CHAPTER 2

REVIEW OF LITERATURE

2.1 The Inadequacies of the Present Classroom Situation in the Teaching of Mathematics

In the teaching of Mathematics to children, the school is concerned with imparting to the child a large number of responses of a special sort. Skinner (1961) was of the opinion that the child usually does his homework to avoid or escape punishment which may take the form of the teacher's displeasure, the criticism or ridicule of his classmates, low marks, or a word to the parent who may resort to the cane. In such circumstances, getting the right answer is in itself an insignificant event, any effect of which is lost amid the anxieties, the boredom, and the aggressions which are the inevitable by-products of aversive control.

In the classroom situation, the reinforcement of being right is usually accorded by the teacher. The contingencies she provides are far from optimal. Unless explicit mediating behaviour has been set up, the lapse of only a few seconds between response and reinforcement destroys most of the effect (Skinner, 1961). One such example of delayed reinforcement by teachers - students' work are usually brought home by teachers to be corrected. This may cause a delay of at the very least 24 hours!

Another shortcoming is that the teacher is usually unable to provide reinforcement at each step of a complex Mathematical problem. This is because she cannot deal with the pupil's responses one at a time.

One of the most serious weaknesses of the classroom situation is the relative infrequency of reinforcement. This is because the pupil is usually dependent upon the teacher for being right and many pupils are usually dependent upon the same teacher! Skinner (1961) suggested that efficient Mathematical behaviour requires approximately 25,000 contingencies as opposed to the probable few thousand provided by the teacher over the same period of time.

Silverman (1960) was of the opinion that all classroom techniques have certain disadvantages in common. (1) Students are not instructed individually. (2) One student may be entirely passive, another active. (3) Careful organization of material is ineffective when the student is inattentive and passive. (4) Although a student may be responding to the material that is presented, he does not receive immediate information about the correctness of his response, nor is he able to proceed at his own rate.

From the point of effective teaching, the success of a curriculum depends heavily on the ability of the teachers implementing it. Nik Azis & Ng (1991), reported that a number of Form One and Form Two Mathematics teachers lack pedagogical knowledge regarding Mathematical education. According to the same report, some teachers also lack content knowledge of certain Mathematical topics. The report also revealed that the teaching of the Form One Mathematics syllabus is not satisfactory. The example cited was that by the end of the second term, on the average only five or six topics were covered. However, the syllabus has 11 topics.

The study conducted by Nik Azis & Ng (1991) revealed that there were problems with individualization of instruction in the classrooms. The students from the good classes feel bored as they did not feel that the lessons were challenging. This problem is because teachers tend to go through the lesson too slowly and follow the text-book strictly page by page. As for the students from the average classes, a number of them were weak in the basics of Mathematics and also weak in the Bahasa Malaysia language. As for the students from the weak classes, majority of them were weak in the basics of Mathematics, lacked self esteem, and also weak in the Bahasa Malaysia language. This situation is sadly different from what the Secondary School Integrated Curriculum (KBSM) intended it to be. The Curriculum Development Centre (1988) of the Ministry of Education is of the opinion that the learning of Mathematics should be a challenging and enjoyable experience for all students and due attention should also be given to the different rates of learning among students.

This is not to state that auto-instructional devices are generally superior to traditional methods of teaching. As learning requires motivation, information, practice, and transfer, then there is certainly a place for all methods.

2.2 The Concept, Characteristics and Potential of Programmed Instruction

In 1903, B.F. Skinner an American psychologist distinguished between the *elicited* behaviour (Pavlov's conditioning resulting from unobservable stimuli such as drives) and *instrumental* conditioning (Lottich, 1968).

While Skinner worked mainly with white rats and pigeons he eventually drew conclusions between his experiments and the training of human beings in other educational situations. The student must actually write in the missing words or, depending upon the nature of the device, make some other appropriate but constructive response. The student is constantly informed as to the accuracy of his responses.

According to Lottich (1968), teaching machines frequently exist as a complement to programmed learning. In some instances, programmed instruction was identified with the 'teaching machine' (Pipe, 1966). There were fears that these teaching machines would eventually replace the human teacher. On the contrary, Lottich (1968) was of the opinion that the teacher needs to be even more efficient and more technically educated. He thought that the teacher and his teaching machine could make a generally more superior 'team'. According to Silverman (1960), the term "teaching machine" is unsatisfactory. This is because the medium of instruction does not necessarily require actual machines; it also utilises programmed textbooks and paper-and-pencil devices. He favours the term "auto-instructional".

Programmed instruction was first designed for presentation with early teaching machines (Skinner, 1961), later printed for use as regular textbooks (Lumsdaine & Glaser, 1960), and finally displayed on the computer screen (Coulson, 1962), where they remain to this day (Steinberg, 1991).

Programmed instruction is a systematic instructional approach that focuses primarily on improving learning outcomes. Its potential lies chiefly in its inherent qualities that facilitate learning which is absent or lacking in conventional teaching situations (Koh, 1977).

Self-paced learning is possible with programmed instruction. Individual differences are expressed as differences in speed (Austwick, 1964). This individualised instruction is in contrast with the conventional teaching which is usually mass group teaching. This individualised instruction is possible with programmed instruction because it consists of careful and explicit description and analysis of desired learning outcome and subsequent careful sequencing of the content elements. The careful planning, development and control of instructional stimuli and environment to procure continuous and explicit responding from the learner under circumstances that allow him to obtain immediate confirmation of responses (Corey,1967). This, of course, is particularly reinforcing and helps to ensure mastery (Chuah & Myint, 1981).

According to Rowntree (1966), the longer one delays in telling the student how he has done, the less likely is one's telling to have any effect on the student. He is of the opinion that the time-lapse - hours, days, weeks - between the student thinking up his answers and getting to know his results is the great weakness of much of the 'marking' that gets done in schools. He advocates programmed instruction because in a programme, the student checks his own answer just as soon as he can turn a page or press a button. That way he is immediately aware of whether or not he is correct, and he gets a sense of progress.

Kulhavy & Wager (1993) classified feedback as: a) a motivator or incentive for increasing the rate or accuracy of performance; b) a "satisfying state of affairs," which according to Thorndike's Law of Effect automatically "connected" responses to preceding stimuli; c) as information which learners could use to validate or change a previous response.

At this point, feedback in programmed instruction had assumed its status not only as a reinforcer, but also as a motivator (Kulhavy & Wager, 1993). There is really no question that feedback increases lesson performance, provided that students process the instruction prior to seeing the feedback (Bangert-Drowns, Kulik, Kulik & Morgan, 1991). Feedback primarily acts as a unit of information, and has its greatest effect when it follows an incorrect response. The Computer Science Department at Central Connecticut State University (1997) stated that a student receives motivation when he has successfully answered a question, or has successfully completed a task. It can be depicted as in Figure 2.1. Answering a question successfully and the ability in making progress through the lesson motivates the student to attempt the next short lesson. Success begets success.

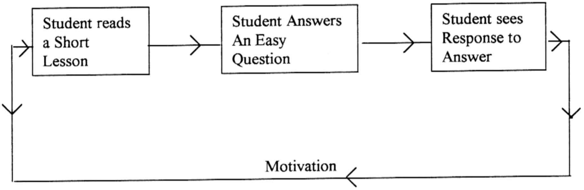

Figure 2.1: Programmed Instruction and Motivation

Programmed instruction makes it possible for independent study or self-instruction. Its characteristic of small steps, active participation and immediate confirmation of results allows the student the freedom to learn with or without minimal supervision by a live teacher. The successful student had probably learnt to free himself from dependency on immediate verbal feedback from the teacher and had probably become capable of sustaining self-responsibility in carrying out a programme (Wong, 1975). As for the teacher he is spared the tedious work of marking the pupils' answers.

Programmed instruction also has the potential of providing remedial teaching. This is often lacking in the conventional classroom teaching (Hodge, 1969). Rowntree (1966) is of the opinion that when the student makes an error, the programmed instruction can provide remedial instruction. After all, the student does not reach the next step in the programme until he has corrected his error. His difficulty is explained to him before he proceeds to the next stage.

Chuah (1988) commented that as the student is forced to think about the material, and while his rate of data acquisition is slowed in relation to the textbook, retention and understanding of certain types of material have been shown to be improved through this technique. Dean (1982) commented that programmed learning has been successfully used by pupils in obtaining lower level educational objectives in the learning of Mathematics.

In the local context, Chuah & Myint (1981) expected that print-based materials for self-instruction will form the mainstay of the Off-Campus Academic Programme, Universiti Sains Malaysia .

In general, programmed instruction promises to make learning more effective, individualised and flexible as training can start anywhere and anytime (Rowntree, 1966).

2.3 Teaching Machine Terms

Listed below are some of the terms commonly used in educational technology and instructional technology. These terms as defined by Cook (1961), however modified for clarification will be used in the following chapters in this study.

Auto-instructional methods: A comprehensive term to describe instruction characterized by the controlled presentation of material, the elicitation of appropriate response, guidance with respect to the subject matter, and control of the way in which learning proceeds.

Choice: Refers to the selection of an answer from several alternatives presented to the subject as opposed to having the subject construct or write out an answer.

Construction: The process of requiring the subject to write out or prepare an answer as opposed to choosing one of several alternative answers.

Error: An incorrect or non-appropriate answer to a specific item in the program.

Feedback: Communicating to the subject pursuing a sequence of programmed materials the information needed to modify responses so that failures or errors can be eliminated and correct responses maintained.

Frame: A single item or statement is exposed at a time. The exposed material constitutes a single frame.

Pacing, self: The rate at which the subject might complete the material at his own rate depending upon success on the previous steps.

Paper teaching machine: Refers to the "scrambled" or "programmed" textbook type of self-instructional devices.

Program: The subject matter that is to be learned by the student via the machine or other device.

Programmed book: A special book in which the subject matter to be learned has been arranged into a series of sequential steps leading from familiar concepts to new materials. Differs from a "scrambled textbook" in that the content is arranged so that the student proceeds directly from one step to the next, or one succeeding page to the next, rather than skipping around. The student generally is asked to construct a response as opposed to choice.

Programmed learning: A term sometimes used synonymously to refer to the broader concept of "auto-instructional methods".

Programmer: Generally, a curriculum specialist who subdivides the material to be learned into the sequential steps for later use with the mechanical method of presenting the program.

Programming: The process of arranging the material to be learned into a series of sequential steps; usually moves the student from a familiar background into a complex and new set of concepts, and understanding.

Programming, intrinsic: A method of programming materials that directs the erring subject along certain corrective pathways before he is permitted to proceed to the next step in the program. It requires that each step contains multiple choice answers.

Reinforcement, immediate: The process of providing the subject with immediate feedback or information regarding the success or failure of his performance.

Self-instructional device: A mechanical or paper device which presents a set of planned sequential materials to be learned and which the student can complete in the absence of a live instructor and at his own rate of speed.

Step: The increment in subject matter level to be learned with each succeeding item or frame in the program.

Terminal behaviour: The behaviour a program is designed to produce.

2.4 Types of Programming

Three types of programming will be discussed here. They are the linear programming (or sometimes known as the Skinnerian programming), intrinsic programming (or Crowderian programming or branching programming or the multiple-choice response programming) and the spiral programming. The objectives of the three schools of programming are to produce materials that permit efficient individual study by a student independent of an organized study group and without the continuous intercession of a live instructor.

Crowder (1963), is of the opinion that in linear programming, the student is confronted with a series of stimuli which, building from the presumed known or previously learned responses, cause him to emit new responses (or old responses to new stimuli); the emission of the desired responses is rewarded by the student discovering that he was correct, and the desired responses are thus learned. Errors by students on a fully developed program are so few that their occurrence may be neglected.

According to Crowder, the technique used in the intrinsic or "branching" programming is based on this simple fact: The student's choice of an answer to a multiple-choice question can be used automatically to direct him to new material; the student who chooses one alternative can automatically be directed to different material than that to which a student choosing a different alternative is directed.

Finn (1960), said that in devices incorporating branching techniques, if the student makes a mistake, the machine may take him off the main track of the program onto a "branch" in order to build up information or background before he returns to the main program. In a sophisticated machine, branching also permits a bright student to move ahead rapidly after he has demonstrated competence by answering a certain number of questions correctly.

Reynolds and Glaser (1962), mentioned that in spiral programming, the initial portion of each of several topics are presented together, reviews of the initially learned portions are then made before further material in those topics are presented.

The three types of programmes mentioned above have their pros and cons. In practice, Dececco (1964), is of the opinion that several programmers are borrowing the best from both worlds. A basically linear program may include branching forward or backward on the basis of student performance on criterion frames imbedded in the program. A basically intrinsic program can refer students to a linear sequence where the need for closer, step-by-step instruction is indicated.

In this study, the programmed text is that of a branched program or a scrambled book. However, on a few occasions, the students are referred to a linear sequence for remedial instruction.

An adapted version of Alsagoff's (1981) presentation of the more popular linear and branched programming is shown in Figure 2.2.

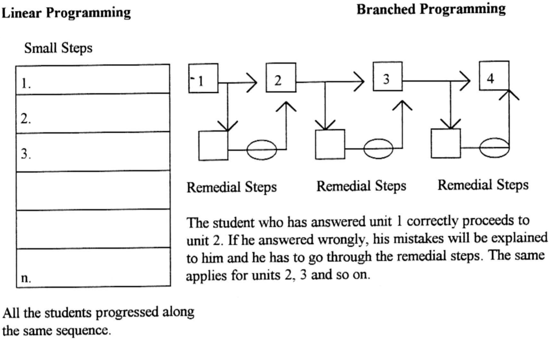

Figure 2.2: Linear and Branched Programming

2.5 Application of Programmed Instruction

2.5.1 Review of Selected Literature

In the early stage of development, programmed instructional materials were thought to be the possible solution to the many problems affecting the conventional educational system. However, research findings over the past decades have shown that programmed instruction has stood up to some of the promises but other claims were overstated. Hanna (1971) as cited by Cruthirds & Hanna (1998) reported from the massive research literature that programmed instruction worked as well as other forms of instruction, programmed instruction was dramatically more efficient than traditional forms of instruction and programmed instruction methods were liked as much as other forms of instruction.

The following review of selected research studies on programmed instruction will focus on findings of past studies particularly those concerned with the teaching of Mathematics. The review is not meant to be comprehensive but to highlight some studies of programmed instruction particularly its effectiveness in mathematical instruction. It does not indicate convincingly the superiority of programmed instruction over conventional teaching. Past studies showed mixed results, not all of which are favourable.

Homme & Glaser (1963) cited two related experiments which were conducted to compare the effectiveness of material presented in conventional textbook form with the same material presented in the programmed textbook. These experiments utilized a sequence written directly from a portion of a standard statistics text. Results show that, in general, the students who interacted with the programmed text make higher achievement scores and exhibited less variability of performance than did students receiving conventional presentation of the same materials.

Silverman (1960) cited Calvin's study which was conducted with a group of Eighth-grade pupils in Roanoke, Virginia. It was found that the students were able, without teacher, textbooks, or homework , to cover an entire year of ninth-grade algebra in one semester.

Two case studies were conducted in Penang to see the outcome of programmed text in the teaching of Mathematics to slow learners in secondary schools. Robles, Poonyarat and Yap (1986) and Nazareno, Mohamad and Srijareon (1986) found that the students like the materials, could work independently and their standard of performance was satisfactory.

Two other studies conducted by participants in a Regional Education Centre for Science and Mathematics (RECSAM) course evaluated the effectiveness of self instructional programmes for remedial teaching of mathematics to low achievers. Panta, Melayong, Vimala and Darsono (1988) and Vanitchayapong (1988) used linear programmes in their studies. Panta et al. (1988) found that the students who used the programmed text had higher mean gain score as compared to the students who were taught by the chalk-and-talk method. The results from Vanitchayapong's (1988) study showed that the self instructional programme was effective and valid.

Chuah (1988) developed some programmed texts covering 3 subjects: Chemistry, Physics and Mathematics for the Matriculation Science Centre, The Science University of Malaysia. The evaluation was conducted by an independent researcher from RECSAM over a period of time that is, from 1983-1986. The results were considered highly satisfactory (very favourable and favourable).

However, some of the past studies have less favourable results. For instance, an experiment conducted in the United States, revealed junior high school mathematics slow learners liked learning through programmed instruction. However, according to Fanning (1965), the results indicate the use of the programs alone was not as effective as pupil-teacher interaction.

An experiment was conducted on community college students comparing the use of traditional lecture methods and alternative methods including programmed texts. Pearlman

(1977) stated that data revealed no significant results for programmes using alternative methods.

Machetanz and others (1967) designed an experiment to determine the extent to which programmed material is effective in the teaching of exponents to an intermediate algebra class. The experimental group followed the course on programmed instruction while the control group received regular class instruction. It was reported that there was no significant difference between the groups.

In an experiment by Bornstein (1964), a comparison was made of the rate and level of achievement of 150 deaf students resulting from the use of programmed texts as against the usual lecture methods in high school mathematics. The programmed text classes in Elementary Algebra and Plane Geometry did not gain significantly over lecture methods. However, in intermediate algebra the programmed text was favoured.

This inconclusiveness of past research findings on programmed instruction is further confirmed by reviews of findings of past studies on programmed instruction. Schoen (1976) stated that a review of seventeen studies of self-paced instruction in Algebra, Geometry, Trigonometry, and college Mathematics courses did not indicate that individualized programs were superior to the regular instruction with which they were compared.

2.5.2 Factors Affecting the Effectiveness of Programmed Instruction

Results of past studies on programmed instruction had not shown conclusive evidence of the superiority of programmed instruction over traditional teaching method measured by the gain in learning outcome. Koh (1977) is of the opinion some of the factors may be due to:

- Difficulty in integrating programmed instruction into the existing administrative and curricular system.
- Inadequacies in experimental design and control of past studies.
- Complexity of the instructional process and impossibility to control variables.
- Lack of internal efficiency of programmed materials.

Chuah & Myint (1981) commented that programmed instructional materials are more suitable for highly motivated mature students and that it may not work well with students who require prodding by other people.

2.6 Reflection - a Subset of Transformation Geometry

2.6.1 The Importance of Transformation Geometry

Reflection is one of the basic concepts in Transformation Geometry. The other concepts include Translation, Rotation, Enlargement, Stretching and Shearing. Usiskin, (1972) commented that transformations are convenient examples of one to one functions, Transformations can easily lead to an elementary study of groups, certain Transformations are useful in analysis and much of the study of advanced Geometry is done with the aid of Transformations. Transformations provide a unified approach to secondary school Geometry by which the formal definitions of Congruence, Similarity and Symmetry are closely related to the intuitive ideas.

Two other advantages for the introduction of transformation approach in the study of Geometry given by Jackson (1975) were:-

a. Transformations are merely the application in Geometry of the idea of function, which is one of the fundamental treads running through all Mathematics.

b. Transformations open extensive opportunities for both visual and tactile experience to help a student feel and 'see' what is going on. It provides a dynamic rather than a merely static way of looking at certain Geometric topics.

From a review of secondary school Mathematics textbooks, under the Secondary School Integrated Curriculum, *Kurikulum Bersepadu Sekolah Menengah* (KBSM), the Education Ministry has dropped the topics of Shearing and Stretching from Transformation Geometry. To achieve the aims of the new curriculum (KBSM), students are provided with a Mathematics content organized according to three interrelated areas, namely, *number, shape* and *relationship.* The topic of Reflection in Geometry falls under the *shape* category. The Education Ministry feels it is important that an individual needs the knowledge and skills related to shapes, such as recognizing their properties and working with measurements. Under the new curriculum, the following subtopics of Transformation Geometry will be taught. They are Translation, Reflection, Rotation, Isometry and Congruence, Enlargement, Similarity and the area of similar shapes, and combination of two Transformations (Curriculum Development Centre, 1988). Knowledge attained under the subtopic Reflection will be useful in the learning of Rotation, Isometry and Congruence, Similarity and combination of two Transformations.

The News Bulletin of National Council of Teachers of Mathematics (NCTM), reported that Algebra and Geometry are considered gateway courses to higher education and career opportunities (NCTM, 1997, Jan). The most recent in a series of international studies is the Third International Mathematics and Science Study (TIMSS). TIMSS is considered as the largest, most in-depth study of mathematics and science education ever undertaken. Researchers assessed students, teaching, and curricula in different countries from 1991 to 1995. According to the study, grade 8 students in the United States fare lower than average in Geometry and Measurement (NCTM, 1996, Dec.). The topic area of Geometry covered by the study consisted of visualisation and properties of geometric figures, including Symmetry, Congruence, and Similarity. Some of these are important and related to the topic of Reflection in Transformation Geometry

It is with these in mind that the topic of Reflection is chosen for the present study. I t is hoped that the successful usage of LIY Reflection could help students improve their geometry marks.

2.6.2 Problems Faced in the Teaching of Transformation Geometry

During a national Mathematics and Science seminar in 1973, two of the crucial problems related to the teaching of transformation geometry were brought up (Malaysia, Ministry of Education, 1973). They were:-

a. Mathematics teachers found it difficult to complete the syllabus and give practical work within the allotted time.
b. Teachers with 'traditional geometry' background had difficulty teaching 'Transformation Geometry' effectively even though they had attended Modern Mathematics in-service courses in which they learnt both the content and the methods of teaching.

Hart and Johnson (1980) reported that secondary school pupils encountered specific difficulties in some basic concepts in Mathematics including concepts in

Transformation Geometry. According to the same report, the majority of secondary school pupils tested could only cope with the simplest and most concrete levels of understanding. This is supported by a study on secondary students conducted by Lee (1982). Generally, the pupils have problems when the axis of Reflection is slanted (as opposed to vertical or horizontal axes). Lee mentioned that the pupils tended to neglect the congruency of an object and its image after a Reflection. The study also revealed that pupils tended to reflect the object about a vertical or horizontal axis even though a slanted axis was given. One other problem faced by the pupils was they tended to extend one or more of the sides of an object to obtain its Reflection if the object touched the axis of Reflection. Besides these reports and studies, personal interviews with some experienced Mathematics teachers revealed that Reflection is not an easy concept to teach in Transformation Geometry. The teachers are of the opinion that the weak students have problems in answering some Reflection questions and encountered misconceptions. Reasons given were the students got the concept of Reflection mixed up with the other concepts (Translation, Rotation, and Enlargement) of Transformation Geometry.

According to a study, *What Matters Most: Teaching for America's Future*, problems begin before teachers even take on their professional responsibilities. The report found that more than 40 percent of Mathematics teachers and 30 percent of Science teachers are not fully qualified to teach their subjects (NCTM, 1996, Nov.). This is consistent with results from previous studies. Research conducted by Fuys, Geddes, & Tischler; Hershkowitz & Vinner; Mason & Schell; and Mayberry (as cited in Swafford, Jones, & Thornton, 1997) in the 1980s documented that both practising and preservice elementary teachers exhibit low levels of geometrical knowledge.

NCTM (1989) has advocated increased emphasis on Geometry instruction at all levels. McKnight, Travers, Crosswhite, & Swafford and Mullis, Dossey, Owen, & Phillips' reports (as cited in Swafford, Jones, & Thornton, 1997) have indicated low achievement patterns in Geometry for eight graders on both U.S. schools and international assessments over the past two decades.

Elsewhere in the world, Chaiyasang (as cited in Suydam, M.N. & Crocker, D.A., 1990) conducted a study on the level of geometric thinking and the ability of students (grades 6-9) in Thailand to construct proof. He discovered that the majority of students at each grade level were at van Hiele level 1. The study revealed almost no growth occurring from grades 6 to 7, and little growth between other levels.

It is for these reasons that programmed instructional materials for a topic in Geometry, in this case the topic of Reflection in Transformation Geometry is chosen for this study.

2.7 Theroretical and Research Considerations

2.7.1 The Role of Feedback in Learning

Generally, some form of feedback is better than no feedback. Feedback increases lesson performance, provided that students process the instruction prior to seeing the feedback (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991). For purpose of clarity, four common text-based feedback types, adapted from Dempsey, Driscoll & Swindell (1993) will be discussed here.

1. *Simple verification feedback or knowledge of results* (KR) informs the student of a correct or incorrect response.

2. *Correct response feedback or knowledge of correct response* (KCR) informs the student what the correct response to the question should be.

3. *Elaborated feedback* provides an explaination for why the student's response is correct or incorrect or allows the student to review material relevant to the attributes of a correct response.

4. *Try-again feedback* informs the student when an incorrect response has been made and allows the student to make one or more additional attempts to answer correctly.

If the feedback provides a new stimulus, one might expect that knowledge of the correct answer would be more effective than elaborated feedback because simple feedback should require less selective perception (Wager & Mory, 1993). However, the correction of misunderstandings should be facilitated by elaboration, as it provides a richer context for remembering the new information. When the student responds to a question, he attempts to confirm the correctness or appropriateness of his response. Feedback serves to provide reinforcement. Corrective information to the student provides cues for future performance. Probably the most important role of feedback at this stage is to correct misunderstandings; feedback in the form of remediation (Wager & Mory, 1993).

Try-again feedback is when the student is given an opportunity to apply corrective information supplied by feedback on a subsequent practice opportunity. Smith & Ragan (1993) commented that when a 'second try' or other subsequent practice opportunity is not provided in instruction, the utility of feedback and how it is applied might be altered substantially. They also mentioned that feedback might be coupled with second tries with practice items, so that if learners are incorrect they can use the feedback to correct the error on that very problem. Except for cases in which feedback provides the correct answer, feedback may be used in conjunction with several tries so that learners may have the opportunity to apply the feedback to correct their own learning.

2.7.2 Design Guidelines

In designing the programmed instructional material of this study, all the four types of feedback mentioned are used where appropriate. Whenever KR is used, the student if he has made an error is usually directed to a frame with *elaborated feedback* or *try-again feedback.* KCR is usually used when the student is correct. He is sometimes directed to an *elaborated feedback.*

2.7.3 Research Findings on Feedback

Gilman (1969) conducted a computer-based instruction study that considered type of feedback. An important finding in his study was that undergraduate students who received KCR performed significantly better than those not receiving KCR. His interpretation that the factor which accelerated the learning of students was being informed as to which response was the correct one. Another important finding of this study was that it took the KCR-only group significantly less time to reach criterion than any of the other feedback conditions.

Roper's study (as cited in Dempsey, Driscoll & Swindell, 1993) confirmed Gilman's conclusion that KCR feedback is more effective than KR feedback. Gilman's and Roger's studies that KCR with elaborated feedback is superior to simple KR feedback were supported by Waldrop, Justin and Adams (1986).

Generally, findings of studies on try-again feedback are non-conclusive. Clariana (1990) compared the effects of KCR and try-again feedback on learning of social science materials being learned by low ability eleventh graders. The findings showed that the learners in the KCR treatment performed significantly better on a post-test. Noonan (as cited in Smith & Ragan, 1993) investigated the learning of procedural rules in high school algebra, providing second tries with variations in feedback. Noonan found no differential effects for second tries. However Nielson (as cited in Smith & Ragan, 1993), investigating college-age students' learning of navigation skills found that second tries increased performance on both immediate and delayed tests.