Chapter I

INTRODUCTION

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INTRODUCTION

Learning is the business of education. Inherent in it is acquisition of knowledge and skill through a systematic study or experience. Learning therefore necessitates growth and growth is change. Since educators are responsible for planning and carrying forward this systematic process, they must orchestrate environments conducive to learning.

If the goal of educators is maximised learning for each student, the end result of teaching efforts must be successful planting of long-term retrievable memory. We teach a content or skill not because it is important for ninth standard but because it is important for life.

Learning results from the interaction of brain and body processed with a backdrop of external and internal condition, a sort of dynamic intelligence (Sylwester, 2000). An experience, and hence memory is more than the sum total of sights, sounds, taste, smell or the feel of the world. If it was, we would all play the same music, dread the same activities, love the same colours, and enjoy the same vegetables. There would be no need for different political parties and little need for different points of view. What all humans would need is reality and they would arrive at the same conclusions!

Learning is not just amassing a huge body of trivial information but acquiring knowledge and skills that can be transferred to real-life
situations. Student must be capable of applying concepts beyond the classroom, beyond the context of summative assessment.

For years, it was believed that meaning was constructed by assembling bits of inputted information into a whole, much like puzzle pieces fit together. The brain is likely more adaptive than that when processing information to construct meaning. Cognition (knowing) is closely related to action. For learning to have meaning it requires the interaction of current sensory input with neuronal networks (sensorimotor memories) that exist from earlier and somewhat similar experiences.

Learning for life, then, comes when tasks require children to form and experience strategies in problem solving. The result provides a rich cache of behaviors from which to choose – and deepens understanding of concepts.

To expect a child to automatically connect ideas or skills to the real world is unrealistic, as the average 13-year-old is not eager to employ formulas for surface area. Instruction must bridge that gap to help students see the usefulness of the facts, so the student who passes the math test with flying colors is not dumbfounded when he or she is asked to create a 25-square-foot stage set in language arts class. Finding meaning and application in one’s life changes the purpose of knowledge from isolated trivia to a useful tool.

The twenty-first century is a thinking century. Career projects and adult tasks are often so complex that they require the
collaboration of many skilled people to reach creative solutions. Thus, individual mastery and replication of a static body of information is no longer adequate for maneuvering in the world of work. Tomorrow’s adults will need to apply an ever-expanding body of information in new, unique scenarios to strategize and discover solutions to arising dilemmas. Skill is taken to a new level: one of problem solving, creating and applying. Dynamic intelligence!

Even more than the politician, the educationist must be prepared for the probable trend of events; for on him lies the responsibility of training the next generation to face those events.

1.1 Why Teach Mathematics? Why Learn Mathematics?

There are likely to be few more important jobs at the beginning of the twenty-first century than that of a mathematics teacher. Knowledge in many of the key contemporary growth areas, and the ability to harness them for the benefit of humanity, requires a competence with the appropriate underlying mathematical ideas. These key areas include:

- the software and hardware associated with information and communication technology;
- finance and economics, including the control of risk;
- design in a variety of fields, from machinery to fabrics, and from graphics to architecture;
all branches of science, from the biotechnology of genetic engineering and medicine to the physics of cosmology; 

- the quantification of performance, and the statistics and modelling involved in research and development in all fields.

For children to be able to hold their own in the new century, it is thus critical that they have an appreciation of, a competence in manipulating, and a positive attitude towards, the big mathematical ideas that are central to the functioning of our global culture. This means understanding the development of these ideas by individuals and groups within particular social contexts, and enjoying the elegance and beauty of their patterns and symmetries for their own sake, as well as an ability to participate in the implementation and the shaping of future advances which rely on them.

Because of the increasing impact of technology on society, more people than ever must use mathematics to solve problems in daily situations. Concern has been expressed in numerous reports that our past methods of teaching school mathematics will not produce enough quantitatively literate citizens needed for the increasing number of technologically based careers of the present century. The Mathematics Sciences Education Board and National Research Council (1990) emphasized this view in their statement, “More than ever before, we need to think for a living; more than ever
before we need to think mathematically”. These reports along with the National Council of Teachers of Mathematics’ Curriculum and Evaluation Standards for School Mathematics (1989) have recommended that instruction in elementary school mathematics shift from a skill oriented, teacher-directed approach to one in which students are actively involved in searching for patterns, experimenting with their own conjectures, describing and evaluating quantitative and spatial situations, making decisions under uncertainty and so on. All of these activities can be thought of as problem-solving experiences in which the teacher acts as a facilitator and resource while students construct their own understanding from their own experiences.

Mathematics teachers have a significant part to play in ensuring that the next generation is both excited and well-equipped. The job is uniquely challenging in requiring familiarity and engagement simultaneously with the unsullied abstraction of mathematics and the sometimes crude realities of classes of teenagers. Successful beginning together of these diverse worlds is at the same time uniquely rewarding and very worthwhile. The teacher should be the one who inspires young people to learn and to enjoy learning mathematics.

1.2 Information Processing Strategies

Research has identified a number of links between effective teaching and improved learning. Increased emphasis is being placed
on the development of critical thinking skills. Cognitive psychologists continue to unravel the mysteries of learning and memory through the use of research focusing on the information processing strategies of learners. So the importance of students’ active involvement in the learning process is increasingly apparent.

Cognitive psychologists are of the view that by encouraging students to process information meaningfully, we can help them construct an understanding of the world around them and apply what they have learned more easily to new situations.

From an information processing perspective, the degree to which students learn from expository instruction is a function of how they process information. In other words, it depends on the particular cognitive responses they make. The more students pay attention, and the more they engage in meaningful learning, organization, elaboration, and so on, the more they are likely to benefit form the lectures they hear and the textbooks they read.

As teachers, we can facilitate students’ concept learning by placing concepts in a larger context by explaining how each one fits into the larger scheme of things. In doing so, we help students make some educated guesses as to what the defining correlational and irrelevant features of any given concept are likely to be. Effective learning occurs when students are actively involved in organizing and finding relationships in the information they encounter rather than being the passive recipients of teacher-delivered bodies of knowledge.
This actively results not only in increased learning and retention of content but also in improved thinking skills. Teaching strategies based on information processing theory require that learners become active participants in the learning process. These strategies ask students to observe, compare, find similarities and differences and to form concepts and generalizations, based on the similarities.

If students are to be drawn into and involved in information strategies, they must be provided with data to process. They cannot think in a vacuum. A second characteristic of this approach to teaching is the providing of materials which serve as the focal point for the thinking and interaction in the lesson.

An orientation towards problem solving is the next characteristic of the information processing approach. Rather than simply teaching algorithms at a rote level, we must instead help students understand why they do the things they do to solve problems. (Greeno, 1991; Hiebert & Wearne, 1993). When we talk about student’s knowledge and beliefs regarding their own cognitive processes and when we talk about students attempt to regulate their cognitive processes to maximize learning and memory, we are talking about metacognition. The more students know about effective learning strategies – the greater their cognitive awareness- the higher their classroom awareness is likely to be. (Baker, 1989; Perkins, 1995). In each instance students were asked to find patterns in the
information through their own investigation and analysis. With continued practice in these processes, students learn not only the content of the lesson but also develop their thinking skills.

Information Processing Models are teaching strategies based on information processing theory that are designed to help students to learn content at the same time as they practice thinking skills under the guidance and direction of an active teacher. They are designed to realize specific instructional goals. Different models are required to realize different instructional goals.

1.3 Need and Significance of the Study

After leaving primary classes behind last year, twelve-year old Reggie is adjusting easily to high school. He has new friends and established good working relationships with his teachers. He has high grades in almost every subject. But Reggie has a problem—mathematics.

Reggie knows the usual routine of Ms. Jain’s math class. After reviewing the previous night’s home assignment, Ms. Jain explains a new concept (e.g. central angle, sector) or demonstrates a new procedure (e.g. finding the area of sector). She then assigns several in-class exercises through which students can practice the things she has taught them. Finally she hands out the home assignment for the following day.

Reggie knows that mathematics is important, so he attends closely to each day’s procedure and works diligently at his in-class
exercises and home works. Yet despite his efforts, Reggie is feeling completely lost in math class.

“I am getting farther and farther behind”, he complains to his friends. “I am not sure what I am supposed to be learning, but whatever it is, I obviously haven’t learned it”. Why is Reggie experiencing difficulty in his mathematics class?

Mary is studying for tomorrow’s test in her math class. As she looks over her class notes, she finds the following formula in her notebook. \( C=2\pi r \) and \( A= \pi r^2 \), where \( r \) is the radius, \( A \) the area and \( C \) the circumference of the circle. Mary memorizes the formulae until she knows them by heart. The following day, Mary encounters this problem on her mathematics test: “A circular dining table has radius 1.3 m. What length of wooden rode should be bought to make a border around its edge?”

Mary puzzles over the problem for several minutes. What is to be found out here, area or circumference? She realizes she does not know the difference between area and circumference. She finally turns in her test with this and several similar questions unanswered. She later confides to a classmate, “I really blew the test today, but I don’t know why, I mean, I really studied hard!”

The critical mistake that Mary made in studying was not mastering the concepts correctly. As a result she could not apply her knowledge in a meaningful way.
Reggie and Mary are the true representatives of present-day secondary school students who are the victims of faulty methods of teaching mathematics. What measures can be taken to save them so that they become equipped with the right skills and attitudes which enable them to face the challenges of the twenty first century? How can they be helped to transfer the acquired knowledge and skill to real life situations?

Problem solving is the main goal of teaching mathematics. All successful engineers, scientists, social scientists, lawyers, accountants, business managers, ministers, and so on, have to be good problem solvers too. Because of the universal importance of problem solving, the main professional group in mathematics education, the National Council of Teachers of Mathematics, recommended in its 1980 ‘An Agenda for Action’ that “problem solving be the focus of school mathematics.” What strategies can be adopted so that the students become effective problem solvers?

What steps can be taken by the mathematics teacher so that the students get equipped with the skill of logical thinking and reasoning which will enable him to meet the demands of tomorrow? How is it possible for a mathematics teacher to develop in secondary school students an interest in and a positive attitude towards mathematics? It is the urgent need of the hour to find solutions to the questions mentioned above.
The investigator hence reviewed the studies and literature related to this area and became familiar with many interesting findings and also with the gaps that exist in this area. These findings gave light on how an effective kind of learning can take place in students and that eventually lead to the formulation of the research problem.

Bochenhauer (1990) and McKeown & Beck (1990) found that the focus of most school textbooks is on teaching specific facts, with little attention to helping students learn these facts in a meaningful fashion. Ausubel et al (1978) and Mayer (1987) found that information learned in a meaningful fashion is more likely to be transferred or applied to a new situation.

By using an analogy to compare new material to things with which our students are already familiar, we can help them store that material more meaningfully and retrieve it more easily (Donnelly & McDaniel, 1993; Newby et al., 1994; Zook, 1991). At the same time, we must be careful to point out ways in which the two things are different; otherwise, our students may take an analogy too far and draw some incorrect conclusions. (Duit, 1990; Zook & DiVesta, 1991).

Students tend to learn more effectively when they are given advance notice of the things they will be learning and how these things are interrelated. Students also tend to benefit from summaries presented at the end of a verbal lecture or written passage: they learn
more effectively when they hear or read a synopsis of the information they have just studied (Hartley & Trueman, 1982).

When children begin to learn a particular concept, they are often led astray by correlational features, thinking that such features are essential for concept membership (Keil, 1989; Mervis, 1987). Thus it is not surprising to find pupils omitting squares from their concept of rectangles because most rectangles have widths unequal to their lengths.

People typically learn a concept more easily when they are shown several positive instances (Barringer & Gholson, 1979; Tennyson & Cocchiarella, 1986). We should present as many examples of a concept, including as many different examples, as space and time constraints allow (Merrill & Tennyson, 1978). It is certainly more helpful to see what a concept is than what it is not.

The investigator has rightly found that all these findings regarding the meaningful learning of concepts are actually incorporated in the Information Processing Models of teaching like Concept Attainment Model, Advance Organizer Model and Inductive Thinking Model.

The Inductive Thinking Model is a straightforward but powerful strategy designed to develop the thinking skills of observations, thinking, finding patterns and generalising while at the same time teaching specific concepts or generalisations.
The Concept Attainment Model is an inductive thinking strategy designed to help students of all ages learn concepts and practice analytical thinking skills. Advance Organiser Model on the other hand is designed to help students to structure knowledge.

Mathematics is a science and a meaningful study of mathematics is based on the perfect understanding of its fundamental concepts. It is a discipline which is abstract in nature. Even the simplest and very basic concepts like numbers addition etc. are very abstract. We cannot perceive them directly. Mathematics has its own language which includes various symbols and signs. Like other languages, it has its own grammar. But this language is far more abstract than other languages. The teachers need to select, combine and integrate various theories and values for the effective teaching of it.

Mathematics, being a subject full of abstract concepts, principles and processes can be taught most effectively through the application of the above mentioned models of teaching namely Concept Attainment Model, Advance Organizer Model and Inductive Thinking Model. The students can learn to reach at clear understanding of concepts through Concept Attainment Model and generalisations through Inductive Thinking Model. Meaningful relationships among concepts can be understood by using Advance Organiser Model. These models can be used in combination so that
teaching could become a multi-faceted, more purposeful and dynamic activity to achieve the various goals of education.

A number of studies were found in the area of Models of Teaching. Majority of them compared the effectiveness of one model with another model or with the conventional method of teaching. [Singh (1990), Kaur (1991), Jaimini (1991), Mohanthy (1992), Remadevi (1999), Gupta (1991) Santhosh (2004), Minikutty (2005) etc.]

The application of different models of teaching for the realisation of specific instructional goals was rare. Combined use of different models was not attempted in mathematics. Hence the investigator has decided to apply three different models of teaching in an integrated manner and to find its effectiveness in teaching mathematics. Thus the present study is a hopeful attempt towards better mathematics learning as well as teaching.

1.4 Statement of the Problem

The present study is undertaken with the objective of testing the effectiveness of Information Processing Models over the Activity Oriented Method of teaching mathematics at secondary level. Hence the study is entitled APPLICATION OF INFORMATION PROCESSING MODELS IN TEACHING MATHEMATICS AT SECONDARY LEVEL.
1.5 Operational Definition of Key Terms

1. Application

Application is the act of turning into practical use. (New Webster’s Dictionary and Thesaurus, 1991)

2. Information Processing Models

Information Processing Models are teaching strategies based on information processing theory that are designed to help students learn content at the same time as they practice thinking skills under the guidance and direction of an active teacher. [Eggen & Kauchak, 1988]. In the present study, the investigator has selected only three Information Processing Models namely, Concept Attainment Model, Advance Organiser Model and Inductive Thinking Model.

3. Secondary Level

Secondary level as used in the study refers to students attending standards VIII, IX and X in schools of Kerala. For the present study, the investigator has selected students of standard IX.

1.6 Objectives of the Study

1. To compare the effectiveness of Information Processing Models with the Activity Oriented Method on the Total Achievement in Mathematics of the secondary school students.

2. To compare the effectiveness of Information Processing Models with the Activity Oriented Method on the Achievement in Mathematics of the secondary school
students with respect to categories of objectives such as Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

3. To compare the effectiveness of Information Processing Models with the Activity Oriented Method on the Problem Solving Ability of the secondary school students.

4. To compare the effectiveness of Information Processing Models with the Activity Oriented Method on the Mathematical Interest of secondary school students.

5. To compare the effectiveness of Information Processing Models with the Activity Oriented Method on the Mathematical Attitude of secondary school students.

1.7 Hypotheses

Keeping in view the objectives of the study, following hypotheses were formulated.

1. The Total Achievement in Mathematics of secondary school students taught using Information Processing Models is significantly higher than that of students taught using the Activity Oriented Method.

2. The Objective-wise Achievement of secondary school students in Mathematics taught using Information Processing Models is significantly higher than that of students taught using the Activity Oriented Method.
3. The Problem Solving Ability of secondary school students taught using Information Processing Models is significantly higher than that of students taught using the Activity Oriented Method.

4. The Mathematical Interest of secondary school students taught using Information Processing Models is significantly higher than that of students taught using the Activity Oriented Method.

5. The Mathematical Attitude of secondary school students taught using Information Processing Models is significantly higher than that of students taught using the Activity Oriented Method.

1.8 Methodology in Brief

The study was conducted by using experimental method. Experimental verification was necessary to determine the effectiveness of the Information Processing Models of teaching over the Activity Oriented Method. The design selected was pre test-post test non equivalent group design.

Four schools were selected from Kottayam and Pathanamthitta districts, giving due weightage to sex, locale and type of management. Two divisions of standard IX were selected from each school out of which one was taught through the Information Processing Models of teaching while the other was taught through the Activity Oriented Method.
1.8.1 Tools Used

The investigator prepared lesson transcripts based on Information Processing Models of teaching from the two major units Mensuration of circles and Solids from mathematics textbook of standard IX. Lesson transcripts based on Activity Oriented Method were also prepared from the same units. All the necessary support systems were developed for the teaching to be effective in all respects. The investigator has developed and standardized an achievement test and a test of problem solving ability which could be used as both pre test and post test. A mathematical inventory prepared and standardized by Prasannakumar and a mathematical attitude scale prepared and standardized by Desai were also used in the study.

The investigator herself conducted classes in both the groups. Before the experiment, pre tests were conducted by administering the achievement test, test of problem solving ability, mathematical interest inventory and mathematical attitude scale in both the groups. After the experiment, all the four tests were administered again to both the groups as post tests.

1.8.2 Statistical Techniques Used

The scores obtained by the students in the pre test and post test were classified and subjected to statistical analysis. This included comparison of mean scores and standard deviation with a view to arriving at a rough estimate of the comparative effectiveness
followed by more precise comparison made using the technique of analysis of covariance.

1.9 Scope and Limitations of the Study

The major scope of the study is the evolving of a new instructional strategy to teach mathematics at secondary level. The combined use of concept attainment model, advance organiser model and inductive thinking model for the realization of specific objectives is the new strategy adopted here. Enhancement of specific type of thinking is made possible through the use of such a strategy. This strategy can help the secondary students to learn more meaningfully and effectively the content of mathematics which is usually abstract in nature.

The findings of the study would help the curriculum planners and those who are related to the field of education to understand the necessity and effectiveness of the application of this new strategy in the teaching of mathematics.

It is further hoped that the procedure adopted for the present study is adequate to throw light on the problem under investigation. Two major units of standard IX mathematics curriculum were taught by the investigator herself in both experimental and control groups. A sample of 310 students from 8 divisions of standard IX from four schools of Kottayam and Pathanamthitta districts was chosen. The statistical techniques adopted for the analysis of data were sufficiently comprehensive to obtain the results. On the basis of the
conclusions arrived at, relevant suggestions are put forth. It is hoped that they may serve as guidelines for teachers and students to make teaching and learning a more enjoyable task. In spite of all possible precautions taken up to get valid and reliable results, certain limitations have crept into the study.

Due to lack of time, the study was confined to only four schools from two districts. Also the students of standard IX were only considered from the set of secondary school pupils. The study would have been better if more models could be included in the study.

The shortage of experimental duration was another limitation.

The investigator selected the classroom intact groups for experimenting, as the one-to-one equalized group was not possible practically.

\subsection{1.10 Organisation of the Study}

The study is reported in six chapters

Chapter I contains a brief introduction, the need and significance of the study, statement of the problem, definition of key terms, objectives, hypotheses, methodology in brief and scope and limitations of the study.

Chapter II contains the theoretical background of information processing models of teaching

Chapter III presents a brief review of related literature and reported research findings pertaining to the area of study.
Chapter IV gives the description of the tools, sample used for the study, data collection procedure, scoring, consolidation of data and the statistical techniques used in the study.

Chapter V gives a detailed analysis of the data.

Chapter VI contains a summary of the procedure and major findings of the study together with certain suggestions for improving educational practices and some suggestions for further research.