LEARNING STYLES OF TALENT STUDENTS IN MATHEMATICS

A

THESIS

BY

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FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTERS IN MATHEMATICS EDUCATION

SUBMITTED TO

DEPARTMENT OF MATHEMATICS EDUCATION

CENTRAL DEPARTMENT OF EDUCATION

UNIVERSITY CAMPUS

TRIBHUVAN UNIVERSITY

2017

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शिक्षा शास्त्र संकाय
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Letter of Certificate

This is to certify that Mr. Laxman Singh Khatri, a student of academic year 2070\2071 with campus roll no. 286, exam roll no. 280442, T.U. registration no. 9-2-156-94-2009 and thesis no.1223, has completed his thesis under my supervision, during the period prescribed by the rules and regulations of Tribhuvan University, Nepal. The thesis entitled "**Learning Styles of Talent Students in Mathematics**" has been prepared on the results of his investigation conducted during the period of 2073. I hereby, recommend and forward that his thesis is submitted for the evaluation as the partial requirements to award the Degree of Masters in Mathematics Education.

…….

(Assot. Prof. Laxmi Narayan Yadav)

Date: ……..

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Letter of Approval

This thesis entitled **"Learning Styles of Talent Students in Mathematics"** submitted by Mr. Laxman Singh Khatri in partial fulfillment of the requirements for the Degree of Masters in Mathematics Education has been approved.

Viva Voce Committee	**Signature**
Associate Prof. Laxmi Narayan Yadav (Chairman)	……..
Prof. Dr. Hira Bahadur Maharjan (External)	……...
Mr. Dipak Mainali (Supervisor)	…….

Date: …….

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Recommendation for Acceptance

This is to certify that Mr. Laxman Singh Khatri has completed his M. Ed. thesis entitled **"Learning Styles of Talent Students in Mathematics"** under my supervision during the period prescribed by the rules and regulations of Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommend and forward his thesis to the Department of Mathematics Education to organize final viva-voce.

……

(Mr. Dipak Mainali)

Date: ……

Defense Date: 7/4/2017

Dedication

This work is affectionately dedicated to my late grandfather **Sher Singh Khatri** and late grandmother **Dikari Khatri** who even in a very difficult situation gave me a great span of their life for what I am now.

Declaration

This thesis contains no material which has been accepted for the award of other degree in any institutions. To the best of knowledge and belief this thesis contains no material previously published by any authors except due acknowledgement has been made.

…….

Laxman Singh Khatri

Date: ……

Acknowledgement

First of all, I want to express my heartfelt gratitude to my respected thesis supervisor Mr. Dipak Mainali, Department of Mathematics Education, Central Department of Education, Tribhuvan University, Kirtipur, Kathmandu. His valuable and constructive suggestions, instructions and scholarly guidance have become the greatest property in this thesis. So, I am heavily indebted towards him.

Similarly, I would like to extend my gratitude to Associate Prof. Laxmi Narayan Yadav, Head, Department of Mathematics Education, Central Department of Education, Tribhuvan University, Kirtipur for their encouragement and kind support ideas. My sincere appreciation goes to Prof. Dr. Hira Bahadur Maharjan, Prof. Dr. Hari Prasad Upadhyay, Abtar Subedi and Krishna Adhikari, Department of Mathematics Education, T.U. Kirtipur for their valuable suggestions, encouragements and inspiration to complete the study. In the same way, I am very grateful to all respondents and concerned persons who helped me in data collection.

I would like to express my gratitude to my late grandfather Sher Singh Khatri, late grandmother Dikari Khatri, father Pratap Singh Khatri, mother Rukmani Khatri and elder brother Lokendra Singh Khatri and whole family members who supported me to study up to master's level and to complete this thesis. Finally, I would like to thanks to Mr. Dhrm Dev Ojha who supported for language correction.

…….

Date: April, 2017 Laxman Singh Khatri

Abstract

The objectives of this study were to analyze the learning styles of talent students in mathematics and to find causes adopting the learning styles. Kolb's learning theory, Myers- Briggs Type Indicator and Dunn and Dunn learning style were reviewed for theoretical literature. Six talent students were purposively chosen from three schools of Kirtipur Municipality to conduct case study. Talent students' peer, their guardian and mathematics teacher were selected for data collection where tools were in-depth interview, interview and observation. The collected data was analyzed by thematic approach and triangulation.

Studying in formal environment and individually, more focus on concept rather than learning in detail, focus on logic, asking 'how' sort of questions to know the problem solving process, revising mathematical concepts while walking on the way and working at house, studying with the help of making image in mind and drawing figures of mathematical concepts in copy, making note and highlighting main concepts, relating mathematical concepts with society and using internet to study mathematics were major findings of this study. The reasons behind such learning styles were feeling comfortable to learn in formal environment, to avoid the disturbance created by family members, to feel psychologically comfortable to study individually, to become difference in problem faced by talent students and their friends, lack of materials, exam centered learning and lack of time to study practically, to know step wise solution of problems, to keep in long term memory, to avoid pressure of rote learning, to know mathematical knowledge from social context and to widen the mathematical knowledge. The conclusion of this study is talent students are not limited only on book, they learn through social context, internet and by self-effort. They learn meaningfully with the help of figures and notes.

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Chapter-I

INTRODUCTION

Background of the Study

All the students learn in their own ways. So, it is significant to understand students' learning styles. Learning style is an individual reaction to several environmental, emotional, psychological and sociological factors (Dunn and Dunn, 1992). Since past twenty years, the study on learning styles, both theoretical and applied simultaneously sparked a strong interest, but also a whole controversy of opinion among both academic experts and among those who learn independently. Much of the research and practices went forward in the face of significant difficulties in the confusion of definitions surrounding the conceptualization disturbing cognitive styles and learning styles (Coffield et. al. 2004). In a classroom where only one approach to learn is encouraged by teacher, some students may possibly work and learn less effective than others (Alan, 2009). For this reason, an awareness of learning styles is important for teachers.

How can we make teaching learning activities more child-centered? This is the focus on research nowadays. Child centered learning makes meaningful understanding and students can learn easily. For child centered learning, it is necessary to study learning styles of students.

Some mathematics learners are self-motivated, they learn by their own effort. Some students learn by depending on their friends where as many students enjoy by practicing mathematics in their copies. Some learners learn by listening to teachers'

lecture whereas other by looking figures; drawing figures and charts and some learn by reading. So, it is essential to understand students' learning style.

Teaching learning activities should be conducted according to learning styles of students. The concept of individualized instruction is also in highlight. There is also the concept of problem solving method, discovery method, discussion method and laboratory method. It is better to understand learning styles of talent students to use proper method of instruction.

Most of the students from different parts of Nepal can be found studying in Kathmandu district. It is the new subject and current demand to study on learning styles of talent students in mathematics. There may be various causes to adopt learning styles by talent students. So, the focus of this study was to investigate learning styles of talent students in mathematics.

Understanding learning styles of talent students helps teacher to present lesson effectively based on their learning styles. Consequently, students' performance in mathematics improves. Some average and slow learners may also copy the learning styles of talent students which can help to learn mathematics easily. Therefore, this study investigated the learning styles of talent students in Kirtipur Municipality and causes behind adopting those learning styles.

Statement of the Problem

The objective of mathematics curriculum is to make students capable in every contents of each grade. Nation, family, school family and students have input in education. In a class, some students are talented and some average but the teachers, textbook, time duration and classroom are same. Input is being wasted without

achieving minimal objectives in mathematics. As a result poor students do not know properly in further classes. By following the learning styles of talent students, most of the poor students can also do better in mathematics. To meet the needs of talent students and poor students in a classroom is difficult. Consequently, talent students have also problems to study mathematics in order to compete in international level. Hence, investigating about learning styles of talent students in mathematics and finding reasons behind adopting the learning styles in Kirtipur Municipality was research problem of the study.

Objectives of the Study

The specific objectives of this study were as follows:

- To analyze the learning styles of talent students in mathematics.
- To find reasons behind adopting the learning styles.

Research Questions

On the basis of objectives mentioned above the research questions were as follows:

- How do talent students learn Mathematics?
- Why do talent students follow particular learning styles?

Significance of the Study

At first this study is significant to those who are interested in learning styles of talent students in mathematics. This study helps to parents, teachers, students and policy makers in applying learning styles of talent students which results to learn mathematics easily.

This study was conducted with following significances:

- This study gives clear picture of learning styles of talent students in mathematics.
- This study provides support to teachers to apply learning styles of talent students. Consequently, poor students can progress in mathematics.
- Study helps to decrease failure rate in mathematics.
- This study informs to teachers, parents and administrator for their responsibilities in enhancing achievement in mathematics.
- This study informs to teachers, parents and other concerned persons about why talent students follow particular learning styles in mathematics.

Delimitation of the Study

This study was conducted with the following delimitations:

- This study was limited to case study design and qualitative approach.
- This study was confined to only six talent students in mathematics from three schools.
- This study was limited in Kirtipur Municipality of Kathmandu district.
- In-depth interview, interview and non-participant observation were only the tools for data collection.
- Students' learning styles were analyzed on the basis of Kolb's learning theory, Myers-Briggs Type Indicator, auditory, visual and tactile learning styles.

Operational Definitions of Key Terms

The main terms in this research are defined as follows:

Learning style

It is the students' own way from which they learn mathematical axioms, definitions, formulas, theorems and concepts.

Talent students

The students of grade X who had secured 80 percent or above in previous three grades were talent students in this study.

Extraverts

The students who could learn mathematics by discussing in group were considered students with extravert learning style. Such students practice mathematics in groups, ask mathematical problems to their friends and they always interact to learn mathematics.

Introverts

The students who could learn mathematics themselves without depending on group were considered students with introvert learning style. Such students practice mathematics individually and feel less comfortable to discuss in group. They try to find mathematical solution by their self-effort.

Sensors

The students who are detail oriented; focus on facts, procedures and practical works are considered students with sensor learning style. Students with such learning style understand mathematics when teacher explains in detail. They want to look by their eyes. For example, when teaching 1000 cm^3 = one liter, they pour one

Liter liquid in the object having area 1000 cm^3 and observe whether that object is filled or not.

Intuitors

Students belonging to such type of learning style focus on concept and are imaginative. They do not depend on concrete objects for learning and construct an abstract image of the subject matter to be learnt.

Thinkers

Students belonging to such type of learning style make decision based on logic and try to find out reasons behind every fact. They learn based on the axioms, theorems, definitions, formulas and rules.

Feelers

Students belonging to such type of learning style make decision depending on what their society do. They learn from their friends, teachers and people around them.

Abstract-active

Students belonging to such type of learning styles learn through mistake. They learn through the process of trial and error.

Abstract-reflective

Students with such learning style ask 'what' types of questions. They focus on content knowledge of mathematics.

Auditory Preference

Students with such learning style learn by lectures, discussions and recording. Their listening ability is highly sensitive.

Visual Preference

Students with such type of learning styles learn through reading and observing pictures, tables, diagrams and maps. When they recall something, they close their eyes and try to take picture in their mind. They learn through reading and writing.

Tactile preference

The students who trace underline, highlight key sentences, take note and listen to music while studying mathematic are called students with tactile preference.

Kinesthetic Preference

Students with such preference move their lips, head, legs and hands when learning mathematics.

Chapter- II

REVIEW OF RELATED LITERATURE

Literature review is the process of locating, obtaining, reading and evaluating the research literature in the area of the research. This section deals with the review of both empirical literature and theoretical literature. Review of theoretical literature provides clear picture of theories related to learning styles. Similarly, conceptual framework helps to conduct study properly.

Review of Empirical Literature

Review of empirical literature answers the questions:- What is find out under related topic? What were the aims of research? What was the sample size and tools for the data collection? What was the procedure for data collection and analysis process? What is new thing to find under research topic? Empirical literature also helps to carry out research properly and to make research original. Here, the researcher reviewed literature related to learning styles.

The study of Pyrat (1998) investigated the preferred learning styles of gifted and ordinary male and female students in preliminary American schools. The study indicated that gifted students tend to be more independents in their learning and depends on self- motivators rather than exterior ones; they also prefer to take part in the learning process. The study results indicated that there is no statistical significance in learning style preference that may be justified by gender, and that gifted students prefer to learn through multiple sensory channels.

Kopsovich (2001) conducted a study on learning styles of students and their mathematical score. The problem of this study was to determine whether learning

styles of students affect their main scores. The Pearson Product Moment Correlation Coefficient and the Point- biseral applied to the data collection from 500 fifth grade students attending a North Texaz Intermediate School. The significance level was established at the 0.05 level. The finding established that the learning style preferences of all students in the area of persistence significantly impacted their math achievement scores. Students were told to respond to the statements using a five point Likert Scale ranging from strongly agree to strongly disagree.

Dennis G. and Huisman (2002) conducted research on 'A Descriptive comparative study of student learning styles from selected medical education programs'. The author's hypothesis was to determine whether comparable variation co- existed among the individual learning styles of health professional students and the general population. The main objectives were to demonstrate learning style variability, as well as justification for the utilization of different teaching modalities throughout education.

Researcher administered Kolb's learning style inventory model to sample population of Emerging Medical Technician (m=53), third and fourth year medical students (m=28), under graduate nursing students (n=65), second and third year physician assistant students (n=49), and a general population (n=70). The results were analyzed using Pearson’s Chi-Square test and compared using analysis of variance (ANOVA) methods. A statistical difference did not exist among the learning styles of health professional students and the general population. The purpose of this research project was to assets learning styles of various medical professions individually and as a whole. The research found no significant learning style difference among the students of the selected health professions, within the students of general education or from the general population.

Al Mane study (2005) aimed at defining the preferred learning styles of intermediate stage students as well as the common teaching styles. The study sample consisted of 579 male and 579 female students in the ninth grade from 26 different schools in AL Riyadh city in Saudi Arabia. The results have shown that the most preferred teaching styles by students are learning through verbal reaction with the teacher; whereas the least preferred style is through conversations and recitations, activity exercises and applications. The study concluded that the teachers have to determine the students' preferred learning styles, and prepare their lessons according to it teaching styles applied by the teachers shall be varied in order to ensure the satisfaction of all students learning styles they needed.

Rayneri; Letty J; Gerber; Brain L; and Larry P. (2006) investigated the relationship between classroom environment and the learning style preferences of gifted middle school students' perception of the classroom environment, student learning styles and students' achievement levels. The Learning Style Inventory (LSI) was given to eighty gifted students from the sixth, seventh and eighth grades aiming at defining their learning style preferences. They were also administered the Student Perception Inventory (SPI), in order to determine perceptions of these learning style elements in their classroom environment. The results of this study found that gifted students to be more kinesthetic and more likely to be encouraged using hand on activities which make them to reach their potential. Gifted students also have shown to need to a more interactive class environment where the teacher notes and responds to their preferences hence motivating them to achieve better results.

Chen, Oxford and Chi (2009) conducted survey on Learning style with the objectives: to raise students awareness of their own learning style performances, to encourage students to expand their learning style repertoire, to help students get to

know each other and foster respect for and awareness of diversity in learning styles. There were eleven representing 12 different aspects of learning style. It typically took 30 minutes to complete survey.

The study of Altuna and Yazici (2010) aimed at determining learning styles of gifted students in Turkey. The sample of the study composed of two groups from primary-second phase students, gifted students group consisted of 386 (female=164, Male=222) and non-gifted students group consisted of 410 (Female=209, Male=201). The learning Style Scale developed by Sever (2008) and data collection form developed by the researcher were used as data gathering tools. The result indicates significant difference which was found between the gifted students learning styles and non-gifted students learning styles. Significant difference was found between visual learning styles, kinesthetic learning styles of gifted and non-gifted, a significant difference has been determined between auditory learning style scores of gifted females and gifted males, this difference stems from higher scorers of females than of males. Additionally, significant difference was also found among learning styles of the gifted students taking their grade levels into consideration.

Damvandi (2011) conducted research on the topic 'Academic Achievement of Students with Different Learning Styles.' This study investigated the impact of learning styles on the academic achievement of secondary school students in Iran. The Kolb Learning Style Inventory (1999) was administered in eight public schools in Iran. The mean of test scores in five subjects namely English, Science, Mathematics, History and Geography was calculated for each student and used as a measure of academic achievement. A total of 285 grade ten students were randomly selected as sample of this study. The results of the analyses of variance show that there is a statistically significant difference in the academic achievement of Iranian students that

correspond to the four learning styles [$F(3,285)=9.52$, $p<0.05$]; in particular, the mean scores for the converging and assimilating groups are significantly higher than for the diverging and accommodating groups.

Pema (2011) conducted research on 'Learning styles and their effects on students' learning.' This study describes different learning styles, discusses a range of learning style inventories and analyzes the impact of learning styles on student performance in an American government class. The central purpose was to make professors aware that their students learn differently and to share strategies to address these different needs. According to his research, learning styles do make a difference in the classroom and causes students to respond differently to various activities or styles of presentation that may be utilized in a class. However, traditional lecture classes are geared towards students who are reflective, intuitive, verbal and sequential and tend to ignore the other learners. The researcher concludes students with different learning styles do learn differently. Their various learning styles cause them to perform better or worse in different areas of the class, depending on how closely it is adapted to their learning style preference. There were no profound differences, but they were present nonetheless.

Aljaberi (2015) conducted research on University Students' Learning Styles and Their Ability to Solve Mathematical Problems. The purpose of this study was to determine the learning styles of pre-service elementary school teachers at the University of Petra, and to assess their ability to solve mathematical problems according to Polya's strategy. This research was administered to 85 students who had completed a course on basic concepts in mathematics during the second semester of 1013-1014 academic years. To collect the data, the researcher employed two types of instruments: the Learning Style Inventory (LSI) and, which was prepared by Honey &

Mumford (1992), and the Mathematical Problems Solving Test (MPST) according to Polya's strategy, which was prepared by the researcher. The study concluded that students lack the ability to solve mathematical problems and that varies depending on the school year. In addition, the study concluded that student's ability to solve mathematical problems varies depending on their learning style. The most frequently preferred learning style was Activist-Reflector style, which showed better performance in solving math problems than other styles.

Review of Theoretical Literature

In order to build the theoretical knowledge of the related field review of theoretical literature is essential. That's why researcher reviewed theories related to learning styles of students. Until now there are many leaning theories such as behaviorist learning theory, cognitive learning theory, constructivist learning theory and critical learning theory. According to behaviorist learning theory students learn as a result of strong bond between stimulus and response with the help of appropriate response. By repeating time to time same thing learning occurs. The study of behavior by scientific methods is called behaviorist learning theory.

Cognitive learning theory came against behaviorist learning theory. According to this theory; for learning, there is important role of mental activities. There is storage of information in the mind of human. When human being takes information from his or her environment then he or she compares information with pre-existing information in the mind, organize, reorganize, analyze information in mind as a result of this new knowledge is formed. In this system, whatever is conveyed through stimuli in the environment is the 'input' the cognitive functioning of the human mind is the 'process' and the result of the cognitive functioning is the 'output' or the product.

According to cognitive field theorist, teaching is a process of developing insight in the learner, learning is the organization of percepts and purposes by the learner. Without meaningful perception there is no learning (Sharma, 2011).

We cannot perceive any object or situation in vacuum. For perception base is necessary. For example for the perception of moon sky is necessary, for the perception of book rack is needed. We perceive any object in whole. For example to give concept of house; house should be shown but if we show bricks, men cannot perceive the concept of house. Similar words, numbers and objects organize in one group. It helps in recall and in perception. When objects are near to each other then we can perceive soon in good manner (Sharma, 2011).

Constructivist learning theory is based on mental development of students. The main aspect of formation of behavior is social environment and ZPD. There is role of environment and ZPD in learning. According to this theory, learning is subjective, wider and meaningful. It is based on collaborative learning. The cognitive development of students occurs from social process. As a result of Zone of Proximal Development student can solve problem by his or her own capacity or by the few help of teacher or by fully support of teacher (Alan, 2009).

Instruction begins when teacher learn from learner. A teacher must know the learning styles, needs, interest, beliefs, attitudes, developmental stages, emotions, feelings, hobbies, stress, family background of the students and teacher should understand student's problems in learning, should provide affection, guidance praise. Teacher have to respect them rather dominating. Nowadays child centered pedagogy should be applied.

The Learning Styles Inventory (LSI) of Dunn, Dunn and Price was designed to get an individual's personal preferences. According to them learning styles of students can be explained as below:

Some students need quiet when they are learning, while others notice neither noise nor movement once they begin to concentrate. Some students work best under very bright lights, while others need dim, indirect or low light to concentrate. Some students concentrate best when the temperature of the learning environment is warm while others prefer a cool environment. Many students concentrate best in an informal environment- on a bed, lounge chair or carpeting.

Some students prefer studying alone while others prefer to study with a peer. In the latter situation, discussion and interaction facilitate learning. Some students prefer to study alone but in close proximity to others. Some students feel more comfortable when someone with authority is present. Students who have auditory preference learn through lecture, discussions or recording. The students whose primary learning preference is to read or observe material to be learnt fall under visual preferences. When these students are questioned, they usually close their eyes and visually recall the information from diagrammatic or printed material. Students with tactile preference need to underline as they read and take notes when they listen to a lecture. Requires intake describes a student's preference to eat, to drink and to bite objects while concentrating as opposed to those students whose preference to eat, to drink, to bite objects while concentrating as opposed to those students whose preference for any type of intake is after studying. Some students read in evening/ morning whereas some read in late morning and late afternoon.

According to Myers -Briggs Type Indicator (1962), learning styles are categorized into three types which are extraverts or introverts, sensors or intuitors, thinkers or feelers. Students who are extravert ask; which is doubtful, discuss with friends and try things out. Sensors learners are practical, detail oriented, focus on facts and procedures. Intuitors are imaginative, concept oriented, focus on meaning and possibilities. The thinkers are skeptical; tend to make decisions based on logic and rules whereas students who are feelers are appreciative; tend to make decisions based on personal and humanistic considerations.

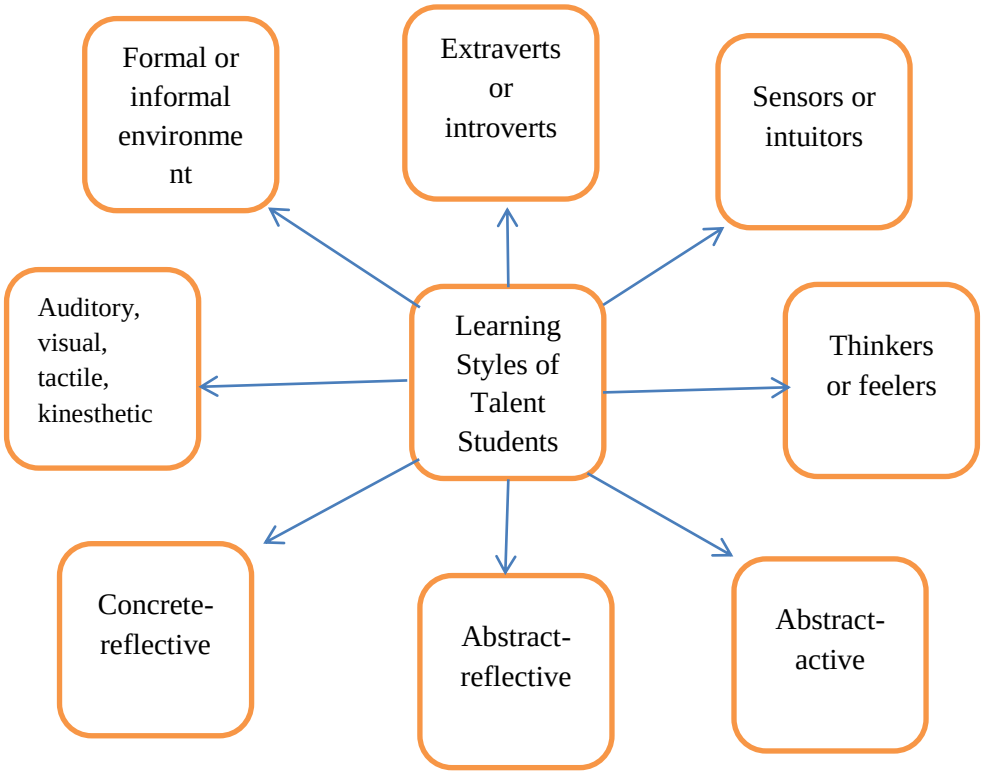
Kolb's Experimental Learning Model (1984) divides students into four categories according to their learning styles. Students who are concrete-reflective think how course material relates to their experience, interests, and future carriers. Their characteristic question is why-type. To be effective with such students, the instructor should function as a motivator. Students who are abstract-reflective ask question-What? To be effective with such students, instructor should function as an expert. Abstract-active students learn through mistake. So that we have create environment where students learn through trial and error. Their characteristic question is- how? To be effective with them, the instructor should function as a coach providing guided practice and feedback. Concrete-active students have characteristic question-"What if?" To be effective with such students, instructor should pose open ended questions. Instructor should crate maximizing opportunities for the students to discover things for themselves. Problem based learning is ideal pedagogical strategy for these students.

Kolb's learning model and Myers-Briggs Type Indicator are essential because these models give the clear picture of learning styles and can be observed in school level students. Dunn and Dunn learning style inventory categorizes the learning styles

on the basis of learning through sense organs but Kolb's learning theory categorizes learning styles on the basis of type of questions asked by students. That's why these both theories and MBTI are reviewed.

Conceptual Framework of the Study

A conceptual framework is a representation either graphically or in narrative for of the main concepts or variables and their presumed relationship with each other**.** To show the relationship among the various concepts, theories and variables of the study was the main purpose of the conceptual framework. Conceptual framework helped the researcher in drawing clear picture of how to conduct research properly. Abstract- active, abstract-reflective and concrete reflective are the learning styles of Kolb's learning theory (1984) which are presented in following conceptual framework.



Source: Kolb's theory, MBTI and Dunn and Dunn theory of learning

The above figure shows that extravert learners work in group, learn by discussion and interact in group whereas introvert learner learn individually, by thinking himself or herself but such learner do not work in group for learning. Sensors want to see anything practically. They enjoy in detail explanation. Intuitor learners focus on concept. For example, while learning sphere they make figure of sphere and generate concept of sphere considering three dimensional figure and compare with ball. Thinkers focus on logic, rules and enjoy in mathematical beauty whereas feelers think mathematics is good because society values mathematics.

While solving mathematical problems, abstract-active learners try and try by blind practice, reduce mistake and finally problem gets solve. Abstract-reflective students focus on content. They ask for example what is set, what is formula to find area of rectangle, what is equal to $(a+ b)^2$ etc. Auditory learners listen and keep in mind. They learn by recording formulas, statements and definitions. Visual learners learn by looking picture, figures and drawing figures. Students with kinesthetic preference move at the time of learning mathematics. They move their hands, legs and head. Students with tactile preference make note when learning mathematics and trace underline when they get important thing in the process of reading formulas, definitions etc. The causes of adopting those learning styles were found by asking talent students.

Chapter-III

METHODS AND PROCEDURES

Methods and procedures is the most important part of research. In the absence of this section it is difficult to conduct research and we cannot achieve research objectives (Koul, 2000). So, to fulfill research objectives, methods and procedures should be appropriate. This chapter contains design of the study, selection of study site, case of the study, selection of case respondents, data collection tools, validity and reliability of data collection tools, data collection procedures and data analysis procedure.

Design of the Study

The study was carried out on the basis of qualitative research approach. The case study design was conducted. The study of any individual, group, institution, program or event which is bounded by certain characteristics, using tools such as observation interview, figure\ proof, discussion etc. is called case study. Case study is a comprehensive study of a social unit -be that unit a person, a group, a social institution, a district or a community. A case study is research method which investigates the condition or status of a person or group in the past and is designed to increase understanding as it exists in real life.

In this study, the cases were talent students in mathematics of grade X. Case study was conducted because it helps to study about any individual, institution or program in detail. Particularly, case study is conducted in school context. Talent students also had common characteristics. So, case study was chosen for this study.

Study Site

Kathmandu is heart of Education in Nepal. Kirtipur Municipality is considered as famous in the sector of education. Therefore, the researcher selected Kirtipur Municipality in comparison to other municipalities in Kathmandu district. So, Kirtipur Municipality was the study site.

Selection of Case Respondents

On the basis of researcher's interest and convenience three schools were chosen purposively from Kirtipur Municipality of Kathmandu district such that where two students of grade X from each school were selected whose mathematics score were 80 and above continuously in previous three grades. Each talent student's peer, six guardians of six talent students and one mathematics teacher teaching at secondary level from each school were selected for this study. Talent students were named as respondent 'A' , respondent 'B', respondent 'C', respondent 'D', respondent 'E' and respondent 'F'.

Data Collection Tools

Data collection helps to the researcher to study and analyze each aspects of the study. The success of the study depends on tools for data collection. Therefore, in-depth interview, interview and observation were the tools for data collection.

In-depth Interview

In-depth interview is a loosely structured interview which is used for primary data collection in qualitative research. It allows freedom for both the interviewer and the interviewee to explore additional points and changes direction, if necessary. It

offers the opportunity to capture rich, descriptive data about people's behaviors, attitudes and perceptions.

In-depth interview can be defined as a qualitative research technique which involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program or situation. In this research, in-depth interview was based on in-depth interview guidelines. In-depth interview guidelines were made through the suggestions of supervisor and studying learning styles in internet. In-depth interview was conducted with talent students to find the learning styles in mathematics and causes adopting those learning styles.

Interview

Interview is an important method for primary data collection in qualitative research. It is the method of collection data from telephone or face to face interaction. The researcher made interview schedule to conduct interview with talent students' peer, mathematics teachers and guardians which helped to find the learning styles of talent students in mathematics.

Observation

Observation is mainly used in qualitative research to collect primary data. It consists of behaviors to be observed during observation. There are two types of observation which are participant observation and non-participant observation. In participant observation, researcher enters in research field playing same role as respondent. In such observation, respondents do not know whether researcher is observing their behaviors or not. But in non-participant observation respondents easily know. In this study to conduct non –participant class observation, class

observation schedule was made. In each school, seven mathematics classes were observed to find the learning styles of talent students and to become confident on the responses as provided by talent students, their peers and mathematics teacher.

Validity and Reliability of Data Collection Tools

To establish the validity and reliability of data collection tools, the researcher took the help of supervisor, studied Kolb's Learning Theory, Myer's Briggs Type Indicator and Dunn and Dunn Learning Style Inventory (LSI) and surfed in net about different sorts of learning styles as included in the conceptual framework.

Data Collection Procedure

At first, the researcher visited most of the schools of Kirtipur Municipality such as Kirtipur Secondary School, Balkumari Secondary School, Adinath Secondary School and Baisnabi Secondary School with the help of letter given by Department of Mathematics Education. But, it became difficult to get students of grade X securing more than eighty percent in previous three grades. So, the researcher left such schools and went in Jansewa Higher Secondary School, Mangal Secondary School and Green Village Secondary School. From school record, the researcher listed the names of talent students. Plan was made where, why and how in- depth interview and class observation should conduct, how could start and end in-depth interview and class observation and what should be time duration.

After the selection of talent students, the researcher went in related schools, visited head teachers then class teachers, showed letter and requested to call talent students. Initially, the researcher informed about his goal and established rapport with them. After taking filled forms from talent students, in-depth interview was conducted

with talent students taking the help of in-depth interview guidelines as mentioned in appendix-I. Their responses were recorded by computer. After the completion of in-depth interview with first respondent, second respondent was allowed to attend for in-depth interview.

After finishing in-depth interview with talent students, their mathematics teachers and peers were interviewed with the help of interview schedules as mentioned in appendix-II and IV. After that, data were noted in diary. The researcher mentioned his objectives and took the permission of head teacher and mathematics teacher to observe mathematics class of grade X. Then seven mathematics classes in each school were observed on the basis of class observation schedule as mentioned in appendix-III. Essential information was written in note book. Interview with respondents' guardians was taken on the basis of interview schedule and recorded. Finally, all of the informants were thanked for their co-operation.

Data Analysis Procedure

Thematic approach was the base of data analysis in this study. Qualitative data were collected through in-depth interview, interview and class observation. That data which were taken in symbols or incomplete sentences were completed at room. Verbal data were transcribed by listening time to time from computer. After that, the researcher studied written data compressively. The information was then coded under codes such as writing, listening, looking, practical, detail, media, underline, logic and movement based on meaning carried on each paragraph of transcribed data. Then, themes such as auditory or visual, sensor or intuitor, thinkers or feelers and contextual or ICT based learning were made on the basis of meaning from codes. Taking theme as a base, data were analyzed regarding Kolb's Learning Theory (1984), Myers -

Briggs Type Indicator (1962) and Dunn and Dunn Learning Style Inventory by triangulation.

Chapter-IV

ANALYSIS AND INTERPRETATION OF THE RESULTS

This chapter deals with the analysis and interpretation of the collected data from the research field .To fulfill the objectives of the study, in-depth interview, interview and class observation were conducted to collect required data. To derive findings and conclusion for any research, it is necessary to analyze raw data. So, it is important to pay attention in the process of data analysis. On the basis of collected data from talent students, their peers, their guardians, home visit and mathematics teacher, the researcher developed nine themes. Data was arranged theme wise. After that, the collected data were matched with each other. Finally, the data were compared with Myer's- Briggs Type Indicator (1962), Kolb's Learning Theory (1984) and Dunn and Dunn Learning Style Inventory. Then, the researcher came to findings and conclusion. Causes of adopting the learning styles are presented in each theme.

Many students fail in mathematics. So, it is considered difficult subject in Nepalese context. To learn any mathematical concept in short time and to keep it in long term memory, learning style is essential. Therefore, the researcher analyzed the learning styles of talent students under different themes after the completion of data collection.

Learning Environment Preferred by Talent Students (Formal or Informal)

Researcher conducted in-depth interview with talent students, interview with respondents' guardians and visited homes to find out how talent students learned in formal and informal environment. The researcher asked the respondent 'A'- What sorts of environment do you prefer to study mathematics: formal or informal? The reply of respondent 'A' was- "*My parents have managed a separate room for me*

where there are books, practice books and guides available. I study using chair and table as I feel it comfortable. It is also easier to draw lines, tables and figures. I study in quiet environment." This response reflects that respondent 'A' learned in quiet environment taking the comfort of table and chair. She was interested in drawing mathematical figures accurately. She liked comfortable environment while studying mathematics.

Depending on the reply of first question, the researcher asked next question, 'Do you feel alone in quiet environment?' The respondent 'A' replied, "*No, I do not feel alone in quiet environment. I need peaceful environment to remember and practice the things that I learn at school. In noisy condition I cannot concentrate on mathematical problems and cannot find solutions.*" This response shows that respondent 'A' was mostly interested in quiet environment to concentrate mind. She could not learn in noisy environment. So, she preferred quiet environment.

To verify the response of respondent 'A', the researcher visited her home and found that she was studying in separate room with chair and table at her home. This information also supports that she used chair and table while studying mathematics.

After that, the researcher consulted her mother who replied -*"She studies in separate room taking the comfort of chair and table because she studies mathematics for longer period in comparison to other subjects.*" This response informs that respondent 'A' liked quiet and comfortable environment.

The response of respondent 'A' and her guardian and the data taken from home visit show that she studied in separate room taking the comfort of chair and table. That's why it can be claimed that she liked to study in separate room with chair and table. The theory of Dunn and Dunn states that the learners who study sitting on

chair and using table are called learners studying in formal environment. So, it can be concluded that respondent 'A' preferred formal environment for learning mathematics.

The same question that was asked to respondent 'A' was also asked to respondent 'B' as well. Her response was- "*I need peaceful environment while studying mathematics. Moreover, I get self-satisfaction from my habit of solving mathematical problems by putting exercise copy on the table.*" From this response it can be reflected that learning taking the comfort of table was highly interested for her. Moreover, she was interested to study mathematics when there were no obstacles to disturb.

The respondent 'B' informed that she used chair and table while studying mathematics. To check whether her response was wrong or right, the researcher visited her home and consulted to her guardian who informed that her daughter did not use table while learning mathematics. After this, the researcher observed her room and found her reading in room without bench and desk. Here the information taken from guardian and home visit is in favor of learning without taking the comfort of chair and table but respondent 'A' claimed studying taking the comfort of chair and table. So, the information provided by respondent 'B' about her study environment was wrong and the information provided by her father was correct.

Similarly, the respondent 'C' said, "*I study mathematics sitting on chair and using table because in this way I feel comfortable and spinal cord becomes straight.*" This shows that he wanted to study mathematics for longer period without any physical pain. He was aware about his health. The information provided by respondent 'C' was verified by consulting his guardian. His guardian said, "*He requires chair and table while studying mathematics. He usually draws figures.*" This response suggests that respondent 'C' was aware about his study. So, he used chair and

table while studying mathematics. To draw mathematical figures precisely and quickly he must have used table and taking comfort of chair and table. Therefore, from Dunn and Dunn learning theory, it can be said that he had formal learning style.

Regarding learning environment, the respondent 'D' said, "*I like formal environment such as bench-desk and separate room while studying mathematics. Such environment helps to study for longer period of time with self-interaction*." When the respondent 'D' was asked whether he felt alone in a separate room then he replied-

"*I do not feel loneliness in separate room. There is no one to disturb in separate room. I can study, revise and learn new mathematical concepts following a time table. The noise and informal group of the family disturbs my study. So, I prefer to study alone. In this way, I can concentrate on study and keep the learning in long term memory.*" From this response, the researcher reflection is that he was interested in learning alone because he wanted to learn according to timetable and his focus was on study rather than taking enjoy with family members. Peaceful environment could help him to repeat, memorize and to learn effectively.

After conducting in-depth interview, the researcher asked same question to his guardian who replied, "*He does not need chair, table and desk. He studies with his elder sister in separate room.*" This response shows that respondent could study in common also without the need of chair and table. The response of the respondent D's guardian did not support the response of the respondent 'D'. So, the researcher visited the student home and found that he was reading with table and chair in his room. Here the information taken from respondent and home visit informs taking the comfort of chair and table but respondent's guardian view is in contradiction. What is seen with the researcher eyes is right. That's why his guardian must be wrong. So, we can come to decision that he took the comfort of chair and table. Who use bench and desk while

learning are called learner with formal learning style. Therefore, it can be concluded that respondent 'D' studied mathematics in formal environment. He learned in formal environment in order to avoid the noise and informal gossip of the family. This ultimately helped to concentrate in his study.

On the matter of learning environment, the response of the respondent 'E' was- "*I study mathematics sitting on carpet or in bed. I do not need chair, table etc. I sometimes study while eating. I do so because I do not have much time for homework and exercises in practice book*." This view suggests that she did not use any objects to take comfort. She was interested to learn more and more and her teacher provided much homework.

To verify the response of the respondent 'E', the researcher consulted to her guardian whose response was, "*She studies in both formal and informal environment. She can read even in the presence of other family members but there should not be any noise*". This response reflects that respondent 'E' could learn in common only when there was not any gossip. It means she needed quiet environment whether formal or informal. The respondent 'E' said that she did not need chair and table but her mother said she studied in both formal and informal environment. To find the reality, the researcher visited her room and found that she was studying in balcony without chair and table.

From this, it can be said that the respondent 'E' studied mathematics in informal environment such as in bed, out of the room and while eating. She did not need chair and table. Thus, according to the theory of Dunn and Dunn we can say that she studied in formal environment.

The respondent 'F' said that he did not need formal environment to study mathematics. However, peaceful environment was preferred by him. In this regard his

father informed, "*He studies in separate room using chair and table as it is comfortable to study for long time. He also likes quiet environment.*" From this response it is clear that to study for longer duration without any pain he used chair and table in peaceful environment.

Both the respondent and his father were in line with the peaceful environment as required conditions for studying mathematics but there was contradiction on the matter formal environment. That's why, the researcher visited his home. During the researcher visit to his home, it was found that he was proving theorem on circle putting the copy on table and chair was in a separate room. Here teacher's view and the information collected from observation are same in regard to using chair and table. Thus, according to Dunn and Dunn learning theory, he was studying in formal environment.

The analysis above shows that the four talent students were found to be studying in formal environment. These responses indicate that talent students prefer to learn in both formal and informal environment. Formal environment was in practice because of understanding nature of mathematics and studying for longer period. Behind adopting informal environment the reason was lack of economic source. But talent students wanted to learn in formal environment.

Learning in Group or Individually (Extraverts or Introverts)

To find out whether talent students learn in group or individually, the data was collected through in-depth interview with respondents 'A' to 'F', interview with mathematics teacher and seven days class observation.

Each of the respondents in the study was asked whether they studied mathematics individually or in group. They were also asked why they preferred to study individual or in a group. In response to such question, the respondent 'A' said, "*I*

practice mathematics individually and in group. But, I prefer to study individually because studying in group is noisy. Moreover, there is difference between problems that I have and the problems faced by my friends. It takes me long time to study in group but sometimes I get solutions of problems from group discussion also."

The response presented above reflects that respondent 'A' studied individually rather than in group because there was gap in problems faced by her and her friends. She wanted to learn quickly without consuming time in group discussion. To get new ideas she sometimes learned in group.

After that, the researcher asked next question- Why you are interested learning individually? She replied, "*I do not get any opportunity to discuss in class. Sometimes, I tell when my friends ask and I also ask my friends if I have any problems. Our teacher also says that we cannot learn until we practice our self. So, I focus on individual study*." This response shows that there was not opportunity to discuss in class and her teacher's suggestion was also to study through self-effort.

While the researcher consulted her teacher about her learning style, the teacher informed that she often studied mathematics herself. However, sometimes she shared mathematical solution with her friends. Similarly, during the class observation she was rarely found to be discussing with her friends about the mathematical problems.

Here, the information derived from in-depth interview, interview and classroom observation is same. Thus, it can be said that she studied mathematics individually and hence she was an introvert learner as Myer's Briggs Type Indicator (MBTI) describes the students who learn individually as introvert learners.

The same question that was asked to respondent 'A' was asked to respondent 'B'. The respondent 'B' replied, "*I usually study mathematics individually because none of my family members have knowledge of mathematics. But, sometimes in*

classroom I study in group because I believe that learning by discussion helps to remember things for long time." This view shows that there was not opportunity to discuss with family members because they could not solve mathematical problems. Due to his positive believe towards group discussion she also learned in group.

When the teacher was asked about her learning style he replied, "*Some girls ask to her about their problems and she also shares her knowledge of mathematics with her friends*." This response shows that she learned in group. Here, the response of respondent 'B' and her teacher is same. To find the reality in these responses, the researcher observed mathematics class.

During the class observation, it was found that she solved the mathematical problems asked by her teacher herself without asking help from her friends. The teacher had asked her to find out surface area of sphere in which she was given the radius of sphere and volume. She wrote the formula of volume of sphere and surface area of sphere on right side of copy and solved without asking to teacher and friends. From the responses of respondent 'B' and her teacher we can say that respondent 'B' usually studied mathematics individually and sometimes in group. This information was further supported by the class room observation. According to MBTI, who learn individually are called introvert learner. Therefore, we can say that she was introvert learner. The causes for studying mathematics individually were the lack of mathematical knowledge among family members and rare opportunities in class to discuss.

Similarly, the respondent 'C' said, "*I practice mathematics individually because I can concentrate more on my study when I study alone. It helps me to solve the problems quickly. I feel psychologically comfortable while learning individually*." This response reflects that he could concentrate mind in peaceful environment as a

result of this he could get solution quickly. He liked to study individually because he must have felt shyness to study in group.

Again, the researcher asked if he learnt from his friends. His reply was- "*I am not interested in studying in group. Teacher also does not provide opportunity for group discussion in class. I think it is not necessary to study in group for better learning. I can solve mathematical problems quickly when I try myself. Sometimes I surf internet to expand my knowledge. I have knowledge of mathematics as much as my friends have. So, I do not find group study fruitful*."

This response shows that the respondent 'C' was more knowledgeable than his friends. He thought learning in group cannot increase his knowledge. That's why to increase knowledge he surfed internet. To become confident in his response, the researcher asked to his teacher who informed that he did not interact with students in class. In the classroom observation it was found that teacher asked him to solve the problem $10 \setminus (1+\sqrt{2})$ which he solved by looking at the example. It means he could solve without taking the help of teacher if he could took the help of examples.

From the information above we can say that respondent 'C' studied mathematics individually. The reasons behind individual learning were better concentration, quick learning, psychological comfort and friends being not more knowledgeable than him. Therefore, according to MBTI's, theory of learning style, he was an introvert learner.

Similarly, the respondent 'D' had habit of studying individually because he liked freedom. His teacher informed that he sometime learned in group. From class observation, it was found that he was not consulting his friends. He was solving $10/(1+\sqrt{2})$ himself. From this information, it can be said that he learned individually. So, from MBTI, it can be said that he was also introvert learner.

In response to the question about learning alone the respondent 'E' was said, "*I practice mathematical problems in group because the concept discussed in group can be remembered for long time*." She thought learning in group is sustainable. Therefore, she studied in a group. Again, the researcher asked her what she did when she did not know some solution. Then she replied, "*While I do not know solution to some problem I take some ideas from friends. When I discuss mathematical concepts in group I can understand them better and more quickly."* From this response, it can be reflected that when she had problems she took the help of her friends.

To conform on her responses, the researcher asked to her teacher who said, "*She shares mathematical problems and doubts to her friends and me. She says- Different people have different ideas. So, I learn from other. I can read and solve problems myself in house but I cannot get chance to discuss at house*." From this response it can be said that respondent 'E' was interested to take different ideas from her group. She could learn in group at home but there was not opportunity.

In the classroom, it was observed that she was solving problem on trigonometry by asking her friends and writing reviews: p/h, b/h, p/b and angle of elevation. Researcher consulted her peer who informed that she asked her teacher and friend while she could not find the solution herself. From these responses it is clear that respondent 'E' took help from her friends to solve problems because she thought that different people had different ideas. Thus, from MBTI, it can be said that she was extravert learner.

Regarding the query of learning style, the response of respondent 'F' was, "*I study individually and in a group because if I do not know, I learn from my friends.*" From this response it is reflected that to get the solution of problems which were unknown to him, he asked to his friends. It means he also learned from other.

The researcher asked next question- Why do you learn individually and how do you learn individually? The reply of respondent 'F' was-

"*I collect everything necessary for mathematics learning e.g. geometrical box, graph paper, book, guide book, note copy, practice book and calculator. I check myself raising question what I have known and what should I know. Until we practice mathematics, it is difficult to learn. If we discuss, I forget. If I practice I know. Therefore, I usually learn individually. The discussion goes out of subject matter in a group sometime.*"

The above response reflects that before going on problem solving, the respondent 'F' collected things needed to study. To increase self-confident he did self-interaction. His focus was on practicing himself rather than group discussion because practicing himself was more fruitful than group discussion. He looked goal oriented and studying with the speed of time without falling in things out of subject matter.

Mathematics teacher reported that he learned himself rather than depending on others. To find the reality among above responses, the researcher observed his mathematics class and found there was not communication between him and his friends. The respondent 'F' said that he studied in group and individually but class observation and teacher's response did not support it. Thus, it can be said that he learned mathematics individually. Therefore, from MBTI (1962) we can say that he was an introvert learner. The reasons for studying individually were the factors such as better learning caused by individual learning and possibility of irrelevant gossip in group discussion.

Detail Oriented or Concept Oriented (Sensors or Intuitors)

To analyze whether talent students were sensors or intuitors, the researcher conducted in-depth interview with talent students, interview with mathematics teacher

and class observation with the help of guidelines and schedules as mentioned in appendixes I, II and III respectively.

In the question- Do you learn in detail or concept is enough for you? The response of respondent 'A' was-"*We ought to solve problems from book and practice book. For this I also take tuition. To learn each concept in detail, one side there is lack of time another side I have to secure distinction in mathematics. So, I focus only to get solution but not practically.*"

It is clear from above response that she had lack of time to study any concept in detail and she had pressure of studying through reference materials to secure high marks. So, she focused only on concept rather than in detail and practically.

The researcher raised next question - How do you learn $1000cm^3$= one liter? She replied, "*I learn it by reading time to time and writing on copy"*. This response reflects that she learned mathematical concept by repetition. Again it was asked - Do not you pour one liter liquid into the bottle having volume $1000cm^3$? Her response was, "*I do not pour because it is difficult and time consuming to do practically. By practicing, we can learn about many areas. There is no use of studying only one area in detail. After all, we cannot secure higher marks by studying only one area in detail*."

This shows that learning practically was more time consuming and not better to get good result. Therefore, she did not learn practically. To find the reality behind her response, the researcher asked to her teacher – Does she learn in detail or concept is enough to her? The reply of mathematics teacher was-"*She asks to me which is doubtful but detail answer is not necessary to her. I think she behaves such because we are exam centered to get peak result*."

Teacher view clarifies that school environment was exam centered. To learn in detail could not help to get good result. That's why she did not learn in detail. After that, the researcher observed mathematics class. The focus of respondent 'A' was only on calculating solution but not asking in detail. When proving theorems on circle, she was using pencil and compass in the construction of figure and to measure arcs of a circle but she did not ask to teacher to prove the theorem theoretically. In the context of other problems, her activities were related to calculating answers without practical works and in detail (Class observation of respondent 'A').

From these responses and information obtained from class observation, it can be generalized that respondent 'A' focused only on concept but not in practical work and detail knowledge. The reasons behind adopting such learning styles were exam centered school environment and lack of time to teach and study more mathematical concepts. According to Myers -Briggs Type Indicator (1962) who focuses on concepts rather than practical and detail learning are called intuitors. Thus, the respondent 'A' was intuitor.

In the same question which was asked to respondent 'A', the reply of respondent ‘B’ was, "*I have lack of materials. So, I do not study any mathematical concept in detail. It is also time consuming. Therefore, I focus on concepts*."

From her reply, it is clear that due to lack of materials and time she focused only to get solution of problems without any practical works.

After listening above response researcher asked another question - How do you learn abstract concepts? The respondent 'B' replied, "*To learn abstract concepts, I make figure in copy. I read and write for three or four times and then I understa*nd".

From this response, it can be said that she learned mathematical concepts through figure and self-effort.

To confirm the information provided by respondent 'B' her teacher was consulted. The teacher said, "*She does not ask in detail, we have not time to describe in detail and to show practically.*" This view shows that due to lack of time, there was not opportunity in class to learn practically. So, she did not study in detail.

The researcher also observed mathematics class where it was found that she was satisfied with what teacher taught but did not ask for further and detail.

These information shows that respondent 'B' had focus on concepts rather than detail and practical learning. Thus, from Myers -Briggs Type Indicator (1962), he was intuitor.

The respondent 'C' replied, "*I learn only new concepts practically*." This response reflects that he was interested to learn some concepts practically but not all concepts. After listening to the response, the researcher asked next question - Why do you learn new concepts practically but why not other concepts? His response was, "*The mathematical concepts which are in daily practice can be understood easily but it becomes difficult to understand new concept. Therefore, I learn in detail and practically which makes easier to make image in mind.*"

The above reply shows that respondent 'C' learned mathematical concept practically and in detail which were not in daily practice. To learn new concepts as like as daily used concepts and to keep in long term memory he learned new concepts in detail and practically.

To find the reality behind above responses, the researcher consulted mathematics teacher whose view was-"*While teaching mathematical concepts, for example say similarity; he asks questions- Where it is used? What are its applications? What is the difference between similarity and congruence? Who took the concept of Similarity?*" This view suggests that respondent 'C' learned in detail.

To become confident in the information above, the researcher observed mathematics class. He was asking- why, where and how types of questions during the period of class observation. So, it can be concluded that he was detail oriented. Therefore, from MBTI, it can be said that he was sensor.

In the same question which was asked to the respondent 'C', the respondent 'D''s response was- *"Detail explanation is not essential because if I learn in detail it becomes difficult to learn all chapters*." From this view it can be said that to learn all chapters he did learn in detail. After listening the response of first question, the researcher asked next question- How do you learn $(a+ b)^2= a^2+2ab+b^2$? His response was-"*I read time to time and sets in mind. I also learn in this way-* $(a+ b)^2 = (a+ b) (a+ b) = a^2+ab+ba+b^2= a^2+2ab+b^2$." From this response, it is reflected that he did not learn practically but he applied meaningful approach. Again the researcher asked the question- 'Do you learn this concept practically?' His reply was not learning practically. Researcher also observed that there were not practices of learning in detail and practically. Teacher said that respondent 'D' asked in detail and learned practically but in-depth interview and class observation did not show that he learned practically. He learned $(a+ b)^2=a^2+2ab+b^2$ by rote learning and meaningfully but not practically. Hence, the researcher concludes that respondent 'D' had only focus on concepts. MBTI theory of learning states that who learn focusing on concepts are intuitor. So, the view of respondent 'D' is supported by MBTI. Therefore, it can be concluded that he was an intuitor.

The respondent 'E' and 'F' were also learning mathematical concepts and formulas by reading and writing it time to time but not practically. For example $1000cm^3$= one liter, learning it by saying time to time but not by empowering one liter liquid in the bottle having volume 1000 cm^3. The Myers-Briggs Type Indicator (1962)

suggests that who do not learn practically and who focus on concept are called intuitor. Therefore, from MBTI, it can be concluded that they were also intuitor.

From this analysis, it is clear that only one talent student was sensor but other intuitor.

Thinkers or Feelers

To collect data related to thinkers or feelers; in-depth interview was conducted with talent students taking the help of in-depth interview guidelines as mentioned in appendix- I.

Researcher had asked the question- Which sentence is best: Mathematics is good because it is used everywhere or Mathematics is good because most of the people in my society think it is good. The reply of all respondents was "*Mathematics is good because it is used everywhere. This is the best sentence*." This response shows that all respondents focused on logic rather than human values.

The researcher asked next question. The question was- Which sentence do you think best : Ram is learning mathematics because in his society who learn mathematics are highly praised or Ram is learning mathematics because it helps to earn more money. The respondents' reply from 'A' to 'F' was "*Ram is learning mathematics because it helps to earn more money. This sentence is best*". From this reply, it is easy to say that all respondents focused on activity which directly helps their daily life rather than social values.

The researcher observed mathematics class. When solving $(x/x+1) \div (x^2/x^2-1)$, the respondent 'A' assumed required term 'y'. After that she wrote $(x^2/x^2-1) \times y = x/x+1$. After writing further steps she calculated the value of y. - From episode- I.

The above information reflects that she did not solve directly. She solved getting meaning of problem. She thought numerator is equal to product of quotient and denominator which shows that she focused on logic.

The Myers-Briggs Type Indicator (1962) says that thinkers make decision on the basis of logic and they do only that work which does better to them rather than human considerations. All respondents selected sentences which were based on logic and important for them. They did not emphasis on what their society do. When solving $(x/x+1) \div (x^2/ x^2-1)$, the respondent 'A' did not solve directly as- $(x/x+1) \div (x^2/x^2-1) = (x/ x+1) \times (x^2-1/x^2)$. She did not focused on rote learning but focused on logic. So, from MBTI, it can be concluded that all respondents were thinker.

Abstract-Active

Researcher asked the question to respondents-When you have problems in mathematics and your teacher, your parent and your peer are unable to solve. What do you do in this situation? Respondent 'A' replied-"*I try myself whether wrong or right after that I see note*." This view shows that she was self- dependent. Therefore, she tried herself. She must have learned in that way believing on learning by doing.

The researcher raised next question to find causes behind above response. The question was- Does it take to much time while learning in this way? Why do you learn in this way?

"A*bsolutely, it takes time but if I do in this way different ideas come in the process of solving and I can get solution. It is said that- If I listen, I forget, if I see I remember, if I do, I learn. For learning it is essential to do ourselves rather than asking to teacher. If any difficulty comes then I use note copy which makes easy to learn. Therefore I learn in this way*" (View of respondent 'A').

From this response, it is clear that by trial and error she could get different ideas which could help in getting solution. His believe was on learning through self-effort.

To check whether she was abstract-active or not, the researcher asked third question-What sort of questions do you ask to learn mathematics? Why do you ask such question? Her reply was- *"I usually ask 'how' type of questions because we can find answer of 'what' question in book, guide and net. But, it becomes difficult to find how problem is solved*." From this response, it is reflected that due to the impossibility of getting answer of 'how' type questions easily in book, to know the method of problem solving respondent 'A' focused on 'how' sort of questions.

After this reply, the researcher raised next question-Why do you focus on process while solving mathematical problems? Her response was-
"*This is good question. I focus on process rather than answer of any question because I want to know step by step. If I do not know step by step with reason then it becomes compulsory to rote. If I wrote solution of mathematical problems, it results quickly forgetting. If I forget quickly, it takes time to learn again*. *Therefore, I focus on answer of how question*."

Here above response illustrates that to avoid rote learning and to keep in long term memory respondent 'A' focused on 'how' sort of questions.

To become confident on above responses, the researcher asked third question to mathematics teacher which was also asked to respondent 'A' to find whether she was abstract-active learner or not. Teacher's response was- "*She usually asks 'how' type of questions but sometime 'why' type of questions*." To check whether respondent's 'A' replies and teacher's replies were correct, the researcher observed mathematics classroom.

In the process of teaching learning surface area and volume of a sphere , respondent 'A' asked- what is π and what is r? In next class teacher wrote the volume of pyramid $V=a^2h/3$.After this, respondent 'A' asked- how $V=a^2h/3$? (From episode -I and II)

Here, responses taken from in-depth interview and interview with teacher informed respondent 'A' asked 'how' sort of questions whereas class observation reflected that asking 'how' and 'what' sort of questions. From all these information, respondent 'A' found asking 'how' type of questions but merely 'what' and 'why' sort of questions.

From in-depth interview he informed that while he had problems in mathematics he tried himself whether wrong or right. The reasons behind it were learning by doing and knowledge taken from hearing, looking is not long lasting. He focused on asking 'how' sort of questions to know step wise solution, to keep in long term memory and to avoid pressure of rote learning. According to Kolb's learning theory (1984), who try himself or herself whether they are wrong or right and who ask 'how' sort of questions are called abstract-active learners. Therefore, we can conclude that respondent 'A' was an abstract-active learner.

The response of respondent 'B' was-"*While there are problems in mathematics and if I, my peer, my teacher and my parents do not know at that time I solve problems using definitions, formulas, axioms and theorems. I ask 'how' and 'why' sort of questions but usually 'how' sort of questions because I focus on problem solving process*." This response shows learning depending on logic rather than self-effort and is line to focus on process rather than product.

After listening to these responses, the researcher raised next question -If you do not get solution using definitions, formulas, axioms and theorems. In such situation

what do you do? Her reply was- "*In such situation, I again try to find solution and mistake.*" It is clear from this reply that she focused on self-effort rather than asking to other and searching in net.

Teacher's response was-"*She asks questions like- how we can prove the sum of interior angles of a triangle is equal to 180 degree, how did you get such solution?*"

To find the reality among above responses, the researcher observed mathematics class. In classroom, teacher provided chance to calculate the surface area and volume of sphere where volume of sphere was given. Respondent 'B' wrote what is given and what should be find out. At first she reviewed value of π, formula of volume of sphere and surface area of sphere. Then, she solved herself without depending on her friends. Process was right but there became mistake while inputting in calculator. From class observation it is again true that she tried her-self.

Here, the respondent and mathematics teacher reported that respondent 'B' asked 'how' sort of questions. In-depth interview and class observation reflected that trying herself without depending on other people. The reason behind trying her-self was focus on problem solving process. Kolb's learning theory states that learners who ask 'how' sort of questions and try themself are called abstract-active learner. So, from Kolb's learning theory, it can be concluded that she was an abstract-active learner.

In the same question which was asked to respondent 'B', the reply of respondent 'C' was-"*At first I try myself and I apply definitions, axioms, formulas and theorems. If solution does not come then I ask to teacher*." It is reflected from this response that his first priority was on trying himself after that teacher's lecture. His habit was near to child centered pedagogy. Teacher's view about the respondent 'C' was-"*When I teach at that time taking some ideas, he solves problems. If difficulty*

comes then he asks to me." This response supports to view of respondent 'C'. He could solve taking some main ideas but not copying same to same.

To become more confident on his learning style, the researcher observed mathematics class where, he was frequently asking 'how' type of questions. These all responses show that respondent 'C' learned from his self-effort and 'how' sort of question was asked by him. So, from Kolb's learning theory, he was abstract-active learner.

The respondent 'D' reported that he asked 'how' type of questions because teacher could write directly. At that time, became difficult to know how problem was solved? From observation, he was asking how sort of question. Therefore, he was also an abstract-active learner.

The researcher asked same question which were asked to respondent 'D' and his teacher. The reply of respondent 'E' was- "*I ask 'why' and 'how' sort of questions. If there are problems in mathematics; teacher, peer and parent does not know at that time I try myself, may it right or wron*g." This response is line to learning without depending on other and focusing on method of solution. The view of mathematics teacher about respondent 'E' was-"*She asks 'what' sort of questions and she learns from her friends rather learning from definitions, axioms and formulas*."

To become confident on these views, the researcher observed mathematics class. In classroom, she was asking 'what' and 'how' sort of questions. Asking 'how' sort of question was reported from in-depth interview and classroom observation but teacher and class observation shows 'what' sort of question was in practice. According to Kolb's learning theory, learners who ask 'how' sort of questions are called abstract-active learner and who ask 'what' sort of questions are called abstract-

reflective learner. So, from Kolb's learning theory, it can be concluded that she was abstract-active and abstract-reflective learner.

Thus, here it is clear that four talent students were abstract-active and one student both abstract-active and abstract-reflective.

Abstract-Reflective

Four talent students were abstract- active and one student was both abstract-active and abstract-reflective. Therefore, here is presented analysis of only one student. For this in-depth interview with respondent 'F', interview with guardian and mathematics class observation was conducted.

Researcher asked the question - What sort of questions do you ask while teaching learning mathematics? In this question, the response of respondent 'F' was – "*I ask 'what' sort of questions*." It means his focus was on content knowledge. The researcher asked next question after listening this response. The question was- Why do you ask ‘what’ sort of questions? His reply was-"*I ask 'what' sort of questions because I want to gain mathematical knowledge. Mathematical knowledge is base of science. It has own beauty. For example, if we have given length of pencil, length of its shadow and shadow length of tree; in this situation we can find height of tree without measuring it*."

This response shows that respondent 'F' priority was on mathematical content rather than method of solution and finding reasons behind any mathematical concepts. He was familiar to daily life application of mathematics. So, he asked 'what' of questions.

To find the reality behind the responses of respondent 'F', the researcher observed mathematics classroom where he was asking 'what' sort of questions.

The data taken from in-depth interview reflects that not trying whether wrong or right and asking 'what' sort of questions. From Kolb's learning theory, it is clear that students who are abstract- reflective ask 'what' sort of questions and focus on content knowledge. From in-depth interview and class observation respondent 'F' asked 'what' sort of questions. Therefore, it can be said that he was abstract-reflective learner. The reasons behind it were highly impressed by mathematical knowledge and to become confident on applications of mathematical knowledge in the sector of science and society.

Concrete-Reflective

In-depth interview was conducted with talent students to find whether they were concrete-reflective or not. The researcher asked the question-What sort of questions do you ask in the process of teaching learning mathematics? Out of six talent students the reply of five talent students was asking except 'why' sort of questions whereas the reply of respondent 'C' was-

"*I ask questions like- 'why not the sum of interior angles of triangle is less than 180 degree?' Why should we divide at first among multiplication, addition and subtraction during simplification? 'The well-defined collection of objects is called set'. It is the definition of set but {} is an example of null set. Why this is set. Are here well defined collection of objects?*"

The above response is most interesting. He was highly interested in all mathematical concepts. Justifications and causes were necessary for him. His analytical power was good. After this response, the researcher raised next question- Why do you ask such type of questions? His reply was- "*I believe on cause. So, to become confident in any concepts I ask 'why' sort of questions*." The reasons behind asking 'why' sorts of questions were to become confident on mathematical contents

with the help of causes. The view of mathematics teacher about the respondent 'C' was- "*He asks questions like- what is sphere? What are applications of learning trigonometry? What is the accurate value of* π?"

Here is contradiction between the views of respondent 'C' and mathematics teacher. That's why researcher asked to his peer. The reply was-"*He asks 'how' and 'why' sort of questions during teaching learning mathematics.*" This view is in favor of respondent 'C'. To check the responses of respondent 'C', the researcher observed mathematics class. During the period of classroom observation, he was asking 'why', 'where' and 'how' sort of questions.

The respondent 'C' claimed asking 'why' sort of questions whereas his peer and class observation informed that asking 'why' and 'how' sort of questions. Teacher was only one who reported asking 'what' sort of questions. Thus, we can say teacher's response was wrong because his response did not match with data taken from respondent 'C', his peer and class observation. Kolb's learning theory (1984) states that the learner who ask 'how' and 'why' types of questions are called abstract-active and concrete-reflective. The respondent 'C' asked 'how' and 'why' sort of questions from above data. That's why, the respondent 'C' was abstract-active and concrete-reflective learner.

Auditory, Visual, Tactile and Kinesthetic

To identify auditory, visual, tactile and kinesthetic learning styles, the data were collected from in-depth interview, interview and class observation. The researcher raised the question to talent students. The question was-Which is on most focus for you: listening, reading, writing and looking? The respondent 'A' replied-"*My first priority is on listening after that writing. At first I listen carefully after that I*

write taking ideas from listening." This response shows that she focused on teachers lecture. The researcher raised next question -Why do you give most focus on listening? Her reply was- *"Listening is on most focus because teacher explains, gives new ideas and solves in different method which makes me easy than self-study. I listen to teacher's lecture which sets in my mind.*" From this view, it is clear that it became easy to understand from teacher's lecture because teacher must have solved problems in good melody and comprehensively. To check whether the respondent 'A' was visual or not, the researcher raised question -Do you make image in your mind when learning mathematics?

She replied-"*I make image in mind for example when learning triangle, sphere and prism, I make image of figure enclosed by three sides, tennis ball and match box respectively in my mind*." This response gives clear picture of learning through making picture of mathematical concepts through the effort of relating them with community. She compared all mathematical concepts with the objects in community and made their image in mind to learn meaningfully.

After this reply, the researcher raised next question- Why do you make images while learning mathematical concepts? Her reply was-"*I make image in my mind while learning mathematical concepts because in this way I can remember any time and it prevents from forgetting*." This response reflects that the reason behind drawing mathematical picture in mind was to avoid pressure of forgetting.

It was not only aim to take data from in-depth interview. That's why the researcher observed mathematics class where she was giving attention on observing figures. From her reply, she learned through listening and making images in my mind. According to Dunn and Dunn, who learn by listening are auditory learners and who

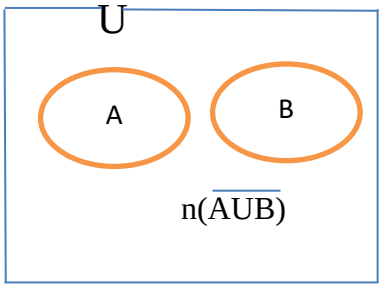
learn by looking and observing figures are called visual learner. Therefore, she was auditory and visual learner.

To find whether the respondent 'A' had kinesthetic preference or not, the researcher asked to her peer. The question was-Does she move her body while studying mathematics? She replied-"*While she know answer of questions and while she read problems, she moves her hands*." From this response it is reflected that on the period of transfer of knowledge and while studying mathematics, she wanted to concentrate mind. Therefore, she moved her hands.

In the duration of class observation, she was writing only key sentences and sometime head movement had seen during class observation. Her peer also supported on the point moving hands. According to Dunn and Dunn Learning Style Inventory, who move their hands while studying are called learner with kinesthetic preference and who write key sentences are learner with tactile preference. Therefore, this theory supports to the point of moving hands and writing key sentences. Thus, it can be said that she had tactile and kinesthetic preference. Therefore, she had auditory, visual, tactile and kinesthetic preference. From above collected data, the reasons behind her learning style were taking different ideas from teacher's lecture, to memorize while necessary and to prevent from forgetting.

The question-'What is about your reading, writing and learning style' was asked in in-depth interview? The respondent 'B' replied –"*I read and write together because in this way I know. I read slowly.*" What can be reflected from this response is that she focused on studying mathematics. So, she read and wrote together. She must have understood nature of mathematics which is impossible by practicing in copy.

Mathematics class was observed by the researcher. She made Ven-diagram



and wrote n(U)= n(A)+n(B)+ n(AUB) . It was most interesting to know why she made picture when learning. The question-Why do you make picture when learning mathematics?

"*Figure reflects answer and avoids rote learning. Figure helps to keep any formulas, axioms, definitions and theorems in long term memory. When learning definition of a set, at first I make picture of {1, 2, 3} in my mind. From this, I can remember and write definition of set"* (View of respondent 'B').

The above response helps to the researcher to say that she could see answer in figure and it was easier to keep figure in mind rather than long theorems, definitions and axioms.

The researcher motivated to ask next question- How can you write definition of a set from {1, 2, 3}? Her reply was- "*Here 1, 2 and 3 are numbers which can be defined as first three natural numbers. Hence, {1, 2, 3} well-defined because 1, 2 and 3are first three natural numbers. Thus it is a set. I do not rote definition but I generate definition from short form or notation.*" From this response, it is easy to say that she learned mathematics making it short in meaningful pattern.

In a classroom, body movement was not observed but she was tracing underlines in copy. In addition to it her focus was on reading and observing. This reflects that the respondent 'B' was interested in focusing main concepts.

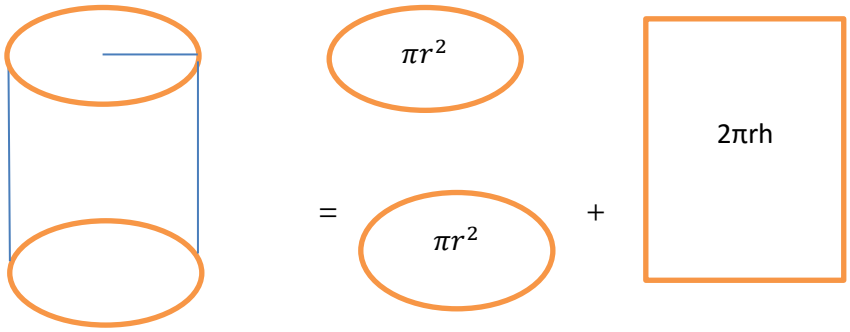
The data taken from in-depth interview show that the respondent 'B' learned through reading, writing and making pictures in mind. In classroom, she was making figures and learning through it. She was tracing underlines but body movement was not in practice. According to Dunn and Dunn who learn by figure, charts and graphs are called visual learner and who draw underline or highlight key sentences are called learners with tactile preference. Who move their body while learning are called learner with kinesthetic preference. Therefore, from above collected that it can be said that respondent 'B' had visual and tactile preference but not auditory and kinesthetic. The reasons behind adopting such learning styles were to internalize the concepts, to learn meaningfully, avoiding rote learning and to prevent from forgetting.

The researcher asked – Which is on most interesting and focus while learning mathematics? The response of respondent 'C' was –"*I like mostly figures, charts, graphs and figures rather than teacher's lecture, content, blind practice, and solving using note because it does not need to rote, sets in mind, image comes and remains for long* time." This response illustrates that to keep in long term memory and to set in mind, he focused on figures, graphs and charts.

The reply of mathematics teacher was- "*He moves head and hand when studying mathematics*." Similarly, the view of his peer was-"*He does not move her hands and head on the period of mathematics class."* From these views, it can be said that he had physical expressions while studying mathematics. He must have focused on mathematical contents. So, physical expression was in practice.

Teacher jumped in solving $10\backslash (1+\sqrt{2})$. Respondent 'C' and respondent 'D' wrote note- Multiplying in numerator and denominator by conjugate of denominator. His focus was looking on whiteboard and on book. He was moving his head. (From episode- V)

Teacher wrote directly the formula of total surface area of a cylinder that is A=2πr(r+h) but respondent 'C' drew the figure of cylinder and separated the whole Figure as below:



He observed figure and found two circular surfaces and one curved surface then he added πr^2, πr^2 and $2\pi rh$. At the end of class observation, the researcher raised next question-Why did you add here? He said that total surface area of a cylinder is equal to area of two circular surfaces and one curved surface because cylinder is made up of two circular surface and one curved surface. He reported it was learnt from reading book. In classroom respondent 'C' learned the formula by observing figure. The theory of Dunn and Dunn states that who learn by figures are called visual learners. Hence, it can be concluded that he was a visual learner.

The collected data from in-depth interview shows that respondent 'C' focused on figures, charts and graphs rather than lecture and blind practice. According to Dunn and Dunn, who focus on figures, charts and graphs are called visual learner. Therefore, he was visual learner. Class observation and view of mathematics teacher show that moving head while learning mathematics. But, his peer was against this view. So, it can be claimed that his peer response was wrong. Thus, it can be said that he moved hands while studying mathematics.

The theory of Dunn and Dunn states that who move their body while learning are called learners with kinesthetic preference. Thus, it can be concluded that he had

kinesthetic preference. He was making note while learning. Dunn and Dunn states that who learn music while learning and make note are learner with tactile preference. Thus, he was learner with tactile preference.

Therefore, we can conclude that respondent 'C' was visual learner with kinesthetic and tactile preference.

The researcher asked the question-Which of the learning do you prefer most: reading, writing, listening and looking? Then the respondent 'D' replied- "*Among reading, writing, listening and looking, my focus is on looking because how teacher solves problem can be seen stepwise*." It reflects that he focused on looking to see step wise solution. The researcher asked next question - What is useful for you while studying mathematics? His reply was-"*I make picture in mind (for example while learning set; making image of number;* while *learning work; making image of pulling water from pond).*"

The above response shows that the respondent 'D' related mathematical concepts with his community then he trace image in mind. He must have done such because to learn meaningfully and to remember any time.

To check the responses of the respondent 'D', the researcher asked to mathematics teacher. His reply was-"*He focuses on listening and looking and asks could you make picture sir*." He was usually solving new problems depending on examples and he was investing more time in reading book and practicing in rough copy. He had not body movement but highlighting main words and taking note. – From Episode-VI

The collected data from in-depth interview show that respondent 'D' focused on looking and making images in mind. Teacher also informed that respondent

requested to make figures. Here, view of respondent and teacher is same. So, we can claim that he focused on looking rather than listening, reading and writing. Thus, according to Dunn and Dunn it can be concluded that he was visual learner.

To find whether he had kinesthetic preference and tactile preference or not, the researcher asked questions -What is about your body movement? Do you highlight main sentences while learning mathematics? His reply was –"*Body movement and highlighting main sentences are not useful for me*." This shows that he was emotionally controlled.

To check the responses of the respondent 'D', the researcher asked to mathematics teacher. His reply was- "*He focuses on listening and looking and asks could you make picture sir*." He claimed body movement and note making was not in practice. From class observation, he found highlighting main sentences and not body movement while learning mathematics. His peer also supported to this point. The view of respondent his per and his teacher were same in the matter of body movement. So, it can be claimed that respondent D' had not body movement. But, there was contradiction on the response highlighting. He was highlighting main sentences in mathematics class. So, it can be claimed that his response was wrong related to highlighting. Thus, he highlighted main sentences. Dunn and Dunn suggest that who highlights and makes note are learner with tactile preference and who have body movement during learning are learner with kinesthetic preference. Thus, it can be said that he had not kinesthetic preference but tactile preference. Therefore, it can be concluded that respondent 'D' was visual learner with tactile preference but not kinesthetic preference.

The same question which was asked to respondent 'D' was asked to respondent 'E'. Her reply was- "*My focus is on teachers lecture rather than figures, charts and trying by self-effort".* This view reflects that respondent 'E' was interested in listening teacher's lesson. The reasons behind it must have teacher centered learning and taking some ideas from teacher.

In the next question- Why is your focus on teacher's lecture? Her response was- "*Teacher solves any problem logically and provides causes in each step of solution which makes me easy to remember.*" This reply illustrates that she was interested in teacher lecture because her teacher explained and solved problems including causes in each steps. From above views, it can be said that she was focusing on the concepts which were taught in previous classes. She must have repeated mathematical concepts before going on problem because new problem was based on reviewed concepts.

From above collected data, the respondent 'E' focused on teacher's lecture rather than looking, reading and trying by her-self. The reason behind it was she could find reasons from teacher. Her teacher also reported that she requested to teacher to say again which shows that she was interested in listening teacher's lecture. Dunn and Dunn suggest who learn by listening to lecture are called auditory learners. She learned by listening lecture. Thus, it can be concluded that she was auditory learner.

To check whether respondent had kinesthetic preference or not, the researcher repeated questions as asked to previous respondents. The view of respondent 'E' was- "I *highlight main words. I move my hands when solution doesn't come in mind because, when I read such highlighted words my mind focuses on central point then I can explain automatical*ly." This response reflects that she had habit of highlighting

main words and explaining on her own-way. Only taking main ideas were enough for her.

To become confident on her view, the researcher asked to her teacher. The question was- Does she highlights while studying mathematics? Teacher's reply was- "*She does not highlight main sentences. I have not found underlines traced in her copy. She requests to me to say again*." This response reflects that she had not the habit of highlighting any concepts. The reasons behind it may be focusing on every topic but not only on particular and important contents.

After finishing interview with her teacher, to find the reality behind above responses, the researcher observed mathematics class. She was pointing by finger, moving head, tracing underlines and writing essential reviews when solving problems in trigonometry. The reviews were- angle of elevation p\h, b\h and p\b (From episode-VIII).

She claimed moving hand when learning and it was observed in a class observation. His peer also supported to this point. Therefore, it can be believed that her claim was right. Thus, from Dunn and Dunn, it can be said that she had kinesthetic preference.

Her response was highlighting main words. In classroom, she found writing essential reviews. Here, view of respondent 'E' and data taken from class observation match with each other. What is seen is true rather than what is listened. Therefore, researcher claims teacher was wrong. Thus, she took reviews and highlighted main words. Consequently, from Dunn and Dunn, she had tactile preference. The reasons behind such learning style were to focus on key sentence and making it easier to explain.

Thus, it can be concluded that respondent 'E' was an auditory learner with kinesthetic and tactile preference.

The response of respondent 'F' was, "*Looking is on first priority among reading, writing, listening and looking. I have not habit of body movement*." But, from class observation he had not eye contact, he was moving head and underlines were traced in copy. His peer also supported the point of moving head. Teacher was also in favor of above information who informed–"*He highlights key words and he is active in looking rather than listening. He reads more and more but writes only important thing*." This information depicts that he was visual learner with tactile and kinesthetic preference.

Among six respondents, five were visual learner, six had tactile preference and four had kinesthetic preference. Thus, in sum what can be concluded that talent students were visual learners with tactile preference but less kinesthetic. The reasons behind adopting such learning styles were- to keep in long term memory, helping highlighted words to explain easily, to concentrate mind in main concepts, to get solution by observing figures and to avoid pressure of rote learning.

Contextual and ICT Based Learning

In the process of in-depth interview the talent students were asked the question: Could you give examples of any mathematical concept from your society?

The respondent 'A' replied -"*The set of female members in my family is an example of a set. Tennis ball and Lemon are examples of a sphere. The screen of computer is an example of plane. In holiday it becomes difficult to meet teacher and to understand mathematical concept easily. So, I sometime surf internet*."

The above view suggests that she was able to learn mathematics relating it with community. That's why she had contextual learning. She learned through electronic media to understand easily and to save time because it took time to meet teacher.

The respondent 'B' replied –"*I relate mathematics with daily life. The students of grade X in Jansewa higher secondary school is an example of a set. Mathematics is used in daily life. For example: profit and loss, population growth rate, telephone and electrical bill*. This response illustrates that respondent 'B' learned mathematics by relating with society. She did not use internet because permission was not given to her. So, it can be said that she had not ICT based learning.

The view of respondent 'C' was- "*I make image and I relate mathematics with society, for example newspaper and rectangle are plane surface. The Girls of class X studying in Mangal school is an example of a set*." He became able to say examples of mathematical concepts from his social background. Therefore, it can be said that he had contextual learning.

The next question was asked- Why do you relate mathematics with society? His reply was-"*When I observe my society then I find more and more mathematical concepts in society. If I find such mathematical concepts in society, it becomes easier to remember when necessary. Therefore, I learn through social context*."

It is clear from his replies that he learned through social context because he could find mathematical concepts in society and it was easy to remember while necessary. Thus, he had contextual learning.

The researcher asked the question –Do you use any media when learning mathematics? The reply of respondent 'C' was – "*I use Internet definitely when there is doubt in problems. Another cause behind searching on internet is to widen the knowledge."* His guardian also informed that he learned by surfing internet. Both responses were same. So, it is clear that to become confident in mathematics and to get more and more knowledge in mathematics, respondent 'C' had used internet. Thus, it can be said that he had ICT based learning style.

"*I relate mathematics with society. The tank on the top of a building is as like as cylinder. Female member in my family is an example of a set*." This was the reply of respondent 'D'. It shows that he learned relating mathematics with society. The question- If you have doubt in mathematics at that time what you do? Why? It was, asked during in-depth interview. The response of respondent 'D' was –"*If there is doubt in mathematical problems then I see related books, I ask to elder brother, elder sister, if they don't know; I search in internet because if I leave, problems remains forever and in net, I find easier explanation of any mathematical concepts*." This response points out that respondent 'D' tried to search in Internet to get the solution of problems and to make easier understanding. So, he also learned through the electronic media. Therefore, he had ICT based learning.

From in-depth interview, respondent 'E' could not give example of mathematical concepts from social context. She did not use internet in mathematics learning but her mother claimed that she used computer to learn mathematics. Thus, it cannot clearly be said whether she used computer or not for learning mathematics. In addition, she did not learn mathematics by relating it with society.

The question -If you, your teacher, your parent and your peer does not know mathematical problems at that time what do you do? It was asked during in-depth interview with talent students. The response of respondent 'F' was- "*In this situation, I search in net.*" His parent view was-"*When problems come at that situation he searches in net."* Respondent's view and his guardian's view were similar. So, the researcher comes to conclusion that respondent 'F' learned by using electronic media. Respondent 'F' could not give examples of mathematical concepts from his community. Therefore, he did not learn from social context.

This above analysis reflects that four talent students learned using electronic media and four talent students learned mathematics through social context. Thus, in this study, talent students used internet to learn mathematics. Most talent students learned mathematics by relating it with society whereas some did not.

Chapter-V

SUMMARY, FINDINGS, CONCLUSION AND RECOMMENDATIONS

The first section of this chapter presents summary, the second section findings and discussion, the third section conclusion, the fourth section reflection and the last section presents educational implications based on the findings of the study.

Summary

The researcher did not found any research conducted in learning styles of talent students concerning MBTI theory of learning, Kolb's learning theory and Dunn and Dunn learning theory. In a class, few students are talented but many students are average even the teachers, textbook, time duration and classrooms are same. That's why, the researcher got motivated to conduct research on the topic 'Learning Styles of Talent Students in Mathematics' concerning MBTI theory, Kolb's theory and Dunn and Dunn learning Style. The objectives of this study were to analyze the learning styles of talent students in mathematics and find causes of adopting those learning styles.

On the basis of collected data from the research field, the researcher made nine themes. Data was arranged theme wise. The collected data from in-depth interview, interview and class observation were matched with each other. After that, the data was compared with Myers-Briggs Type Indicator (MBTI), Kolb's Learning Theory and Dunn and Dunn Learning Style. Then, the researcher derived to findings and conclusion.

Talent students were found to be studying in formal environment because they wanted to study mathematics for longer period of time. They were highly motivated to study individually because they wanted to study on their own speed; there was difference between problems faced by them and their friends. They were concept oriented because they had not opportunity to study practically and they had lack of time to study practically. While solving mathematical problems, it was observed that talent students solved problems depending on logic rather than rote concepts. Their focus was on logic and rules. So, it can be said that they were thinkers.

Four talent students were found to be abstract-active, one student was both abstract-active and abstract-reflective and remaining talent student was both abstract-active and concrete-reflective learner. Thus, it can be generalized that talent students are abstract-active. Most of the talent students were found to be studying through mathematical figures, making note, highlighting key concepts and moving their body. From this, the researcher came to conclusion that talent students are visual learner with tactile and kinesthetic preference. In studying formula, it was found that student broke whole figure into its parts. From this, it can be said that talent students learn mathematics with the help of perception of mathematical figures. It was found surfing internet, relating mathematical concepts with their society and making symbols while learning definitions.

Findings and Discussion

Four talent students were found to be studying in formal environment whereas two talent students were studying in informal environment. The reasons behind adopting formal environment were to study for longer period, to draw mathematical figures accurately and to concentrate mind. Lack of chair, table and separate room

were the causes of adopting informal environment. Five talent students were introvert whereas one talent student was an extravert. The reasons behind learning individually were difference between problems faced by them and their friends, to do anything quickly, psychologically comfortable to learn individually and to concentrate mind while learning individually. Only one talent student was sensor and remaining were intuitors. The causes behind learning practically were to keep in long term memory and to become confident in mathematical concepts. The concept oriented learning was in practice because there was lack of time to study in detail, exam centered school environment and lack of materials. All talent students were thinkers.

Four talent students were abstract-active, one was both abstract-active and abstract -reflective whereas other talent student was abstract-active and concrete-reflective. The respondent 'A' was an auditory and visual learner with tactile and kinesthetic preference, the respondent 'B' was visual learner with tactile preference, the respondent 'C' was visual learner with tactile and kinesthetic preference, 'D' was visual learner with tactile preference and 'E' was auditory learner with tactile and kinesthetic preference and the respondent 'F' was visual learner with tactile and kinesthetic preference. Therefore, out of six cases, five were visual, six had tactile preference, four had kinesthetic preference and two had auditory preference.

Except two talent students other used internet to study mathematics whereas two students learned without using it. Except one case, all read while they write. Talent students of Green Village Secondary School did not relate mathematics with their society whereas talent students of Jansewa Secondary School and Mangal Secondary School related mathematics with their society while studying. All case students had paid attention, they were looking, revising, taking notes, tracing under lines, reading and writing, asking and observing mathematical problems during class

observation. Talent students tried themselves. While they had problems, they used book, note copy and guide. Finally, they had the habit of asking with teacher and searching in net. They were not only limited to book and they also practiced from practice book after finishing problems included in book. They revised, thought mathematical concepts time to time while they did some work in house. Some talent students compared and related new concepts with old concepts and revised old concepts while learning new concepts.

All talent students were found highly motivated towards mathematics. Studying in formal environment and individually rather than in informal environment and in group, more focus on concepts rather than learning in detail, focus on logic, asking 'how' sort of questions to know the problem solving process, revising mathematical concepts while walking on the way and working at house, studying with the help of making image in mind and drawing figures of mathematical concepts in copy, making note and highlighting main concepts, relating mathematical concepts with society and surfing internet to study mathematics were major findings of this study.

The reasons behind such learning styles were family environment, to study for longer period, feeling comfortable to study in formal environment, to avoid the disturbance created by family members and other people around the room, to feel psychologically comfortable to study individually, to become difference in problem faced by talent students and their friends, to take ideas from group, to solve any problem quickly, lack of materials, exam centered learning and lack of time to study practically, to know step wise solution of problems, to keep in long term memory, to memorize and to avoid pressure of rote learning, teacher making easier to understand, highlighting on main concepts making easy to explain, want to know mathematical

knowledge from social context, to become familiar with mathematics and its applications and to widen the mathematical knowledge.

Conclusion

Talent students have their own learning style. There is similarity and difference in their learning style. They focus on concepts rather than practical works while learning mathematics. They learn in formal environment and follow different learning styles according to situation and are not limited only to book. To broaden the knowledge talent students surf internet and are curious to study mathematics. Comparing, relating, revising, practicing, converting problems into figures, converting definitions into meaningful symbols, questioning with teacher and focusing on process enhance mathematics learning. It can be concluded that talent students are introvert, thinker, intuitor, abstract -active and visual learner with tactile and kinesthetic preference. They learn through their self-effort and make decisions based on logic while learning mathematics. Talent students' focus is on securing high marks rather than studying in detail and practically. More focus on problem solving process rather than solution of answer and to expand knowledge is the main concern of talent students.

Reflection

From this study, it is reflected that talent students perceive mathematical problems, concepts and figures, make meaningful pattern to study abstract concepts and observe whether mathematical concepts studied in book are in social context or not. This shows that talent students follow Gestalt learning theory and Social constructive learning theory which seem better for meaningful understanding of mathematics. In order to compete in international level and for the better transfer of

mathematical knowledge in the sector of practical life, science and technology; it is better to study mathematical concepts through the use of manipulative materials as far as possible. More practice, meaningful understanding, curiosity to learn, having knowledge of practical agendas of mathematics, self-effort and to study all concepts in mathematics are the factors enhancing in mathematics learning.

Educational Implications

This study was limited to Kirtipur Municipality of Kathmandu district. So, further research needs to be conducted out of this area. This study did not cover learning styles of talent students in each contents of mathematics that's why further research needs to study learning styles of talent students in each unit of mathematics. Learning styles of average students are not incorporated in this research. Therefore, further study needs to conduct in the topics-, 'Difference between talent students' learning styles and average students' learning style' and 'Learning Styles of talent students and its effect on achievement'. Moreover, it is recommended that learning practically and group learning to learn practical agendas of mathematics, to use mathematics in daily life and other disciplines and to take different ideas from group. It would better to manage mathematics laboratory in each school and opportunity should be provided to learn practically and by discussing in a group. The use of mathematical software needs to enhance mathematical knowledge of students.

There was similarity and difference in the learning styles of talent students. So, it can be said that each talent student learn by their own way. Average students must have their own learning style. Talent students wanted to study in group, practically and surfing in net but teachers and guardians did not provide such opportunities to them. That's why, it is better to manage mathematics learning

environment, teaching methods and teaching learning activities according to learning styles of students and average students. This study is useful to talent students and average students to study through figures, charts and graphs, surfing in net, converting definitions and mathematical concepts into meaningful symbols and depending on logic. Talent students perceive any mathematical concepts and solve. Therefore, it is better to manage environment from where students can perceive and find solution of mathematical problems.

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Appendix- I

In-depth Interview Guidelines for Talent Students

Formal or Informal Environment

- Bench, desk, table, separate room, library and math lab.
- Bed, under the tree, in forest, in ground, on carpet and on the way.

Extraverts or Introverts

- Learning in group.
- Learning by interaction with teacher
- Asking and sharing ideas with friends.
- Interaction with students.
- Trying to solve by their self-effort.
- Learning individually.
- Most interested in social environment.

Sensors or Intuitors

- Practical and focus on learning by sense organs.
- Detail oriented. For example when teaching the concept set, asking- what is set? What is counter example of a set? What is its notation? Who discovered the concept of set?
- Focus on concrete things

- Concept oriented.
- Focus on abstract concepts.

Thinkers or Feelers

- Focus on facts and figures.
- Making decision based on facts, data and detail information.
- Making decisions based on emotions, personal values and interpersonal realities.

Focus on which sentence?

1. Mathematics is good because it is used everywhere.
2. Mathematics is good because most of the people in my society think it is good.

- Teaching learning mathematics practically such as empowering one liter liquid in the bottle having volume1000 cm^3.
- Concept only e.g. 1000cm^3= one liter. One liter liquid fills the bottle having volume 1000 cm^3.

Abstract-Active

- Asking 'how' type questions.
- Focus on process.
- Concern on step by step learning.
- Likes interactive learning method but not passive.

- Learning by trial and error.
- Likes computer assisted instruction.

Abstract-Reflective

- Asking 'what' types of questions.
- Respect of authorized knowledge and expert’s knowledge.
- Like accurate organized delivery of information.
- Like lecture method.
- Focus on content knowledge. For example set, arithmetic, algebra, trigonometry etc.

Auditory Learners

- Often talk to them-selves.
- Read out loudly.
- Move their lips.
- May have difficulty with reading and writing.
- Learning by recording
- Learning by recording.
- Learning by listening.

Visual Learners

- Learn through written language such as reading and writing tasks. Why?

- Do not read over than once.
- Frequency of writing usually, writing or reading.
- Remember what has been written down.
- Pay better attention to lectures if they watch them.
- Learning through charts, videos, projector and other visual materials.
- Recall something by closing their eyes.

Tactile Preference

- Highlight main words.
- When listening lecture, taking note by drawing pictures and diagrams.
- Using color to highlight main points.
- Playing music when learning.

Kinesthetic Preference

- Moving head, legs, hands etc.

Appendix- II

Interview Schedule for Mathematics Teachers

Extravert or Introvert

- Sharing mathematical ideas in a group.
- Practicing him-self or her-self but not asking to their friends.

Sensors or Intuitors

- Asking any concept in detail, practically (e.g. teaching $(a+ b)^2= a^2+2ab+b^2$ by using card sheet.
- Only focus on concept (e.g. calculate the value of $(a+ b)^2$ by multiplication of (a+ b) with itself.

Abstract-Active

- Asking which type of questions
- Try out whether may it wright or wrong.
- Solving using note, books, net etc.
- Focus on content e.g. set, trigonometry, algebra etc.

Concrete -Active

- Type of question asking e.g. what if?

Concrete-Reflective

- Focus on searching reasons behind any concept.
- Type of question asked by talent students.

Tactile and Kinesthetic

- Tracing underlines.
- Highlighting main words.
- Moving head, hands and body.

Appendix- III

Class Observation Schedule for Talent Students

Respondent's Name: Topic: Time: Period:

No. of students: Date:

Behaviors to be observed:

Extraverts or Introverts

- Student learning more in group or individually.

Sensors or Intuitors

- To learn concept is enough
- Detail explanation is required

Thinkers of Feelers

- Learning depending on axioms, definitions, formulas and theorems or depending on their friends, teachers, or people around them.

Abstract-Active

- Learning through trial and error or not.

Abstract-Reflective

- Focus on content knowledge of mathematics asking 'what' types of questions?

Auditory Preference

- Learning by lectures, discussions and recording.

Visual Preference

- Learning through reading, looking pictures, tables, diagrams and maps.

Kinesthetic Preference

- Movement or not when learning mathematics.

Tactile Preference

- Making note
- Writing essential reviews
- Highlighting main words

Appendix- IV

Interview Schedule for Peers

Concrete-Reflective

- Asking which type of questions among 'what', 'why', how' and what if?

Kinesthetic

- Movement when learning for example body, hands or head.
- Physical expressions for example eye contact, pointing by finger etc.
- Raising hands and non-verbal language.

Appendix-V

Interview Schedule for Guardians

Formal or Informal Environment

- Collecting all things required for learning then starting learning.
- Time table for math learning.
- Taking the comfort of in bench, desk, chair etc.
- Reading in bed, carpet or outside the room.

Abstract-Active, Abstract- Reflective, Concrete-Active and Concrete-Reflective

- What sort of question does he\she ask?

I-Observation

Researcher entered in grade X with mathematics teacher and stood from where Niruta Karki and Rima Darlami Magar were seen clearly. Teacher provided chance to solve $(x/ x+1) \div (x^2 / x^2 -1)$.

Niruta Karki solved in this way-

When solving $4 \div 2$, let y is required quotient then wrote, $2 \times y = 4 = 2 \times 2$

Or, $2 \times y = 2 \times 2$

Or, $y = 2$

In the same way, let y is required term then, $(x^2/ x^2-1) \times y = x/ x+1$

Or, $[x^2 / (x-1)(x+1) \times y = x/ (x+1)$

Or, $[x^2/ (x-1)] \times y = x$

Or, $[x/ (x-1)] \times y = 1$

Or, $xy = x-1$

Or, $y = x-1/ x$

But, Rima solved in this way, $(x / x+1) \div (x^2/ x^2-1)$

$= (x/ x+1) \times (x^2-1) / x^2$

$= (x / x+1) \times [(x+1)(x-1)] / x^2$

$= x(x-1) / x^2$

$= x-1 / x$

II-Observation

Mathematics teacher wrote the formula, total surface area of a cylinder, $A=2\pi r(r+h)$. At that time Mr. X stood and asked to teacher. Teacher asked students to do. Respondent C did on this way: At first, he made figure of cylinder and wrote- Let r be the radius of a circular base then, total surface area of a cylinder = area of circle + area of circle + area of curved surface.

Or, $V=\pi r^2+\pi r^2+2\pi rh$ or, $V=2\pi r^2+2\pi rh$. Or, $V=2\pi r(r+h)$.

III-Observation

There was first period. Researcher went with class teacher. Class teacher informed to students about classroom observation. Teacher wrote the topic- Surface area ad Volume of a Sphere and asked to respondent 'A'- Have you seen sphere? She replied-"Yes sir, e.g. Lemmon, tennis ball." She has eye contact with teacher when replying answer but not gesture and body movement. Teacher wrote the formula of surface area of sphere ad volume of sphere the he allowed to solve problem, where volume was given, radius and surface area should be find out. Respondent 'A' and 'B' read problem, they wrote what is given and what should be find out. Respondent 'A' asked- What is Pi and R? She was busy in reading the problem and solving it by herself. She used formula and calculated answer. She did not depend on her teacher and friends to calculate answer. Mathematics teacher wrote second problem and provided chance to solve. Finally teacher wrote question for homework. At 10:50 teacher and researcher left the class after saying good bye!

IV-Observation

When teacher directly wrote the formula, Volume of pyramid $V= a^2h/3$. Niruta asked- how? Rima replied volume of pyramid= (1/3) area of base X height. Here base is square whose area is a^2 and 'h' is height of a pyramid. Then all students clapped.

Teacher was describing about volume of Pyramid but Niruta and Rima jumped in problems. They were making figure related to problems. Niruta was discussing with her friend. She also wrote formula which is used to calculate the surface area of sphere and formula to calculate the volume of sphere on right side of copy but her focus was on making picture related to problem and observing its base, height and formula.

V-Observation

She did not use formula directly to calculate total surface area of given solid. She observed figure and found, solid was made by three surfaces. She became confused, touched her mouth and looked formula- area of curved surface of cylinder. She found surface area of all three parts then added. She was not asking question to teacher but she was finding answer of - 'what' sort of questions.

VI-Observation

Researcher observed learning styles of Respondent 'C' and 'D'. The total number of students was 29.The topic was simplifying related to rationalization. Teacher jumped in solving 10\ (1+ √2). He directly solved, at that time they were carefully looking in whiteboard. Sometime they were discussing in group and looking in example. The teacher provided chance to give answer to students. Respondent 'C' stood and said 1- √2 is conjugate of 1+ √2. To rationalize we should multiply. Both

students were busy on content. They wrote note first 'We need to multiply numerator and denominator by conjugate of denominator'. They were solving themself and were checking answer from answer key.

They were not discussing in a group. When teaching learning mathematics, he was asking questions such as why, where and how. 'How' type is the question frequently asked by them. Their most focus is on looking on whiteboard and on book.

VII-Observation

The respondent 'D' looked more active in classroom. He put all things in front of him which are necessary and joined his eyes on book before starting chapter. He was not asking to his friends and practicing on his own way. In each problem he was writing- given thing, necessary thing, process and output. He was usually solving new problems depending on examples and spending only few time with teacher's activities where as more time is investing in reading book and practicing in rough copy. He has not any body movement but highlighting main words. He was not giving more time in same concept but only 'how' was the question asked by him.

VIII-Observation

The respondent 'A' was sitting on second bench. She is not fully depending on their friends but learning individually also. Her most focus was on listening and looking rather than writing. Sometime she was solving herself but sometime she was solving with the help of examples. Underlines were traced in her copy. She moved head in two days on the period of mathematics learning. She was found reading pointing by finger. She has not leisure to talk. She was writing essential reviews before solving problems. At the time of solving problem- The angle of elevation of

the top of a tower from a point 25m away from its foot is found to be 45 degree. Find the height of the tower, She read two times, had written reviews: angle of elevation, p\h, b\h and p\b. She made figure and solved the problem. There were not practices to learn in detail and practically. Reading, looking and listening are main activities for learning. What and how types of questions were raised by her.