Chapter III

REVIEW OF LITERATURE AND CONCEPTUALIZATION
OF THE RESEARCH PROBLEM

Introduction

This chapter reviews the literature in terms of psychological researches, brain research and other researches in order to understand the bases of constructivism. This chapter reviews the related literature in detail to:

• explain the basis and explore the trends of research in this field;
• provide insight and direction;
• formulate research questions;
• find areas which are less explored.

The chapter ends with a formal statement of the problem and a description of the objectives of the study.

Epistemological Aspects of Constructivism

"Constructivism may be characterized as both a cognitive position and a methodological perspective" (Noddings, 1973). Noddings elaborated, "As a methodological perspective in the social sciences constructivism assumes that human beings are knowing subjects, and that human behaviour is mainly purposive. These assumptions suggest methods, ethnography, clinical interviews and overt thinking. As a cognitive position, constructivism holds that all knowledge are constructed and the instruments of construction include cognitive structures that are either innate (Chomsky, 1968) or are themselves products of developmental construction (Piaget, 1953)".

According to Neisser (1967), all mental processes are constructive. Nodding further states, "If Neisser is correct, then learners are necessarily performing acts of construction even in situations of so-called rote learning". Nodding further referred Glasersfeld (1987 p. 217) for writing "Perceiving, from a constructive points of view, is always an active making rather than a passive receiving...".

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While Neisser traced his construction to act psychology, Piaget structures his own on more directly to Kantian philosophy. **Kant** described the structures by which any competent subjects acquires or generate knowledge. Piaget followed Kant in distinguishing between empirical knowledge and logic-mathematical knowledge (Knowledge is necessary truths). Piaget bifurcated from Kant in describing cognitive structures as products of development rather than innate structures. This is a matter on which he also differed from chomsky. Where as Chomsky holds that the linguistic structures of mind are innate, Piaget (1971) insisted that certain logical structures, developed through the coordination of action, precede linguistic development and make the construction of linguistic structure possible. Although both Chomsky and Piaget call for the development of competence theories that describe the structure of mind (Nodding, 1974); Chomsky's view is anchored in the philosophical tradition of rationalism, while Piaget's is much closer to the dynamic perspective of pragmatism.

Piaget's cognitive construction leads logically to methodological constructivism. The need to identify and describe various cognitive structures suggests methods such as the clinical interview and prolonged observations that permit us to make inferences about the structures that underlie behaviour. In Piaget's sense abstracting the inferences or simply the regularities is always the result of assimilation. If a scheme does not lead to the expected result, then perturbation/dissonance occurs which may lead to either to a modification of a result or reasoning pattern that was abstracted or to an action taken.

Every individual's abstraction of experiential items is guided by social interaction and the need of collaboration and communication with other members of the group in which he or she grows up. No individual can afford not to establish a relative fit with the consensual domain of the social environment. This connection with everyday experience of an individual within the society leads to viable connection to mathematics which in turn also reflects the real world.

The critics of **Copernicus** who argued that his system must be wrong because it denied that the earth is the centre of the universe could not claim to be "scientific" they argued in that way for political and religious reasons. The science we have today holds that neither the earth nor the sun has a privileged position as mentioned above in the universe. Like the contemporary
philosophers of science, constructivists have tried to learn from that development and to give up the traditional conception of knowledge as a "true" representation of an experience (independent state of affairs). This is why radical constructivism does not claim to have found an ontological truth but merely proposes a hypothetical model they may turn out to be a useful one.

Many writers do not even use the word constructivism, although they embrace the central idea that the operations of mind are constructed. Lave (1988) argues that our thinking on cognition has been shaped by psychologists and our thinking on culture has been shaped by anthropologists. The way to visualize and interpret the cognition and cultural aspect of constructivism in teaching is to be reviewed.

*Literature Related to Constructivism as a way of Teaching*

**Braathen (2000)** found no significant difference between groups, having constructivist and behaviourist methods of instruction, on posttest scores when controlled pretest scores was taken as a covariate.

**Makanong (2000)** developed constructivist teaching based model on a framework of constructivist theory and used in teaching of algebra to 164 students. He found that quantitative data indicated no significant differences of mathematics problem solving processes. The qualitative data indicated that constructivist teaching was a promising approach capable of getting students more involved in learning mathematics. Students in this study who learned mathematics based on constructivist teaching tried harder, as measured by the interview task problems, than those learned based on traditional teaching.

**Chilcoat (1999)** in his study using both qualitative and quantitative technique and pretest-posttest design found that treatment, constructivism, did not produce significant differences in procedural or conceptual scores than control group.

**Chung (1999)** did a study on the effectiveness of two different theoretical models, constructivism and traditionalism, on grade third student's academic achievement in establishing mathematical connections in learning multiplication basic facts. All lessons were written by the researcher with cooperation of the regular classroom teachers. The test scores were analyzed by ANOVA with a probability level of less than 0.05. The results of the test scores revealed that...
students from both approaches improved their multiplication skills, as well as their understanding of the multiplication concept which involves basic facts 0 to 5. In addition, there were no statistical differences between the two groups of students with respect to their achievement of multiplication understanding and skills.

Dupree (1999) did a study of the relationships that developed among the students in a small class of mathematics for critical thinking by organizing the class on the social constructivism of Vygotsky. The challenges of this class offered the students opportunities to engaged in mathematics in a personal way that was empowering. They all left the class with new and positive attitudes towards mathematics and their abilities to actively engage in challenges and rewards.

Kerr (1999) in his Ed. D. dissertation reviewed that the traditional mathematics curriculum, teaching, and learning at the school had resulted in low levels of mathematics achievement and pointed to the need for a constructivist, standards based approach on the basis of data to improve the mathematics achievement.

Maden et al (1999) in their study, using constructivist approach on the two pilot schools, which were weak previously than the other two schools as a whole, found the score of the students increased above average scores.

Sherman (1999) in his dissertation found that there were no statistical difference between the two groups of students, constructivist approach and traditional approach, with respect to their achievement of multiplication understanding and skills.

Walker (1999) in his research "The effect of different pedagogical approaches on mathematics students' achievement" found that constructivism produced higher probability of obtaining the correct answer to mathematics items that measure conceptual, rather than procedural understanding. He hypothesized that middle school mathematics students whose teachers utilized a more student-centred, or constructivist pedagogical approach would have a higher probability of obtaining the correct answer to mathematics items that measured conceptual, rather than procedural understanding. This hypothesis was explicitly tested using differential item functioning analyses, results support the hypothesis, although not as strongly as had been expected.
Abdal-Haqq (1998) stated that constructivist approaches are regarded as producing greater internalization and deeper understanding than traditional methods. He further states that the overreaching challenge constructivism presents to teachers and teacher educators is translating a learning theory into a theory of teaching, which raises questions about what teachers need to know and be able to do. He also alarmed that educators also face the pitfall of regarding constructivism as the only viable theoretical framework for teaching and learning. Prospective teachers should be exposed to varying perspectives and given opportunities to develop the discretion needed to choose most appropriately and the skills to implement their choices.

Gatlin (1998) using nonequivalent control group pretest, posttest and delayed-posttest quasi-experimental design and found that traditional pedagogy scored higher than the students taught by the constructivist pedagogy. However, the scores of students receiving constructivist-infomemed pedagogy showed a slight increase on the delayed-posttest, while the traditionally taught student's scores decreased. Thus the difference in the achievement of the two groups (experimental and control) was diminished over time.

Similarly, Koebley (1998) in his research found that project students were significantly more likely to orient themselves toward the task and internal schemes of reward rather than external motivators.

Similarly, Masquaud (1998) found that general ability, metacognitive awareness, math achievement, and positive attitudes were all higher for the experimental group.

Saenz-Ludlow & Walgamuth (1998) by using socio-constructivist teaching experiment and concluded that children expanded their conceptualizations to equality due to an active role in class discussion.

Graham (1998) reviewed that recent paradigm shifts in mathematics education to constructivism as the predominate learning theory and mathematics viewed as socially determined have implications for classroom instructional strategies. She used a qualitative case-study approach on six students through in-depth study and found that the students were benefited. The degree of benefit depended on the degree of participation in constructivist paradigm.
**Hill and Land (1998)** overviewed on the model for designing open-ended learning environments. They presented key characteristics such as meaningful, complex context, tools and resources, learner & self-monitoring. They found that understanding is best achieved when situated in relevant contexts through negotiation and interpretation of meanings.

Concerning the aesthetic change, **Warrington & Kamii (1998)** in their teaching guides conclude that children will go much further with depth, pleasure, and confidence if they are allowed to construct their own mathematics to make sense to them every step of the way.

Summarising the status of constructivism, **Blunden (1997)** in his article explored the incompatibility between constructivist theories of learning and realist metaphysics. He shows how this results in conflict between constructivist teaching approaches and the transmission or banking mode favoured by realist metaphysics.

Similarly, **Dunlop (1997)** presented a paper and provides an overview of instructional methodologies-problem based learning. Using collaboration, reflection, student autonomy, and intrinsically motivating activities, these instructional methodologies help students develop the metacognitive and self-directed learning skills needed to remain competitive in an ever changing professional climate.

**Kim (1997)** suggested in his Ph. D. dissertation that constructivist-based instruction including the use of multimedia helped the participants develop more positive attitudes toward computer-related technologies and influenced their decisions to plan more constructivist-based teaching strategies than those participants in the comparison groups. This study offered a potential teaching model of constructivist-based instruction.

With regard to other subjects, say science, **Lord (1997)** did a research on the topic "A Comparison Between Traditional and Constructivist Teaching in College Biology" and found that the student studied in constructivist model performed significantly better on the same tests, and maintained a better attitude throughout, and enjoyed the course more.
Similarly Beeth (1996) explained that constructivist paradigm demands are a learning environment, a set of teaching-learning strategies. But a method of assessment differs significantly from those usually found in classrooms that operates from a behaviourist theory or from an objectivist epistemology.

Differentiating between personal and social forms of constructivism, Lerman (1996) discusses intersubjectivity and examines limitations of radical constructivism. He further compares Piaget’s positioning of the individual in relation to social life with that of Vygotsky in support of the claim that radical constructivism does not offer enough as an explanation of children’s learning of mathematics.

Schulte (1996) defines constructivism as a process where emphasis is placed on the learner rather than the teacher and suggest it as a viable framework for instructional strategies.

With regard to the behaviour of teachers, Giles (1995) presented an opinion paper on "A Piagetian view of learning styles". He writes, "Most teachers are unprepared to shift attention from explicit presentations of subject matter to fostering development of abstract thinking and are reluctant to reduce or substitute content despite the implications of Piagetian instruction when they teach in ways that bring about not only learning in that particular subject, but also cognitive growth."

Ward (1995) in his study of perception about constructivism and found that it is related to longer retention of concepts.

Kammi & Lewis (1991) found that children demonstrated superior higher-order thinking on tasks involving place-value, double digit addition, story problems and estimation in constructivism.

Research Related to Ingredients of Constructivism

Action and Reflection

Landine (1998) found significant positive relationship between meta-cognition, motivation, locus of control, self-efficacy and academic average.
Likewise, Everson (1997) in one study, explored the correlations among measures of metacognitive knowledge, learning, and study strategies, and academic achievement across the domains of verbal ability and mathematics. Results suggest that metacognitive knowledge is generalizable across both verbal and mathematical domains. The correlations between the two knowledge, monitoring measures and students' confidence estimates, were also in the expected directions.

Wilburne (1997) with the objective to determine the effects of being taught to use metacognition strategies while engaged in mathematical problem solving achievement and attitude. A quasi-experimental study was designed. The study took place over a seven week period. One class was taught metacognition strategies along with a problem-solving unit (experimental class) and another was taught the same problem solving unit with no emphasis on using metacognition strategies (control class). Each class had approximately 25 students. Students in the metacognitive treatment groups (experimental) significantly improved in both problem-solving achievement and attitude towards problem solving.

Lin et al (1994) used a pretest-posttest group design with random assignment, together with qualitative data collection and analysis, to investigate whether metacognitive, cognitive, and affective-awareness cues embedded in a which program could facilitate college students' near and far transfer problem solving in learning. It was assumed "When subjects are asked to explain reasons for their own actions during the problem solving, they must engage in self-evaluative intermediate processes comparable to metacognitive processes of monitoring, evaluating, and regulating ongoing problem solving". Four treatment groups were used: one received no metacognitive cues; one received cognitive cues; one received affective-awareness cues; and the control group received no cues. Results showed that subjects in the metacognitive group performed better on far transfer tasks than all other groups. The qualitative analysis indicated that metacognitive-oriented questions encouraged students to "stop, think, and reflect" on their problem solving process which in turn helped students understand the process of how the problems were solved.

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Northfield (1993) presented a paper on the topic "Interpreting some different approaches to teacher education" to the Annual meeting of the National Association for Research in Science Teaching in Atlanta. He describes the teachers' **reflective judgement** as the best way to teach. He further states that pre-service teacher education should incorporate more valid and extended school experience into educational programs.

Simon & Schifter (1987) found that students attitude scores and teachers observations reflected improvements in student's attitudes about, concepts of and communication in mathematics as well as problem solving and conceptual understanding. Study demonstrated that teacher can make student understand and problem solving high priority and decrease emphasis on computational skills without a drop of in tests results in reflective teaching.

**Viability and Autonomy**

Focusing on student autonomy, Heller (1996) presented a paper in which he reported by examination of literature that educators should decrease the competitive nature of the classroom, pay more attention to developing student's self-esteem, note the importance of making content viable and learning enjoyable.

**Scaffolding and Ethnography**

Coco (1999) evaluated the effect of instructional scaffolding interventions on pre-service teachers's knowledge structures (concept maps) over time in control -experimental groups. Results indicated that expert-novices had a more developed knowledge of subject-matter continent than control group.

Lehman(1996) found that scaffolded instruction promoted learning consistently across individuals.

**Research Related Pedagogy close to constructivism**

Cabral-Pini (1994) point out clear differences between the co-operative learning and more traditional teaching methods. The findings point out clear differences between the co-operative learning classroom and the traditional classroom. The co-operative learning classroom
is more flexible as well as creative. Students measure more positive attitudes and feelings towards mathematics in this environment. Results show that the co-operative learning group demonstrates stable gains in mathematics appreciation and achievement.

Singh (1992) has discussed the relative merit of teaching mathematics through computer assisted instruction and conventional methods of teaching. Computer assisted instruction was always found superior.

Prabha (1992) has found that programmed learning of mathematics is superior to conventional learning of Mathematics.

Wagh (1991) has developed a multi-media instructional system for remedial purposes for fractional numbers and has expectedly found that package leads to better understanding than the conventional remedial methods.

Shankara (1990) has found that guided discovery learning is always better than learning under reception conditions.

Rawool (1988) has found that in geometry, students fail at understanding and application levels.

Sie (1970) and Sharma (1966) found in their studies that programme instruction produced better result in students achievement than conventional way of teaching.

In summary, it may be pertinent to discuss some salient points that emerge out of the researches reviewed in the previous chapters.

1. Constructivist way of teaching results in better performance of the students in immediate learning and retaining the learned things, and transfer of skill than the conventional method of teaching.

2. Students can solve a problem in their own way. Their own solutions promotes learning environment.

3. Accepting the responsibility for finding errors and correcting their own errors makes the learning environment viable.

4. Students do not always use the prescribed technique to solve a given problem.
Rationale of the Study

To date, these studies have failed to clarify many of the questions pertaining to constructivist and conventional instruction; rather the findings of the various studies, when taken at face value, often seem to be contradictory.

A review of the related literature shows that many of the relevant variables have been explored to a marked degree, while others have received relatively little attention such as sequencing of the task.

Many of the investigators have been primarily concerned with the amount of time involved and type of external guidance to which the learner is subjected. Others have been concerned chiefly with the role of teacher in the constructivist and conventional teaching processes. One factor of investigation which has received somewhat less attention is that of the sequence characteristics of the learning tasks. In fact, many previous studies have failed to consider or specify such parameters as sequence of presentation.

In addition to the lack of clarity of research evidence pertaining to the constructivist conventional dilemma, there is another factor which often disturbs the practitioners who depend on research to determine the best instructional techniques for classroom use. Most constructivist studies have been conducted in a laboratory setting and consequently have dealt with small time samples, small numbers of contents, and very discrete & often manipulative learning tasks. One might argue that such sampling of time, contents, and tasks is so restrictive and limited in scope that any attempt to generalize the results to classroom learning or instruction would be subject to serious question. It would seem that the results of a carefully controlled classroom experiment where both time sample and learning task are representative of curriculum. It would be generalized to classroom practice with more confidence than would the results of the typical short-term laboratory experiment. Thus the emergence of the present study evolved.

The primary purpose of the present study was to describe and compare instructional methods in a naturalistic setting where the learning tasks and time sample approximated normal classroom conditions. The methods compared were a constructivist method and a conventional method which differed primarily in terms of the sequence of the presentations and secondarily in terms of teacher guidance necessary to maintain these characteristics.
Several studies have dealt with problems relating to individual differences in performance using programmed methods of instruction. Some found correlation between intelligence test scores and performance was positive and significant for the subjects taught by conventional methods and insignificant correlation was found for subjects taught by programmed instruction.

While these findings are important, it should be noted that design of these studies differ largely. Some one used qualitative and other used quantitative data which were was not intended to investigate these relationships. So, there is a need for a research which involves both types of data and compares this dilemma.

The present study was undertaken to investigate the effect of constructivism upon mathematics achievement. While constructivism appears to have some advantages over conventional methods of teaching, research is needed to determine if these advantages hold for all levels of achievement.

Research Questions

This study was planned to answer the following research questions:

- Does constructivist approach produce better results than conventional approach in students' achievements in terms of immediate learning, retention, and net gain.
- Does constructivism encourage the habit of self-learning and self-correcting?
- Can constructivism in mathematics be applied in Nepalese school situation?
- What could be the problems that might arise while applying constructivism?

Statement of the Problem

Almost all national baseline surveys of school education in Nepal indicate the poor achievement in mathematics. Research, conducted in the setting outside of schools in different ethnic groups and work places, reflects that people do construct mathematical ideas and adopt their own strategies to solve their problems. This skill of doing "on their own" is valuable skill in
later life. This was the reason why present study was undertaken using constructivism as a method of teaching with the following statement:

EFFECT OF CONSTRUCTIVISM ON MATHEMATICS ACHIEVEMENT OF GRADE V STUDENTS IN NEPAL

Objectives of the Study

The main purpose of this research was to see the effect of constructivism on students' achievement in mathematics with respect to overall performance of students:

• in terms of immediate learning, retention and net gain in knowledge and skills;
• in terms of content areas taught viz. Fraction measurement, Equation, & Angle; and
• in terms of cognitive aspects viz. knowledge comprehension & application.

In addition to that the study was also carried out with the following specific objectives:

• To develop different teaching-episodes for selected concepts of grade V mathematics in order to achieve the main objectives of the study;
• To assess in what way, in which situation, the students learn independently;
• To examine if constructivism is viable method of teaching in Nepalese schools; and
• To identify the problems faced by teachers while teaching mathematics through constructivism.