Chapter III

REVIEW OF RELATED LITERATURE

3.1 Studies Related to Models of Teaching

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REVIEW OF RELATED LITERATURE

The Review of Related Literature involves the systematic identification, location and analysis of documents containing information related to the research problem (Gay, 1996). A summary of the writings of recognised authorities and of previous research provides evidence that the research is familiar with what is already known and what is still unknown and untested. Since effective research is based upon past knowledge, this step helps to eliminate the duplication of what has been done and provides useful hypotheses and helpful suggestions for significant investigation. Citing studies that show substantial agreement and those that seem to present conflicting conclusions help to sharpen and define understanding of existing knowledge in the problem area, provides a background for the research project and makes the reader aware of the status of the issue.

The review of related literature presented in this chapter falls under four major heads.

- Studies related to Models of Teaching.
- Application of Psychological theories in Mathematics Education- A historical perspective.
- Studies based on application of different strategies in teaching mathematics.
• Studies based on achievement and problem solving in mathematics.

3.1 Studies related to Models of Teaching

Many studies were found in this area. For better analysis, they were classified as those in which individual models have been taken up and those in which two or more models were used.


The AOM was found to be effective in developing teaching competence among student teachers under simulated as well as classroom conditions (Gupta, 1991). Kaushik (1988) studied the long term effect of Advance organizers in relation to reading ability, intelligence and scientific attitude of the learners found that the general introduction or an overview, which generally precedes learning
material, is less effective as compared to a the advance organisers. Ghosh (1986) found that Prose passage type and pictorial type advance organisers facilitated the retention of Life Science subject matter even after an interval of four weeks.

Borne (1982) found that the use of advance organisers had a significant effect on delayed retention level readers but no significant difference in the case of above level readers. Noel (1983) found that while students benefit from systematically designed instruction to teach rules, advance organisers incorporated in that instruction do not necessarily enhance learning transfer. Alexander (1984) arrived at an inference on the correlative effects of learning style preference on learning when an advance organiser was used. He found that while an advance organiser was used, it did not account for any variability in the achievement scores. Carnes (1985) found no significant difference in achievement or retention when advance organisers were used. Swarup et al (1987) and Drowning (1994) both obtained the result that the instructional material with advance organisers more effective.

Mehra (1986), Salvi (1991) and Jang (1995) found that the pupils taught through CAM gained significantly more than those taught through traditional methods. Johnson et al (1992) evaluated that students get experience in conceptual thinking when concept attainment model is used, as the students work together upon the shared meaning of the concept and then reflect their thinking.
Nelson (1995) constructed an instructional program to study the effectiveness of CAM using video disc images and hyper cards and found concept attainment model more effective than the lecture method. Pritchard (1994) had the view that the concept attainment model helps students to develop skill for inductive and deductive thinking while learning subject matter in any field in constructive meaningful way. Also the model offers the teachers a method for teaching, thinking across the curriculum using the subject matter of the discipline they teach.

Aggarwal and Mishra (1988) studied the effectiveness of the Reception strategy in enhancing the attainment of science concepts and found it top be effective, while Manocha (1991) studied Reception as well as Selection strategies in comparison to the conventional method for teaching concepts in Biology. The findings indicated no significant difference between the two strategies with respect to achievement scores.

D’lima and Suvarna (1990) compared the effectiveness of the reception and selection strategies of concept attainment model in teaching mathematics. The study revealed that the reception oriented model is more effective than the selection oriented model in teaching mathematics. According to Louvet (1988), the strategies of CAM- the Reception, Selection and Unorganized materials- are effective in second language instruction.
Chaudhury (1989) investigated and found that the teaching skills and competence developed among student-teachers through the use of CAM are easily transferable to other teaching situations, besides the teaching of concepts.

When Anuradha and Anand (1993) studied the impact of CAM on mental ability and general ability of Social Science Students and found it more effective than the traditional methods, Prabhakaran and Rao (1998) reached at the same result in teaching of Mathematics. But Ayishabi (1996) compared the effect of CAM and traditional method in teaching zoology at +2 level and found that there was no significant difference in the attainment of concepts in the selected topics between experimental and control groups. Gough (1991) found that CAM of instruction is one of the most effective methods to develop student higher order thinking skills.

Bawa’s study (1991) attempted to review the research possibilities on conceptual learning (Bruner’s view) and indicated that there is a dearth of research studies in the area of concept learning. Another review study (Khan & Siddiqui, 1992) on effectiveness of concept attainment strategies came up with the findings that the concept attainment strategies were effective over the traditional approach and that personality factors have no significant effect on the concept attainment process.
Singh (1994) compared inductive thinking model with traditional method of teaching Economics to class XI students. Santhoshkumar (2004) in his study made an effort to determine the impact of inductive thinking model on the learning of Physical Science with reference to knowledge, understanding, application and retention of information levels. The result showed that the inductive thinking model is superior to ordinary classroom practices followed in Physical Science instruction like verbal illustration and demonstration with respect to levels of learning namely understanding, application and retention of information. But it is not superior with respect to knowledge level.


Malhotra (1990), Martis (1990) and Kumari (1990) attempted studies on the effectiveness of synectic model.

There were some studies in which two or more models were used. There were some studies in which the effectiveness of two models has been compared. The studies by Sood (1990), Jaimini (1991) and Mahajan (1992) compared AOM with CAM. CAM was compared with JIM (Mohanthy, 1992) with the inquiry training model (Singh, 1990) and with mastery learning by Vaidya (1990).

Mahajan (1992) found that during the peer group sessions as well as class room teaching sessions the group taught by CAM was found to be superior to the group taught by AOM as well as the routine method as far as the teaching ability of student-teachers was concerned. There were two studies (Kaur, 1991 and Jaimini, 1991) which aimed at comparing the effectiveness of CAM and AOM in relation to the creativity of students. They came to the conclusion that both CAM and AOM are effective in Economics and in Chemistry respectively and that AOM is more effective than CAM.

Another study (Sood, 1990) on comparative effectiveness of AOM and CAM for acquisition of language concepts in relation to cognitive style, intelligence and creativity reported that CAM was more effective than AOM in teaching of concepts in Hindi.

Bhaveja (1989a, 1989b) in her two studies compared the effectiveness of CAM with inductive thinking model in regard to the
concept learning in Biology and also analyzed the thinking strategies used by the learners. The two studies differed in their sample population and elaboration. The findings were quite similar in the two studies supporting the role of inductive thinking processes in the process of conceptualization and generalization.

Patil (1995) made a comparative study of the effectiveness of inductive thinking model and concept attainment model for teaching Marathi grammar. Instructional materials prepared by Buddhisagar (1987) based on operant conditioning model and advance organizer model for teaching Educational psychology was found to be equally effective in terms of achievement of students. Azis (1990) developed teaching programs in specified content areas in Chemistry to teach inductively through concept attainment model and inductive thinking model and compared it with the traditional teaching program. Result indicated the group based on information processing model performed significantly better than the pupils taught through lecture method.

Singh (1990) investigated the comparative effectiveness of inquiry training model and concept attainment model as compared to the traditional method in terms of gain in achievement scores and change in attitude of the pupils towards Physical Science. Both the models were found to be equally effective with respect to scores in achievement and attitude than the traditional method of teaching. The same result was obtained by Kumari (2002) also.
Sushma (1987) found both concept attainment model and biological science inquiry model significantly superior to conventional teaching in terms of pupil achievement. Pandey (1986) reported that both advance organizer model and inquiry training model were significantly superior to the traditional method in terms of pupil achievement where as all the three were equally effective in terms of pupils attitude towards Social Science.

Gupta (1991) found inductive thinking model more effective than the concept attainment model when compared on achievement and also in promoting right attitude towards Science. Mohanty (1992) compared jurisprudential inquiry model with concept attainment model in the development of moral concepts and judgment and the personal values of class VIII pupils. The findings indicated JIM more effective for developing the moral judgment and the personal values of students where as CAM was effective in developing moral concepts.

Viney (1992) found computer model of teaching to be superior to the concept attainment model for teaching concepts in mathematics and for inculcating positive attitude towards mathematics.

Vaidya (1990) studied the effect of mastery learning and concept attainment model on achievement in Hindi and self-concept and attitude towards Hindi of upper primary school children. Mastery
A review study of research on the information processing models of teaching was carried out by Sau (1988). Findings indicated that most of the studies were one-dimensional although the concept was multi dimensional. Eggen et al (1979) listed that the major goals of Information Models in the class room are the following 1, the development of intellectual capabilities such as the ability to reason and think more logically.2, the acquisition of content and 3, the mastery of methods of inquiry. Shineman (1980) investigated the effect of information behavior on student teachers having similar or different conceptual level on the initial and final information processing behavior. Significant difference was found between high and low conceptual level student teachers on information processing ability.

Remadevi (1998) reported from her study that students taught through information processing models of teaching were found superior to the students taught through the traditional method of teaching with respect to achievement and attitude towards Chemistry.

Saminathan (1999) studied the effect of information processing approach on developing problem solving ability in physics. Mary (2001) concluded from her study that information processing models of teaching is more effective than the teacher centered conventional method in teaching Geography. The result was significant with respect to the immediate post test scores as well as in the delayed post test scores. AOM was found to be more effective than the other two models.
3.2 Application of Psychological Theories in Mathematics Education – A Historical Perspective

It was very interesting to find and report the application of different theories of psychology in the field of teaching mathematics. It starts from the application of Thorndike’s behaviouristic theory in the early twentieth century to the application of information processing theory of recent times.

In the 1920’s Thorndike’s theories significantly influenced the design of the elementary arithmetic curriculum. Instruction based on behaviourist principles tended to fragment the curriculum into a number of isolated parts that could be learned through appropriate reinforcement (Becker and Carnine, 1980).

Initial attempts to apply behaviourism to instruction were opposed in 1935 by Brownell and others who argued that effective instruction in Mathematics needed to be grounded on understanding of basic concepts of mathematics. But they did not develop a comprehensive theory that could specify criteria for developing instruction to further understanding. Principle of Gestalt psychology also suggested instruction to be based on understanding but that theory also provided little guidance regarding the design to promote understanding.

In the 1960’s several theories of learning and development emerged that promised to provide a more direct link between learning
theories and the teaching of Mathematics. The theories of Ausubel (1968), Bruner (1960, 1966) and Gagne (1965) focused explicitly on the structure of the content to be learned. From a different perspective, Piaget [Piaget, 1952; Piaget and Inhelder, 1956] proposed a theory of development of the foundations of basic number, measurement and geometric concepts (Shulman; 1970). Logical operations that Piaget described seemed on face value to underly much of the basic mathematics taught in the primary grades. A number of studies attempted to empirically establish how Piagetian logical operations were related to the learning of mathematics concepts (Hiebert and Carpenter, 1982).

Although performance on Piagetian tasks has consistently been found to be correlated with arithmetic achievement, Piagetian logical operations have generally not proved helpful in explaining children’s ability to learn most basic mathematics concepts and skills (Hiebert and Carpenter, 1982).

The theories of Ausubel, Bruner and Gagne could be applied more directly to the curriculum, than could Piaget’s theories. It was Gagne who provided the clearest specification of how the mathematics curriculum could be analyzed and researched (Case and Bereiter, 1982). Gagne’s task analysis provided a framework for systematically organizing a content domain into a hierarchy of principles, concepts and skills. Task analysis was used in the design of several elementary
Review of Related Literature

mathematics projects including Individually Prescribed Instruction (Lindvall and Bolvin, 1967) and developing mathematical processes (Romberg, Harvey, Moser and Montgomery, 1975) and the careful specification of relationships between different principles, concepts and skills is reflected in present analysis of mathematics content. Rational task analysis, which is based on a logical analysis by experts, has evolved empirical task analysis, which focuses on what children actually do when they solve mathematics problems.

In the 1970’s a new approach to the study of human thinking began to gain widespread support – Information Processing Approach. They describe thought processes in terms of symbol manipulation (Siegler, 1983). They focus on the processing and representation of information and they attempt to achieve a high degree of precision in describing cognition.

Researchers in information processing have been concerned with more complex cognitive operations. This type of research appears to have the greatest potential for understanding how mathematics is learned.

Wittrock (1974) was one of the first to point out the broad implications of the developing field of cognitive science for research in mathematics education. It emphasises the processes that children use in doing mathematics and a careful analysis of the specific domain in which the research is conducted.
Most recent cognitive research in Mathematics has focused on the processes that children use to solve certain kinds of problems. It is generally agreed that some sort of structure is imposed on concepts, stored in long-term memory (Anderson and Bower, 1973). The particular structure is important because the central problem in remembering is retrieving concepts from long-term memory. If there is a rich structure, concepts will be more accessible and can be accessed in chunks which allow related concepts to be used more efficiently in problem solving.

Chi et al (1982) concluded that problem solving deficiencies of novices can be attributed primarily to limitations in their knowledge base rather than to lack of general problem solving skills. In general, it appears that it is important to stress relationships between concepts, especially higher order relationships that are related to ways the concepts may be used to solve the problems.

Schoenfeld (1980, 1983) and Silver (1982) argued that it is necessary to consider metacognitive aspects of performance as well. Metacognition refers to knowledge about one’s own thought process.

3.3 Studies Based on Application of Different Strategies in Teaching Mathematics

This section includes recent studies related to the application of different strategies in teaching mathematics. The studies on how
mathematical interest and attitude towards mathematics are affected by the application of different strategies are also given in this section.

Yadav (1984) found that achievement in mathematics taught through mastery learning strategies was significantly higher than that of conventional method. Chitkara (1985) found that achievement in mathematics was affected by different strategies of teaching. The different strategies adopted were found to be equally effective in terms of achievement in mathematics disregarding levels of intelligence, sex and personality type.

When Rao (1986) found that there was no significant difference in problem solving ability and in the achievement of mathematical concept when taught by the guided discovery approach and by the expository approach, Bhalwankar (1985) found that they are equally effective on knowledge and comprehension objectives with respect to the immediate post test as well as retention test and that expository method was more effective than the guided discovery method on the criterion scores on application objectives. Norwood’s study (1995) showed cooperative learning and problem solving had a significant effect on mathematical success.

Marsh and Cooke (1996) conducted a study on third graders with a history of low achievement in math. They were first given verbal (abstract) instruction in solving word problems. Students were then introduced to manipulatives instruction using Cuisenaire rods to
set up word problems. Students exhibited immediate and sustained improvement on subsequent probes administered without manipulatives available.

Woodward and Baxter (1997) conducted a year-long study of an innovative approach to mathematics, which emphasized in-depth problem solving and achievement of automaticity through math games, found such methods to be viable for students with average and above average academic abilities, but students with learning disabilities or at-risk students need much greater assistance if they are to be included in general education classrooms.

An experimental study conducted by Oladunni (1998) focuses on the effects of the application of two problem-solving techniques - metacognitive and heuristic - on the achievement of students in the computation of creative mathematics problems. Results indicate that there was a significant difference in the achievement of experimental and control groups.

Mevarech (1999) compared the effects of three cooperative-learning environments on Israeli seventh grader’s mathematical problem solving (metacognitive training, direct strategy instruction and neither). Pencil-and-paper testing assessed student’s problem-solving abilities. Results indicated that students exposed to metacognitive training significantly outperformed their counterparts.
who received strategy instruction, who in turn significantly outperformed students who received neither training.

Shyu (1999) found that computer-assisted video-based anchored instruction was more important than media attributes in the teaching of problem solving among the Taiwanese elementary students studied.

The report by Blume et al (2001) describes the effect of integrating math and science and employing technology to bridge the gap. Post intervention data indicated strengthened mathematical computation skills, increased problem solving skills, and increased student interest.

Autry (2002) conducted a study to examine first-grade student’s achievement in mathematics and attitudes towards mathematics using different instructional approaches. Results indicate that there is no significant difference on achievement tests between the constructivist approach and the direct instruction approach.

Kariuki and Wilson (2002) examined the effects of motivational teaching strategies and traditional teaching strategies on academic achievement and student attitudes toward mathematics. The results showed a significant difference in teaching strategies on academic achievement and in student attitudes toward mathematics.

Vaughan (2002) investigated the effects of cooperative learning on achievement in and attitudes towards mathematics among fifth
graders of color in a culture different from that of the United States. Result indicated that participants made positive gains in mathematics attitudes and achievement.

Jayaraman (2003) found that high achievement is possible in learning fractions in mathematics at upper primary level due to the application of the activity-centred as experimental approach when compared with the conventional approach.

The study by Cass et al (2003) evaluated effects of manipulative instruction on perimeter and area problem-solving performance of high school students with learning disabilities in mathematics. Students rapidly acquired the problem solving skills, maintained these skills over a two-month period, and transferred the skills to a paper-and-pencil problem solving format.

Jothikani and Thiagarajan (2004) found that conventional method is more effective and efficient than the Computer Assisted Instruction method on the achievement in Mathematics.

The purposes of the study by Fuchs et al (2004) were to assess the effects of schema-based instruction (SBI) in promoting mathematical problem solving and to investigate schema induction as a mechanism in the development of mathematical problem solving. Students receiving SBI, improved more than the contrast group on problem-solving measures. SBI group’s schema development exceeded that of the contrast group.
The study done by Chung and Tam (2005) examined the effects of different approaches to teaching learners with mild intellectual disabilities to solve mathematical word problems. Students presented with worked example and cognitive strategy instruction solved more problems correctly and generally outperformed students presented with conventional instruction in both immediate and delayed tests.

When an experimental group was taught geometry concepts using drama and the control group using the traditional instruction, Kariuki and Humphrey (2006) found significant difference between the academic achievement of experimental and control groups. No difference was found in the interest and attitude toward math between experimental and control groups. Finally, no significant relationship was found between academic achievement and interest and attitude towards math.

3.4 Studies Based on Achievement and Problem Solving in Mathematics

This section includes recent studies done in the area of mathematics teaching other than the application of different strategies.

Association between computational ability and high achievement in problem solving was revealed by Englehardt (1982). Tyler (1983) found that boys performed better in mathematics while girls frequently performed better on computation. Marshall (1984)
conducted a study on a sample of 30000 sixth grade children in California. It was found that girls were more likely than boys to solve computations successfully and those boys were more successful with story problem.

An investigation by Bloor Phobe (1988) confirmed that instructional program integrated with conceptual and procedural knowledge improved students’ ability to solve word problems.

Akpan (1991) found that cognitive abilities exerted the strongest and the most significant total effect on students’ problem solving ability and students’ affective behavior had no direct causal impact on their ability to solve problems in mathematics.

Rangappa (1993) made an attempt to estimate the effects of reading ability on mathematical achievement of pupils of grade vii. The study comprised of 1000 subjects who belonged to rural and urban locales of Bangalore district. Significant difference was found in the achievement of high and low reading ability groups in favor of the high ability group.

Gowrikutty (1993) attempted to ascertain ability correlates of secondary school mathematics achievement measure using Bloom’s taxonomy with a specific reference to cognitive domain. The study provided confirmed evidence of association between ability variables and different cognitive achievement variables although association varied from one structure to another.
Thampuratty (1994) examined the effects of the variables including creativity, attitude towards problem solving and social position on achievement in mathematics. Positive high and significant relation existed between attitude towards problem solving and achievement in mathematics. Nagalakshmi (1996) found significant difference in the problem solving ability in mathematics of students of rural and urban areas in favor of the latter group but no sex difference found in the problem solving ability.

Rabinowitz and Woolley (1995) examined the hypothesis that problem comprehension and computational process interact during the solving of arithmetic word problems. Results suggested the absence of any interaction between the two processes.


Kaplan and Patino (1996) described a method for teaching mathematical problem solving for use with students with limited English proficiency. The five key components of the method are; (1) provide a linguistic warm-up to problem; (2) break down the problem into natural grammatical phrases; (3) students work out the problem in pairs; (4) students present their own solutions to the group; and (5) students create problems with similar structures. Study results
indicated that students became more successful independent mathematical problem solvers.

Wilkins (1997) attempted to determine the effects of a resident mentor teacher on student achievement in mathematics. It is concluded that utilizing a mentor model where a master teacher trains resident mentor teachers results in higher student mean scores when compared with means scores of non-mentored students. This paper also contains additional evidence that the model helps increase student interest level in mathematics and increases teacher enthusiasm for teaching.

Card (1998) examined the levels of achievement and metacognition in expressing mathematics understanding and problem solving processes by students in a second grade classroom when the students used writing in daily mathematics learning according to their scores on a mathematical problem solving assessment and individual interviews. This paper concludes that through daily writing activities that involved expressing mathematics thinking, problem solving and the creation of word problems, students’ mathematics achievement and metacognition increased.

Davenport and Howe (1999) investigated the effect of children solving addition and subtraction problems collaboratively in contrast to solving problems on their own and explored the effects of ability and gender on the outcomes of group collaboration.
Yusof (1999) studied the effects of a course encouraging cooperative problem solving and reflection on thinking activities on students’ attitudes. Reported that a majority declared negative attitudes but during the problem solving course, the changes were almost all in the desired direction.

Capraro (2001) conducted a study to determine the effects of teacher beliefs measured by the Mathematics Beliefs Scales on the problem solving skills of fourth and fifth grade student. It was determined that the achievement in problem solving was higher when the students were in classrooms of teachers who had higher constructivist beliefs.

The study done by Leonard and Derry (2001) investigated whether adapting instructions to gender-type preferences can improve the attitudes of students, especially female students and their performances in mathematics. The study found no effect on performance of problem context sex stereotype.

Longitudinal investigation done by Ma and Cartwright (2003) of gender differences in the rate of change in mathematic affect (attitude and anxiety towards mathematics) across middle and high school. The study found no gender differences in the rate of decline in attitude but females grew faster in anxiety than males. Perels et al (2005) found that it is possible to improve mathematical problem solving through short trainings.
In conclusion, we are cautiously optimistic about the potential for meaningful change in the teaching of mathematics. The dramatic advances in technology will almost surely force change both in what mathematics is taught and in how it is taught. Research on learning and research on teaching are on the threshold of providing the kinds of knowledge that could lead to real advances in mathematics instruction. Change is inevitable. If we can build upon a solid knowledge base derived from research on teaching and learning the change could result in real progress in the teaching and learning of mathematics.