43,44,45,46,47,48,49,50,51,52,53,54,55	15
Total		55

Appendix 24

Rulon and Flanagan Formula

The Rulon Formula is:

$r_{tt} = 1 - \frac{\sigma_d^2}{\sigma_t^2}$,Where r_{tt} = reliability coefficient

σ_d^2 = variance (SD squared) of the difference between two half scores for each examinee;

And σ_t^2 = variance (squared of the std dev) of the total score.

Total score for an examinee is the sum of his /her scores on the two halves of the test.

And the Flanagan Formula is:

$r_{tt} = 2\ (1 - \frac{\sigma_1^2 + \sigma^2{}_2}{\sigma_t^2})$

Where, r_{tt} = reliability coefficient

σ_1^2 = variance of scores of first half;

$\sigma^2{}_2$ = variance of score of the second half;

And σ_t^2 = variance of total scores.

The computation of reliability coefficient by the Rulon Formula and Flanagan Formula is

Computation of reliability coefficient of the items by

i. Rulon Formula:

$r_{tt} = 1 - \frac{\sigma_d^2}{\sigma_t^2} = 1 - \frac{10.17}{122.54} = 0.91$

ii. Flanagan Formula:

$r_{tt} = 2\ (1 - \frac{\sigma_1^2 + \sigma^2{}_2}{\sigma_t^2}) = 2(1 - \frac{31.80 + 35.16}{122.54}) = 0.92$

Appendix 25

Year Wise Distribution of Grade XI Science Students

Year (BS)	male	percentage	female	percentage	total
2065	14230	70.78	5875	29.22	20105
2066	15780	70.20	6700	29.80	22480
2067	19526	71.77	7679	28.23	27205
2068	22951	71.25	9263	28.75	32214
2069	24680	69.07	11050	30.93	35730
2070	26647	68.95	11998	31.05	38645

Source: HSSEP-DOE, 2014

Appendix 26

Certificate from Supervisor

CERTIFICATE

This is to certify that the thesis entitled " *Students' learning styles and views: Effect on higher secondary level mathematics achievement* **"** being submitted by Mr Kaji Prasad Ghimire to the Faculty of Education, Tribhuvan University, Nepal for the award of the degree of Doctor of Philosophy in Mathematics Education is a bonafide research work carried out by him under my supervision. The results presented in this dissertation have not been submitted elsewhere for the award of any other degree.

In my opinion, this work has reached the standard fulfilling the requirements for the award of the degree of **Doctor of Philosophy** in accordance with the regulations of the University.

………………………………

Prof Dr Hari Prasad Upadhyay

February 4, 2018