Chapter-I

Introduction

Background of the Study

"Teaching is a means for establishing a harmonious relationship between teacher, pupil and subject. It gives useful information and causes the child to learn. It is a stimulation and direction of learning. It helps the child to make effective adjustments. The pupil's activities are guided by it. It is a means for transforming emotions of teacher and students" (Bhatia and Bhatia, 1987).

Teaching of mathematics is not just transmitting a mathematical knowledge to student, but helping student to construct a deep understanding of mathematical ideas and process by engaging them in doing mathematics. Skemp (1982) said that to understanding something means to assimilate it into an appropriate schema. The notion that understanding in mathematics is making connection between ideas, facts or procedure. The main purpose of teaching mathematics is to develop the understanding, reasoning and analyzing power which is necessary to various aspect of human civilization. In order to make mathematics teaching meaningful and effective in the classroom, the students should be interested and attracted to learn mathematics and they should also find its usefulness and application to their real life situations.

A number of factors may influence the teaching of mathematics but teachers play an important role in teaching process. The common belief in society is if mathematics teachers know mathematics very well, he or she is the best person to teach mathematics. But what about "knowing to teach mathematics"? Fennema and franke (1992) determined the components of mathematics teachers' knowledge as;

1)   Knowledge of mathematics

   *)   Content knowledge

)   The nature of mathematics

)   The mental organization of teacher knowledge

2)   Knowledge of mathematics representations

3)   Knowledge of students

)   Knowledge of students cognitions

4)   Knowledge of teaching and decision making

The first item is about having conceptual understanding of mathematics. Fennema and Franke (1992) argue that if a teacher has a conceptual understanding of mathematics, this influences classroom instruction in a positive way; therefore, it is important to have mathematics knowledge for teachers. Teachers' interrelated knowledge is very important as well as procedural rules. They also emphasized the importance of knowledge of mathematical abstractions. Fennema and Franke (1992) state that " if teachers do not know to translate those abstractions into a form that enables learners to relate the mathematics to what they already know, they will not learn with understanding".

Knowledge of students' cognitions seen as one of the important components of teachers' knowledge, because, according to Fennema and Franke(1992), learning is based on what happens in the classroom, and thus, not only what students do, but also the learning environment is important for learning. The last component of teacher knowledge is "Knowledge of teaching and decision making". Teachers' beliefs, knowledge, judgments and thoughts have an effects on the decision they make which influence their plans and actions in the classroom (Fennema and Franke).

Knowledge of mathematics knowledge of mathematical representations are related to content knowledge, while knowledge of students and knowledge of teaching are related to pedagogical content knowledge. Shulman (1995) defines

content knowledge as the knowledge about subject, for example mathematics and its structure. According to Shulman (1995; 130) pedagogical content knowledge includes," the ways represent ting and formulating the subject that make it comprehensible to others'…..'An understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different age backgrounds bring with them to the learning of those most frequently taught topics and lessons".

Based on Shulman's (1987) notions of pedagogical content knowledge, effective teachers can possess an in-depth knowledge of how to represent the subject matters to the learners (Parker and Heywood, 2000). Shulman (1987) also stated that pedagogical content knowledge must include the knowledge of learners and their characteristics, knowledge of educational contexts, knowledge of educational ends, purposes and values, and their philosophical and historical bases. Additionally, pedagogical content knowledge refers to the ability of the teachers to transform content into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students (Shulman, 1987, cited in An, Kulm and Wu, 2004).

According to an, Kulm and Wu (2004) pedagogical content knowledge has three components:

⟩ Knowledge of content

⟩ Knowledge of curriculum

⟩ Knowledge of teaching

Pedagogical Content Knowledge

The term pedagogical (PCK) was introduced by Lee Shulman in his presidential address to the American content knowledge Educational Research Association (Shulman,

1986). Shulman argued that, for a long time, research on teaching and teacher education had undeservedly ignored questions dealing with the content of the lessons taught. Shulman presented a strong case for PCK as a specific form of knowledge for teaching which refers to the transformation of subject matter knowledge in the context of facilitating student understanding. Teachers need this type of knowledge to structure the content of their lessons, to choose or to develop specific representations or analogies, to understand and anticipate particular preconception or learning difficulties of their students, and so on. Shulman asserted that teachers had a unique way of looking at practice and his intrigue with the manner in which they did so encouraged an examination of teachers' pedagogical thinking in ways that, it was anticipated, would reveal what teachers must know to best teach their content to their students.

Mathematical Content Knowledge

It refers to the facts, concepts, theories and principles that are taught learned in specific academic courses, rather than to related skills such as reading, writing or researching that students also learn in school (Glossary of Education Reform). According to Ball and her colleagus (2008), the mathematical content knowledge consists of three sub-domains. They are common content knowledge, specialized content knowledge and knowledge at the mathematical horizon. The common content knowledge refers to the mathematical knowledge and skills that not only teachers but also others might have. This knowledge is not unique to teaching. Solving mathematical problems or knowing how to carry out a procedures as well as knowing the definition of concepts are examples of common content knowledge. The second domain, specialized content knowledge, is mathematical knowledge specific to teaching. This knowledge differs both from knowledge of students or pedagogy and from shulman's pedagogical content knowledge. When identifying patterns in student's

errors or assessing whether a nonstandard approach would work, teachers need to have a kind of mathematical knowledge that others do not. The third domain, horizon knowledge, is "an awareness of how mathematical topics are related over the span of mathematics included in the curriculum"(Ball, Themes and Phelps, 2008).

Teachers Influences on Teaching

The teacher who has passed any degree from faculty of education is called teacher having PCK otherwise they are called teacher without having PCK. In the context of Nepal, education background teacher is also known as trained teacher. Education background teacher has good knowledge of PCK and SMK. So, they are qualified and skillful for teaching. They are able to make a plan for teaching, to construct and use of teaching materials with applying appropriate technique and teaching strategies. They are able to transmit knowledge, skill, and attitude to the learners in a more effective ways. They are also able to identify students' interest, desire, learning capacity and learning problems. But Non-education background teacher are unknown from all these things. They have only content knowledge.

Statement of the Problem

The pedagogical content knowledge is a useful construct for understanding the mechanism of a teacher's impact on student achievement. The PCK plays a vital role in teaching and students' learning activities. It gives the knowledge of how to teach, when to teach, why to teach and what to teach to the teacher. It helps the teacher to be a good teacher and perfect teacher. The PCK is very important for every teacher to make their teaching learning activities effective and to increase student learning achievement. Thus to explore the effects of teachers' PCK on students achievement is an important topic to study at present time.

Objectives of the Study

The study is intended to accomplish the following objectives

) To compare the achievements of students taught by teacher having PCK and teacher without having PCK.

) To explore class-room behaviors of teachers having PCK and without having PCK, to motivate students in the teaching hours.

Research Questions

The research questions concerning with the study are as follows:-

) Is there any difference between the achievements of students taught by teacher having PCK and teacher without having PCK?

) Is there any difference in the teaching learning activities of teacher having PCK and teacher without having PCK?

) Whose way of interaction is better in classroom teaching between teacher having PCK and teacher without having PCK?

Significance of the Study

The study provided the information about the differences in the class-room behavior and teaching learning activities of teacher having PCK and teacher without having PCK, differences between the achievements of students taught by teacher having PCK and teacher without having PCK and the effect of teacher's PCK on student's achievement. This study also provided the introduction of PCK and the terms related to PCK. Thus the some significance of this study are as follows:

) To give information of MKT.

) To give information of PCK and it's components.

) To emphasis knowledge of instructional strategies for mathematics, students understandings within mathematics, curriculum for

mathematics and assessments for mathematics for teaching mathematical contents.

⟩ To improve teaching learning activities of math teachers

⟩ To develop teaching skill of math teachers

⟩ To increase achievement level of students in mathematics.

Research Hypothesis

The study attempted to seek the result of the following research hypothesis:

⟩ There is significant difference between the achievements of students taught by teacher having PCK and teacher without having PCK.

Statistical Hypothesis

$H_0: \mu_1 - \mu_2 = 0$

$H_1: \mu_1 - \mu_2 > 0$

Where μ_1 and μ_2 are mean achievement scores of students taught by teacher having PCK and teacher without having PCK respectively.

Delimitation of the Study

This study has several limitations. Some of them are given below:

⟩ The researcher selected the teachers by purposive sampling method which is non-random sampling method.

⟩ The researcher selected only two teachers, one teacher having PCK and another teacher without having PCK for the study.

⟩ The researcher collected the achievement scores of students taught by teacher having PCK and teacher without having PCK only from the annual results of the year 2070, 2071 and 2072.

) The researcher collected the achievement scores of only 30/30 students taught by both selected teachers from each of the three years. In this way 90/90 students were taken from both teachers for the study.

) The researcher applied only teacher class observation form and teacher interview schedule to collect qualitative data related to teaching learning activities of both teacher having PCK and teacher without having PCK.

Definition of Related Terms

The terms which are used in this study are described as follows :

Content Knowledge The content knowledge refers to the facts, concept, theories and principles that are taught and learned in specific academic courses rather than to related skills such as reading writing or researching that students also learn in school (glossary of education reform). In my study, content knowledge is related to the sufficient knowledge of taught chapter where chapters are mensuration and ratio and proportion.

Pedagogical Content Knowledge The pedagogical content knowledge is a type of knowledge that is unique to teachers and is based on the manner in which teachers relate their pedagogical knowledge to their subject matter knowledge in the school context, for teaching of specific students (Cochran, King and DeRuiter, 1991, p.211).In my context, PCK is related to the sufficient knowledge of taught chapter where chapters are mensuration and ratio and proportion.

Pedagogy The pedagogy is the discipline that deals with the theory and practice of teaching. Informs teaching strategies, teachers actions and teacher judgements and decisions by taking into consideration (Wikipedia)

Knowledge of Context A view of the relation between teachers TPCK and their context in which teacher develop situated knowledge of technology, pedagogy and content and area of knowledge (dictionary).

Teacher having PCK The teacher who has passed B.Ed. degree from faculty of education or got teacher training. In my study I took B.Ed. degree holder teacher as teacher having PCK.

Teacher without having PCK The teacher who has passed B.A., B.Sc., B.Com. degree and also did not get any teacher training. In my study, I took B.A degree holder teacher as teacher without having PCK.

Chapter-II

Literature Review

Research is a continuous and dynamic process. Research is any sector of skill wants suitable studied with the works in which there are many research have been done in the same area. We gain deep knowledge from research with must have already developed theories and researcher which is approximately connected with the problem chosen by him or her. From the review of literature, we must identify the study what has been established and what has not been try to be found yet. It also provides knowledge to find out the different facts in research for further study of task. The purpose of review of literature is to study open the text and back ground of the study. There are so many books, reports and related studies that have been reviewed in order to explain the present problem of the study. It helps to conduct the research programs and give the better ideas for the research to formulate research hypothesis. To conduct this research, the researcher reviewed the literature on teachers' pedagogical content knowledge, with special attention given to its effect on student achievement. I begin the chapter with review of empirical literature and theoretical literature related to effects of pedagogical content knowledge on students' achievement in mathematics.

Empirical Literature

The researcher reviewed the following books, journals, thesis, articles, bulletins and web sites for this study.

Khatiwada (1974) , in his study entitled" A study to compare the Students concluded in Teacher with and without education background in the town of Birgunj" conducted that teaching was more pupil centered in class conducted by trained Teachers than by untrained ones.

A research "Comparative study of Trained and Untrained teachers" conducted by CERID (1996) with the purpose of finding differences between trained and untrained teachers on profession and teaching activities. Academic qualification of trained and untrained teacher, their behavior, and attitude, intention in classroom teaching and different aspects of their teaching activities had been studied to fulfill the objectives. The research conducted on different schools of 12 districts; Kaski, Tanhu, Gorkha; Morang, Sunsari, Jhapa, Chitwan, Makawanpur, Parsa, Kathmandu, Lalitpur and Bhaktpur. Classroom observation, FGD, interviews were the main instruments of this study. The research concluded that teaching activities adapted by trained teachers are more positive than the teaching activities adapted by untrained teachers.

Subedi (2001), conducted a research entitled. "Training needs Assessment of Secondary School Mathematics Teacher" concludes that the training needs for the in-service mathematics teacher of secondary school to develop instructional materials, techniques of teaching and conceptualization of subject matter to teach mathematics.

ICS (2002), conducted a research entitled "Follow up Study of Teacher Training Programme" submitted to MOE by ICS education campus with the objectives to prepare manpower for follow up activities of teacher training programme and to evaluation the classroom situation and major hindrance to the transfer of acquired training skills as well as to help improve classroom teaching though the application of the follow up strategy. Document analysis, classroom observation, and interview with teachers, Head teachers, with different of officials of NCED were the means of collecting data. Five hundred thirty eight teachers, one hundred twenty six head teachers, one hundred twenty six schools working in eight different districts as well as parents of the children studying in grade III, and IV & V were selected as sample of this study. Parents (pre-feedback observation, post-

feedback observation) observation FGD, interviews were the instrument of this study. The conclusions of the report are usefulness of the training was noticed to be high in mathematics followed by social Studies and English,little co-operation from the school ones crowed classroom, heavy workload, worked of instructional support of poor physical facilities discouraged the teachers to use the skill they acquired in the teaching and homework was not checked at all English teachers remained a head of all the other teachers in this act.

Subedi (2002), did study " A Study of the Effectiveness of Mathematics Teacher Attitude Towards the Visually Impaired/ blind Student Achievement Integrated School" concluded that specially trained teacher holds significantly better attitude towards the blind students than that of untrained teacher.

Neupane (2004), his research entitled "Classroom Behavior of trained and untrained teachers" conducted on six schools of Shivagunj VDC on Jhapa district, This research was done with the purpose to compare teaching classroom behavior and extra actives of trained and untrained teacher. To fulfill the objectives of the study classroom behavior and extra activities of Nepal and Social Studies teachers were studied. This comparative study concluded that trained teachers are more active and positive in teaching than untrained Teachers.

Himal (2005), his research entitled " A Study of the Effectiveness of Teacher Training Programme in Mathematics at Primary Level" conducted in pyuthan district, concluded that there is slightly a difference between the effectiveness of trained and untrained teacher. The conclusions of the study are primary level trained mathematics teachers had positive attitude than untrained mathematics teachers, students taught by trained and untrained teacher   had slightly difference attitude towards mathematics

and student taught by the trained teacher had higher achievement than the students taught by untrained teacher.

Khanal (2006), his research entitled " Trained Teachers and Teachers Training" conducted to fulfill the objectives of finding teachers attitude towards trained teachers and teacher training and concluded that teachers have positive attitude towards teacher training and teacher training is a part of teacher for professional development.

Pulami (2007), his research entitled "Teaching Effectiveness of Trained and Untrained Teacher, A Comparative Study" conducted on Jhapa district with the purpose to compare teaching effectiveness of trained and untrained teachers. Class observation, questionnaire and interview tools were applied for data collection. The research concluded that there is only slightly a difference in teaching effectiveness between trained and untrained teacher. Only nominal affection of training is found in teaching performance of trained teachers.

Ghimire (2010), did research on the entitled "Comparative Study on Use of Teaching Methods & Instructional Materials of Trained and Untrained Teacher." He conducted the research on Bhojpur district with the objectives to find similarities & differences in using teaching method & materials between trained and untrained teacher, to find students achievement taught by trained and untrained teacher. Observation, questionnaire, achievement test and FGD were applied to collect data. This research concluded that trained teacher has used proper teaching methods & instructional materials than untrained teacher. Thus in classroom students taught by trained teacher is more active than the students taught by untrained teachers.

Ball (1988a) did a study entitled "Knowledge and reasoning in mathematical pedagogy: examining what prospective teachers bring to teacher education". In this

study, Ball explains that there are three ways to teach math. The first way is ordinary teaching where students memorize facts and algorithms and are expected to recall what they have memorized at the appropriate times. It is more of a practice and drill method and would really only involve the use of teacher content knowledge. The second way to teach math is the conceptual way. While this still involves lots of practice, this is more "hands-on" approach to mathematics with manipulative and better exaltations. The third way is mathematics pedagogy, in which students are actively involved in the learning process and the teacher facilitates the learning by helping students decides which routes to take in problem solving. Ball (1988a) states, "the goal of mathematical pedagogy is to help students develop mathematical power and to become active participants in mathematics as a system of human thought". These last two teaching methods involve mathematical PCK on the teacher's part in order to better explain and help guide student learning. Mathematical PCK stresses knowing the "depth and detail" of algorithms instead of knowing only how to use them to solve a problem (Ball, Hill and Bass, 2005, p. 22).

Carpenter, Fennema, Peterson, and Carey (1988) did a study entitled "Teachers' Pedagogical Content Knowledge on Students Problem Solving in Elementary Arithmetic". The study involved forty first-grade math teacher in twenty seven schools in wisconsin. The teachers participated in a mathematics in-service program and classroom study. One researcher question in the study wanted to learn if certain measure of math pedagogical content knowledge (distinguishing between problems type, knowledge of problem solving strategies and knowledge of students) correlated to student's achievements on the addition and subtraction problems in question. It was found that the teachers' knowledge of the topic, strategies for teaching, or knowledge of problem difficulty did not correlate to student achievement,

but teacher knowledge of students did correlate. Carpenter et al (1988) make a point to state that the sample used seemed to have a lower PCK than expected, so a sample with different PCK levels could have produced different results.

Derry, Wilsman, and Hackbarth (2007) did a study entitled "Using contrasting case activities to deepen teacher understanding of algebraic thinking and teaching". The study suggested that mathematical PCK could be increased. Twenty teachers participated in a summer workshop. Observation, journals, interviews, video taps and field notes were used in data collections. In the same study, twelve teachers took a graduate level course about connecting to mathematics. The workshop and course involved conflicting case studies. Two assessments were given to all participants; one about content and PCK and another about analyzing student work. The results showed that the workshop and course helped increase teacher PCK by causing them to reflect on why students got correct answers or incorrect instead of just grading for right or wrong answers.

Rowan, Chiang, and Miller (1997) used the National Education Longitudinal Study of 1988 (NELS:88) data and tested the effects of teachers on student achievement in mathematics by using a general employees' performance model. This model suggested that teacher' abilities, motivation, and work situations could explain teachers' effects on students' performance in mathematics. Teacher ability was defined in terms of teachers' knowledge of teaching strategies. Two separate measures were used as an indication of teachers' knowledge in mathematics. One was the teachers' response to a one-item math questionnaire, and the other was whether a teacher majored in math education or not. The results indicated that students whose teachers answered the item correctly and students whose teachers had a math education major had higher achievement levels than those whose teachers' answer was wrong and

whose teachers did not have a math education major. However, in both cases the size of the effect was quite small.

After analyzing and reviewing the above studies, I found that the classroom teaching learning activities of teachers having PCK are better than teacher without having PCK and the achievement of students taught by teacher having PCK are better than the achievement of student taught by teacher without having PCK. Also I found that most of the researcher used mixed method research design to fulfill the objectives, applied achievement test to collect quantitative data and classroom observation form, interview schedule and FGD to collect qualitative data. Mean, standard deviation, variance and coefficient of variance have been used to analyze quantitative data and thematic approach for qualitative data.

Current Conceptualization of Teachers' Pedagogical Content Knowledge in Mathematics

Pedagogical content knowledge (PCK) is a useful construct for understanding the mechanism of a teacher's impact on student achievement (Abell 2008). In 1986, Lee Shulman of Stanford University sought to influence the scope of teacher certification examinations by introducing the concept of pedagogical content knowledge (PCK). He defined it as a particular kind of content knowledge for teaching that included a grasp of common preconceptions and misconceptions. Shulman suggested that PCK includes knowledge of the most powerful demonstrations, illustrations, and explanations that make content comprehensible to students. Finally, he included the teacher's understanding of what students of a particular age or background may find challenging about a concept. Shulman described this body of knowledge as a "special amalgam of content and pedagogy" that distinguished a teacher's competence from that of a content specialist. He offered

the example of pedagogical skills that are essential for a science teacher, but not developed in a research scientist. Shulman's concept of pedagogical content knowledge has been refined, re-defined, and adapted to study teachers' knowledge for specific content areas.

According to Shulman(1986),Components of Pedagogical Content Knowledge include

Content Knowledge

Important information, processes, principles, skills and theories within a field of study (Shulman,2004).

Pedagogical Knowledge

Teachers' repertoire of instructional strategies that effectively transfer the knowledge to others(Geddis,1993).

Knowledge of Context

Includes understanding of typical learning patterns and the individual learner's mind(Shulman and Grossman,1988).

A conceptual diagram of teachers' pedagogical content knowledge is displayed in Figure1, along with defining statements of this theoretical concept from researchers and theorists from the 1980s to 2011. Their writings suggest that, in addition to content knowledge, teachers must possess knowledge of generally-effective instructional practices and instructional strategies that fit specific content or topics. It is hypothesized that a teacher's pedagogical content knowledge (PCK) develops through professional training, experience, support of colleagues, experience, and self reflection during instruction. The teacher's PCK support his or her professional judgment. PCK may impact the learner through teacher-student interaction and experiences a teacher orchestrates for the student (Abell, 2008).

Pedagogical Content Knowledge is:

"…A special amalgam of content and pedagogy," (Shulman, 1986, p. 8).

"…The manner in which teachers relate their pedagogical knowledge to their

subject matter knowledge in the school context, for the teaching of specific

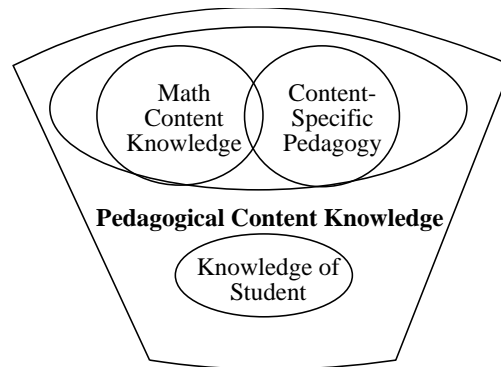students," (Cochran, King, & DeRuiter, 1991).

Figure 1

Figure 1. Perspectives on Pedagogical Content Knowledge (PCK). The concept of

pedagogical content knowledge has been refined, re-defined, and adapted to study

teachers' knowledge for specific content areas. The teacher's blending of types of

knowledge to make instructional decisions and increase students' learning is

illustrated by the funnel diagram. Developed by Lisa Ivey Waller, 2011.

Marks (1990) clarified PCK for mathematics teachers by identifying four

components strands: knowledge of student understanding, knowledge of subject

matter for instructional purposes, knowledge of media for instruction and knowledge

of instructional processes. An et al. (2004) utilized a PCK framework that included

three components: knowledge of content, knowledge of curriculum, and knowledge of

teaching. In the past decade, Deborah Ball and her colleagues (Ball and Bass 2005;

Hill et al.s 2008) have, through investigations focused on elementary teachers'

knowledge, developed a construct called MKT. As presented in Hill, et al. (2008),

MKT is composed of two major categories: subject matter knowledge and PCK.

Subject matter knowledge contains common content knowledge (CKT), specialized content knowledge (SCK) and knowledge at the mathematical horizon. In this model, the authors characterized PCK as containing three components: knowledge of content and students (KCS), knowledge of content and teaching (KCT) and knowledge of content and curriculum (KCC). Philip (2007) made a PCK framework that included four components: knowledge of instructional strategies for mathematics, knowledge of students understanding within mathematics, knowledge of curriculum for mathematics and knowledge of assessment for mathematics.

On the above theoretical review, there are different persons defined the components of PCK in different ways. But in this study, the researcher determined some PCK factors comparing with the Philip (2007) four PCK components that affect student achievement. They are related to knowledge of organization of lesson, management of classroom environment, understanding of students psychology, use of teaching material, use of teaching method and students evaluation. The researcher correlated knowledge of students understanding within mathematics with knowledge of understanding of students' psychology, knowledge of curriculum for mathematics with knowledge of organization of lesson, knowledge of instructional strategies for mathematics with knowledge of use of teaching material, use of teaching method and management of classroom environment and knowledge of assessment for mathematics with knowledge of students evaluation. On the basis of these PCK factors, the researcher moved his study a head.

Conceptual Framework

There are several PCK factors that affect on student's achievement. But for this study, the researcher determined some PCK factors and on the basis of these factors, he moved his research work. These PCK factors are related to knowledge of

organization of lesson, management of classroom environment, understanding of student psychology, use of teaching material, use of teaching method and students' evaluation. On the basis of these PCK factors, he made a conceptual framework which ground this study. He made this conceptual framework, modifying from Philip(2007)"A model of PCK for teaching mathematics".

Source: Philip(2007)
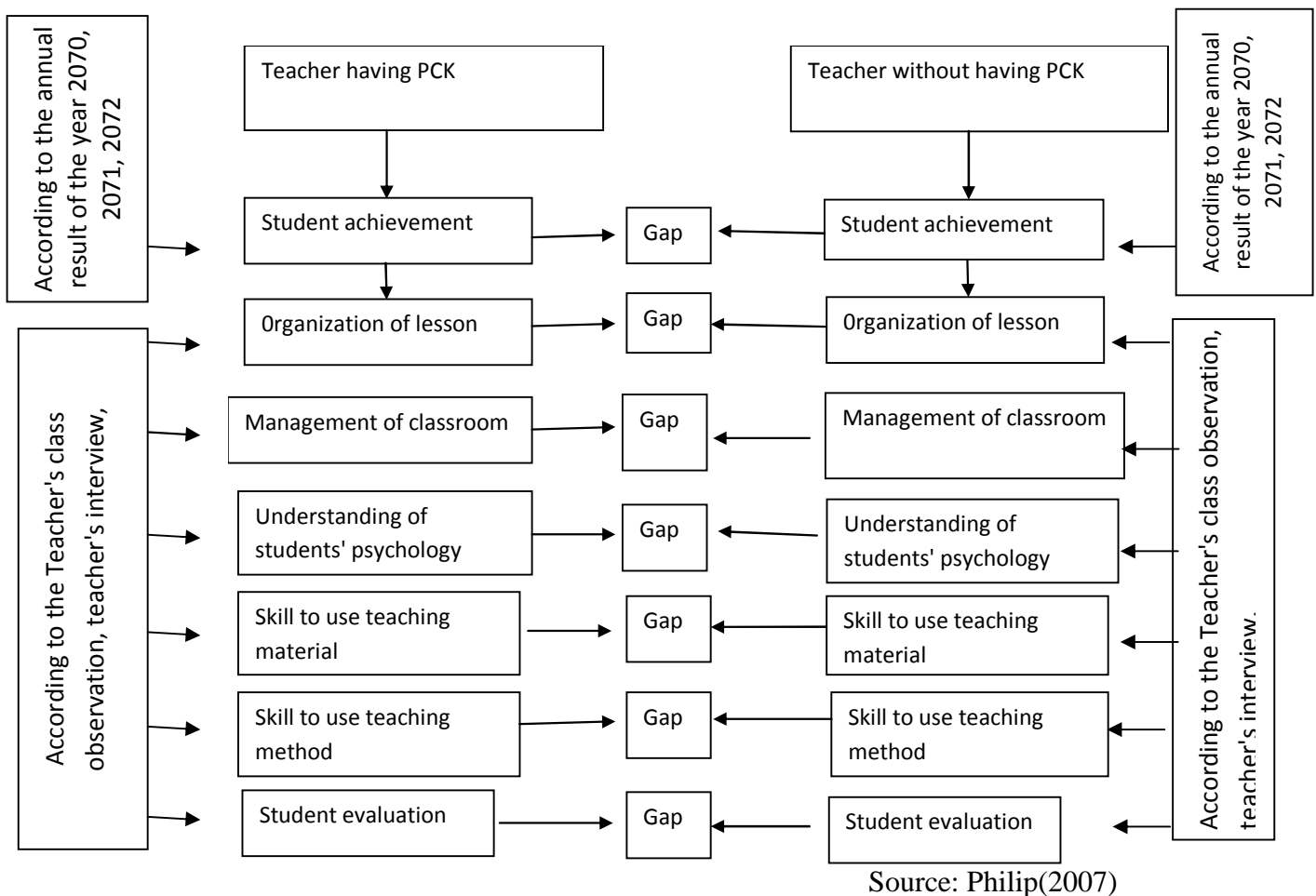
This framework shows that the researcher, at first, found the gap between the achievement scores of students taught by teacher having PCK and teacher without having PCK. Then to find the reason of gap between the teacher having PCK and teacher without having PCK, the researcher observed classroom behavior and took interview of both teachers on the basis of 6 PCK factors i.e. organization of lesson, management of classroom environment, understanding of students psychology, use of

teaching material, use of teaching method and student evaluation. The short description of these terms are as follow:

Organization of Lesson

Organization of lesson is very important part of teaching and learning. Teachers should have the good knowledge of organization of lesson. When they organize the lesson well, then their teaching will be effective and they can able to fulfill the objectives of the lesson. Therefore, every teacher should pay attention to the organization of lesson in their teaching.

Management of classroom environment

Management of classroom environment means that to make the classroom environment well for learning. The classroom in which the relation between teacher and students is as father and son and the relation between student and student is as brother is called good classroom environment. It is also includes good management of desk, bench, blackboard, windows, doors, sitting style of students and students activities etc. It is also very important part of teaching and learning. So every teacher should pay attention to the management of classroom environment, to make their teaching effective.

Understanding of Students' Psychology

Understanding of students' psychology means that the understanding of student's interest, desire, age level, cognitive level, learning capacity, home environment, family background, and behavioral psychology etc. It is very important part of teaching and learning. So every teacher should have good knowledge of understanding of students' psychology and they should pay attention to it in their teaching.

Skill to use Teaching Materials

The materials which is used in teaching learning activities to make the teaching effective, meaningful, behavioral and objective full is called teaching

materials. It helps to make the subject matter easy, clear and interested. It also helps to make abstract content as concrete. So it is also very important part of teaching and learning activities. So every teacher should have the good knowledge about the skill to use teaching materials and should emphasis to use the teaching materials in teaching learning activities.

Skill to use Teaching Method

The teaching process which is used by teacher in their class to teach the subject matter is called teaching method. It is a strategy which is made to carry the subject matter to the students. It is a mean to achieve the objectives of curriculum. There are so many teaching methods in the field of teaching. There are different teaching method can be used for teaching a content. Every teaching method cannot be suitable for every subject matter. Teacher should select the teaching method especially on the basis of teaching objectives, nature of subject matter, students' pre-knowledge, interest, desire, learning capacity and age level etc for effective teaching. So every teacher should have the good knowledge about the skill to use teaching method. Therefore the researcher tried to know about the condition of use of teaching method represented by both teachers in their classes.

Use of Student Evaluation

Evaluation is a process of finding or measuring how much learners have achieved the given objectives of curriculum. It provides information about student progress and weakness as well as teacher weakness that help students and teacher to improve their weakness. It guides to the teacher to select suitable teaching learning strategies and to make his teaching effective. So it is very essential part of teaching learning activities. Therefore, every teacher should have good knowledge about the student evaluation. By considering this view, the researcher tried to know about the condition of use of student evaluation of both teachers.
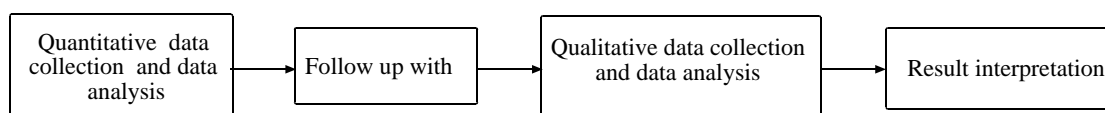
METHODS AND PROCEDURES

This chapter contains the separate sub-headings as research design, sources of data, population, sample, data collection procedures and data analysis procedure. The main purpose of this study is to explore the effects of teacher's PCK on student's achievement. In this study, teachers' pedagogical content knowledge is independent variable and student achievement is dependent variable.

Research Design

For this study, the researcher used explanatory sequential mixed method to fulfill the objectives of the study. It is such kind of mixed method in which, at first, quantitative data are collected and analyzed them. Then, to clarify them, at second, qualitative data are collected and analyzed. Then only, result is interpreted (creswell and plano clark,2011). It can be shown in the figure as follows;

Quantitative data collection and data analysis	→	Follow up with	→	Qualitative data collection and data analysis	→	Result interpretation

In this study, the researcher, at first, collected achievement scores of students taught by teacher having PCK and teacher without having PCK from the annual results of the year 2070, 2071 and 2072 as quantitative data and compare these achievements by using mean, standard deviation, variance, coeff. of variance. Then, at second, the researcher found qualitative data related to PCK of teacher having PCK and teacher without having PCK by teachers' class observation and teachers' interview to investigate whether the effects of teacher PCK exists on student's achievement. In this way, the researcher conducted his research work. So, this research design is fit for this study.

Population of the Study

All the secondary mathematics teachers and students of grade IX of Rautahat district were population for this study.

Sample of the Study

For this study, the researcher selected two teachers, one teacher having PCK of B.Ed. degree holder and another teacher without having PCK of B.A. degree holder, by purposive sampling method. As quantitative data, 30/30 students taught by teacher having PCK and teacher without having PCK were taken from the annual results of the each year 2070, 2071 and 2072. In this way, 90/90 students of both teachers having Roll n. 1-30 were selected for the study. For qualitative data, two selected teachers and 3/3 students of both teachers were are taken as sample of the study.

Data Collection Tools

The main data collection tools for this study are class observation form, interview schedule, and school documents:-

Class observation Form: -Teacher class observation form is a tool which is used to collect the information about both teachers related to PCK. For this study, the researcher made teacher class observation forms related to teacher's PCK. The researcher observed 30 classes of each selected teachers.

The classroom observation form has taken modifying the form of department of teaching practice of M.Ed. level, T.U as according to my need regarding objectives. Then consulted to my supervisor and subject experts to make it more valid and reliable.

Interview schedule: -The researcher designed interview schedule to find the information about both teachers related to PCK. For this study, the researcher made

semi-structure interview schedule related to teacher's PCK. The researcher took interview of both teachers after he had completed teacher's class observations.

The interview schedule has taken modifying interview schedule of Yasemin Coper Genturk(2012) as according to my need regarding objectives. Then consulted to my supervisor and subject experts to make it more valid and reliable.

School document:-The school document is a data collection tool which help the researcher to collect the achievement scores of students taught by teacher having PCK and teacher without having PCK. The researcher took annual results of the year 2070, 2071 and2072 as school document, to compare the achievement of students taught by teacher having PCK and teacher without having PCK.

The validity and reliability of annual result of the school was approved by district education office of Rautahat.

Data Collection Procedure

This topic represents how the data were collected. For this study, the researcher collected both qualitative and quantitative data. First of all, the researcher visited the selected schools and requested the head teacher of the schools to give the annual results of grade IX of the year 2070, 2071 and 2072. From the annual results of each of the year, the researcher collected achievement scores of 30/30 students taught by both teacher having PCK and teacher without having PCK, having Roll no.1-30. In this way, the researcher collected achievement scores of 90/90 students of both teachers. Also the researcher met the selected mathematics teachers and told him about the purpose of the study and requested him to get their class observation. Then the researcher observed 30 classes of both teachers and collected the required information about teachers. The researcher also conducted teacher interview to collect

required information about teachers. The researcher conducted the teacher's interview after he had completed teacher's class observation.

Data Analysis Procedure

Both quantitative and qualitative data were be used for this study. So, for this study, both quantitative and qualitative data analysis method were be used to investigate the research question. The researcher, at first, collected the achievement scores of 30/30 students taught by teacher having PCK and teacher without having PCK, from the annual results of the each year 2070,2071 and 2072 and found their mean, standard deviation, variance, coeff. of variance and bar diagram separately. The mean was used to find the achievement level of students in mathematics. Standard deviation was used to find representativeness of mean. Coeff. of variance was used to compare the variability, homogeneity or uniformity of two distribution, achievement of students taught by teacher having PCK and teacher without having PCK. Then the z-test were be used at 0.05 significance level, to investigate whether there is significance difference between the achievements of students taught by teacher having PCK and teacher without having PCK. In addition, the researcher collected qualitative data related to teachers' PCK, by teachers' class observation and teachers' interview, to support analyzing the quantitative data. The qualitative data were be analyzed by using thematic approach. The thematic approach is a method for describing, analyzing and interpreting the qualitative data in which the researcher, at first, collect the data, then give code of these data according to their meaning, arrange the codes comparing their meaning and build the theme of these codes respectively. Then describing and analyzing these themes, the researcher interprets the result (Ary et al.,2002)

Chapter-IV

Analysis and Interpretation

This chapter deals with the analysis and interpretation of the data obtained from the annual result of the school, Teacher class observation and Teacher interviews . This includes the analysis and interpretation of mathematics achevement of students of grade ix taught by teacher having PCK and teacher without having PCK. The collected datas were tabulated and analyzed for the study of the attainment of the objectives and verification of the research problem. The datas were analyzed by using mean, standard deviation, coeff of variance and right tailed z-test at 0.05 level of significance.

Sequentially, this chapter follows the analysis and interpretation in the following headings:-

) Comparison of achievement scrores of students obtained from the annual result of the year 2070, tought by teacher having PCK and teacher without having PCK.

) Comparison of achievement scores of students taught by teacher having PCK and teacher without having PCK, obtained from the annual result of the year 2071.

) Comparison of achievement scores of students taught by teacher having PCK and teacher without having PCK, obtained from the annual result of the year 2072.

) Comparison of achievment scores of students taught by teacher having PCK and teacher without having PCK, obtained from the annual result of the three year 2070, 2073, 2072.

) Analysis and Interpretaion of qualitative data.

Comparison of Achievement Scores of Students Taught by Teacher having PCK and Teacher without having PCK, Obtained from the Annual Result of the Year 2070

The achievement level of students taught by teacherr having PCK and teacher without having PCK, are presented in the table below which are analyzed by mean, standard deviation, coeff. of variance and z-value.

Table 4.1 : Achievement of students taught by teacher having PCK and teacher without having PCK

Group	Sample	Mean	S.D.	Var.	C.V.	Z-value	Remarks
A	n_1=30	$\overline{x}_1 = 62$	$\sigma_1 = 12.42$	$\sigma_1^2 = 154.33$	$(c.v)_1 = 20.03\%$	2.69	significant
B	n_2=30	$\overline{x}_2 = 51.67$	$\sigma_2 = 17$	$\sigma_2^2 = 188.89$	$(c.v)_2 = 32.90\%$		

The above table shows that the mean of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 62 and 51.67 respectively. From this result, the researcher concluded that the achievement level of students taught by teacher having PCK is better than the achievement level of students taught by teacher without having PCK. The standard deviation of achievement scrores of students taught by teacher having PCK and teacher without having PCK, are 12.42 and 17 respectively. From this result, it was concluded that the mean of achievement scores of students taught by teacher having PCK is more representalive than the mean of achievement scores of student taught by teacher without having PCK. The coeff of variance of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 20.03% and 32.90% respectively. From this, it was concluded that the achievement scores of students taught by teacher having PCK is

more consistant or more homegenous than the achievement scores of students taught by teacher without having PCK. The calculated z-value is 2.69 which is greater than the critical value z $_{0.05}$=1.645.

Hence the null hypothesis was rejected and alternatives hypothesis was accepted. Therefore it was interpreted that there is significance difference between the achievement of students taught by teacher having PCK and teacher without having PCK.

Bar Diagram

In addition, statistical datas were presented in visual form to understand the differences of those results more effectively. The datas were presented diagrammatically through bar graph which are given below:-

Figure 4.1 : Mean, SD and coeff of variance of achievement scores of students taught by teacher having PCK and teacher without having PCK.

The above bar diagram shows that the mean of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 62 and 51.67 respectively. From this result, the researcher concluded that the achievement level of

students taught by teacher having PCK is better than the achievement level of students taught by teacher without having PCK. The standard deviation of achievement scrores of students taught by teacher having PCK and teacher without having PCK, are 12.42 and 17 respectively. From this result, it was concluded that the mean of achievement scores of students taught by teacher having PCK is more representalive than the mean of achievement scores of student taught by teacher without having PCK. The coeff of variance of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 20.03% and 32.90% respectively. From this, it was concluded that the achievement scores of stu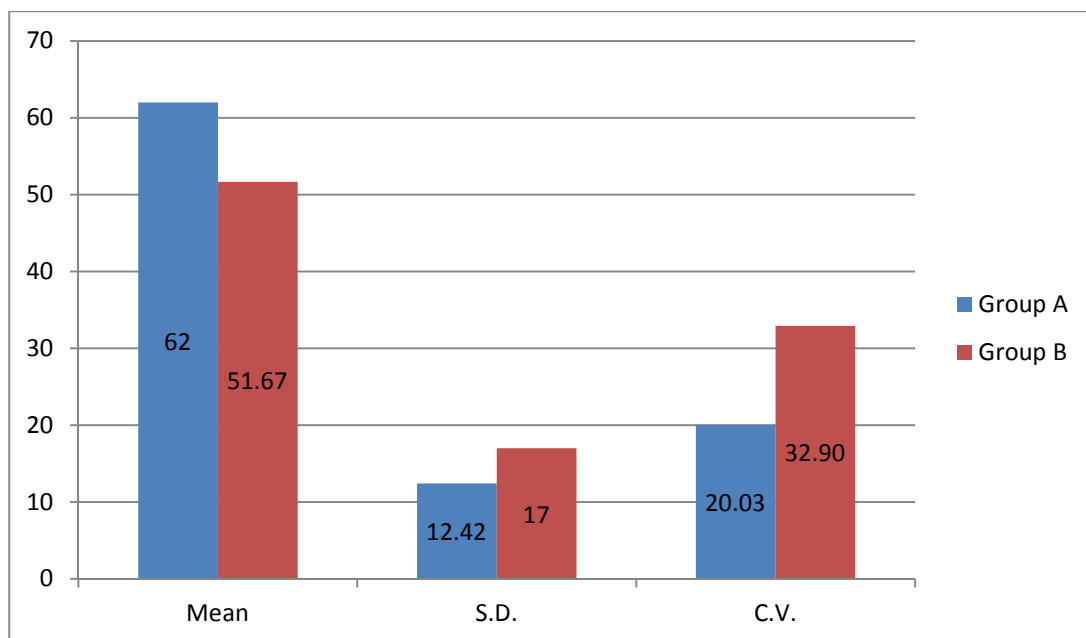dents taught by teacher having PCK is more consistant or more homegenous than the achievement scores of students taught by teacher without having PCK. The calculated z-value is 2.69 which is greater than the critical value z $_{0.05}$=1.645.

Hence the null hypothesis was rejected and alternatives hypothesis was accepted. Therefore it was interpreted that there is significance difference between the achievement of students taught by teacher having PCK and teacher without having PCK.

Comparison of Achievement Scores of Students Taught by Teacher having PCK and Teacher without having PCK, Obtained from the Annual Result of The year 2071

The achievement level of students taught by teacher having PCK and teacher without having PCK, are presented in the table below which are analyzed by mean, standard deviation, coeff. of variance and z-value.

Table 4.2 : Achievement of students taught by teacher having PCK and teacher without having PCK

Group	Sample	Mean	S.D.	Var.	C.V.	Z-value	Remarks
A	$n_1=30$	$\bar{x}_1$ = 69.33	σ_1 = 14.07	σ_1^2 = 197.89	$(c.v)_1$ = 20.29%	3.07	Significant
B	$n_2=30$	$\bar{x}_2$ = 57.67	σ_2 = 15.26	σ_2^2 = 232.89	$(c.v)_2$ = 26.46%		

The above table shows that the mean of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 69.33 and 57.67 respectively. From this result, the researcher concluded that the achievement level of students taught by teacher having PCK is better than the achievement level of students taught by teacher without having PCK. The standard deviation of achievement scrores of students taught by teacher having PCK and teacher without having PCK, are 14.07 and 15.26 respectively. From this result, it was concluded that the mean of achievement scores of students taught by teacher having PCK is more representalive than the mean of achievement scores of student taught by teacher without having PCK. The coeff. of variance of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 20.29% and 26.46% respectively. From this, it was concluded that the achievement scores of students taught by teacher having PCK is more consistant or more homegenous that the achievement scores of students taught by teacher without having PCK. The calculated z-value is 3.07 which is greater than the critical value z $_{0.05}$=1.645.

Hence the null hypothesis was rejected and alternatives hypothesis was accepted. Therefore, it was interpreted that there is significance difference between

the achievement of students taught by teacher having PCK and teacher without having

PCK.

Bar Diagram

In addition, statistical datas were presented in visual form to understand the

differences of those results more effectively. The datas were presented

diagrammatically through bar graph which are given below:-

Figure 4.2 : Mean, SD and Coeff of variance of achievement scores of students

taught by teacher having PCK and teacher without having PCK

The above bar diagram shows that the mean of achievement scores of students

taught by teacher having PCK and teacher without having PCK, are 69.33 and 57.67

respectively. From this result, the researcher concluded that the achievement level of

students taught by teacher having PCK is better than the achievement level of students

taught by teacher without having PCK. The standard deviation of achievement scrores

of students taught by teacher having PCK and teacher without having PCK, are 14.07

and 15.26 respectively. From this result, it was concluded that the mean of

achievement scores of students taught by teacher having PCK is more representalive

than the mean of achievement scores of student taught by teacher without having

PCK. The coeff. of variance of achievement scores of students taught by teacher

having PCK and teacher without having PCK, are 20.29% and 26.46% respectively.

From this, it was concluded that the achievement scores of students taught by teacher

having PCK is more consistant or more homegenous that the achievement scores of

students taught by teacher without having PCK. The calculated z-value is 3.07 which

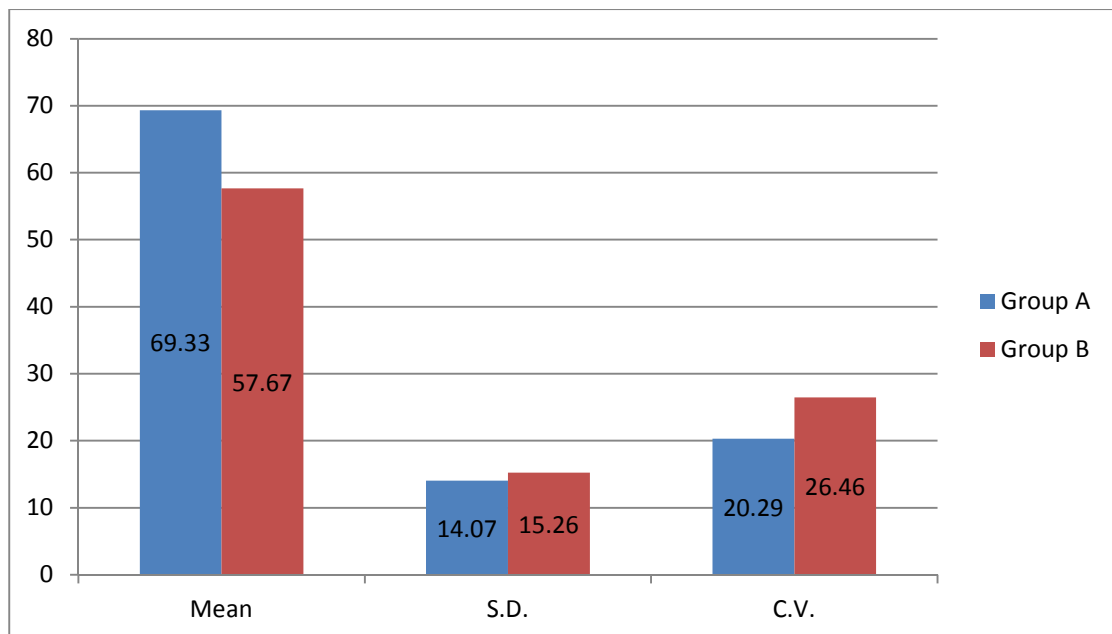is greater than the critical value z $_{0.05}$=1.645.

Hence the null hypothesis was rejected and alternatives hypothesis was

accepted. Therefore, it was interpreted that there is significance difference between

the achievement of students taught by teacher having PCK and teacher without having

PCK.

Comparison of Achievement Scores of Students taught by Teacher having PCK

and Teacher without having PCK, Obtained from the Annual Result of the Year

2072

The achievement level of students taught by teacher having PCK and teacher

without having PCK, are presented in the table below which are analyzed by mean,

standard deviation, coeff. of variance and z-value.

Table 4.3 : Achievement of students taught by teacher having PCK and teacher

without having PCK

Group	Sample	Mean	S.D.	Var.	C.V.	Z-value	Remarks
A	n_1=30	$\overline{x}_1$ $= 68.33$	σ_1 $= 14.22$	σ_1^2 $= 202.22$	$(c.v)_1$ $= 20.81\%$	2.96	Significant
B	n_2=30	$\overline{x}_2 = 57$	σ_2 $= 15.36$	$\sigma_2^2 = 236$	$(c.v)_2$ $= 26.95\%$		

The above table shows that the mean of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 68.33 and 57 respectively. From this result, the researcher concluded that the achievement level of students taught by teacher having PCK is better than the achievement level of students taught by teacher without having PCK. The standard deviation of achievement scrores of students taught by teacher having PCK and teacher without having PCK are 14.22 and 15.36 respectively. From this result, it was concluded that the mean of achievement scores of students taught by teacher having PCK is more representalive than the mean of achievement scores of student taught by teacher without having PCK. The coeff. of variance of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 20.81% and 26.95% respectively. From this, it was concluded that the achievement scores of students taught by teacher having PCK is more consistant or more homegenous than the achievement scores of students taught by teacher without having PCK. The calculated z-value is 2.96 which is greater than the critical value $z_{0.05}=1.645$.

Hence the null hypothesis was rejected and alternatives hypothesis was accepted. Therefore it was interpreted that there is significance difference between the achievement of students taught by teacher having PCK and teacher without having PCK.

Bar Diagram

In addition, statistical datas were presented in visual form to understand the differences of those results more effectively. The datas were presented diagrammatically through bar graph which are given below:-

Figure 4.3 : Mean, SD and Coeff of variance of achievement scores of students taught by teacher having PCK and teacher without having PCK
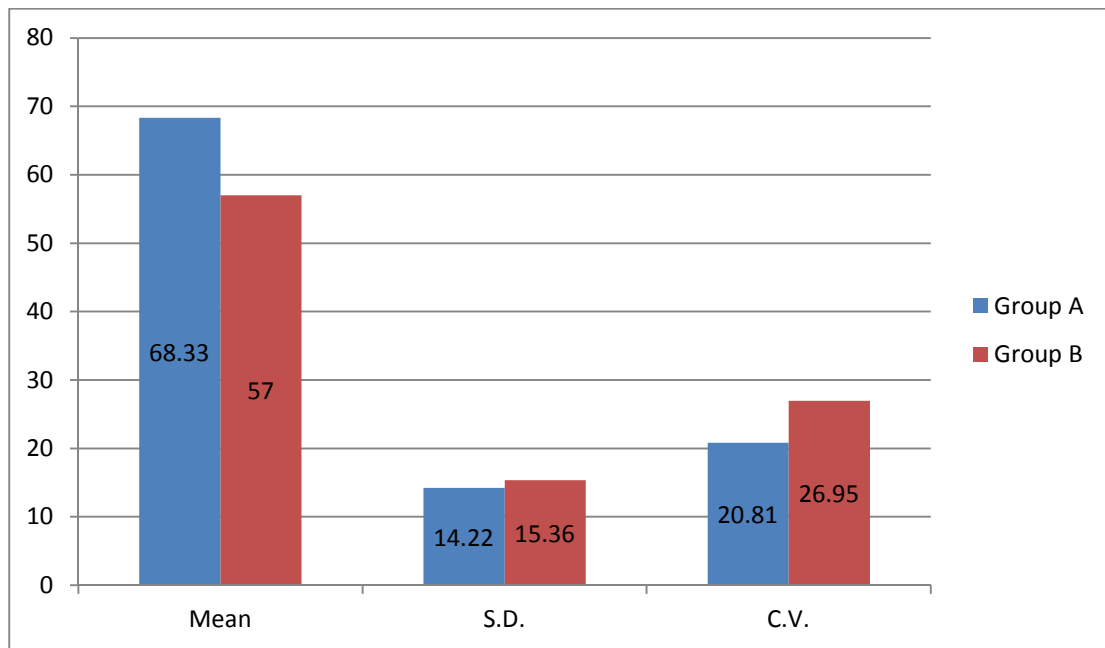

The above bar diagram shows that the mean of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 68.33 and 57 respectively. From this result, the researcher concluded that the achievement level of students taught by teacher having PCK is better than the achievement level of students taught by teacher without having PCK. The standard deviation of achievement scrores of students taught by teacher having PCK and teacher without having PCK are 14.22 and 15.36 respectively. From this result, it was concluded that the mean of achievement scores of students taught by teacher having PCK is more representalive than the mean of achievement scores of student taught by teacher without having PCK. The coeff. of variance of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 20.81% and 26.95% respectively. From this, it was concluded that the achievement scores of students taught by teacher having PCK is more consistant or more homegenous than the achievement scores of students taught by teacher without having PCK. The calculated z-value is 2.96 which is greater than the critical value $z_{0.05} = 1.645$.

Hence the null hypothesis was rejected and alternatives hypothesis was accepted. Therefore it was interpreted that there is significance difference between the achievement of students taught by teacher having PCK and teacher without having PCK.

Comparison of Achievement Scores of Students Taught by Teacher having PCK and Teacher without having PCK, Obtained from the Annual Result of the Three Years 2070, 2071, 2072

The achievement level of students taught by teacher having PCK and teacher without having PCK, are presented in the table below which are analyzed by mean, standard deviation, coeff. of variance and z-value.

Table 4.4 : Achievement of students taught by teacher having PCK and teacher without having PCK

Group	Sample	Mean	S.D.	Var.	C.V.	Z-value	Remarks
A	n_1=90	$\overline{x}_1$ = 66.56	σ_1 = 13.98	σ_1^2 = 195.36	$(c.v)_1 = 21\%$	6.56	significant
B	n_2=90	$\overline{x}_2$ = 51.56	σ_2 = 16.58	σ_2^2 = 274.89	$(c.v)_2$ = 32.16%		

The above table shows that the mean of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 66.56 and 51.56 respectively. From this result, the researcher concluded that the achievement level of students taught by teacher having PCK is better than the achievement level of students taught by teacher without having PCK. The standard deviation of achievement scrores of students taught by teacher having PCK and teacher without having PCK, are 13.98 and 16.58 respectively. From this result, it was concluded that the mean of achievement scores of students taught by teacher having PCKis more representalive than the mean of achievement scores of student taught by teacher without having PCK. The coeff. of variance of achievement scores of students taught by teacher

having PCK and teacher without having PCK, are 21% and 32.16% respectively. From this, it was concluded that the achievement scores of students taught by teacher having PCK is more consistant or more homegenous than the achievement scores of students taught by teacher without having PCK. The calculated z-value is 6.56 which is greater than the critical value $z_{0.05} = 1.645$.

Hence the null hypothesis was rejected and alternatives hypothesis was accepted. Therefore, it was interpreted that there is significance difference between the achievement of students taught by teacher having PCK and teacher without having PCK.

Bar Diagram

In addition, statistical datas were presented in visual form to understand the differences of those results more effectively. The datas were presented diagrammatically through bar graph which are given below:-

Figure 4.4 : Mean, SD and Coeff of variance of achievement scores of students taught by teacher having PCK and teacher without having PCK

The above bar diagram shows that the mean of achievement scores of students taught by teacher having PCK and teacher without having PCK, are 66.56 and 51.56

respectively. From this result, the researcher concluded that the achievement level of students taught by teacher having PCK is better than the achievement level of students taught by teacher without having PCK. The standard deviation of achievement scrores of students taught by teacher having PCK and teacher without having PCK, are 13.98 and 16.58 respectively. From this result, it was concluded that the mean of achievement scores of students taught by teacher having PCKis more representalive than the mean of achievement scores of student taught by teacher without having PCK. The coeff. of variance of achievemen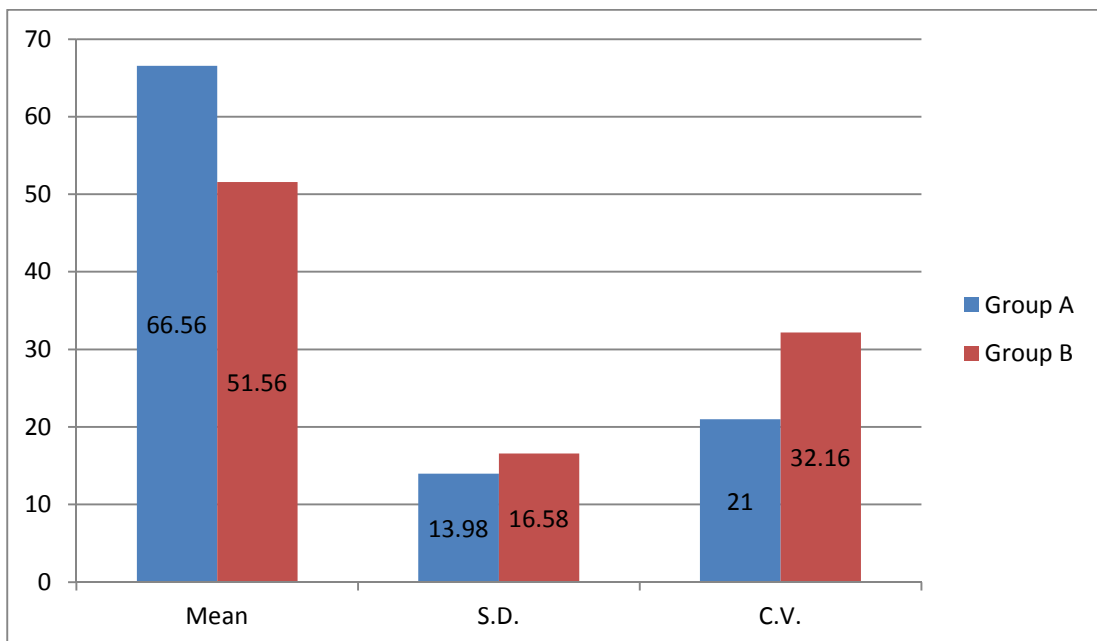t scores of students taught by teacher having PCK and teacher without having PCK, are 21% and 32.16% respectively. From this, it was concluded that the achievement scores of students taught by teacher having PCK is more consistant or more homegenous than the achievement scores of students taught by teacher without having PCK. The calculated z-value is 6.56 which is greater than the critical value z $_{0.05}$=1.645.

Hence the null hypothesis was rejected and alternatives hypothesis was accepted. Therefore, it was interpreted that there is significance difference between the achievement of students taught by teacher having PCK and teacher without having PCK.

Analysis and Interpretation of Qualitative Data

In above sub-topic, the quantitative data were analyzed and interpreted to fulfill the first objective but it did not tell why and how this result occurred. Thus, to elaborate the quantitative findings and to fulfill the second objective, the researcher has needed to analyze and interpret the qualitative data related to the teaching strategies adapted by both teacher having PCK and teacher without having PCK. The qualitative data were analyzed and interpreted on the basis of teacher class observation, teacher interview and student interview. The qualitative data related to the teaching strategies and process adapted by teacher having PCK and teacher without having PCK, were analyzed and interpreted according to the factors explained

in the conceptual framework, where observation and interview are based on different themes as; organization of lesson, management of classroom environment, understanding of students psychology, skill to use teaching materials, skill to use teaching method and student evaluation. According to these themes the analysis were conducted as follows:-

Organization of Lesson

Organization of lesson is very important part of teaching and learning. Teachers should have the good knowledge of organization of lesson. When they organize the lesson well, then their teaching will be effective and they can able to fulfill the objectives of the lesson. Therefore, every teacher should pay attention to the organization of lesson in their teaching. By considering this view, the researcher has tried to know about the condition of organization of lesson represented by both sample teachers in their teaching.

Table 4.5 : Condition of organization of lesson

(In Percentage)

Statements	Teacher having PCK	Teacher without having PCK	Remarks
a) Teacher made lesson plan.	100%	66.67%	
b) He revised the previews lesson and connected with present lesson.	93.33%	50%	
c) He gave attention to the allocated time of the lesson.	100%	60%	
d) He organized the lesson in sequential form.	100%	83.33%	

Above conditions of organization of lesson of both teachers were found by observing their 30 classes. The above table shows that the teacher having PCK regularly made lesson plan mentally whereas teacher without having PCK made

66.67% lesson plan only in his classes. The teacher having PCK revised 93.33% previous lesson and connected it with present lesson in his classes whereas the teacher without having PCK did it only 50%. The teacher having PCK gave 100% attention to allocated time of the lesson in his all classes whereas the teacher without having PCK did it only 60% in his classes. The teacher having PCK organized 100% lesson in sequential in his all classes whereas the teacher without having PCK did it only 83.33% in his classes.

For supporting the quantitative findings, the researcher had taken teacher interview. When the researcher asked the questions," How do you organize your lesson for teaching? Do you make lesson plan? What do you mean by vertical and horizontal arrangement of lesson?" to the both teachers, the teacher having PCK replied," *To organize the lesson, I make the lesson plan mentally due to the scarcity of the time and follow it in my class*". For second question, he replied, *"The vertical arrangement of lesson is the arrangement of the lesson lower grade and upper grade where the lesson of lower grade helps to learn the lesson of upper grade"*. For the first question, the teacher without having PCK replied, "*To organize the lesson, I followed the textbook but I don't make special plan".* And for the second question, he replied," I don't know".

On the class observation, I saw that the teacher having PCK made lesson plan regularly, he revised the previous lesson and connected with the present lesson almost in his all classes and his organization of lessons were also in sequential form whereas the teacher without having PCK didn't make lesson plan regularly, he revised the previous lesson and connected with the present lesson in his least classes but his organization of lesson were in sequential form. On the interview, I found that the teacher having PCK was able to give correct answer of my all questions but the teacher without having PCK was not able to give the answer of my all questions. For example, he didn't give the answer of the question, what do you mean by vertical and

horizontal arrangement of lessons. From this, it was concluded that the teacher having PCK has more knowledge about the organization of lesson than the teacher without having PCK. Also implementation side of it of teacher having PCK is better than the teacher without having PCK.

Management of Classroom Environment

Management of classroom environment means that to make the classroom environment well for learning. The classroom in which the relation between teacher and students is as father and son and the relation between student and student is as brother is called good classroom environment. It is also includes good management of desk, bench, blackboard, windows, doors, sitting style of students and students activities etc. It is also very important part of teaching and learning. So every teacher should pay attention to the management of classroom environment to make their teaching effective. Therefore, the researcher tried to know about the condition of management of classroom environment represented by both teachers in their classes.

Table 4.6 : Condition of management of classroom environment

(In Percentages)

Statements	Teacher having PCK	Teacher without having PCK	Remarks
a) Sitting arrangement of the students was good.	96.67%	96.67%	
b) The atmosphere of the classroom was participated.	93.33%	56.67%	
c) Students were interested to learn.	93.33%	56.67%	
d) Students listened attentively.	90%	50%	
e) Students asked questions relatively.	40%	30%	

Above conditions of management of classroom environment of both teachers were found by observing their 30 classes. The above table shows that the sitting style of 96.67% students was good in the class of teacher having PCK and the same result was found in the class teacher without having PCK. It was also shown that 93.33% students were participated actively in learning in the class of teacher having PCK whereas 56.67% student were only participated actively in learning in the class of teacher without having PCK. Similarly it was shown that 93.33% students well interested to learn in the class of teacher having PCK whereas 56.67% students were only interested to learn in the class of teacher without having PCK. 90% students listened attentively in the class of teacher having PCK whereas 50% students only listened attentively in the class of teacher without having PCK. 40% students asked questions relatively in the class of teacher having PCK whereas 30% students asked questions relatively in the class of teacher without having PCK. The management of desk, bench, blackboard, windows, and doors etc in the classroom of teacher having PCK and teacher without having PCK, was 96.67% well.

In the interview, when research asked the questions, "How do you manage classroom sitting ? Is there enough physical facilities for well arrangement, in your view? What does the good classroom environment contains?". For the first question, the teacher having PCK replied, "*I get noisy and weak students to sit on the first bench and other students at the next bench*". For second question, he replied, "*there are not enough facilities for well arrangement'.* For third question, he replied, "*good classroom environment contains sitting arrangement of students, arrangement of desk, bench, whiteboard, size of classroom etc".* Also the teacher without having PCK replied the similar answers for three questions.

On the class observation, I found that the sitting arrangement of students was good, atmosphere of the classroom was participated, students were interested to learn, students listened attentively but students didn't asked more questions in the class of

teacher having PCK whereas these all conditions were be found less in the class of teacher without having PCK. On the interview, Both teachers are able to give correct answer of my all question but teacher without having PCK gave answer of my question with less confident. From this information, it was concluded that the teacher having PCK slightly more knowledge than the teacher without having PCK about the management of classroom environment. Also the implementation side of it of teacher having PCK is better than the teacher without having PCK.

Understanding of Students' Psychology

Understanding of students' psychology means that the understanding of student's interest, desire, age level, cognitive level, learning capacity, home environment, family background, and behavioral psychology etc. It is very important part of teaching and learning. So every teacher should have good knowledge of understanding of students' psychology and they should pay attention to it in their teaching. Therefore, the researcher emphasis to know about the condition of understanding of students' psychology represented by both teachers in their teaching.

Table 4.7 : Condition of understanding of students' psychology

(In Percentage)

Statements	Teacher having PCK	Teacher without having PCK	Remarks
a) He paid attention to the student's interest and desire.	86.67%	60%	
b) He paid attention to the student's age level, cognitive level and learning capacity.	83.33%	60%	
c) He gave attention to the student's home environment and family background.	80%	56.67%	
d) He gave attention to the student's behavioral psychology.	80%	56.67%	

Above condition of understanding of students' psychology represented by both teachers were found by observing their 30 classes. The above table shows that the teacher having PCK paid 86.67% attention to the understanding of student's interest and desire whereas the teacher without having PCK did it 60% only. The teacher having PCK paid 83.33% attention to the understanding of student's the teacher without having PCK did it 60% only. The teacher having PCK paid 80% attention to the understanding of student's home environment and family background whereas the teacher without having PCK did it 56.67% only. The teacher having PCK paid 80% attention to the understanding of student's behavioral psychology whereas the teacher without having PCK did it 56.67% only.

In the interview, when the researcher asked the question, "How do you find students' misconceptions and how do you help them? What types of strategies students may use to solve the problem?". For the first question, the teacher having PCK replied, "*I find students' misconception from their problem solving process and I help them clearfying misconception. For this, firstly I find reason of misconception and then clearfy the concept".* For the second question, he replied, "*At first students remember definition of terms and formulas related to the topic and then they go to problem".* Also the teacher without having PCK replied similar answer for the two questions.

On the class observation, I saw that the teacher having PCK paid attention to the students' interest, desire, pre-knowledge, misconceptions and behavioural psychology more than the teacher without having PCK. On the interview, both teachers gave correct answers but the teacher without having PCK gave answer of my questions with less confident. From this, it was concluded that the teacher having PCK slightly more knowledge than the teacher without having PCK about the

understanding of students' psychology. Also the implication side of it of teacher having PCK is slightly better than the teacher without having PCK.

Use of Teaching Materials

The materials which is used in teaching learning activities to make the teaching effective, meaningful, behavioral and objective full is called teaching materials. It helps to make the subject matter easy, clear and interested. It also helps to make abstract content as concrete. So it is also very important part of teaching and learning activities. So every teacher should have the good knowledge of use of teaching materials and should emphasis to use the teaching materials in teaching learning activities. Therefore, the researcher emphasis to know about the condition of use of teaching materials represented by both teachers in their classes:-

Table 4.8 : Condition of use of teaching materials

(In Percentage)

Statements	Teacher having PCK	Teacher without having PCK	Remarks
a) He used appropriate teaching materials.	96.67%	86.67%	
b) He used ready- made teaching materials.	86.67%	86.67%	
c) He used locally prepared teaching materials.	13.33%	0%	
d) Size and clarity of teaching materials were proper.	80%	80%	
e) He used teaching materials in needed places.	100%	60%	

Above condition of use of teaching materials represented by teacher having PCK and teacher without having PCK were found by observing their 30 classes. From

the above table, it was shown that the teacher having PCK used 96.67% appropriate teaching materials whereas the teacher without having PCK used 86.67% appropriate teaching materials. The teacher having PCK and teacher without having PCK used 86.67% ready- made teaching materials. The teacher having PCK used 13.33% locally prepared teaching materials whereas the teacher without having PCK did not used locally prepared teaching materials. Size and clarity of teaching materials used by both teachers were 80% proper. The teacher having PCK100% used teaching materials in needed places whereas the teacher without having PCK 60% used teaching materials in needed places.

In the interview, when the researcher asked the questions, "What types of teaching materials did you use in your classes? Is it necessary to use teaching materials in the math classes? Why?", the teacher having PCK replied, *" I used ready-made teaching materials as well as prepared by me like chalk, duster, blackboard, textbook, model of cube, cuboids, cylinder, cardboard paper etc. Yes, it is necessary for some classes because it helps to clarify some difficult concepts"* whereas the teacher without having PCK replied,*" I used daily used and ready-made teaching materials like chalk, duster, blackboard and textbook etc. Yes, it is necessary for teaching but I teach the concept of any geometrical figure and other figures by making their figures in the blackboard. I think students can understand every concept in this way "*.

On the class observation, I saw that size and clarity of teaching materials of both teachers are proper. The teacher without having PCK used only ready-made and daily used teaching materials but teacher having PCK also used teaching materials prepared by himself and locally. Also teacher having PCK more used teaching materials than the teacher without having PCK. On the interview, I found that the

teacher having PCK was able to give the correct answer of my all question but teacher without having PCK was unable to give clear answer of the questions, why do you use teaching materials?. From this it was concluded that the teacher having PCK has more knowledge about teaching materials than the teacher without having PCK and also the implementation side of it of teacher having PCK is slightly better than the teacher without having PCK.

Use of Teaching Method

The teaching process which is used by teacher in their class to teach the subject matter is called teaching method. It is a strategy which is made to carry the subject matter to the students. It is a mean to achieve the objectives of curriculum. There are so many teaching methods in the field of teaching. There are different teaching method can be used for teaching a content. Every teaching method cannot be suitable for every subject matter. Teacher should select the teaching method especially on the basis of teaching objectives, nature of subject matter, students' pre-knowledge, interest, desire, learning capacity and age level etc for effective teaching. So every teacher should have the good about the use teaching method. Therefore the researcher tried to know about the condition of use teaching method represented by both teachers in their classes.

Table 4.9 : Condition of use of teaching methods

(In Percentage)

Statements	Teacher having PCK	Teacher without having PCK	Remarks
a) He applied different teaching method.	80%	60%	
b) He applied teacher centered method.	40%	70%	
c) He applied student centered method.	60%	30%	
d) Methods were appropriate for subject matter.	70%	50%	
e) Good in presentation of methods.	90%	75%	

From the above table, it was shown that the teacher having PCK applied 80% different teaching method whereas the teacher without having PCK applied 60% different teaching method. The teacher having PCK applied 40% teacher centered method whereas the teacher without having PCK applied 70% teacher centered method. The teacher having PCK applied 60% student centered method whereas the teacher without having PCK applied 30% student centered method. The methods used by teacher having PCK were 70% appropriate for subject matter whereas the methods used by teacher without having PCK were 50% appropriate for subject matter. The presentation of methods of teacher having PCK was 90% good whereas the presentation of method of teacher without having PCK was 75% good.

In the interview, when the researcher asked the questions, " Do you have idea of teaching methods that you are using in your classes? Which method is more preferable for teaching mathematics?", the teacher having PCK replied, " *I used different teaching methods like discussion method, problem solving method, lecture*

method, question-answer method etc. In my view, problem solving method is more preferable for teaching mathematics" whereas the teacher without having PCK replied, *" I don't know the name of teaching methods".*

On the classroom observation, I found that teacher having PCK used student centered method more in his classes whereas teacher without having PCK used teacher centered method more in his classes. On the interview, the teacher having PCK was able to give correct answer of my all questions but teacher without having PCK was not able to give the answer of the questions, what are teacher centered method and student centered method?. From this, it was concluded that the teacher having PCK has more knowledge about teaching method than the teacher without having PCK and also the implementation side of it of teacher having PCK is better than the teacher without having PCK.

Use of Student Evaluation

Evaluation is a process of finding or measuring how much learners have achieved the given objectives of curriculum. It provides information about student progress and weakness as well as teacher weakness that help students and teacher to improve their weakness. It guides to the teacher to select suitable teaching learning strategies and to make his teaching effective. So it is very essential part of teaching learning activities. Therefore, every teacher should have good knowledge about the student evaluation. By considering this view, the researcher tried to know about the condition of use of student evaluation of both teachers:-

Table 4.10 : Condition of the use of student evaluation

(In Percentage)

Statements	Teacher having PCK	Teacher without having PCK	Remarks
a) He gave assignment regularly.	80%	60%	
b) He gave class-work and home work regularly.	70%	50%	
c) He checked class work and homework regularly.	60%	60%	
d) Evaluation came out satisfaction.	90%	60%	
e) He gave feedback to the students after the evaluation.	75%	50%	

From the above table, it was shown that the teacher having PCK gave 80% assignment regularly whereas the teacher without having PCK gave 60% assignment regularly. The teacher having PCK gave70% class-work and homework regularly whereas the teacher without having PCK gave 50% class-work and homework regularly. The teacher having PCK checked 60% class-work and homework regularly whereas the teacher without having PCK checked also 60% class-work and homework regularly. Evaluation of students taught by teacher having PCK came out 90% satisfactory whereas evaluation of students taught by teacher without having PCK came out 60% satisfactory. The teacher having PCK gave 75% feedback after the evaluation whereas the teacher without having PCK gave 50% feedback after the evaluation.

In the interview, when researcher asked the questions, "What types of tools do you use to evaluate the students? What are the purposes of student evaluation?", the teacher having PCK replied, "*I use class-work, homework and exam to evaluate the students. The purposes student evaluation are to find achievement level and weakness of students and guide to select instructional strategies to the teachers."* whereas the teacher without having PCK replied, *"I use class-work and homework to evaluate the students. The purpose of student evaluation are to find achievement level and weakness of students".*

On the classroom observation, I saw that teacher having PCK focused class-work, homework and feedback more than the teacher without having PCK. On the interview, I found that teacher having PCK was confused what is summative evaluation and formative evaluation but teacher without having PCK didn't know what is summative evaluation and formative evaluation. From this, it was concluded that the teacher having PCK has slightly more knowledge about the use of student evaluation than the teacher without having PCK. Also the implementation side of it of the teacher having PCK is slightly better than the teacher without having PCK.

Summary, Findings, Conclusions, Recommendations and Implications

After analyzing and interpreting the following data, the researcher tried to summarize the study and to derive findings, conclusions, recommendations and educational implication of the study. The first section reveals summary of the study, the second section lists the findings of the study, the third section represents conclusions of the study and the four sections represents recommendations for the further study and the last section represents educational implication of the study.

Summary of the Study

The present study entitled" The effects of teachers' pedagogical content knowledge on students' achievement in mathematics" was conducted to fulfill the following objectives:

) To compare the achievement of students taught by teacher having PCK and teacher without having PCK.

) To explore the classroom behavior of teacher having PCK and without having PCK, to motivate students in teaching hours.

To fulfill the first objective of the study, the researcher selected two teachers, one teacher having PCK and another teacher without having PCK, by purposive sampling method. The achievement scores of students taught by teacher having PCK and teacher without having PCK were collected from the annual results of the year 2070, 2071 and 2072 of grade IX. The achievement scores of students having Roll n. 1-30 were only taken for the study from each year. In this way, achievement scores of 90/90 students taught by teacher having PCK and teacher without having PCK were taken for the study. These quantitative datas were analyzed by using mean, standard deviation, variance, coeff. Of variance and bar diagram. The significance difference

between the mean achievement scores of students taught by teacher having PCK and teacher without having PCK was determined by using right tailed z-test at 0.05 level of significance. To support the quantitative findings, the researcher collected qualitative data related to the teacher's PCK, by teacher's class observation, teacher's interview. The researcher made teacher class observation form for teacher's class observation, teacher interview schedule for teacher's interview. The qualitative data were analyzed by thematic approach.

Findings and Discussions

The outcomes of the present study established several findings. The major findings related to the study are presented below:

- There is significance difference between achievement of students taught by teacher having PCK and teacher without having PCK on the basis of the annual result of the year 2070.

- There is significance difference between achievement of students taught by teacher having PCK and teacher without having PCK on the basis of the annual result of the year 2071.

- There is significance difference between the achievement scores of the students taught by teacher having PCK and teacher without having PCK on the basis of the annual result of the year 2072.

- There is significance difference between the achievement scores of the students taught by teacher having PCK and teacher without having PCK on the basis of the annual result of the three combined year.

- The teacher having PCK has more knowledge about the organization of lesson than the teacher without having PCK. Also the

implementation side of it of teacher having PCK is better than the teacher without having PCK.

) The teacher having PCK has slightly more knowledge than the teacher without having PCK have about the management of classroom environment. Also the implementation side of it of teacher having PCK is better than the teacher without having PCK.

) The teacher having PCK has slightly more knowledge than the teacher without having PCK about the understanding of student. Also the implementation side of it of teacher having PCK is slightly better than the teacher without having PCK.

) The teacher having PCK has more knowledge about teaching materials than the teacher without having PCK. Also the implementation side of it of teacher having PCK is slightly better than the teacher without having PCK.

) The teacher having PCK has more knowledge about the use of teaching materials than the teacher without having PCK. Also implementation side of it of teacher having PCK is better than the teacher without having PCK.

) The teacher having PCK has slightly more knowledge about the use of student evaluation than the teacher without having PCK. Also the implementation side of it of teacher having PCK is better than the teacher without having PCK.

Conclusion

From the above findings it were shown that the teacher having PCK has more knowledge about the organization of lesson, management of classroom

environment, understanding of students' psychology, skill to use teaching materials, skill to use teaching methods and use of student evaluation than the teacher without having PCK. Also its implementation side of teacher having PCK is better than the teacher without having PCK. It means that the pedagogical content knowledge and its implementation side of teacher having PCK is better than the teacher without having PCK. Also the achievement of students taught by teacher having PCK is higher than the achievement of students taught by teacher without having PCK and there is significance difference between the achievement of students taught by teacher having PCK and teacher without having PCK. From this, it was declared that the achievement of students taught by teacher having PCK became higher than the achievement of students taught by teacher without having PCK due to the pedagogical content knowledge. Hence the researcher concluded that teacher's pedagogical content knowledge affects on the achievement of students and plays a vital role to deliver PCK in their teaching.

Recommendations

From the findings of the study, the researcher made the following recommendation:-

) Every teacher should have good pedagogical content knowledge for effective teaching.

) Every person who wants to be a teacher should study education faculty.

) Education faculty should be made compulsory for teaching profession.

) Every teacher should pay attention to the organization of lesson, management of classroom environment, student understanding, skill to

use teaching materials, skill to use teaching methods and student evaluation in their teaching.

) Every teacher should have knowledge of different teaching method.

) Every teacher should emphasis to the student centered method.

) Every teacher should give feedback compulsory after the evaluation.

Implications

The findings of this study has several implications spanning a variety of areas, including research, education, professional development and education policy. Some of them are given as follows:

) The study help the ministry of education and teacher service commission to make the effective educational policies for the teachers.

) It help the math teachers to improve professional development.

) It help the math teacher to improve instructional strategies.

) It help the researcher for further researcher related to this topic.

) It help educationist, educational administer and researcher to make effective math education curriculum.

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Marks obtained by students taught by teacher having PCK

School's name: Teacher's name:

Grade:

(i)Achievement scores of students according to the annual result of the year 2070

S.N.	Achievement scores	S.N.	Achievement scores	S.N.	Achievement scores
1	88	11	64	21	54
2	86	12	64	22	52
3	82	13	60	23	52
4	82	14	60	24	52
5	74	15	60	25	52
6	74	16	58	26	48
7	70	17	56	27	48
8	68	18	56	28	44
9	66	19	56	29	44
10	66	20	56	30	42

(ii)Achievement scores of students according to the annual result of the year 2071

S.N.	Achievement scores	S.N.	Achievement scores	S.N.	Achievement scores
1	94	11	78	21	58
2	88	12	78	22	58
3	86	13	72	23	54
4	84	14	70	24	54
5	84	15	66	25	54
6	84	16	66	26	52
7	82	17	66	27	50
8	82	18	62	28	50
9	82	19	62	29	46
10	80	20	60	30	46

(iii)Achievement scores of students according to the annual result of the yea 2072

S.N.	Achievement scores	S.N.	Achievement scores	S.N.	Achievement scores
1	92	11	74	21	58
2	88	12	74	22	54
3	88	13	74	23	54
4	86	14	74	24	52
5	86	15	70	25	52
6	86	16	70	26	52
7	80	17	68	27	46
8	78	18	62	28	46
9	78	19	62	29	46
10	76	20	60	30	42

Appendix-B

Marks obtained by students taught by teacher without having PCK

School's name: Teacher's name:

Grade:

(i)Achievement scores of students according to the annual result of the year 2070

S.N.	Achievement scores	S.N.	Achievement scores	S.N.	Achievement scores
1	90	11	50	21	38
2	82	12	50	22	38
3	76	13	50	23	38
4	74	14	44	24	36
5	70	15	44	25	36
6	70	16	42	26	36
7	64	17	40	27	36
8	62	18	40	28	34
9	54	19	40	29	34
10	54	20	40	30	34

(ii)Achievement scores of students according to the annual result of the year 2071

S.N.	Achievement scores	S.N.	Achievement scores	S.N.	Achievement scores
1	92	11	58	21	48
2	86	12	58	22	48
3	86	13	54	23	46
4	80	14	54	24	42
5	78	15	54	25	42
6	72	16	52	26	40
7	66	17	52	27	40
8	64	18	50	28	40
9	64	19	50	29	36
10	60	20	48	30	34

(iii)Achievement scores of students according to the annual result of the year

2072

S.N.	Achievement scores	S.N.	Achievement scores	S.N.	Achievement scores
1	84	11	60	21	44
2	82	12	58	22	44
3	80	13	54	23	44
4	80	14	52	24	44
5	74	15	52	25	42
6	74	16	52	26	42
7	70	17	46	27	42
8	66	18	46	28	40
9	64	19	46	29	36
10	64	20	44	30	32

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Appendix C
Data Statistics

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$z_{0.05} = 1.645$

</div>

Year	Group	Sample	Mean	S.D.	Variance	Coeff. of variance	z value	Remarks
2070	A	$n_1 = 30$	$\overline{X}_1 = 62$	$\sigma_1 = 12.42$	$\sigma_1^2 = 154.33$	$(C.V.)_1 = 20.03\%$	2.69	Significance
	B	$n_2 = 30$	$\overline{X}_2 = 51.67$	$\sigma_2 = 17$	$\sigma_2^2 = 288.89$	$(C.V.)_2 = 32.90\%$		
2071	A	$n_1 = 30$	$\overline{X}_1 = 69.33$	$\sigma_1 = 14.07$	$\sigma_1^2 = 197.89$	$(C.V.)_1 = 20.29\%$	3.07	Significance
	B	$n_2 = 30$	$\overline{X}_2 = 57.67$	$\sigma_2 = 15.26$	$\sigma_2^2 = 232.89$	$(C.V.)_2 = 26.46\%$		
2072	A	$n_1 = 30$	$\overline{X}_1 = 68.33$	$\sigma_1 = 14.22$	$\sigma_1^2 = 202.22$	$(C.V.)_1 = 20.81\%$	2.96	Significance
	B	$n_2 = 30$	$\overline{X}_2 = 57$	$\sigma_2 = 15.36$	$\sigma_2^2 = 236$	$(C.V.)_2 = 26.95\%$		
Combined	A	$n_1 = 90$	$\overline{X}_1 = 66.56$	$\sigma_1 = 13.98$	$\sigma_1^2 = 195.36$	$(C.V.)_1 = 21\%$	6.56	Significance
	B	$n_2 = 90$	$\overline{X}_2 = 51.56$	$\sigma_2 = 16.58$	$\sigma_2^2 = 274.89$	$(C.V.)_2 = 32.16\%$		

Note : A = students taught by teacher having PCK

B = students taught by teacher without having PCK

Appendix-D

Data obtained from class observation form

S.N	Statements	Teacher having PCK	Teacher without having PCK	Remarks
1	**Organization of lesson**			
a.	Teacher made lesson plan	100%	66.67%	
b.	Teacher revised the previous lesson and connected with present lesson	93.33%	50%	
c.	Teacher gave attention to the allocated time of the lesson.	100%	60%	
d.	He organized the lesson in sequential form.	100%	83.33%	
2.	**Management of classroom environment**			
a.	Sitting arrangement of the students was good.	96.67%	96.67%	
b.	The atmosphere of the classroom was participated.	93.33%	56.67%	
c.	Students were interested and enthusiastic to learn.	93.33%	56.67%	
d.	Students listened attentively.	90%	50%	
e.	Students asked questions relatively.	40%	30%	
f.	The management of desk, bench, blackboard, windows and doors etc was well.	96.67%	96.67%	
3.	**Understanding of students' psychology.**			
a.	He paid attention to the student's interest and desire.	86.67%	60%	
b.	He paid attention to the student's age level, cognitive level and learning capacity.	83.33%	60%	
c.	He paid attention to the student's home environment and family background.	80%	56.67%	

d.	He paid attention to the student's behavioral psychology.	80%	56.67%	
4.	**Skill to use teaching material.**			
a.	He used appropriate teaching materials.	96.67%	86.67%	
b.	He used ready-made teaching materials.	86.67%	86.67%	
c.	He used locally prepared teaching materials.	13.33%	0%	
d.	Size and clarity of teaching materials were proper.	80%	80%	
e.	He used teaching materials in needed places.	100%	60%	
5.	**Skill to use teaching method.**			
a.	He applied different teaching methods.	80%	60%	
b.	He applied teacher centered methods.	40%	70%	
c.	He applied student centered methods.	60%	30%	
d.	Methods were appropriate for subject matter.	70%	50%	
e.	Good in presentation of methods.	90%	75%	
6.	**Use of student evaluation.**			
a.	He gave assignment regularly.	80%	60%	
b.	He gave class-work and homework regularly.	70%	50%	
c.	He checked class-work and homework regularly.	60%	60%	
d.	Evaluation came out satisfactory.	90%	60%	
e.	He gave feedback to the students after evaluation.	75%	50%	

Teacher class observation form

Teacher's Name: School's Name:

Qualification: Grade:

Teaching Experience: Lesson:

Subject: Date:

S.N	Statements	Yes	No	Remarks
1	**Organization of lesson**			
a.	Teacher made lesson plan			
b.	Teacher revised the previous lesson and connected with present lesson			
c.	Teacher gave attention to the allocated time of the lesson.			
d.	He organized the lesson in sequential form.			
2.	**Management of classroom environment**			
a.	Sitting arrangement of the students was good.			
b.	The atmosphere of the classroom was participated.			
c.	Students were interested and enthusiastic to learn.			
d.	Students listened attentively.			
e.	Students asked questions relatively.			
f.	The management of desk, bench, blackboard, windows and doors etc was well.			
3.	**Understanding of students' psychology.**			
a.	He paid attention to the student's interest and desire.			
b.	He paid attention to the student's age level, cognitive level and learning capacity.			
c.	He paid attention to the student's home environment and family background.			

d.	He paid attention to the student's behavioral psychology.			
4.	**Skill to use teaching material.**			
a.	He used appropriate teaching materials.			
b.	He used ready-made teaching materials.			
c.	He used locally prepared teaching materials.			
d.	Size and clarity of teaching materials were proper.			
e.	He used teaching materials in needed places.			
5.	**Skill to use teaching method.**			
a.	He applied different teaching methods.			
b.	He applied teacher centered methods.			
c.	He applied student centered methods.			
d.	Methods were appropriate for subject matter.			
e.	Good in presentation of methods.			
6.	**Use of student evaluation.**			
a.	He gave assignment regularly.			
b.	He gave class-work and homework regularly.			
c.	He checked class-work and homework regularly.			
d.	Evaluation came out satisfactory.			
e.	He gave feedback to the students after evaluation.			

Semi-structure Teacher's Interview Schedule

Organization of lesson

1. How do you organize your lesson for teaching? Do you make lesson plan?

2. What do you mean by vertical and horizontal arrangement of lesson?

Management of classroom environment

3. How do you manage your classroom? Is there enough physical facilities for well arrangement, in your view?

4. What does the good classroom environment contain?

Understanding of student psychology

5. How do you find student's misconception and difficulties? How do you help them?

6. What types of strategies students may use to solve the problem?

Skill to use teaching materials

7. What types of teaching materials did you use in your classes?

8. Is it necessary to use teaching materials in math classes? Why?

Skill to use teaching method

9. Do you have the idea of teaching methods that you are using in your classes?

10. Which teaching method is more preferable for teaching mathematics?

Student evaluation

11. What types of tools do you use to evaluate the students?

12. What are the purposes of student evaluation?

Appendix G

Some Statistical Formula used in this study

S.N.	Subject	Notation	Formula
1.	Mean	$\overline{X}$	$\dfrac{fX}{N}$ where, X = Mid value of corresponding class N = Total frequency
2.	Standard deviation	$\exists$	$\sqrt{\dfrac{fx^2}{N}}$ Where x XX Z$\overline{X}$ X = mid value of corresponding class
3.	Variance	$\exists^2$	$\dfrac{fx^2}{N}$
4.	Coeff. of variance	C.V.	$\dfrac{\exists}{\overline{x}}\mid 100\%$
5.	z-statistics	z	$\dfrac{f\overline{x}_1\ Z\overline{x}_2\ AZf\Uparrow_1\ Z\Uparrow_2\ A}{\sqrt{\dfrac{\exists_1^2}{n_1}\ \Gamma\ \dfrac{\exists_2^2}{n_2}}}$ where, $\overline{x}_1$ = mean of achievement scores of students taught by teacher having PCK $\overline{x}_2$ = mean of achievement scores of students taught by teacher without having PCK. $\exists_1^2$ = variance of achievement scores of students taught by teacher having PCK $\exists_2^2$ = variance of achievement scores of students taught by teacher without having PCK n_1 = number of students taught by teacher having PCK n_2 = number of students taught by teacher without having PCK

Appendix-G

Student interview schedule

1. How did your teacher organize the earlier lesson, bad, good or very good?

2. Does your teacher justify your all questions?

3. Does your teacher provide specific help to the weak students?

4. Does your teacher pay attention to your interest and desire?

5. Does your teacher pay attention to your behavioral psychology?

6. How much does your teacher use other teaching materials except daily use materials?

7. How much do you like the teaching method that your teacher used in the class?

8. Does your teacher evaluate you regularly or sometimes?

9. Does your teacher give you feedback regularly or sometimes?

Appendix-B

Marks obtained by students taught by non-education based teacher

School's name: Teacher's name:

Grade:

(i)Achievement scores of students according to the annual result of the year 2070

S.N.	Achievement scores	S.N.	Achievement scores	S.N.	Achievement scores
1	90	11	50	21	38
2	82	12	50	22	38
3	76	13	50	23	38
4	74	14	44	24	36
5	70	15	44	25	36
6	70	16	42	26	36
7	64	17	40	27	36
8	62	18	40	28	34
9	54	19	40	29	34
10	54	20	40	30	34

Chapter I

INTRODUCTION

Background of the Study

"Teaching is a means for establishing a harmonious relationship between teacher, pupil and subject. It gives useful information and causes the child to learn. It is a stimulation and direction of learning. It helps the child to make effective adjustments. The pupil's activities are guided by it. It is a means for transforming emotions of teacher and students" (Bhatia and Bhatia,1987).

Teaching of mathematics is not just transmitting a mathematical knowledge to student, but helping student to construct a deep understanding of mathematical ideas and process by engaging them in doing mathematics. Skemp (1982) said that to understanding something means to assimilate it into an appropriate schema. The notion that understanding in mathematics is making connection between ideas, facts or procedure.The main purpose of teaching mathematics is to develop the understanding, reasoning and analyzing power which is necessary to various aspect of human civilization. In order to make mathematics teaching meaningful and effective in the classroom, the students should be interested and attracted to learn mathematics and they should also find its usefulness and application to their real life situations.

A number of factors may influence the teaching of mathematics but teachers play an important role in teaching process. The common belief in society is if a mathematics teachers knows mathematics very well, he or she is the best person to teach mathematics. But what about "knowing to teach mathematics"? Fennema and franke (1992) determined the components of mathematics teachers' knowledge as;

1)   Knowledge of mathematics

  $\int$ content knowledge

  0   the nature of mathematics

  0   the mental organization of teacher knowledge

2)   knowledge of mathematics representations

3)   knowledge of students

)   knowledge of students cognitions

4)   knowledge of teaching and decision making

The first item is about having conceptual understanding of mathematics. Fennema and franke(1992) argue that if a teacher has a conceptual understanding of mathematics, this influences classroom instruction in a positive way; therefore, it is important to have mathematics knowledge for teachers. Teachers' interrelated knowledge is very important as well as procedural rules. They also emphasized the importance of knowledge of mathematical abstractions. Fennema and Franke(1992) state that " if teachers do not know to translate those abstractions into a form that enables learners to relate the mathematics to what they already know, they will not learn with understanding".

Knowledge of students' cognitions seen as one of the important components of teachers' knowledge, because, according to Fennema and Franke(1992), learning is based on what happens in the classroom, and thus, not only what students do, but also the learning environment is important for learning. The last component of teacher knowledge is "Knowledge of teaching and decision making". Teachers' beliefs, knowledge, judgments and thoughts have an effects on the decision they make which influence their plans and actions in the classroom(fennema and franke).

Knowledge of mathematics knowledge of mathematical representations are related to content knowledge, while knowledge of students and knowledge of teaching are related to pedagogical content knowledge. Shulman(1995) defines content knowledge as the knowledge about subject, for example mathematics and its

structure. According to Shulman(1995; 130) pedagogical content knowledge includes," the ways represent ting and formulating the subject that make it comprehensible to others'…..'an understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different age backgrounds bring with them to the learning of those most frequently taught topics and lessons".

Based on Shulman's(1987) notions of pedagogical content knowledge, effective teachers can possess an in-depth knowledge of how to represent the subject matters to the learners(Parker and Heywood,2000). Shulman(1987) also stated that pedagogical content knowledge must include the knowledge of learners and their characteristics, knowledge of educational contexts, knowledge of educational ends, purposes and values, and their philosophical and historical bases. Additionally, pedagogical content knowledge refers to the ability of the teachers to transform content into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students (shulman,1987, cited in An, Kulm and Wu,2004).

According to An, Kulm and Wu(2004) pedagogical content knowledge has three components:

) knowledge of content

) knowledge of curriculum

) knowledge of teaching

Pedagogical Content Knowledge

The term pedagogical (PCK) was introduced by Lee Shulman in his presidential

address to the American content knowledge Educational Research Association (Shulman, 1986). Shulman argued that, for a long time, research on teaching and teacher education had undeservedly ignored questions dealing with the content of the lessons taught. Shulman presented a strong case for PCK as a specific form of knowledge for teaching which refers to the transformation of subject matter knowledge in the context of facilitating student understanding. Teachers need this type of knowledge to structure the content of their lessons, to choose or to develop specific representations or analogies, to understand and anticipate particular preconception or learning difficulties of their students, and so on. Shulman asserted that teachers had a unique way of looking at practice and his intrigue with the manner in which they did so encouraged an examination of teachers' pedagogical thinking in ways that, it was anticipated, would reveal what teachers must know to best teach their content to their students.

Mathematical Content Knowledge

It refers to the facts, concepts, theories and principles that are taught learned in specific academic courses, rather than to related skills such as reading, writing or researching that students also learn in school (Glossary of Education Reform). According to Ball and her colleagus (2008), the mathematical content knowledge consists of three sub-domains. They are common content knowledge, specialized content knowledge and knowledge at the mathematical horizon. The common content knowledge refers to the mathematical knowledge and skills that not only teachers but also others might have. This knowledge is not unique to teaching. Solving mathematical problems or knowing how to carry out a procedures as well as knowing the definition of concepts are examples of common content knowledge. The second domain, specialized content knowledge, is mathematical knowledge specific to teaching. This knowledge differs both from knowledge of students or pedagogy and

from shulman's pedagogical content knowledge. When identifying patterns in students errors or assessing whether a nonstandard approach would work, teachers need to have a kind of mathematical knowledge that others do not. The third domain, horizon knowledge, is " an awareness of how mathematical topics are related over the span of mathematics included in the curriculum"(Ball, Themes and phelps, 2008).