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Effects of Self-Questioning Guided by Bloom's Taxonomy on the Reading Comprehension of Science Materials

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EFFECTS OF SELF-QUESTIONING
GUIDED BY BLOOM'S TAXONOMY
ON
THE READING COMPREHENSION OF SCIENCE MATERIALS

By

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ABSTRACT

EFFECTS OF SELF-QUESTIONING GUIDED BY BLOOM'S TAXONOMY ON THE READING COMPREHENSION OF SCIENCE MATERIALS

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The study was designed to investigate the effectiveness of the acquisition and maintenance of self-questioning technique, structured from using Bloom's Taxonomy in the reading comprehension of science materials by poor comprehenders.

Poor comprehenders were selected from the seventh grade of an urban middle school and assigned to three groups. Four hundred to five hundred word passages of science material different from the one used in class by these students were selected as assessment measures for this study after being screened for appropriate readability levels. A series of 10 questions were developed for each passage according to Bloom's Taxonomy of Intellectual Skills/Cognitive Domain. A multiple baseline design across subjects was used which consisted of four phases: Baseline, Intervention #1, Intervention #2, and Maintenance.

During the four phases students were asked to read passages and answer questions, and to generate questions. They were instructed in the use of questions through a combination of modeling and direct instruction taking one

question type at a time to distinguish it from other question types and practice making similar questions to be able to read a passage and answer questions following instruction. During phase four, Maintenance, students read and aswered questions independently. Analysis of results showed that the use of self-generated questions alone does not increase the level of reading comprehension but the training in question generation does, especially when trained using Bloom's Taxonomy of Intellectual Skills/Cognitive Domain. Also, the results of the measures taken during maintenance one week after the end of Intervention #2 showed that an increase in the level of comprehension was maintained over the short period of time. Further research is indicated in the use of self-generated questions structured according to Bloom's Taxonomy across settings in the regular science class, observed over a long period of time. Its use is suggested in the training of science teachers to increase overall learning and comprehension of science materials.

This work is dedicated
to my family.

They always encouraged
and supported my
pursuit in learning.

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CHAPTER I

INTRODUCTION

The acquisition of reading is a continuous challenge for those involved in the study of learning. From the key moment when a child or an adult discovers the connection between isolated printed symbols and the language he/she uses to communicate, a series of processes take place. Most of them are unobservable and are usually inferred or hypothesized based upon observable performance. The eye movement displayed over the page, the ability to interpret the graphemes seen, all in a matter of seconds to announce the names of an object or a person, and the sudden understanding of what commercial signs or a passage mean are all pieces of the complex operation called reading.

There is a diversity of opinion as to what reading encompasses. There are those who believe that reading, like speaking and writing, is an active language process (Goodman and Goodman, 1981). Other refer to reading as a complex cognitive process that if ever understood would enable us to discover the mysteries of the human mind (Pearson and Johnson, 1978).

Recent work with computer simulation of mental processes has led the cognitive psychologists to view reading as possessing the same constraints as those of human memory and problem solving. As readers in a problem solving situation we try to discover what the author means while simultaneously building meaning for ourselves. However, these interpretations are limited by what we know (Pearson and Johnson, 1978).

Regardless of how reading takes place, there are certain characteristics that seem to influence the quality of performance of those who read. Some are internal in nature such as motivation, interest, competency and reading ability which vary from individual to individual. Others are external such as the written message and the environment that surrounds the individual (Pearson and Johnson, 1978). When a difficulty arises in any one of these areas the probability of grasping the meaning of what is read is reduced. The efficient reader, when confronted with difficulty in understanding the material read, is capable in one way or another of monitoring and regulating his comprehension. In some cases, certain strategies have been introduced, suggested or observed that seem to account for the student's success in reading. However, there is insufficient information to explain what goes on inside the head of the reader when he reads, what mechanism he activates or uses to regulate and monitor what he reads, which enables him to understand and assimilate the information in a productive manner.

The Problem

In research, when we divert our attention from the efficient reader, the issue of reading comprehension becomes far more complicated to assess. Recent research in the field of cognitive psychology has focused its attention to the study of reading comprehension monitoring or metacognition (Brown, 1975; Brown and DeLoache, 1978; Flavell and Wellman, 1977; Boss and Phillip, 1982; Wagoner, 1983; Brown and Palincsar, 1982).

Metacognition has been defined as:

> "That process which is affected by person strategy and task variables. It is an executive function for competent reading which directs reader's cognitive processes as he or she strives to make sense of incoming textual information." (Brown and Palincsar, 1982, pg. 1)

> "Conscious access to one's cognitive operation and reflexion about those of others. It's a declarative knowledge about the domain of thinking." (Brown and Palincsar, 1982, pg. 1)

> "Metacognition refers to that secondary level of understanding in which a person addresses his/her own thinking or whose knowledge concerning one's own cognitive processes and products." (Flavell, 1976, pg. 232)

These metacognitive processes involve two parts: 1) monitoring and 2) regulation. Monitoring consists of judging the degree of understanding when reading. Regulation is related to the activation of appropriate strategies when comprehension fails to meet the desired levels (Baker, 1979).

Research indicates that poor readers with comprehension difficulties when compared with normal populations appear to have a lack of awareness of task demands (Loper, 1980). Also, they seem to be different in three general classes of cognitive skills: strategic, metacognitive and processing efficiency (Brown and Palincsar, 1982). Some of these deficits include spontaneous use of various types of attentional and mnemonic strategies (Hallahan, Kauffman and Ball, 1973; Tarver, Hallahan, Kauffman and Bale, 1976; Torgesen 1977; Torgesen and Goldman, 1977; Loper, 1980; and Hallahan and Kneedler, 1981). Also, they are deficient in various metacognitive skills such as planning, monitoring and checking (Torgesen, 1977), application of appropriate memory strategies (Loper, 1980) or simply failure to remember academic material presented under normal conditions (Torgesen, 1977).

To summarize, it seems that the lack of spontaneous use of various attentional and mnemonic strategies affects the comprehension of the material the poor comprehender is exposed to. A frequent characteristic is the failure to remember the material read as suggested by Torgesen. Nevertheless, it is possible to assume that the weakness in remembering is a consequence of the failure to understand, perhaps due to the inability to focus spontaneously on the important concepts, principles or elements in a given story. Among the many strategies suggested to assist students to compensate for their comprehension difficulties is the use of questions. Teacher generated questions are commonly used in the classroom to clarify concepts and guide students in the important areas of reading. Student generated questions are less common but are also very important since they tell us what the student is focusing his attention on, whether he understood the passage or not.

Initial investigation supports the use of self-generated questions when reading stories (Andre and Anderson, 1978-1979). Question generating has been shown to be particularly beneficial for poor comprehenders. It appears to assist them monitor their comprehension of the passages read.

Statement of the Problem

The ability to adequately monitor comprehension processes while reading influences the degree of understanding of what is read. Poor comprehenders seem to be unaware of their comprehension monitoring processes (Gardner and Reis, 1981) and therefore fail to adequately apply appropriate regulatory strategies (Torgesen, 1977; Loper, 1980; Hallahan, Kauffman and Ball, 1973).

Self-questioning seems to be a useful strategy to assist poor readers to monitor their own comprehension processes. Furthermore, questioning in general is a strategy that is not content specific. Thus, it may be used effectively across several content areas like science, where a certain amount of reading comprehension is required to be able to perform the experiments correctly and internalize underlying scientific principles (Porterfield, 1974; Russell, 1981). Therefore, the purpose of this study is to investigate the effectiveness of the instruction of self-generated questions, structured using Bloom's Taxonomy, on the acquisition and maintenance of comprehension of science material by poor comprehenders.

Research Objectives

This study has one major goal but several objectives. The first is to determine if the instruction of self-generated questions structured using Bloom's Taxonomy would produce differences on the acquisition and maintenance of comprehension skill of science material by poor comprehenders.

Specifically, if differences do exist, there are several questions that need to be answered in relation to the use of self-generated questions:

1. Will self-generated questions increase the level of reading comprehension of poor comprehenders?
2. Will instruction in question-generating using Bloom's Taxonomy increase the level of reading comprehension of poor readers and the ability to answer high level questions?
3. Will the change observed in comprehension be maintained over time?

Potential Contributions

More research is needed to explore the possibility of whether training in the spontaneous use of self-generated questions can be of assistance to poor comprehenders in other content areas like science. Perhaps through the use of self-generated questions, the poor comprehenders may be able to acquire the necessary skills required in the comprehension of scientific materials. In general, researchers have showed strong support for the use of questions in the classroom (Cohen, 1983; Sadker and Cooper, 1974), but many have observed that there is an excessive use of factual-recall type of questions (Gutzak, 1967; Durkin, 1978) not necessarily increasing reading comprehension skills of poor comprehenders. If the student is able to generate high level questions (especially analysis, synthesis, evaluation) such as those that could be provided in Bloom's Taxonomy one might speculate that students can assume control of their own comprehension, assisting them to focus on the important aspects of the material at hand not only in science materials, but also in other content areas such as history, geography, etc.

Chapter Summary

In this chapter, an introduction to reading comprehension was given. The purpose of this study was stated. The statement of the problem was presented within the context of a brief overview of the relevant literature. The research objectives were explained and the chapter concluded with the description of potential contributions and compensatory strategies to increase the comprehension skills of poor comprehenders when reading science materials and possibly other content areas too.

The next chapter is a more extensive review of the relevant literature.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter is divided into three sections. The first section focuses on the questioning technique. The second section describes Bloom's Taxonomy and its use in the generation of different types of questions. The third section focuses on science learning and its effect on the use of high level questions.

I. Questioning Technique

One of the most common and widely used strategies among teachers and students in the classroom to enhance reading comprehension is questioning. Usually the questions, whether teacher generated, textbook generated or student generated, help to gather new information, clarify concepts, analyze and evaluate situations or organize steps to follow to accomplish a given task. Also, often the student seeks reassurance that he is headed in the right direction when generating questions.

Research studies have indicated that very little instruction in reading comprehension occurs in classrooms. In one study, out of 2174 minutes of reading observed, only 13.04 minutes (0.60%) concerned comprehension instruction (Durkin, 1978). In her study Durkin observed that teachers spent most of their time in comprehension assessment, that is, asking questions to students (Durkin, 1978).

Other studies revealed that when questions are used with students, these emphasize the recall of facts and events, but very few stress other aspects like application of a principle, inferencing information to enhance comprehension, etc. (Durkin, 1978; Gutzak, 1967; Elias and Legenza, 1978). Also, some of the studies have used younger readers (Crowell and Hupei, 1981) where it has been observed that the ability to make inferences, draw conclusions and evaluate a situation is usually evidenced at a later age. There is no explanation as to why this is so. Therefore, teachers feel that the ability to retell the events of a given story is sufficient evidence indicating comprehension.

Historically, question formulation and its use to interpret and solve situations can be traced to the great philosophers like Aristotle and Socrates, who used questions to understand the world. Writers of all times, such as Shakespeare, Poe and Verne, formulated questions through their characters to be able to solve, judge, or raise their uncertainties about life, men, society, moral or religious issues, scientific principles, etc.

Today, there are several reasons according to Marksberry, (1979) for the importance of questions by students in the classroom. These are:

1. Curriculum development is often based on inquiry and discovery techniques and stresses the importance of children asking questions, especially high order questions.

2. Students' questions aid in clarifying and defining dimensions of the problems of being attacked and hypotheses being formulated, for gathering information and for assisting in the control of premature and faulty inference.
3. Having children ask questions and seek answers is believed to arouse their interest and participation in self-directed learning.
4. Through question-asking, children increase their perception and their ability to think and express ideas on both discursive and non-discursive levels (Marksberry, 1979, pg. 190).
5. Once you have learned how to ask relevant, appropriate, and substantial questions, you have learned how to learn and no one can keep you from learning whatever you want or need to know (Postman and Weingartner, 1969, pg. 23).

In addition, the use of questions, properly elaborated to raise high thinking levels, facilitates the understanding of the content material especially by poor readers who seem to have great difficulty comprehending what they read. Furthermore, questions increase the inspection time and the cognitive effort that a reader gives to what is considered relevant to his or her purposes; in this case, answering the questions (Durkin, 1981). However, the questioning technique is by no means the only strategy used as a study skill in the process of reading comprehension. There are other strategies that are used as an attempt to help poor readers with their comprehension difficulties. Some of these are:

1. summarizing (Taylor, 1982; Brown and Palincsar, 1982)
2. outlining
3. advance organizers
4. idea mapping
5. re-telling
6. connecting the old with the new (Wilson, 1983)
7. look-backs (Gardner and Reis, 1981)
8. problem-solving (Ross and Maynes, 1983)
9. inquiry - discovery (Maria, 1981; Porterfield, 1974)

All these strategies and many others have been used in isolation or in combination to assist students in the learning process. Some of these strategies are content specific, that is, they are applicable with best results in certain types of areas like science, literature or social studies (i.e., problem solving in science, etc.). Others, like questioning are not content specific and can be used across several areas. Any social studies or science textbook will carry a section of questions in each chapter or unit of instruction. These questions are frequently used to guide students in their learning. In addition, teachers often ask student questions in relation to the material the students read for a variety of purposes, such as to evaluate the attainment of a specific concept or principle and to recall facts. On occasion the students ask questions to clarify ideas or to compare their preconceived notions of a given event with the printed material to which they are being exposed. In spite of the controversy that surrounds the area of reading comprehension and the processes that may influence it, reading comprehension can be safely defined as the "interaction between the resources of the reader, and the characteristics of the text" (Adams and Collins, 1977; Rumelhart, 1977). Thus, it is important to examine the teachers' and the students' use of questions in the classroom and their relationship to reading comprehension.

The first thing the teacher examined was the type of questions the students could generate that would provide the best results for enhancing comprehension of content material. It has been mentioned previously that most of the questions usually observed in classrooms are those that promote lower levels of thinking activity, like the recall of facts or sequence of events (Gutzak, 1967). In order to be able to fully understand the content material, it is necessary that higher levels of questions are generated. Some examples are those that promote analysis, comparison, evaluation and interpretation, and those that facilitate association of ideas and cause-effect relationships.

Second, content area material like science requires that the student be able to problem-solve situations presented to him. When questions are generated to promote higher levels of thinking they also enable the student to solve problems related to his content area. Research indicates that a significant increase in comprehension can be noticed when high level questions are encouraged (Sadker and Cooper, 1974; Redfeld and Rousseau, 1981; Newton, 1978; Rhoades, 1980) in the classroom. Sadker and Cooper (1974) trained eight elementary school students of whom four received micro-teaching in higher order questioning. The authors considered the following categories as representative of higher order questioning: evaluation, comparison, problem-solving, and cause-effect divergent questions. A reinforcement procedure was later introduced to compare the effect of reinforcement with use of the questioning techniques. Results indicated that trained students responded to both higher order questioning alone and high order questioning with reinforcement. However, it was questioned whether training alone or with reinforcement caused increase in question asking. Redfeld and Rousseau (1981) investigated the relationship between the level of teacher questioning and student achievement. They reviewed 20 studies on teachers' use of higher cognitive questioning. Fourteen studies out of the 20 were selected for the study since many did not fulfill requirements of internal validity. Authors found out that regardless of the type of study the predominant use of higher order questions has a positive effect on students' achievement (Redfeld and Rousseau, 1981). As far as guidelines for question elaboration, Newton (1978) suggested Bloom's Taxonomy as one alternative way to promote high level questions while enhancing comprehension in the classroom. Rhoades (1980) provided a series of guidelines to instruct teachers in questioning strategies to promote generation of higher level questions.

Third, the possibility of students formulating or generating their own questions is an issue of recent concern by researchers in the area to determine potential beneficial effects on reading comprehension. There is initial support for the use of self-generated questions and investigation seems to favor its use (Andre and Anderson, 1978-1979; Frase and Schwartz, 1975).

Andre and Anderson (1978-1979) and Frase and Schwartz (1975) investigated to determine whether or not generating good comprehension questions while studying prose material was an effective study technique. Both found similar positive results with both high school students and college freshmen. However, due to the type of material used in the experiment most of the questions generated were related to knowledge of facts and not higher ordered knowledge. Nevertheless, further research is needed to determine the usefulness of self-generated questions.

<u>Section Summary</u>

To summarize, the use of questions has been discussed. Several types of questions have been described according to their source.

Similarly, questions have been approached according to the type of information obtained from them (i.e., factual, recall, etc.) and issues have been raised in terms of student's ability to generate good questions, guidelines to elaborate good questions, etc.

This study will focus on the student generated question as a study skill strategy to assist the poor reader to enhance his reading comprehension.

Bloom's Taxonomy and High Level Questions

It was conceived by Benjamin Bloom (Bloom, Engelhart, Furst, Hill and Krathwolh, 1956; Gronlund, 1978; Bloom, et. al., 1956). This is a taxonomy of educational objectives created in an attempt to provide a classification system of goals for the American educational program. As such, it has six levels including: knowledge, understanding, application, analysis, synthesis and evaluation. It was Bloom's purpose to classify intended behavior of students, specifically the ways in which students are to act, think or feel as the result of participation in some unit of instruction (Bloom, et. al., 1956).

Bloom's Taxonomy was developed after the idea that taxonomies in general are commonly used to facilitate communication among scientists and to insure accuracy in understanding the organization and interpretation of the various parts of the animal and plant world (Bloom, et. al., 1956).

Therefore, the possibility of creating a taxonomy in education to include the goals and objectives of American curriculum was conceived. The author foresaw several advantages to it. These are: (Gronlund, 1978; Bloom, et. al., 1956)

1. It helps to identify and define instructional objectives.
2. It provides a classification of educational objectives analogous to the classification used for plants and animals.
3. It consists of a set of general and specific categories that encompasses all possible learning outcomes that might be expected from instruction.
4. It was developed by individuals related to the field of education such as psychologists, teachers, and test experts to be used in curriculum development, teaching and testing.
5. It's a tool to help design instruction. However, a word of caution is included here. Authors recommend that the individual should not become a slave of the taxonomy. It should serve as a guide not as a master.
6. Taxonomy should facilitate the communication exchange of information about curricular development and evaluation devices among teachers, researchers, test developers, etc.
7. It's a tool in curriculum development since teachers can find a range of possible educational

goals or outcomes in the cognitive area like: remembering and recall, thinking, problem solving, and creating.

8. Taxonomy can also help one to gain a perspective on the emphasis given to certain behavior by particular set of educational plans.

Nevertheless, authors considered several assumptions in the elaboration of the taxonomy of educational objectives in the area of cognitive domain. These assumptions are: (Gronlund, 1978; Bloom, et. al., 1956).

1. Neutrality

   The taxonomy is intended to maintain neutrality in relation to educational principles and philosophies.

2. Hierarchy

   The taxonomy is based on the principle that it should be an educational logical psychological classification system. There are six levels - knowledge, understanding, application, analysis, synthesis, and evaluation. These categories are ranked in hierarchical order from lowest, simplest behavior to the highest, most complex behavior. In addition, each category is assumed to include the behavior of previous lower levels.

3. Psychological Classification System

   The system is based on the assumption that learning outcomes can be best described in terms of changes of students' behavior. Actually, the author's purpose was to classify intended behavior of students, the ways in which students are to think, act or feel as a result of participating in some unit of instruction.

The authors of the taxonomy are very specific with respect to the behaviors students should exhibit at each level. For example: (Bloom, 1956) (Gronlund, 1978, pg. 26)

Level	Assumed Behaviors
knowledge	To remember by recall of facts or reorganization of information in a form very close to that in which it was originally encountered. Sometimes filed or stored in memory. Role Learning.
comprehension	Behavior that represents an understanding of literal message contained in communication. Three types of comprehension are considered: -Translation -- Individual can put communication into another's language. -Interpretation -- Communication involves reordering of ideas into a new configuration in the mind of the individual, importance of idea, and establishment of

	interrelationships.
	-Extrapolation -- Making prediction on estimates. Being able to demonstrate an abstraction as asked to do by the teacher.
application	To apply something requires comprehension. Being able to use an abstraction without having to be shown how to use it in that situation provided.
analysis	Emphasizes breakdown of material into their constituent parts.
	Detection of relationships of the parts and of the way they are organized. Techniques and devices used to convey meaning or to establish the conclusion of communication.
synthesis	Putting together parts, pieces into a whole.
evaluation	Making judgements about the value for some purpose of ideas, works, solutions, methods materials, etc. It involves the appraisal in which particulars are accurate, effective, economical or satisfying judgements are qualitative or quantitative.
	Placed at the end since it requires the combination of the previous behaviors.

> However although placed at the end, this is not the last of stages. Some other behaviors may involve evaluation.

Some of the categories, especially the latter ones, increase in difficulty when the authors try to explain what behaviors to expect, how the student is supposed to act, think or feel. This may affect the precision needed to evaluate students in a given category of the taxonomy. Thus, recent research has speculated on the validity of the assumptions made by Bloom, et. al. on the taxonomy. Furst (1981), Hill and McGaw (1981), Andre (1979), Miller, et. al. (1979) and Furst (1981) reviewed the philosophical assumptions of the taxonomy specifically the issues of neutrality, comprehensiveness and cumulative hierarchical structure. He indicated that when neutrality was defined it meant "impartiality in relation to the source, such as educational philosophy of education and with respect to the relative worth of the goals." He also suggested that Bloom, et al. ruled out those goals that did not reflect student intended behaviors or could not be described as changes of that type. Therefore, he concluded that the issue of neutrality was violated since "classifications tend to throw emphasis on certain qualities and, in turn, to diminish the apparent significance of other qualities" (Furst, 1981, pg. 442).

The assumption of comprehensiveness was discussed by Furst (1981). He claimed that since an educational objective was described as changes in behavior and ways of acting, thinking, and feeling, it is difficult to include and describe all educational objectives in terms of change of behaviors. He suggests that "many processes and states" are unobservable. Furthermore, goals that cannot be specified in behavioral terms are unfortunately neglected (Furst, 1981). Also, categories like "understanding" do not seem to adequately satisfy some researchers. Ormell (1974, 1979) argues that the behaviors to be observed here are not sufficient to define all the characteristics and information related to comprehension.

The principle of hierarchy has been investigated by several researchers (Miller, et. al., 1979; Hill and McGaw, 1981; Furst, 1981). This has been attacked strongly by investigators who appear to disagree with what seems to be the central core to this taxonomy. Furthermore, some have submitted the hierarchical structure of the taxonomy to experimentation and complex statistical analysis to investigate the validity of this assumption (Furst, 1981; Miller, et. al., 1979).

From the philosophical standpoint, when Ormell (1974) tried to apply the taxonomy, he found contradictions in the frequent inversion of various objectives and tasks. He found that certain demands on knowledge are more complex than certain demands for analysis or evaluation. He solved them by setting levels within each category. Others elaborated arguments about the definitions and skills assumed for each category (Furst, 1981; Miller, et. al., 1979). They felt that definitions are restrictive and sometimes one category early in the hierarchy may include others which are classified at the end of it (Miller, et al., 1979). For instance, Orlandi (1971) implied that meaningful comprehension in social sciences must be accompanied or preceeded by analysis. However, Bloom, et al. (1956) acknowledge that it was not possible to make distinctions as clear-cut as one would like among the categories (1956, pg. 15, 144-145).

Another group has investigated the construct validity of the hierarchy from the statistical point of view (Miller, et al., 1971; Hill and McGaw, 1981), applying a series of analytic methods. Hill and McGaw (1981) found that when the knowledge category was deleted the hierarchy assumption of Bloom's Taxonomy is supported.

There are many other classifications or categories upon which questions could be elaborated like Sanders (1966), Pearson and Johnson (1978), Barrett (1967). However, most of these are derivations, adaptations or combinations of the same original source -- Bloom's Taxonomy (Figure 1).

Therefore, the cognitive domain of Bloom's Taxonomy was selected for this study for the following reasons:

1. Convenience

To teach poor comprehenders to generate good questions while reading science materials, it is necessary to provide them with an adequate sample that can meet the instructional

Figure 1

A comparison of Bloom's Taxonomy

With Other Frequently Used Taxonomies

Bloom	Barrett	Sander	Pearson & Johnson
Knowledge	Literal Meaning	Memory	Textually Explicit
-recognition	-recognition		
-recall	-recall		
Understanding	Inferences	Translation	
-translation	-cause and effect	-interpretation	
-interpretation	-like and differences		
-extrapolation			
Application		Application	Textually Implicit
-abstraction no solution			
Analysis		Analysis	
-break into pieces			
Synthesis		Synthesis	
-put together			
Evaluation	Evaluation	Evaluation	
	Appreciation		Scriptically Implicit

goals of science classes and aid the students to increase their understanding of the scientific processes, as they read about them. Also, if successful, as a consequence of learning to generate their own questions and being able to comprehend science better, the students would be able to apply in given situations the scientific concepts just learned.

In addition, the taxonomy specifies clearly what behaviors are expected from the students as a consequence of a unit of instruction. Therefore, the student's performance in relation to science materials can be measured in terms of the behaviors established for each of the six levels. Moreover, instructions regarding the most effective procedures in the instruction of science include: discovery learning, mastery learning, problem solving and deductive learning (Burton, 1983).

Thus, Bloom's Taxonomy would allow this investigator to expose and train the poor comprehenders in how to think analytically, to interpret information, to apply concepts learned, summarize information, or give an evaluative judgement. Also, students would be able to generalize scientific principles through the elaboration of questions according to the behavioral guidelines set for each level of the taxonomy.

In addition, the use of questions derived from Bloom's Taxonomy may provide both the researcher and the student with a means to meet the needs of the poor comprehender.

2. Familiarity

The researcher also selected Bloom's Taxonomy for reasons of familiarity with the design of regular classroom activities. It is a clear, precise, organized way of planning, and evaluating the content of instruction in a given course or subject. Additionally, another assumption of this taxonomy claimed by the author is that of generality; it can be used across subject matters, curriculum areas (Bloom, et. al., 1956). Due to this acquaintance with the taxonomy, this author thought of the possibility of using it to guide the model questions to train the poor comprehenders.

3. Variety

Science reading materials in general require the ability to master several skills that are content specific such as the ability to: interpret a given scientific conceptual issue, apply it in an experimental situation, analyze a situation, summarize a fact, generalize and evaluate scientific principles, demonstrate comprehension of a given concept by facilitating an example, etc.

The levels of the taxonomy allow for the production of a number of different questions that appear to satisfy those specific study skills required in science. In particular, the last four levels, application, analysis, synthesis and evaluation seem to suggest that questions elaborated this way would help students elicit the behaviors necessary to develop those skills indispensable to succeed in science.

4. Completeness

Another feature of the taxonomy relies on its completeness when compared with other classifications. Bloom's Taxonomy contains more areas and various modes, example of behaviors and/or thinking skills. Each area is very detailed in relation as to what behaviors are expected, how to elicit them, how to evaluate them, etc.

Very little literature is available in regarding the use of Bloom's Taxonomy to develop questions to assist students in the classroom (Elijah and Legenza, 1978; Masland, 1978-1979; Newton, 1978). There is even less information about the use of Bloom's Taxonomy to train students in self-questioning to assist them in the comprehension of science material.

Due to the limited amount of research done in the area, the use of the taxonomy to assist students in the self-generation of questions with science materials was considered a unique opportunity to develop the critical thinking skills required to understand science materials.

In addition, the taxonomy provides a technique for use beyond the remedial reading classes and into regular classroom activities like science.

5. Originality

Bloom's Taxonomy was described point in detail in order for the reader to understand its unique applicability in the design of questions, when compared to other taxonomies so that evaluation of this taxonomy can be made and usefulness with science reading materials can be determined.

Section Summary

To summarize, there are several taxonomies used to assist teachers, test makers, and supervisors design instruction. But analysis of the taxonomies suggests that most of them are variations of Bloom's Taxonomy of Educational Objectives Cognitive Domain. Therefore, this taxonomy was selected to design the questions to aid the poor comprehenders in the understanding of science material. The taxonomy offers completeness, familiarity, convenience, variety and originality.

Research already indicates that the use of questions in the classroom has positive effects on achievement (Cohen, 1983; Sadker, and Cooper, 1987). Bloom's Taxonomy offers us an organized efficient way of elaborating questions to be able to assist the poor comprehenders to grasp the content of the science material they read.

Still, very little information is available in relation to the use and effectiveness of questions made with Bloom's or any other's taxonomy (Elijah and Legenza, 1978; Masland, 1978-1979; Newton, 1978; Andre, 1979) to assist students in the classroom. Newton (1978) suggested that the role of school is to provide opportunities to develop critical reading skills in students as intelligent beings. Newton suggested the use of Bloom's Taxonomy to elaborate questions to help students raise their cognitive thinking abilities, whenever emphasis is made on questions that tap the last three categories of the taxonomy: analysis, synthesis and evaluation. Newton considered that these processes involve higher cognitive thinking. She indicated that several advantages can be observed when teachers ask students questions which are included in those three categories. Higher cognitive questioning can assist students develop critical reading skills since the student "not only literally comprehends the printed page but interacts critically as he reads its contents" (Newton, 1978, pg. 27). Also, the student becomes an "active participant in the reading situation" promoting discussions and enabling the student to use questions as an instrument to formulate evaluative judgements (Newton, 1978, pt. 27). Andre (1979) reviews a series of studies in which it was shown that high level questions defined as those concerned with analysis, evaluation in Bloom's Taxonomy have a positive effect on learning. However, the conditions under which they occur is not very well understood yet by researchers. Elijah and Legenza (1978) and Masland (1979) discussed the existence of several taxonomies, including Bloom's, in their effort to help teachers ask students questions over the material they read. Both proposed and developed their own taxonomies and suggest their use to enhance reading comprehension. Elijah and Legenza (1978) specifically outline theirs in detail and provide suggestions for teachers to use in the preparation of their questions. Similarly Duffelmeyer (1980) advises the use of Barrett's taxonomy to promote reading comprehension beyond literal level. Yet none of them has examined scientifically the effect of a given taxonomy used to develop questions on student's learning. Furthermore, none of them has studied the effects of self questioning using Bloom's Taxonomy in the comprehension of science material of poor comprehenders. It would seem that self-questioning techniques using Bloom's taxonomy promote the development of questions which are compatible with the problem solving discovery methods frequently used in science if we emphasize the production of high level questions, that is analysis, synthesis and evaluation.

In addition, it would provide poor comprehenders with an efficient tool which they can use to control and monitor their comprehension as active readers which can be self-rewarding and perhaps lead to a positive attitude towards reading. Encouraging student generated questions using Bloom's Taxonomy may allow poor comprehenders and their science teacher the opportunity to confront scientific principles in a manner that poor comprehenders can understand; in a way that permits them to identify the relationship of ideas and evaluative judgements necessary to engage efficiently in laboratory experiences.

Science Learning and High Level Questions

Science instruction tries to determine those teaching practices that lead to effective learning of the underlying principle within scientific knowledge. It's a field constantly evolving due to the advancement of science therefore science educators and publishers alike try to adjust, modify their curriculum to incorporate new updated material and scientific discoveries.

Several methods are used in science to assist the students in the understanding and application of a variety of scientific principles such as mastery learning, meaningful learning which includes the use of problem solving strategies, discovery, learning, links to prior knowledge, etc. (Burton, 1983). Similarly, there are several techniques used to increase the meaningfulness of scientific knowledge like the use of concrete analogies, notetaking, and summarizing advance organizers, conceptual cues, and improving the content of science textbooks. (Burton, 1983).

It would seem that the existence of such a variety of methods and techniques would guarantee the success of science instruction. However, this does not appear to be the case. A crisis seems to be a more likely description of the state of the art in science instruction (Burton, 1983, pg. 293).

While it is not the intention of the author to discuss the state of the art in science instruction and the factors that may affect science curriculum, instead it is the purpose of this investigation to provide the poor comprehender with a study skill, as a tool that will assist him in the understanding of science material and serve as a bridge between the general process of comprehension and the thinking skills demands of the science curriculum.

Recent research indicates initial support for the use of questions to enhance reading comprehension in science. Ackerman (1981) studied the use of several forms of adjunct questions in science, to establish encoding by visual imagery and and encoding by semantic stimulation to test whether either coding enhanced performance. Results indicated that there were no differences or main effects but that students who scored higher on visual imagery scored significantly better on criterion tests here adjunct questions had partial diagrams, than did those students whose questions had verbal coding only.

Andre and Anderson (1978-1979) investigated the effects of student generated questions on how it facilitates learning from text. They designed two experiments. Experiment #1: 29 student seniors were exposed to two conditions, questioning training and no questioning. Results indicated that the question generation strategy seems to work better for low ability students. Experiment #2: 81 juniors and seniors were placed into three groups, questioning and training, questioning and not training, and no question with three different types of passage requirements. Results showed that those students involved with questioning and training and questioning without training performed better than those with no training in questioning.

Although the information is limited it seems to encourage positive results towards the use of self generation of questions to enhance comprehension of science materials. Andre and Anderson (1978-1979) point out several explanations for the beneficial effects of self questioning.

1. Accordingly input is analyzed in a hierarchy of processing stages where increasing depth implies greater degree of semantic or cognitive analysis, hence greater retention.
2. Improved retention of textual material by questioned groups is simply a function of extended study time.
3. The combination of metacognitive and cognitive characteristics frequent in reading (promoting comprehension, etc.) (Andre and Anderson, 1978-1979, pg. 620).

Lastly there is the study by Porterfield (1974) where he investigated the effects of teacher questioning students in science with the use of high level questions (comprehension, analysis, evaluation). He found that those trained in (SCIS) method of inquiry discovery science instructional approach using questions asked more questions than those who were not trained in it. Yet, little information was available in terms of the student's level of achievement, to account for a possible relationship between questioning technique, science materials and student achievement.

Section Summary

In summary, the use of questions in the science content area seems to have initial positive results, especially with low ability students (Andre and Anderson, 1978-1979; Porterfield, 1974).

However, little information is available and there is need for further research to determine the usefulness of techniques with students in science content area. Yet, some initial advantages cited by Andre and Anderson (1978-1979) indicate that the self-questioning technique encourages the readers to:

a. Set purposes in reading.

b. Identify important segments of the material.

c. Generate questions which require comprehension of the text to be correctly answered.

d. Think of possible answers to the questions.

e. Actively monitor the learning activity to achieve efficiency (Andre and Anderson, 1978-1979, pg. 620).

Chapter Summary

This chapter was a review of literature related to the present study. The first part of research focused on the study of the importance of questioning as a technique to facilitate comprehension. The second part focused on

Bloom's Taxonomy and its use in the generation of different types of questions. The last section focused on science learning and the effect of high level questions on learning.

CHAPTER III

METHODS AND PROCEDURES

Introduction

This chapter on methods and procedures consists of five sections. The first section identifies the population and the sample and describes how they were selected for the study. The second section presents the design employed and addresses the issues of internal and external validity. The third section includes a presentation of the instruments used to measure the students' reading comprehension and the instructional strategy used to assist the students in reading, as well as a discussion of the validity of the instruments selected. The fourth section includes the procedures used in data collection. The last section describes the analysis of procedures.

Population and Sample

Population

The population for this study was poor readers in seventh and eighth grade of a public middle school in the Lansing School District.

Sample and Selection Procedures

The sample consisted of 11 students nominated by the remedial reading teacher from seventh and eighth grades. The students were chosen from a developmental reading class from a selected middle school in the Lansing School District area. All subjects volunteered to participate in the study. The investigator supplied consent forms to the students' parents (Appendix A).

The principal from the middle school in Lansing was contacted to request the use of their students and teachers for participation in the study. After the study was approved by the Lansing School District Office of Evaluation and the Human Subjects Committee at Michigan State University, the teachers were contacted again to explain the extent of the students' involvement in the study.

The 11 students selected for this study were adequate decoders but poor comprehenders. The students were screened to determine that they were indeed adequate decoders and to assess their reading comprehension abilities.

To determine students' ability to decode and comprehend all nominees were asked to read silently a 400-word passage assessed to be written at a seventh grade level according to Fry Readability Formula (Fry, 1977). The students were then asked to answer in writing 10 comprehension questions. Following the comprehension questions, the students were asked to read the passage aloud to ascertain correct and incorrect reading rates. Students who achieved a minimum of 80 w.p.m. correct and a maximum of 2 w.p.m. incorrect (Lovitt and Hansen, 1976) and a score of 50% or below on the comprehension assessment were eligible to participate in the study. The 11 subjects were randomly selected from a pool of eligible students (Appendix B).

Following this screening, the 11 students who met the criteria were selected from a pool of eligible students. There were seven boys and four girls assigned to three groups. The students were assigned to three different groups on the basis of scheduling needs. The schedule needed to allow the researcher to meet at least four students at one time two to three times per week. Therefore, Group #1 had three boys and one girl and Group #2 had two boys and two girls. Group #3 had two boys and one girl.

The cultural and ethnic background of these children were the same except for the fact that all but one had Spanish surnames. One had a native American Indian surname. Nine students were hispanic, one student was black, and one student was native American Indian.

In Group #1 were Beatriz (S_1), Humberto (S_2), Vicente (S_3), and Federico (S_4). In Group #2 were Carol (S_5), Antonio (S_6), Jeronimo (S_7), and Laura (S_8). In Group #3 were Alfredo (S_9), Roberto (S_{10}) and Adelaida (S_{11}).

Instruments

Assessment and Training Material

Passages used for training and assessment were taken from material different than the students used in their science classes. Six chapters were taken from Life Science (Webster, et. al., 1980) to develop the assessment materials for the study. The topics were cells, vascular plants with seeds, vertebrates, invertebrates, new directions in life science and seed plants. The passages were screened for appropriate readability level according to (Fry 1977) readability formula (Figure 2).

Also, a series of 10 questions were developed for each passage according to Bloom's Taxonomy of Intellectual Skills/Cognitive Domain. The questions developed covered most levels of the hierarchy with the exception of the level of evaluation. The questions were elaborated with strong emphasis on application, analysis, synthesis to be used in all the conditions baseline and experimental as well as in the classroom generalization probes. A total of 186 passages were used in this study divided into 2 for Screening, 3, 5, 7 for Baseline, 3 for Intervention #1, 8 for Intervention #2, 3 for Maintenance per subject, per group. However, there were several problems encountered by the researcher in the development of the assessment/training materials used in the study.

First, there was the selection of the science topics to be used. The selections were influenced by familiarity with subject matter by the researcher, since the researcher was not a Science Education major. Therefore, those topics that were well known to the researcher were selected.

Second, although the length of the passages was established to be between 400-500 words, on many occasions it was necessary to adjust the length to insure that the presentation of a concept was not negatively affected.

Life Science - Webster et al - Prentice Hall, Inc., 1980

Unit	Chapter	Description
Unit I	Chapter 1	Vascular Plants with Seeds (pg. 52-61)
Unit I	Chapter 1	Some Flowering Plant Families (pg. 62-64)
Unit I	Chapter 2	Invertebrate Animals (pg. 67-94)
Unit I	Chapter 3	Vertebrate Animals (pg. 97-124)
Unit III	Chapter 7	Cells (pg. 207-222)
Unit III	Chapter 8	Seed Plants (pg. 225-248)
Unit VII	Chapter 18	New Directions in Life Science (pg. 469-490)

Textbook Used

Units, chapters and topics selected to design the passages used in the study. (a)

Figure 2

a) except for reading concerning laboratory experiments

Therefore, in some instances, passages were extended to 550 words, with no more than 2-3 concepts introduced per passage.

Third, the writing of the questions according to Bloom's Taxonomy area of Cognitive Domain posed problems due to the nature of the content in some passages used and the style in which they were written (EX: descriptive vs. inquiry or discussion). In many cases it became very difficult to produce some of the question types. For most cases it was very easy to make factual-recall questions, knowledge and understanding questions. On the other hand, it was extremely difficult to make application, analysis, and synthesis questions. However, there were always 10 questions always containing at least one application, analysis, and synthesis question with the remainder being knowledge and understanding questions. Therefore, in each passage there were approximately four knowledge, three understanding question types and at least one application, one analysis and one synthesis question.

Fourth, on other occasions, due to the nature of the topic (e.g., cells), it was necessary to add pictures to the reading selection. Otherwise it was very difficult for the reader to understand the science topic without the additional laboratory experience or discussion. In addition, pictures were necessary in many cases to formulate question types like application and analysis.

Passages were adapted and questions constructed. Both were typed separately on letter size paper double spaced so that no relationship or familiarity with the textbook was made by the student. Passages were administered randomly so that no two students had the same passage at one time.

Validity of Instruments

The validation of the instruments used in this study was achieved by having one independent individual familiar with Bloom's Taxonomy rate the questions to confirm that they indeed represented the different levels of the Taxonomy (see Appendix C). In addition, a reliability check was used where a pool of questions of different types was elaborated according to the taxonomy chosen. Two individuals rated them again according to their type. There was 90% reliability agreement. Then those questions disagreed on were rewritten to conform to the types.

Design of the Study

The study was designed to investigate the effectiveness of the instruction of self-generated questions structured using Bloom's Taxonomy on the acquisition and maintenance of comprehension skills of science material by poor comprehenders.

The design selected for this study to investigate the effectiveness of this strategy was a multiple baseline design across subjects (Gay, 1981; Kratochwill, 1978). There were four phases: Baseline, Intervention #1, Intervention #2 and Maintenance. Baseline lasted for 3, 5, or 7 days for students in Group #1, Group #2 or Group #3, respectively. Intervention #1 lasted for 3 days for all individuals in all three groups. Intervention #2 lasted for 8 days for all individuals in all three groups, and Maintenance lasted 3 days for all students in the groups.

The design and timeline for the study are presented in Figure 3. The research questions this study was designed to address include the following:

1. Will self-generated questions increase the level of reading comprehension of poor comprehenders?
2. Will instruction in question-generating using Bloom's Taxonomy increase the level of reading comprehension of poor readers and the ability to answer high level questions?
3. Will the change observed in comprehension maintain over time?

There are several dependent variables to these research questions:

1. The number of comprehension questions answered correctly in the passages read independently in experimental setting.
2. The number of high level questions generated by students.
3. Maintenance measures; that is, comprehension questions answered correctly some time later after the end of the study.

Procedures

The study was carried out by the investigator with the cooperation of the developmental reading and science teachers. The students selected were informed that they were going to do some reading activities that would help them understand and learn science material better and faster. They were told that these activities were varied. At specific times (i.e., Baseline, Intervention #1, Intervention #2, and Maintenance) the students were given an explanation about the activity they were to do. In Baseline they were told that in order for the researcher to assist them in learning science material better, she needed to observe if they knew how to read well and that it would be reflected on how accurately they answered the questions given later. In Intervention #1 the students were told that it was important to know if they knew how to ask good questions about their readings. In Intervention #2 the students were told that the researcher would instruct them in the different question types so that they would assist them to understand science material and learn it better and faster. In Maintenance students were told that the researcher needed to observe how they would apply instruction on the question types independently.

Baseline

Baseline measures were taken in the experimental setting immediately following subject selection. The student was told to ask for assistance with any word that he/she did not understand. Upon completion of the passage, the student was given 10 comprehension questions based on Bloom's Taxonomy. The student was praised for correct responses. The daily measures taken throughout the study and referred to as assessment passages were administered in the same manner.

As was mentioned before in the subject selection process there were 11 students selected from a pool of eligible students who were divided into three groups (Figure 3).

Intervention #1

During Intervention #1 the student received a passage to read silently. The student was asked to generate questions about the passage and write them down on a piece of paper as he/she read. Afterwards the student received 10 comprehension questions to answer about the passage read (Figure 3).

Intervention #2

The student was instructed in the use of questions through a combination of both modeling and direct instruction taking one question type at a time. First, the investigation discussed the use of self-questioning in reading and its importance to enhance comprehension of science materials. Consequently, the student was informed

DESIGN: STRATEGY TRAINING STUDY - TIMELINE

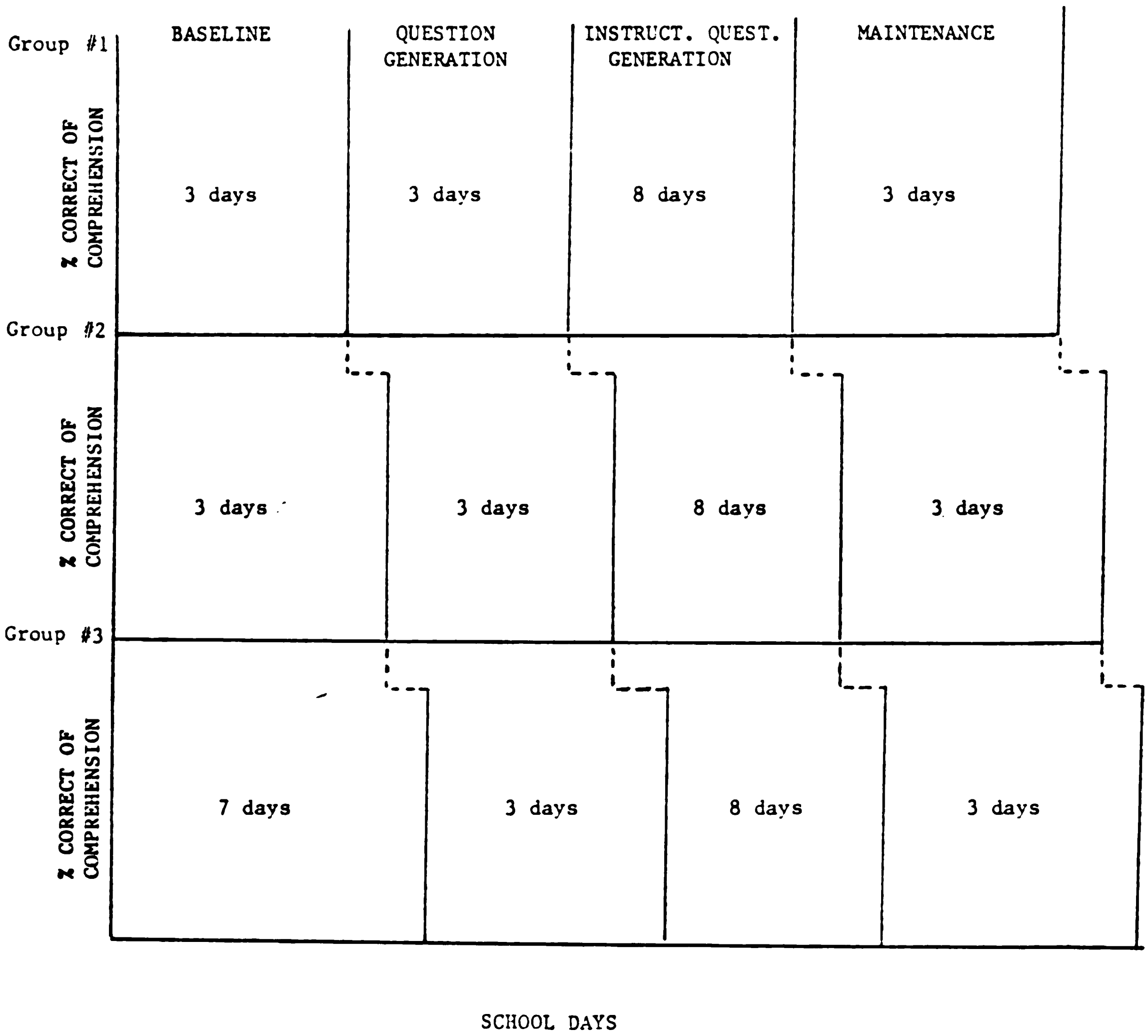

Figure 3

of the different types of questions that could be made according to Bloom's Taxonomy and the different types of information they provided the student with.

The researcher selected one question type (i.e., knowledge or factual recall) and explained to the student its importance and the kind of information he/she was able to obtain by formulating this type of question.

Next, the student distinguished the questions that emphasized the category of knowledge in Bloom's Taxonomy (i.e., recall of facts) from other types of questions in the taxonomy from a list given to him, with the help of the researcher.

Then, the researcher modeled how to make a knowledge type questions. Then, the student practiced making questions.

Finally, the student was given a passage to read silently. Afterwards, the student received 10 comprehension questions to answer in writing (Appendix D).

Emphasis on question generation was made on the level of application, analysis, synthesis types since these were the ones believed by the investigator to be most useful in assisting the student to understand the issue involved in the reading of science materials.

There was one passage given per student, per day. Each was used for assessment purposes. The same procedure was used for the rest of the categories in the Bloom's Taxonomy.

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There was no criteria established to achieve mastery of each question type, rather the time allowed each question type was controlled; one day for knowledge, one day for understanding, and two days for each of the rest of the categories of questions application, analysis, synthesis.

When the student was exposed to all question types possible according to Bloom's Taxonomy area of cognitive domain, the student entered the maintenance phase (Figure 3).

Maintenance

The maintenance phase was similar to Baseline. The student read a 400-500 word passage silently. Upon completion of the passage, the student was given 10 comprehension questions based on Bloom's Taxonomy to answer on a separate piece of paper (Figure 3).

Throughout all of these phases students were given global feedback on their performance encouraging them to do better.

Chapter Summary

This chapter was a description of the methodology and procedures used in this study. A description of the population and subjects was provided. A discussion of the materials was introduced. At last, a description of the design selected and procedures followed in the study.

CHAPTER IV

RESULTS

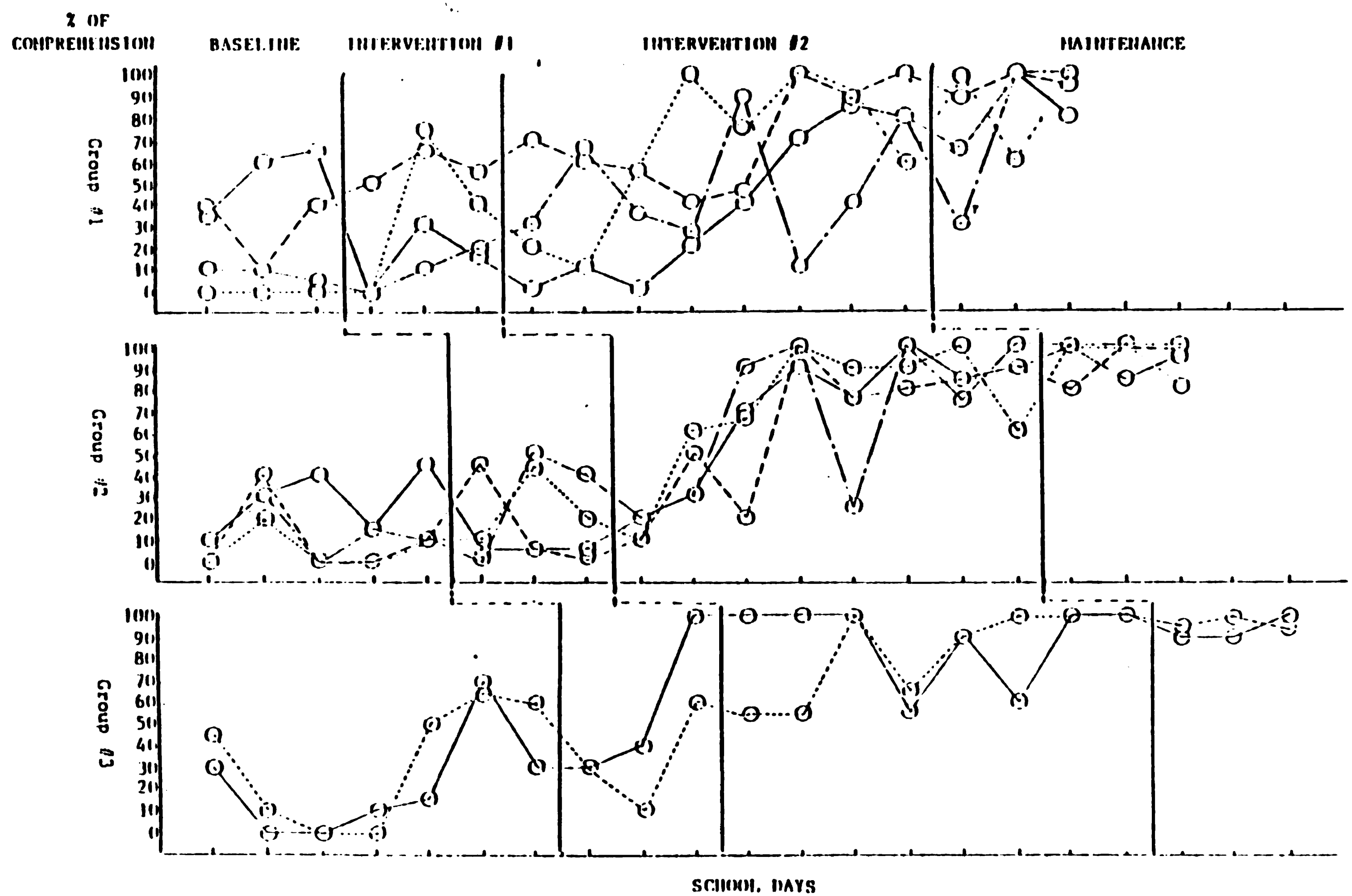
This chapter focuses on the results of the teaching strategy of self questioning. The analysis of the four phases of the study, Baseline, Intervention #1, Intervention #2, and Maintenance, is reported. Within each phase the means and general trends are described as they relate to the three research questions previously stated. The means and general trends within and between phases are described, followed by a discussion of group differences in the percent of accuracy with the questions comprehension, ability to generate questions, and type of questions generated and answered. The number of students selected for the study was 11. All but one completed the study. Student No. 11 was dropped out of the study due to lack of motivation and cooperation, and overall indifference towards the research (Figure 4).

There were three research questions:

1) Will self-generated questions increase the level of reading comprehension of poor readers?
2) Will instruction of questioning using Bloom's Taxonomy, increase the level of reading comprehension of poor readers and the ability to answer high level questions?
3) Will the change observed in comprehension maintain over time?

Percentage of comprehension per subject, per group, per phase.

RESULTS



1. Will self-generated questions increase the level of reading comprehension of poor readers?

The results of the data reported during both Baseline and Intervention #1 were as follows:

Overall when the percent of comprehension both Baseline and Intervention #1 were compared it was found to be below 50% but the number and percent of questions answered correctly moderately increased from Baseline to Intervention #1. In Baseline 61 (13.2%) questions were answered correctly out of 460 questions given to Group #1, Group #2, Group #3. In Intervention #1, 91 (30.33%) questions were answered correctly out of 300 questions given to Group #1, Group #2, Group #3 (Table 1). Therefore, although the percent of comprehension was low in both phases there was a moderate improvement across all subjects in all groups mean performance, most noticeably in Group #3 from Baseline to Intervention #1 (Table 2 and Table 4).

Baseline	Intervention #1
$G_1 \bar{x}_B = 22.9$	$G_1 \bar{x}_1 = 29.7$
$G_1 \bar{x}_B = 12.75$	$G_2 \bar{x}_1 = 19.97$
$G_1 \bar{x}_B = 27.1$	$G_3 \bar{x}_1 = 44.95$

In addition, a description of the results of each phase, per student per group reported the following findings:

Baseline

In this phase the subjects received 3, 5, or 7 passages, one per student per day to be read silently.

Table 1

Total number and type of questions given and answered correclty per phase per group

PHASE	NO. OF QUESTIONS GIVEN				QUESTION TYPES GIVEN G_1, G_2, G_3					NO. OF QUESTIONS ANSWERED CORRECTLY				QUESTION TYPES ANSWERED CORRECTLY G_1, G_2, G_3				
	G_1	G_2	G_3	TOTAL	K	U	AP	AN	S	G_1	G_2	G_3	TOTAL %	K	U	AP	AN	S
Baseline	120	200	140	460	184	138	46	46	46	32	20	9	61	15	26	10	5	5
					40%	30%	10%	10%	10%	6.9%	4.3%	1.9%	13.2%	3.2%	5.6%	2.1%	1.0%	1.0%
Intervention #1	120	120	60	300	120	90	30	30	30	38	26	27	91	28	33	16	8	5
					40%	30%	10%	10%	10%	12.6%	8.6%	9%	30.3%	9.3%	11%	5.3%	2.6%	1.6%
Intervention #2	320	320	160	800	320	240	80	80	80	164	188	146	498	178	153	60	58	49
					40%	30%	10%	10%	10%	20.5%	23.5%	18.2%	62.25%	22.25%	19.1%	7.5%	7.2%	6.1%
Maintenance	120	120	60	300	120	90	30	30	30	95	107	57	259	81	95	26	33	25
					40%	30%	10%	10%	10%	31.5%	35.6%	19%	909	27%	31.6%	12%	11%	8.3%
													TOTAL	302	307	138	104	84
													%	35.1	35.6	16.0	34.6	28

Table 2

Report of the mean, scores and trends per subject in Baseline.

	Student	$\bar{x}$ Mean	Scores	Trend
Group #1 $\bar{x}$ = 22.9	Subject #1	53.3	35, 60, 65	high, accelerating
	Subject #2	30.0	40, 10, 40	low, unstable
	Subject #3	8.3	10, 10, 5	stable, low
	Subject #4	0	0, 0, 0	stable, low
Group #2 $\bar{x}$ = 19.97	Subject #5	28	10, 30, 40, 15, 45	stable
	Subject #6	13	10, 30, 0, 15, 10	variable
	Subject #7	10	0, 40, 0, 0, 10	stable, low
	Subject #8	6	0, 20, 0, 0, 10	stable, low
Group #3 $\bar{x}$ = 44.95	Subject #9	22.1	30, 0, 0, 10, 15, 70, 30	variable
	Subject #10	32.8	45, 10, 0, 0, 50, 65, 60	variable

Afterwards, the subject had to answer from memory 10 comprehension questions given to him/her about the passage read. This phase lasted 3, 5, or 7 days for each subject depending whether in Group #1, Group #2 or Group #3.

Group #1

The mean percent correct on the comprehension measures in Group #1 was $\bar{x}$ = 22.9 and scores ranged from 0% to 65% (Table 2). The trend for S_1 and S_2 was variable, with a high positive trend for S_1. The trend for S_3 and S_4 was low and stable (Figure 4). During Baseline, Group #1 received a total of 120 questions, 10 per passage, per student, which included at least one of each type according to Bloom's Taxonomy. A total of 32 (26.6%) questions were answered correctly (Table 3). There were 7 (21.8%) questions knowledge type and 15 (46.8%) questions understanding type, 7 (21.8%) questions application type, 2 (6.2%) questions analysis type and 1 (3.1%) question synthesis type. That is out of 32 questions answered correctly, 22 (68.6%) of them were knowledge and understanding type.

Group #2

The mean percent correct on the measures for this group was $\bar{x}$ = 14.25 and scores ranged from 0% to 40% (Table 2). S_5, S_7, S_8 had a low and consistent trend. The trend for S_6 was low but variable (Figure 4). Group #2 received a total of 200 questions. A total of 20 (10%) questions were

Table 3

BASELINE

Number and type of questions answered correctly in Baseline

GROUP	STUDENTS	NO. OF QUESTIONS CORRECT K	U	AP	AN	S	TOTALS	
#1	Subject #1	4	8	2	2	1	17 (56.6%)	Total No. of Questions 120 32=26.6%
	Subject #2	3	6	2	0	0	11 (34.3%)	
	Subject #3	0	1	2	0	0	3 (9.3%)	
	Subject #4	0	0	1	0	0	1 (3%)	
	Subtotal	7	15	7	2	1	32	
	%	21.8	46.8	21.8	6.3	3.1		
#2	Subject #5	4	5	0	1	0	10 (5%)	Total No. of Questions 200 20=10%
	Subject #6	0	1	2	1	1	5 (25%)	
	Subject #7	2	1	0	0	0	3 (15%)	
	Subject #8	0	2	0	0	0	2 (10%)	
	Subtotal	6	9	2	2	1	20	
	%	30	45	10	10	5		
#3	Subject #9	4	3	3	1	2	13 (35%)	Total No. of Questions 140 37=26.42%
	Subject #10	4	11	3	3	3	24 (64.86%)	
	Subtotal	8	14	6	4	5	37	
	%	21.6	37.8	16.2	10.8	13.5		

answered correctly (Table 3). There were 6 (30%) questions knowledge type, 9 (45%) questions understanding type, 2 (10%) questions application type, 2 (10%) questions analysis type, 1 (5%) question synthesis type. That is out of 20 questions answered correctly 15 (75%) of them were knowledge and understanding types.

<u>Group #3</u>

The mean percent of accuracy on comprehension measures for this group was $\bar{x} = 27.4$ and scores ranged from 0% to 70% (Table 2). The trend for S_9 and S_{10} was variable but still low (Figure 4). Group #3 received a total of 140 questions. A total of 37 questions were answered correctly (Table 3). There were 8 (21.6%) questions knowledge type and 14 (37.8%) questions understanding type, 6 (16.2%) questions application type, 4 (10.8%) questions analysis type, 5 (13.5%) questions synthesis type. That is that out of 37 questions answered correctly 22 (59.4%) of them were knowledge and understanding types.

The difference in time allocated for Baseline for all individuals in all groups does not seem to cause any noticeable difference in performance. Regardless of amount of days spent in Baseline the overall level of comprehension remained low as expected except for subject 9 and 10. S_9 exhibited one day where he demonstrated his level of comprehension to be unusually high (70%) and S_{10} showed two days where he demonstrated his level of comprehension to be slightly high (65% and 60%). The degree of difficulty of the content of previous passages as opposed to the ones given on these occasions may account for the student's difference in performance.

Intervention #1

During this phase the subjects received 3 passages each, one per student per day, to be read silently. The subjects were asked to generate questions about each passage read and write them down on paper as he/she read. Afterwards the subject had to answer from memory 10 comprehension questions given to him/her about the passage read. This phase lasted three days for all subjects in all three groups.

The results of this phase per student per group were as follows:

In Group #1 The mean percent of accuracy on comprehension measures for the subjects in this group was $\bar{x} = 29.7$ and scores ranged from 10.6% to 56.6% (Table 4). The trend for S_1 and S_4 was variable and the trend for S_2 was low and consistent; S_3 was high and consistent above 50% level. In Group #1 subjects generated a total of 42 questions, that is an average 10.5 questions per subject (Table 5 and Table 6). These ranged from 7 to 16 questions. Out of a total of 42 questions, there were 38 (90.4) knowledge type, 1 (2.3%) comprehension type, 2 (4.6%) application type, 1 (2.3%) analysis type.

The relationship between the number of questions generated and percent of comprehension for subjects in Group

Table 4

Report of the mean, scores and trends per subject in Intervention #1

	Student	$\bar{x}$ Mean	Scores	Trend
Group #1 $\bar{x}$ = 29.7	Subject #1	15	0, 30, 15	variable
	Subject #2	56.6	50, 65, 55	stable, high
	Subject #3	10.6	0, 10, 22	stable, positive accelerated
	Subject #4	36.6	0, 75, 40	variable
Group #2 $\bar{x}$ = 19.97	Subject #5	8.3	5, 5, 5	stable
	Subject #6	30.0	0, 50, 40	stable
	Subject #7	16.6	45, 5, 0	decreasing, stable
	Subject #8	25.0	10, 45, 20	stable
Group #3 $\bar{x}$ = 44.95	Subject #9	56.6	30, 40, 100	accelerating
	Subject #10	33.3	30, 10, 60	accelerating

Table 5

NUMBER AND TYPE OF QUESTIONS GENERATED BY EACH STUDENT DURING INTERVENTION #1

READINGS/STUDENTS	NO. OF QUESTIONS GENERATED			TYPE OF QUESTIONS GENERATED					% OF COMPREHENSION			
	DAY 1	DAY 2	DAY 3	K	U	AP	AN	S	DAY 1	DAY 2	DAY 3	
8, 1, (S#1) Beatriz	4	4	3	9		1	1		0	30	15	
2, 3 (S#2) Humberto	5	4	0	7					50	65	55	
7, 8 (S#3) Vicente	5	5	6	16					0	10	22	
7, 8, 1 (S#4) Federico	3	2	5	6	1	1			0	75	40	
				38	1	2	1					
				90.4%	2.3%	4.6%	2.3%					
8, 18 (S#5) Carol	8	10	14	20	2				5	15	5	
1, 7, 3 (S#6) Antonio	2	0	1	3					0	50	40	
1, 18, (S#7) Jeronimo	0	2	3	4	1				45	5	0	
2, 3 (S#8) Laura	9	10	6	20	1		4		10	45	20	
				47	4		4					
				85.4%	7.2%		7.2%					
3, 2 (S#9) Alfredo	1	2	4	4		1			30	40	100	
18, 1 (S#10) Roberto	7	2	5	14					30	10	60	
				18		1						
				94.7%		5.27%						
READINGS:	TOTAL: 132			TOTAL: 118					G 1	G 2	G 3	TOTAL
Cells Chp. 7	Rejected 14			K = 103 (87.28%)					42	55	19	118
Seed Pl. Chp. 8	G : x = 10.5			U = 8 (6.77%)					35.5%	46.6%	16.1%	
New Dir. Chp. 18				AP = 3 (2.54%)								
Vasc. Pl. Chp. 1, p.11	G : x = 12.75			AN = 5 (4.23%)								
Verteb. Chp. 3				S = 0 (0%)								
Invert. Chp. 2	G : x = 9.5											

Table 6

Number of question generated, means and standard deviation per group in Intervention #1

No. of Questions Generated	Mean	SD
Group #1 = 42	10.5	4.04
Group #2 = 51	12.75	12.31
Group #3 = 19	9.5	4.5

#1 was as follows: S_1 and S_4 generated 11 and 8 questions respectively ($\bar{x}$ = 10.5, SD = 4.04) (Table 5 and Table 6). The percent of comprehension was variable but low for both of them. S_2 generated 7 questions and percent of comprehension was high and consistent above 50% comprehension ($\bar{x}$ = 56.6). S_3 generated 16 questions and the percent of comprehension was low and consistent (Tables 3 and 6). The relationship between the number of questions generated and percent of comprehension for Group #1 seemed to be as follows; the higher the amount of questions generated the lower the comprehension exhibited for S_1, S_3, S_4 and less amount of questions generated the higher the percent of comprehension for S_2. It was observed students spent too much time and attention to small pieces of reading to make questions rather than read the material to answer the questions that followed it.

Group #1 received a total of 120 questions, 4 students, 3 passages each, 10 questions per passage, per student, and each had at least one of each type according to Bloom's Taxonomy. A total of 40 (32.5%) questions were answered correctly, 13 (32.5%) were knowledge type questions, 16 (40%) understanding type questions, 6 (15%) application type questions, 3 (7.5%) analysis type questions, 2 (5%) synthesis type questions. That is out of 40 questions answered correctly 29 (72.5%) of them were knowledge and understanding question types (Table 7).

In Group #2 the average percent of accuracy on

Table 7

INTERVENTION #1

Number and type of questions answered correctly in Intervention #1

GROUP	STUDENTS	NO. OF QUESTIONS CORRECT					TOTALS	
		K	U	AP	AN	S		
#1	Subject #1	1	4	1	0	0	5 (16.6%)	Total No. of Questions 120 40=33.3%
	Subject #2	6	9	3	3	1	22 (55%)	
	Subject #3	3	1	1	0	0	5 (12.5%)	
	Subject #4	3	3	1	0	1	8 (26.6%)	
	Subtotal	13	16.	6	3	2	40	
	%	32.5	40	15	7.5	5		
#2	Subject #5	2	0	1	0	0	3 (13%)	Total No. of Questions 120 23=19.1%
	Subject #6	1	2	2	1	0	6 (26%)	
	Subject #7	1	3	1	0	1	5 (21.7%)	
	Subject #8	1	2	4	1	1	9 (39.1%)	
	Subtotal	5	6	8	2	2	23	
	%	21.7	26	34.7	8.6	8.6		
#3	Subject #9	6	7	1	2	1	17 (62.9%)	Total No. of Questions 60 37=45%
	Subject #10	4	14	1	1	0	10 (37%)	
	Subtotal	10	11	2	3	1	27	
	%	37	40.7	7.4	11.1	5.8		

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comprehension measures for the subjects in this group was $\bar{x} = 19.97$ and scores ranged from 8.3% to 30.0% (Table 4). The trend for S_5 and S_7 was low and consistent, the trend for S_8 was variable and the trend for S_6 was average and consistent.

In <u>Group</u> <u>#2</u> the students generated a total of 55 questions (Table 5). There were 47 (85.4%) questions knowledge type, 4 (7.2%) comprehension type and 4 (7.2%) analysis type. That was an average of 12.75 questions per subject (Table 6). These ranged from 3 to 25 questions.

The relationship between the number of questions generated and the percent of comprehension for subjects in Group #2 was as follows: S_5, S_6 and S_7 generated 24, 3, and 5 questions respectively ($\bar{x} = 12.75$, SD = 12.31) (Table 5 and 6). The percent of comprehension was low but consistent for all of them and S_8 generated 25 questions and percent of comprehension was variable. Similarly in Group #2 the higher the number of questions generated the lower the percent of comprehension for S_5 and S_8. Also, the less amount of questions generated the higher the percent of comprehension for S_6 and S_7. Again, it was observed that students spent too much time and attention to small pieces of information in the passage to make questions rather than reading to be able to answer the questions that followed it.

<u>Group</u> <u>#2</u> received a total of 120 questions, 4 students, 3 passages each, 10 questions per passage, per student and each had at least one of each type according to Bloom's

Taxonomy. Twenty-three questions were answered correctly (19.1%) (Table 7). There were 5 (21.7%) knowledge type questions, 6 (26%) understanding type questions, 8 (34.7%) application type questions, 2 (8.6%) analysis type questions, 2 (8.6%) synthesis type questions. That is out of 23 questions answered correctly 11 (47.7%) were knowledge and understanding type.

In Group #3 the average percent of accuracy on comprehension measures was $\bar{x}$ = 44.95 (Table 4). The trend for S_9 and S_{10} was variable. In Group #3 the students generated a total of 19 questions (Table 5). There were 18 (94.7%) questions knowledge type and 1 (5.2%) comprehension question. That was an average of 9.5 questions per subject (Table 6). These ranged from 5 to 14 questions.

The relationship between the number of questions generated and the percent of comprehension for subjects in Group #3 was as follows: S_9 and S_{10} generated 5 and 15 questions respectively ($\bar{x}$ = 9.5, SD = 4.5) (Table 5). The percent of comprehension was variable for both S_9 and S_{10}. However, the percent of comprehension for S_9 was above 50% comprehension ($\bar{x}$ = 56.6) (Table 4). Similarly, in Group #3 the higher the number of questions generated the lower percent of comprehension for S_{10} and the less the amount of questions generated the higher the percent comprehension for S_9.

Group #3 received a total of 60 questions, 2 students, 3

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3 passages each, 10 questions per passage, per student and each had at least one of each type according to Bloom's Taxonomy. Twenty-seven questions were answered correctly (45%) (Table 10). There were 10 (37%) knowledge type questions, 11 (40.7%) understanding type questions, 2 (7.4%) application type questions, 3 (11.1%) analysis type questions, 1 (5.8%) synthesis type questions. That is that out of 27 questions answered correctly 21 (77.7%) of them were knowledge and understanding type.

The trends observed in Intervention #1 indicated that there is not a positive relationship between the number of questions generated and the percent of comprehension exhibited at this point; on the contrary a general low performance below 50% comprehension was observed for all subjects that ranged from $\bar{x}$ = 19.97 to 44.95 and was consistent with Baseline. The higher the number of questions generated the lower the comprehension exhibited except for S_2, S_6 and S_9 where comprehension increased but the number of questions generated was low. It was noticed on all three groups that students spent too much time and attention to small pieces of reading to write questions and did not read to answer the questions which may account for the low comprehension exhibited. Thus, the self-generation of questions alone does not improve poor readers' accuracy answering comprehension of questions except when results are compared with those of Baseline then, only a small moderate improvement was observed. Also, it seems that the students do not appear to have a specific strategy-study skill to assist them in understanding what is read. In addition it was found that students can generate questions about the passage but out of a total of 118 questions generated, 103 (87.28%) were knowledge type, followed by 8 (6.77%) comprehension type, 3 (2.54%) application type and 5 (4.23%) analysis type. There were no synthesis questions generated (Table 6). That is 94.05% of all questions generated were either knowledge or comprehension type. Very few students were able to generate questions beyond this level. Also, the ratio of the number and type of question answered correctly, per student each day of Intervention #1 indicated that most subjects knew how to answer knowledge and understanding question types (Table 8).

Similarly, out of a total of 300 questions given to G_1, G_2, G_3 91 of them were answered correctly (30.3%) (Table 1). There were 28 (30.7%) knowledge type, followed by 33 (36.2%) comprehension type, 16 (17.5%) application type, 8 (8.7%) analysis type, 5 (5.4%) synthesis type. Again out of 91 questions answered correctly 61 of them were knowledge and comprehension type (67%). These factual recall question types are the ones students are most accustomed to answering (Durkin, 1978).

2. Will instruction of self-generated questions using Bloom's Taxonomy increase the level of reading comprehension of poor readers and the ability to answer high level questions?

Table 8

Ratio of number and type of question answered correctly during Intervention #1

	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	S 9	S 10
Knowledge										
Day 1	0/4	2/3	2/4	0/4	1/3	0/4	1/4	2/3	1/4	1/3
Day 2	0/4	2/3	0/3	3/4	1/4	2/4	0/2	1/3	2/4	1/4
Day 3	1/4	2/4	1/4	1/2	1/3	1/4	0/2	0/4	3/3	2/4
	7 out of 10 answered correctly (70%)									
Understanding										
Day 1	0/3	2/4	1/3	0/3	0/2	0/3	0/3	0/3	2/3	2/3
Day 2	2/3	4/4	0/4	3/3	0/3	1/3	0/4	1/4	2/3	0/1
Day 3	1/3	3/3	0/3	1/4	0/3	1/3	0/3	1/3	3/3	2/3
	6 out of 10 answered correctly (60%)									
Application										
Day 1	0/1	1/1	1/1	0/1	0/2	0/1	0/1	1/2	0/1	0/1
Day 2	1/1	1/1	0/1	1/1	1/1	1/1	0/2	1/1	0/1	0/1
Day 3	0/1	1/1	0/1	0/2	0/1	1/1	0/2	1/1	1/1	1/1
	3 out of 10 answered correctly (30%)									
Analysis										
Day 1	0/1	1/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/2
Day 2	0/2	1/1	0/1	0/1	0/1	1/1	0/1	1/1	0/1	0/2
Day 3	0/1	1/1	0/1	0/1	0/2	0/1	0/1	0/1	1/2	1/1
	1 out of 10 answered correctly (10%)									
Synthesis										
Day 1	0/1	0/1	0/1	0/1	0/2	0/1	0/1	0/1	0/1	0/1
Day 2	0/1	0/1	0/1	1/1	0/1	0/1	0/1	1/1	0/1	0/2
Day 3	0/1	0/1	0/1	1/1	0/1	0/1	0/2	0/1	1/1	0/1
	1 out of 10 answered correctly (10%)									

The results of the data collected during Intervention #2 were as follows:

Intervention #2

During this phase the students were instructed in the different kinds of question types that they could learn to generate when they read to assist them to comprehend better the passages they read.

The training period lasted eight days for all three groups. All students were instructed in each question type for two days, with the exception of knowledge and comprehension types for which there was one training day. The results of both Baseline and Intervention #1 indicated that the greater amount of questions answered correctly were knowledge and comprehension types. In addition, most of the questions generated in Intervention #1 were knowledge and comprehension type. Therefore, it was not necessary to train the students in these two question types for more than a day, since they were already familiar with them in their regular classroom work.

In Group #1, the mean percent accuracy of comprehension measures was $\bar{x}$ = 52.9% and ranged from 0% to 100% (Table 9). The trend for S_1 was positive, accelerated and was highly variable and the trend for S_4 was positive and stable.

Group #1 received a total of 320 questions 4 students, 8 passages each, 10 questions each per passage, per student to answer, which included at least one of each question type

Table 9

Report of the mean, scores and trends per subject in Intervention #2

	Student	$\bar{x}$ Mean	Scores	Trend
Group #1 $\bar{x}$ = 52.9	Subject #1	38.1	0, 10, 0, 20, 40, 70, 85, 80	accelerating
	Subject #2	70.0	70, 60, 55, 40, 45, 100, 90, 100	variable, delayed
	Subject #3	37.5	30, 65, 35, 25, 90, 10, 40, 80	highly, variable
	Subject #4	66.25	20, 10, 55, 100, 75, 100, 90, 55	upward, stable
Group #2 $\bar{x}$ = 69.0	Subject #5	74.3	20, 30, 70, 90, 75, 100, 85, 90, 65	upward, variable
	Subject #6	66.2	20, 30, 90 100, 25, 100, 75, 100	variable upward
	Subject #7	63.7	10, 50, 20, 100, 75, 80, 85, 90	variable upward
	Subject #8	71.8	10, 60, 65, 100, 90, 90, 100, 60	positive upward stable
Group #3 $\bar{x}$ = 85.6	Subject #9	88.1	100, 100, 100, 55, 90, 60, 100, 100	upward stable
	Subject #10	83.1	55, 55, 100, 65, 90, 100, 100, 100	positive upward

Table 10

Intervention #2

Number and type of questions answered correctly in Intervention #2

GROUP	STUDENTS	NO. OF QUESTIONS CORRECT K	U	AP	AN	S	TOTALS	
#1	Subject #1	9	6	4	2	3	24 (30%)	Total No. of Questions 320 164=51.2%
	Subject #2	25	13	8	6	4	56 (34%)	
	Subject #3	15	16	4	3	4	42 (25.6%)	
	Subject #4	15	14	4	4	5	42 (52.%)	
	Subtotal	64	49	20	15	16	164	
	%	39	29.7	12.1	9.1	9.7		
#2	Subject #5	10	15	4	3	3	35 (18.6%)	Total No. of Questions 320 188=58.7%
	Subject #6	19	9	5	6	3	42 (22.3%)	
	Subject #7	14	16	4	9	4	47 (25%)	
	Subject #8	25	14	12	7	6	64 (34%)	
	Subtotal	68	54	43	25	16	188	
	%	36	28.7	22.8	13.2	8.5		
#3	Subject #9	24	25	7	7	8	71(48.6%)	Total No. of Questions 160 146=91.2%
	Subject #10	22	25	8	11	9	75(51.36%)	
	Subtotal	46	50	15	18	17	146	
	%	31.5	34.2	10.2	12.3	11.6		

according to Bloom's Taxonomy. A total of 164 (51.2%) questions were answered correctly (Table 10). There were 64 (39%) knowledge type questions, 49 (29.8%) comprehension type questions, 20 (12.1%) application type questions, 15 (9.1%) analysis type questions and 16 (9.7%) synthesis type questions (Table 10).

In Group #2 the mean percent accuracy of comprehension measures was $\bar{x}$ = 69.0% and scores ranged from 10% to 100%. The trend for S_5 was upward, variable but consistent. The trend for S_6 was variable, upward. The trend for S_7 and S_8 was high, accelerated, stable and consistent (Table 9).

Group #2 received 320 questions to answer. A total of 188 (58.7%) questions were answered correctly. There were 68 (36%) knowledge type questions, 54 (28.7%) comprehension type questions, 43 (22.8%) application type questions, 25 (13.2%) analysis type questions, and 16 (8.5%) synthesis type questions (Table 10).

Group #3 had a mean percent accuracy of comprehension measures of $\bar{x}$ = 85.6 and scores ranged from 55% to 100%. The trend for S_9 and S_{10} was positive, accelerating, upward and consistent or stable (Table 9).

Group #3 received 160 questions to answer, 2 students 8 passages each, 10 questions each per passage, per student which included at least one of each question type according to Bloom's Taxonomy. A total of 146 (91.2%) questions were answered correctly. There were 46 (31.5%) knowledge type questions, 50 (34.2%) comprehension type questions, 15

(10.2%) application type questions, 19 (12.3%) analysis type questions, and 17 (11.6%) synthesis type questions (Table 10).

Overall, mean percent correct during Intervention #2 was above 50% comprehension and shows a marked improvement when compared to the mean percent of comprehension in the previous phase (Table 6, Table 9).

Intervention #1	Intervention #2
$G_1 \bar{x}_1 = 29.7$	$G_1 \bar{x}_2 = 52.9$
$G_2 \bar{x}_1 = 19.97$	$G_2 \bar{x}_2 = 69.0$
$G_3 \bar{x}_1 = 44.95$	$G_3 \bar{x}_2 = 85.6$

Also, the number of questions answered correctly markedly increased when compared to Intervention #1 (Table 1).

Intervention #1	Intervention #2
Total No. of Questions Given	Total No. of Questions Given
300	800
No. of Questions Correct	No. of Questions Correct
90 30.0%	498 62.25%

In addition, the number and percent of question types answered correctly moderately increased during Intervention #2 when compared with Intervention #1 (Table 1).

Question Type		Intervention #1	Intervention #2
Knowledge		28 (9.3%)	178 (22.25%)
Understanding		33 (11%)	153 (19.1%)
Application		16 (5.3%)	60 (7.5%)
Analysis		8 (2.6%)	58 (7.2%)
Synthesis		5 (1.6%)	49 (6.1%)
	TOTAL	90 (30.0%)	498 (62.25%)

Also, the performance of each subject per question type per day of training was as follows (Table 11).

<u>Knowledge - Day 1</u>

In Group #1 S_2, S_3, S_4 answered 3/4, 1/4, 1/3 knowledge type questions correctly. S_1 = 0/4.

In Group #2 S_5, S_6, S_7, S_8 answered 1/4, 2/4, 1/2, 2/4 knowledge type questions correctly.

In Group #3 S_9 answered 3/3 knowledge type questions correctly. S_{10} = 0/4.

In Group #1, Group #2 and Group #3 S_2, S_6, S_7, S_8, S_9, that is 5 out of 10 subjects were able to answer knowledge type questions correctly consistently. In addition, S_3, S_4 and S_5 were able to answer at least one knowledge question type correctly. Thus, as anticipated most of these subjects knew how to answer factual recall questions correctly (Table 11).

<u>Understanding - Day 2</u>

In Group #1 S_2 and S_3 answered 1/2, 3/4 understanding type questions correctly. S_1 = 0/2 and S_4 = 0/2.

In Group #2 S_5, S_6, S_7 answered 2/3, 1/3, 3/3 understanding type questions correctly. S_8 = 0/2.

In Group #3 S_9, S_{10} answered 4/4, 2/3 understanding type questions correctly.

In Group #1, Group #2 and Group #3 S_2, S_3, S_5, S_7, S_9, S_{10} that is 6 out of 10 subjects were able to answer understanding type questions correctly consistently. In

Table 11

RATIO OF NUMBER AND TYPE OF QUESTIONS ANSWERED CORRECTLY DURING INTERVENTION #2

Days	1					2					3					4				
Question Type	K					U					AP					AP				
	K	U	AP	AN	-S	K	U	AP	AN	S	K	U	AP	AN-	S	K	U	AP	AN	S
S 1	0/4	0/3	1/1	0/1	0/1	0/2	0/3	1/2	0/2	0/1	1/4	0/3	1/1	0/1	0/1	0/5	0/2	0/1	0/1	0/1
S 2	3/4	3/3	1/1	0/1	0/1	3/4	1/2	1/2	0/1	0/1	3/4	1/3	1/1	1/1	0/1	3/4	0/2	1/1	0/2	0/1
S 3	1/4	0/3	1/1	1/1	1/1	1/2	3/4	2/2	0/1	1/1	1/3	3/3	0/1	0/2	0/1	1/3	2/3	0/1	0/2	0/1
S 4	1/3	1/3	0/1	0/1	0/1	1/2	0/2	0/2	0/2	0/2	3/3	3/3	2/2	0/1	0/1	3/3	2/3	1/1	2/2	0/1
S 5	1/4	0/2	0/1	1/1	1/1	2/4	2/3	0/1	0/1	0/1	2/2	3/5	1/1	0/1	0/1	0/1	5/5	1/1	2/2	1/1
S 6	2/4	0/3	0/1	0/1	0/1	1/4	1/3	1/1	0/1	0/1	4/4	2/3	1/1	1/1	1/1	4/4	2/3	1/1	1/1	1/1
S 7	1/2	0/2	0/2	0/2	0/2	0/3	3/3	1/1	0/2	1/1	2/4	0/2	0/1	0/2	0/1	2/2	2/2	2/2	3/3	1/1
S 8	2/4	2/3	1/1	0/1	0/1	4/5	0/2	1/1	0/1	0/1	3/5	1/2	1/1	1/1	1/1	4/4	3/3	1/1	1/1	1/1
S 9	3/3	4/4	1/1	2/2	1/1	3/3	4/4	1/1	1/1	1/1	3/3	4/4	1/1	1/1	1/1	3/3	2/2	0/1	0/3	1/1
S 10	0/3	3/3	0/2	1/1	1/1	2/3	2/3	1/1	1/2	1/1	4/5	2/2	1/1	1/1	1/1	3/3	3/3	1/1	2/2	1/1

Table 11 (cont'd)

Days	5					6					7					8				
Question Type	AN					AN					S					S				
	K	U	AP	AN	S	K	U	AP	AN	S	K	U	AP	AN	S	K	U	AP	AN	S
S_1	3/4	3/3	1/1	1/1	1/1	0/4	0/3	1/1	0/1	1/1	3/3	1/4	1/1	1/1	1/1	2/3	2/3	0/2	1/1	1/1
S_2	2/4	1/3	1/1	1/1	0/1	3/3	4/4	1/1	1/1	1/1	4/4	2/2	1/1	1/2	1/1	4/4	3/3	1/1	1/1	1/1
S_3	4/4	2/2	1/1	1/1	0/1	1/3	0/3	0/1	0/2	0/1	3/3	0/3	0/1	2/2	0/1	4/4	3/3	0/1	0/1	1/1
S_4	2/3	3/3	1/1	2/2	1/1	4/4	2/3	1/1	1/1	1/1	3/3	1/4	0/1	0/1	1/1	3/4	2/3	0/1	0/1	1/1
S_5	3/4	2/3	1/1	1/1	1/1	2/2	2/2	2/2	3/3	1/1	2/4	1/2	0/1	1/2	0/1	1/1	4/5	1/1	2/2	1/1
S_6	2/3	1/4	0/1	0/1	0/1	3/3	4/4	1/1	1/1	0/1	4/4	1/3	1/1	1/1	1/1	4/4	3/3	0/1	1/1	0/1
S_7	1/1	4/5	1/1	1/2	1/1	4/4	1/2	1/1	2/2	1/1	2/2	3/3	1/1	0/3	1/1	1/1	6/6	1/1	1/1	1/1
S_8	4/4	1/2	1/1	2/2	1/1	4/4	3/3	1/1	0/1	0/1	2/2	5/5	0/1	0/1	1/1	2/3	1/4	1/1	1/1	1/1
S_9	3/4	3/3	1/1	1/1	1/1	3/5	1/2	1/1	1/1	1/1	2/3	3/3	1/2	1/1	1/1	2/3	4/4	1/1	1/1	1/1
S_{10}	3/4	3/3	0/1	0/1	1/1	2/2	4/4	1/2	1/1	1/1	5/5	3/3	1/1	1/1	1/1	2/2	4/4	2/2	1/1	1/1

addition, S_6 was able to answer at least one understanding question type correctly. Five subjects, S_2, S_4, S_8, S_9, S_{10}, answered this type of question correctly before training in it. However, even though S_4 and S_8 did not answer this question type correctly during training they had answered it correctly once before training in it on Day 1 of Intervention #2. Therefore, as anticipated most of these subjects were familiar with these types of questions most commonly seen in class (70%) (Figure 5) (Table 11).

UNDERSTANDING

Days	Students who answered question type correctly									
1	-	S_2	-	S_4	-	-	-	S_8	S_9	S_{10}
2	-	S_2	S_3	-	S_5	S_6	S_7	-	S_9	S_{10}

Figure 5

Diagram of students' responses to understanding question type throughout Intervention #2.

<u>Application - Day 3</u>

In Group #1 S_1, S_2, S_4 answered 1/1, 1/1, 2/2 application type questions correctly. S_3 = 0/1.

In Group #2 S_5, S_6, S_8 answered 1/1, 1/1, 1/1 application type questions correctly. S_7 = 0/1.

In Group #3 S_9, S_{10} answered 1/1, 1/1 application type questions correctly.

In Group #1, Group #2 and Group #3 S_1, S_2, S_4, S_5, S_6, S_8, S_9, S_{10} that is 8 out of 10 subjects answered application type questions correctly. However, only four subjects, S_1, S_2, S_8, S_9, consistently had answered this question type correctly for two days before training in it. S_3, S_4, S_6, S_{10} answered this question type correctly only once before training in it. S_7 answered this question type once before training but not during Day 1 of training in it Table 11).

Application - Day 4

In Group #1 S_2, S_4 answered 1/1, 1/1 application type questions correctly. S_3 = 0/1.

In Group #2 all subjects, S_5, S_6, S_7, S_8, answered 1/1, 1/1, 2/2, 1/1 application type questions correctly.

In Group #3 S_{10} answered 1/1 application type question correctly. S_9 = 0/1.

In Group #1, Group #2 and Group #3 S_1, S_2, S_4, S_5, S_6, S_7, S_8, S_{10}, that is 8 out of 10 subjects answered application type questions correctly (80%). Again S_1, S_2 and S_8 as expected before training answered this question type correctly. S_4, S_6 and S_{10} answered this question type correctly during both days of training in addition to the one day before training. S_3 did not answer this question type correctly during training in spite of two successful performances before training. S_5 answered this question correctly during both days of training. Only S_7 answered correctly one day before training and again second day of training. S_9 although had consistently answered this question type for two days before training only answered it correctly during one day of training (Figure 6) (Table 11).

APPLICATION

Days	Students who answered question type correctly									
1	S_1	S_2	S_3	-	-	-	-	S_8	S_9	-
2	S_1	S_2	S_3	S_4	-	S_6	S_7	S_8	S_9	S_{10}
3	S_1	S_2	-	S_4	S_5	S_6	-	S_8	S_9	S_{10}
4	S_1	S_2	-	S_4	S_5	S_6	S_7	S_8	-	S_{10}

Figure 6

Diagram of students' responses to application question type throughout Intervention #2

In summary, 9 out of 10 subjects answered this question type correctly consistently Day 3 and Day 4, of training combined (90%) S_1, S_2, S_8 were expected but S_4, S_5, S_6, S_7, S_9, S_{10} learned how to answer this question type correctly (60%).

<u>Analysis - Day 5</u>

In Group #1 all subjects, S_1, S_2, S_3, S_4, answered 1/1, 1/1, 1/2, 2/2 analysis type questions correctly.

In Group #2 S_5, S_7, S_8 answered 1/1, 1/2, 2/2 analysis type questions correctly. S_6 = 0/1.

In Group #3 S_9 answered 1/1 analysis type question correctly. S_{10} = 0/1.

In Group #1, Group #2 and Group #3 S_1, S_2, S_3, S_4, S_5, S_7, S_8, S_9, that is 8 out of 10 subjects answered analysis type questions correctly. S_{10}, S_8, S_9, S_6 had answered this question correctly consistently 4, 4 and 3, 2 days before training in it. S_2, S_4, S_5, S_7 had answered this question correctly only once before training. S_{10} and

S_6 did not answer this question type correctly Table 11).

<u>Analysis - Day 6</u>

In Group #1 S_2, S_4 answered 1/1, 1/1 analysis type questions correctly. S_1 = 0/1 and S_3 = 0/2.

In Group #2 S_5, S_6, S_7 answered 3/3, 1/1, 2/2 analysis type questions correctly. S_8 = 0/1.

In Group #3 all subjects, S_9, S_{10}, answered 1, 1 analysis type questions correctly.

In Group #1, Group #2 and Group #3 S_2, S_4, S_5, S_6, S_7, S_9, S_{10} answered this question type correctly. As expected S_6, S_8, S_{10} answered this question type correctly. S_8 did not answer this question type correctly. S_2, S_4, S_5, S_7 who answered this question type only once before training, answered correctly on both days of training. S_1 did not answer this question type correctly (Figure 7) (Table 11).

ANALYSIS

Days	Students who answered question type correctly									
1	-	-	-	-	-	-	-	S_8	S_9	-
2	-	-	-	-	-	-	-	-	S_9	S_{10}
3	-	S_2	-	-	-	S_6	-	S_8	S_9	S_{10}
4	-	-	-	S_4	S_5	S_6	S_7	S_8	-	S_{10}
5	S_1	S_2	-	S_4	S_5	-	S_7	S_8	S_9	-
6	-	S_2	-	S_4	S_5	S_6	S_7	-	S_9	S_{10}

Figure 7

Diagram of student responses to analysis question type throughout Intervention #2

In summary, 9 out of 10 subjects (90%) answered correctly during Day 5 and Day 6 combined S_6, S_8, S_9, S_{10} were expected but S_1, S_2, S_4, S_5, S_7 learned how to answer this question type correctly (50%) (Table 11).

Synthesis - Day 7

In Group #1 S_1, S_2, S_4 answered 1/1, 1/1, 1/1 synthesis type questions correctly. S_3 = 0/1.

In Group #2 S_6, S_7, S_8 answered 1/1, 1/1, 1/1 synthesis type questions correctly. S_5 = 0/1.

In Group #3 all subjects, S_9 and S_{10}, answered 1, 1 synthesis type questions correctly.

In Group #1, Group #2 and Group #3 S_1, S_2, S_4, S_6, S_7, S_8, S_9, S_{10} answered this question type correctly consistently for 4, 4, 6, 6 days before training. S_3, S_8 had answered this question correctly for three days each before training. S_1, S_4, S_6 had answered this question type correctly only twice before training and S_2 only once before training. Therefore, as anticipated, S_5, S_7, S_9, S_{10} answered this question type correctly. S_1, S_2, S_4, S_6, S_8 did answer this question type correctly. S_3, S_5 did not answer this question type correctly (Table 11).

Synthesis - Day 8

In Group #1 all subjects S_1, S_2, S_3, S_4 answered 1/1, 1/1, 1/1, 1/1 synthesis type questions correctly.

In Group #2 S_5, S_7, S_8 answered 1/1, 1/1, 1/1 synthesis type questions correctly. S_6 = 0/1.

In Group #3 all subjects, S_9, S_{10}, answered 1/1, 1/1 synthesis type questions correctly.

In Group #1, Group #2 and Group #3 S_1, S_2, S_3, S_4, S_5, S_7, S_8, S_9, S_{10} answered this question type correctly. S_6 did not answer this question correctly. As anticipated, S_7, S_9 and S_{10} answered this question type correctly. S_1, S_2, S_4, S_8 answered this question type correctly through training. S_3 answered this question type correctly. S_6 did not answer this question type correctly (Figure 8) (Table 11).

SYNTHESIS

Days	Students who answered question type correctly									
1	-	-	S_3	-	S_5	-	-	-	S_9	S_{10}
2	-	-	S_3	-	-	-	S_7	-	S_9	S_{10}
3	-	-	-	-	-	S_6	-	S_8	S_9	S_{10}
4	-	-	-	-	S_5	S_6	S_7	S_8	S_9	S_{10}
5	S_1	-	-	S_4	S_5	-	S_7	S_8	S_9	S_{10}
6	S_1	S_2	-	S_4	S_5	-	S_7	-	S_9	S_{10}
7	S_1	S_2	-	S_4	-	S_6	S_7	S_8	S_9	S_{10}
8	S_1	S_2	S_3	S_4	S_5	-	S_7	S_8	S_9	S_{10}

Figure 8

Diagram of student responses to synthesis question type

In summary, out of 10 subjects answered correctly during both Day 7 and Day 8 combined S_5, S_7, S_9, S_{10} were expected but S_1, S_2, S_3, S_4, S_6, S_8 learned how to answer this question type correctly (60%).

Therefore, the overall performance of the subjects during Intervention #2 and the data results indicated that the instruction in questions generating using Bloom's Taxonomy increases both the level of reading comprehension and the ability to answer high level questions.

3. Will the change observed in comprehension maintain over time?

The results of the data collected during maintenance which occurred one week after the end of training (Intervention #2) were as follows:

<u>Maintenance</u>

In <u>Group #1</u> the mean percent accuracy of comprehension measures was $\bar{x}$ = 84.9% and scores ranged from 30% to 100%. The trend for S_1 and S_4 was accelerated, positive, high but variable. The trend for S_2 and S_3 was accelerated, high and stable or consistent (Table 12).

During Maintenance the students in Group #1 received a total of 120 questions to answer, 4 students, 3 passages each, 10 questions per passage, per student which included at least one of each type according to Bloom's Taxonomy. A total of 95 (79%) questions were answered correctly (Table 13). There were 24 (25%) knowledge type questions, 39 (41%) questions comprehension type, 10 (10.5%) application type, 14 (14.7%) questions analysis type and 9 (9.4%) questions synthesis type.

Table 12

Report of the mean, scores and trends per subject in <u>Maintenance</u>

	Student	Mean	Scores	Trend
Group #1 $\bar{x}$ = 84.9	Subject #1	81.6	65, 100, 80	accelerated positive variable
	Subject #2	95	90, 100, 95	accelerated stable positive
	Subject #3	76.6	30, 100, 100	accelerated stable positive
	Subject #4	86.6	100, 60, 100	accelerated variable positive
Group #2 $\bar{x}$ = 94.9	Subject #5	93.3	100, 85, 95	accelerated stable positive
	Subject #6	100	100, 100, 100	accelerated stable positive
	Subject #7	93.3	80, 100, 100	accelerated stable positive
	Subject #8	93.3	100, 100, 80	accelerated stable positive
Group #3 $\bar{x}$ = 94.9	Subject #9	93.3	90, 90, 100	accelerated stable positive
	Subject #10	96.6	95, 100, 95	accelerated stable positive

Table 13

MAINTENANCE

Number and type of questions answered correctly in Maintenance

GROUP	STUDENTS	NO. OF QUESTIONS CORRECT					TOTALS	
		K	U	AP	AN	S		
#1	Subject #1	5	6	2	3	3	19 (63.3%)	Total No. of Questions 120 95=79%
	Subject #2	9	12	3	4	3	31 (32.6%)	
	Subject #3	6	9	2	4	1	21 (22%)	
	Subject #4	4	12	3	3	2	24 (80%)	
	Subtotal	24	39	10	14	9	95	
	%	25	41	10.5	14.7	9.4		
#2	Subject #5	7	9	2	4	2	24 (22.4%)	Total No. of Questions 120 107=89%
	Subject #6	9	10	2	2	2	25 (23.3%)	
	Subject #7	9	10	3	3	3	28 (26.1%)	
	Subject #8	11	9	3	4	3	30 (28%)	
	Subtotal	36	38	10	13	10	107	
	%	33.6	35.5	9.3	12.1	9.3		
#3	Subject #9	10	8	3	3	3	27 (47%)	Total No. of Questions 60 57=95%
	Subject #10	11	10	3	3	3	30 (52.6%)	
	Subtotal	21	18	6	6	6	57	
	%	36.8	31.5	10.5	10.5	10.5		

In Group #2 the mean percent accuracy of comprehension measures was $\bar{x}$ = 94.9% and scores ranged from 80% to 100%. The trend for all subjects S_1, S_2, S_3, S_4 was high, accelerated, positive and stable or consistent (Table 12). Group #2 received 120 questions to answer, 4 students, 3 passages each, 10 questions per passage per student which included at least one of each type according to Bloom's Taxonomy. A total of 107 (89.1%) questions were answered correctly (Table 12). There were 36 33.6%) knowledge type questions, 38 (35.5%) comprehension questions, 10 (9.3%) application questions, 13 (12.1%) analysis type questions, 10 (9.3%) synthesis type questions (Table 13).

In Group #3 the mean percent of comprehension was $\bar{x}$ = 94.9 and ranged from 90% to 100% (Table 12). The trend for S_9 and S_{10} was high, accelerating and stable. Group #3 received a total of 60 questions to answer. A total of 57 (95%) questions were answered correctly (Table 13). There were 21 (36.8%) knowledge type questions, 18 (31.5%) comprehension type questions, 6 (10.5%) application type questions, 6 (10.5%) analysis type questions and 6 (10.5%) synthesis type questions.

Overall the mean percent of comprehension during Maintenance was above 50% comprehension and shows again a marked improvement when compared to mean percent of comprehension in the previous phase Intervention #2 (Table 9 and Table 12).

Intervention #2	Maintenance
$G_1 \bar{x}_2 = 52.9$	$G_1 \bar{x}_M = 84.9$
$G_2 \bar{x}_2 = 69.07$	$G_2 \bar{x}_M = 94.9$
$G_3 \bar{x}_2 = 85.6$	$G_3 \bar{x}_M = 94.9$

Also, the number of questions answered correctly showed a marked improvement when compared to Intervention #2 (Table 1).

Intervention #2	Maintenance
Total No. of Questions Given	Total No. of Questions Given
800	300
No. of Questions Correct	No. of Questions Correct
498 62.25%	259 86.3%

At last, the number and percent of question types answered correctly were as follows (Table 1).

Question Type	Intervention #2	Maintenance
Knowledge	178 (22.25%)	81 (27%)
Understanding	153 (19.1%)	95 (31.6%)
Application	60 (7.5%)	26 (8.6%)
Analysis	58 (7.2%)	33 (12%)
Synthesis	49 (6.1%)	25 (8.3%)
TOTAL	498 (62.25%)	259 (86.3%)

Therefore, the overall performance of the subjects one week after end of training suggests that changes observed in comprehension maintained and, in fact, improved over this short period of time.

Students' Performance Throughout the Study

Throughout the study, the students' performance was a positive experience as results have shown. The student's curiosity expressed their overall attitude towards the study before it was initiated. However, when Baseline started and the activity was explained, a degree of variability in motivation towards the task was observed among the students. Some refused to work and had to be encouraged to do so. Others, like Beatriz and Jeronimo who were the ones with the most severe reading and disciplinary problems, tried with effort to read the passages carefully and answer the questions. Overall, in Baseline the students in all groups tried to copy from one another unsuccessfully, unaware of the different readings. Some talked and some like Alfredo only stared at the paper, reflecting an unwillingness to cooperate (Oct. 21, 1985). Specifically, Jeronimo and Carol, for instance, were quite different in their performances, both in attitude and quality of their responses. Jeronimo tried unsuccessfully to read and answer the questions in the passages assigned to him, in spite of his enormous difficulties in reading, and the continuous remarks from other students concerning his inability to cope with the task and school work in general (Appendix G). Carol, a socially popular student, exhibited moderate difficulty reading the passages. However, her ability to concentrate on the reading was poor. Thus, her performance in answering the questions was varied (Appendix G). During

Intervention #1, the students in Group #1, Beatriz, Vicente, Humberto, and Federico, who were the first ones to enter this phase, expressed pride. They thought they had done better than the rest. Eventually, all students, in all groups, were introduced to this phase. Overall, all students were able to write questions. However, when the students were requested to answer the questions about the passages read, some commented, that they were not really reading them but skimming the passages, to write the questions. They did not read to answer the questions. Some found the passages easy to read, others found them difficult. They all seemed to lack a strategy to assist them in monitoring their comprehension as they read and attended to the information in the passage well enough to be able to remember it and answer the questions. In this phase, Jeronimo found it hard to both read and write questions, and also remember enough to answer questions afterwards. On the first day he was not able to write a single question. He wrote two questions on the second day and three questions on the third day. However, his comprehension on the first day was higher than in the other two days (Appendix G) (Table 5). It seem reasonable to assume that some familiarity with the content of the first day material allowed him to answer questions concerning this material, and successfully comprehend a portion of it. Conversely, the selection content on the following two days appear to have not had this same quality of familiarity and thus he was not able to anticipate questions or comprehend and remember the passages.

Carol was able to write many questions each day of Intervention #1 without great effort but did not concentrate in the reading enough, to be able to answer the questions. She was one of the students who mentioned that she was skimming the passages to write questions, and she was not able to answer the questions about the passages (Appendix G) (Table 5).

During Intervention #2, the students were trained in the different question types. In general, students were very cooperative and motivated. They began to see the applicability of learning to formulate the different types of questions, and they showed improvement in comprehension of the material read. They also improved their ability to remember the passages read and on their performance answering the questions afterwards. Overall attention to the task increased. Some, like Roberto, Vicente and Antonio, began to mention their own improvement in classroom work. Also, teachers began to comment on some of their students' improvement, like Roberto's teachers, Beatriz's teacher, etc.

The quality and completeness of their answers began to appear in students' responses to passages read (March 17, 1986).

Throughout this phase, Jeronimo did not show improvement in his regular classroom work, as reported by his teacher, but he did experience improvement in the sessions. A degree of variability in his performance was observed which positively increased towards the end of training. Apparently, a combination of both the questioning training and the practice in small groups seems to have encouraged him to continue his effort to improve his reading. Although the passages represented a continuous struggle for him, the effort and progress made was noticed in the subsequent improvement, reflected in the quality of his answers (Appendix G).

Once Carol was able to understand the importance of question formulation and how these questions assisted her in concentrating and monitoring her reading, she began to improve steadily. She was attentive, followed instructions and practiced question types with minimal help. However, she commented on the difficulty of some of the passages (Appendix G).

During Maintenance, the students, as in Baseline, read the passages and answered questions on their own. Most students worked fast. Antonio, Laura and Carol expressed desire to do well (May 1, 1986).

Jeronimo ended this phase quite satisfied with his performance which had improved during the training period and showed that he could read and monitor his comprehension sufficiently to answer the questions correctly and independently. The other students in his group were surprised with his progress and stopped making degrading remarks about his academic abilities. However, comments from his classroom teacher did not reflect any changes in his perception or performance (Appendix G).

Carol ended this phase without difficulty, was very attentive but commented on the difficulty of the passages assigned to read. However, her performance answering the questions showed the progress made (Appendix G).

Chapter Summary

This chapter focused on the results of the teaching strategy of self-questioning. The analysis of the four phases of the study was reported. The means and general trends between and within groups were discussed. Also, a brief description of the students' performance throughout the phases was provided, including the comments and observations of two students about their performance in each phase of the study.

CHAPTER V

DISCUSSION

This chapter contains a discussion of the research findings as they relate to previous theory and research.

Discussion of Results

The purpose of this study was to investigate the effectiveness of the instruction of self-generated questions, using Bloom's Taxonomy, on the acquisition, maintenance and generation of comprehension skills in science materials by seventh graders who were poor comprehenders.

After conducting the research and reporting the results, it is apparent that investigation of self-questioning, the generating of ability to answer questions that require the application of high order thinking skills, especially when science related and structured using Bloom's Taxonomy, remains in its early stages. Further discussion of the results and an examination of possible explanations for them follow. The initial three research questions follow.

1. Will self-generated questions increase the level of reading comprehension of poor readers?
2. Will instruction of self-generated questions using Bloom's Taxonomy increase the level of reading comprehension of poor readers and the ability to answer high level questions?

3. Will the change observed in comprehension be maintained over time?

Self-Generation of Questions and Students' Level of Reading Comprehension

The first question asked whether the use of self-generated questions increases the level of reading comprehension of poor readers. Results on the differences in performance of the students during Baseline and Intervention #1 indicated that, first, self-generation of questions alone does not improve reading comprehension of poor readers. On the contrary, a general low performance below 50% comprehension was observed for all subjects and was maintained from Baseline. Also the data in Intervention #1 showed that the higher the number of questions generated, the lower the comprehension and vice versa. However, when group means exhibited in Baseline and Intervention #1 were compared, although below 50% comprehension, they indicated a moderate improvement, especially in Group #3.

Baseline	Intervention #1
Group #1 $\bar{x}_B = 22.9$	Group #1 $\bar{x}_1 = 29.7$
Group #2 $\bar{x}_B = 12.75$	Group #2 $\bar{x}_1 = 19.97$
Group #3 $\bar{x}_B = 27.1$	Group #3 $\bar{x}_1 = 44.95$

Research indicates support for these findings. Sadker and Cooper (1974) noticed that when students were asked to generate high level questions without training, they do not respond as well as trained students and that the technique seemed alien to them.

Second, the results on the performance of S_9 and S_{10}, in Group #3 during Baseline showed that there were two instances where these students performed above 50% comprehension: S_9 demonstrated 70% comprehension and S_{10} demonstrated 65% and 60% comprehension. These findings may account for the differences in the group means of comprehension between phases. One may speculate that this was due to higher motivation, attention to the reading at hand and/or difference in the degree of difficulty of the passages read. A look at the passages showed that in both cases the complexity in content of the material read varied to a less difficult one. In S_9 the content of the material changed from Cells to Vertebrates. In S_{10} the content of the material varied from Cells to New Directions in Science. It was observed that simply reading about the structure of the cell was more difficult for students to understand without the additional classroom discussion or laboratory activity of a proper science class. Thus, variability in the content of the passages may account for the moderate improvement observed between Baseline and Intervention #1 for Group #3. Third, data on the number and type of questions generated by the students during Intervention #1 indicated that the higher the number of questions generated by the students, the lower the comprehension exhibited, except for S_2, S_4, S_9 where comprehension increased but the number of questions generated was low (Table 5). It was noticed that in all three groups students spent too much time and attention to small pieces of reading to write questions and did not read to answer the questions which may account for the low comprehension exhibited. In addition, when students were asked about the activity, some of them, like S_5, said that she had not really read but was skimming to write the questions. Also, it was found out that most of the questions generated were of the knowledge and understanding type (94.04%) or factual recall.

There is research evidence that supports both the low level of comprehension exhibited between the phases and the type of questions generated by the students during Intervention #1. As it was mentioned before, students did not seem to have a specific strategy to assist them to monitor their comprehension. One possibility may be the fact that, as the research studies have indicated, very little instruction in reading comprehension occurs in classrooms. In one study which observed 2174 minutes of reading, only 13.04 minutes (0.60%) included comprehension instruction (Durkin, 1978). In this study Durkin observed that teachers spent most of their time in comprehension assessment, that is, asking questions of students. As far as the type of questions used in other class studies, questions used with students emphasized the recall of facts or events, but very few stressed other comprehension factors like the application of a principle, inferencing information to enhance comprehension, etc. (Durkin, 1978; Gutzak, 1967;

Elias and Legenza, 1978). Similar results were found in studies of younger readers (Crowell and Hupei, 1981) where it was observed that the ability to make inferences, draw conclusions or evaluate a situation was usually evidenced at a later stage. There is no explanation as to why this is so, but teachers apparently feel that the ability to retell the events of a story is sufficient evidence of comprehension. Research studies indicate that these factual recall questions are possibly the most used in class and, therefore, the ones students are most accustomed to answer (Durkin, 1978; Gutzak, 1967; Andre and Anderson, 1978-1979). This seems to support an instructional position that says children do learn what and how they are taught. If past experience with reading comprehension instruction involved primarily the answering of factual/detail/literal questions, then logically such students would, if asked to create questions, create factual/detail/literal questions as evidenced by the results of this study.

Effect of Instruction of Self-Generation Questions Structured Using Bloom's Taxonomy on the Reading Comprehension of Poor Readers

The results on the overall performance of subjects during Intervention #1 supports the hypothesis that instruction in questions generated using Bloom's Taxonomy increases the level of reading comprehension. When results of Intervention #2 were compared with those of Intervention #1, a marked change in comprehension was observed which indicated an increase in the number of correct answers/memories after reading, as well as an increase in the ability to answer high level questions as defined by Bloom's Taxonomy.

MEAN COMPREHENSION SCORES

Intervention #1	Intervention #2
Group #1 $\bar{x}_1$ = 29.7	Group #1 $\bar{x}_2$ = 52.9
Group #2 $\bar{x}_1$ = 19.97	Group #2 $\bar{x}_2$ = 69.0
Group #3 $\bar{x}_1$ = 44.95	Group #3 $\bar{x}_2$ = 85.6

PERCENTAGE INCREASE IN RESPONSE TO HIGHER LEVEL QUESTIONS

Bloom's Question Categories

	Intervention #1	Intervention #2
Knowledge	70%	80%
Understanding	60%	90%
Application	30%	50%
Analysis	10%	60%
Synthesis	10%	60%

At the end of Intervention #1, most students had answered knowledge and understanding type questions correctly. However, only 3 of 10 (30%) subjects answered application type questions correctly. Only 1 of 10 (10%) answered analysis type questions correctly. Only 1 out of 10 (10%) answered the synthesis question type correctly. Therefore, findings suggested that students did not seem to monitor their reading to be able to answer these kinds of questions correctly. Nevertheless, when subjects entered Intervention #2 and training began, they started to answer more of these question types correctly; and in some cases they answered certain question types before they were trained in them (Table 10).

In addition, the results of the days of training in the application, analysis and synthesis question types suggested that instruction of self-generated questions structured using Bloom's Taxonomy had the positive effect of improving the reading comprehension of poor readers. Nine of 10 students (90%) learned how to answer application type questions correctly. However, three of these students answered this question type correctly before training, and the other six (60%) learned how to answer this question type correctly only after training. In analysis type questions, 9 out of 10 (90%) subjects answered this question type correctly. Four were expected to do so since they had answered this question type correctly before training in it, but five of them learned how to answer this question type correctly after training (50%).

Nine of 10 (90%) subjects answered synthesis type questions correctly. Four were expected to, but six of them learned how to do it after training (60%).

Therefore, before Intervention #2 at the end of Intervention #1, students demonstrated that they did not monitor reading comprehension effectively. They did not exhibit evidence of the use of successful metacognitive strategy to assist them in understanding what was read. In addition, when the students were requested to make questions about the passage read, they did not appear to make any connection between the questions made and effective learning of the passage. Such a connection would have assisted them in retaining enough information to answer high level questions correctly.

Other research indicates that poor readers with comprehension difficulties appear to lack an awareness of task demands (Loper, 1980). These include difference in three general classes of cognitive skills: strategic, metacognitive and processing efficiency (Brown and Palincsar, 1982). Some of these deficits include a lack of spontaneous application of various types of attentional and mneumonic strategies (Hallahan, Kauffman and Ball, 1973; Tarver, Hallahan, Kauffman and Bale, 1976; Torgersen, 1977; Torgersen and Goldman, 1977; Loper, 1980; and Hallahan and Kneedler, 1981). Similarly, these students are also deficient in various metacognitive skills such as planning, monitoring and checking (Torgesen, 1977), and their application of appropriate memory strategies (Loper, 1980), as well as simple failure to remember academic material presented under normal conditions (Torgersen, 1977). These comprehension deficits were apparent in the population of readers examined in this study. They, too, seemed to exhibit these negative comprehension characteristics. However, with minimal training, these problems were reversed to a long range turnaround of such self-defeating comprehension behavior through continued instruction and training in self-questioning strategies.

To summarize, it seems that the lack of spontaneous use of various attentional and mneumonic strategies affects the comprehension of the material the poor comprehender is exposed to. A frequent characteristic is the failure to remember the material read as suggested by Torgersen. Nevertheless, it is possible to assume that the weakness in remembering is a consequence of failure to understand, perhaps due to the inability to focus spontaneously on the important concepts, principles or elements of a given passage. However, after the students in this study were trained in question generation at the end of Intervention #2, they demonstrated a higher retention of the material read and better understanding of the passages, as demonstrated by the improvement in their comprehension performance.

The students were able to focus their attention on the important aspects of the passages and absorb the information long enough to answer the questions correctly.

Improved performance seems to indicate that students learned how to think analytically, organize principles and concepts, and evaluate situations through the practice of formulating different kinds of questions that required these higher thinking abilities. Hence, students seemed to have acquired a strategy through modeling and direct instruction that assisted them to control and monitor their learning of science material. In addition, this ability may even be transferred to other content areas.

Training in question-generating assisted poor comprehenders to look at scientific information beyond facts; the training gave them a strategy that enabled them to think at higher levels in ways that they had not been exposed to before. It became a tool or routine that assisted them to control and regulate their own learning.

Report on the behavior of students during Intervention #2 revealed that the students were motivated and cooperative. They began to see the applicability of learning to formulate different types of questions, which they verified in their own improvement in comprehension of the readings and the ability to answer questions afterwards. Also, at this point teachers began to mention students' improvement in classroom work. Possibly, these behaviors may have also positively influenced students' overall attitudes towards the task, allowing them to be more attentive to the readings and to the explanation of each question type so as to be able to answer each successfully.

Research indicates strong support for these findings and observations. Marksberry (1979) suggested several reasons to explain the positive effect of training in question generation for students. Some of these are:

--having children ask questions and seek answers is believed to arouse their interest and participation in self-directed learning.

--through question asking, children increase their perception and ability to think and express ideas on both discursive and non-discursive levels (pg. 190).

--once one has learned how to ask relevant, appropriate and substantial questions, he/she has learned how to learn, and no one can keep him/her from learning whatever he/she wants or needs to know (Postman and Wiengartner, 1969, pg. 23).

Also, questions increase inspection time and the cognitive effort that a reader gives to what is considered relevant to his or her purposes, in this case answering questions (Durkin, 1981).

Therefore, the overall performance of subjects during Intervention #2 indicated that instruction in question generation based on Bloom's Taxonomy increased the level of reading comprehension of poor readers and the ability to answer high level questions. This was demonstrated by students' performance during this phase, especially in their ability to answer application, analysis and synthesis question types.

Results also indicated that an increased level of reading comprehension of poor readers was observed by both data on individual performance and group performance and when group means were compared to those in Intervention #1. Research heavily supports the findings on the increased level of comprehension of poor readers whenever students are trained to generate high level questions (Andre and Anderson, 1978-1979; Fraze and Schwartz, 1975; Sadker and Cooper, 1974; Redfeld and Rousseau, 1981; Newton, 1978; Rhoades, 1980).

There are studies that discuss and support the use of taxonomies, like Bloom's, to help teachers ask students appropriate questions over materials read (Elijah and Legenza, 1978; Masland, 1979). Others have proposed the use of other taxonomies to promote reading comprehension (Duffelmeyer, 1980), yet none of them has examined systematically the effect of a given taxonomy used to develop questions on students' learning. Furthermore, no previous research had studied the effects of self-questioning technique using Bloom's Taxonomy in the comprehension of science material of poor comprehenders, as this one has.

The results of students' performance on Intervention #2 indicated strong support for its use with poor comprehenders for reasons stated before:

--Convenience. Bloom's Taxonomy allowed this researcher (and thus it would assist a teacher) to train poor comprehenders in how to think analytically, to interpret information, apply concepts and summarize information, thus meeting the needs of the poor comprehender and those of science.

--Familiarity. Bloom's Taxonomy is normally used in the design of regular classroom activities. It is an organized, precise way of planning and evaluating the content of instruction. Thus, teachers can use across-content areas to assist the comprehension skills of poor comprehenders.

--Variety. The levels of the taxonomy allowed for the production of a number of different questions that satisfied the science content area and may be beneficial to others as well. In particular, the last levels, application, analysis and synthesis, seem to have helped students elicit the behaviors necessary to develop skills indispensable to succeed in science.

--Completeness. Among others, Bloom's Taxonomy contains more areas and various mode examples of behaviors and/or thinking skills. Each area is very detailed in relation to what behaviors are expected, how to elicit them, etc.

In addition, results of the data suggest that a self-questioning technique structured using Bloom's Taxonomy promoted the ability to answer high level questions and, when used with science material, was compatible with the problem-solving discovery methods frequently used in science. The taxonomy specifies clearly what behaviors are expected from students as a consequence of a unit of instruction. Therefore, students' performance in relation to science materials can be measured in terms of the behaviors established for each of the six levels.

Therefore, the taxonomy provided poor comprehenders with an efficient tool they can use to control and monitor their comprehension as active readers developing a positive attitude towards reading.

Change of Comprehension Maintained Over Time

The results of the data collected during the Maintenance phase one week after the end of training suggested that both skill learning based on treatment effect as well as retention of this learning for a short period of time were facilitated. While the data does not explain the retention effect, they suggest that these students learned a routine for pursuing comprehension during the training employed during intervention #2. This routine was then available and perhaps elaborated during the week prior to Maintenance, and was thus available for application during the Maintenance period. This incubation may account for the improvement gains.

Recent research in the field of cognitive psychology has focused its attention on the study of reading comprehension monitoring or metacognitive (Brown, 1975; Brown and DeLoache, 1978; Flavell and Wellman, 1977; Boss and Phillip, 1982; Wagoner, 1983; Brown and Palincsar, 1982).

According to Flavell (1976), metacognition "refers to that secondary level of understanding in which a person addresses his/her own thinking or whose knowledge concerns one's cognitive processes and products" (Flavell, 1976, pg. 232).

Usually, poor comprehenders under normal circumstances seem to fail to apply appropriate memory strategies (Loper, 1980). Thus they are not capable of referring to those thinking processes which could enable them to regulate and monitor their learning (Torgersen, 1977).

Nevertheless, the results from this study obtained from students' performance one week after the end of training suggest that these students seemed to have acquired a process of thinking about what they were reading. The question generation technique enabled them to refer to that secondary level of understanding concerning the individual cognitive processes that Flavell (1976) described. Therefore, these newly acquired routines were not subject to the same laws of forgetting. On the contrary, questioning became a strategy or a tool that assisted students in monitoring and regulating comprehension of science material and is perhaps applicable in other curricular areas, too. However, additional research is needed to examine both short- and long-term memory effects of this technique over time both on the comprehension of science materials and in other school reading contents.

Science Learning and High level Questions

Recent research indicates initial support for the use of questions to enhance reading comprehension (Ackerman, 1981; Russell, 1981; Andre and Anderson, 1978-1979; Porterfield, 1974). Although the information is limited at the present, these findings seem to encourage positive results towards the use of questions to enhance comprehension of science material. Andre and Anderson (1978-1979) point out several explanations for the beneficial effects of self questioning.

1. Accordingly, input is analyzed in a hierarchy of processing stages where increasing depth implies greater degree of semantic or cognitive analysis, hence greater retention.
2. Improved retention of textual material by the questioned group is simply a function of extended study time.
3. The combination of metacognitive and cognitive characteristics frequent in reading (pg. 620).

The results of the data, especially the noticed increase after training in Bloom's Taxonomy of Cognitive Skills in reading comprehension and the improved performance in the students' ability to answer questions that require higher thinking skills support the explanation of input analyzed in a hierarchy of processing stages. It showed that through training students were able to monitor reading at a greater depth than prior to training, thus enhancing retention, as demonstrated in the positive students' performance.

Improved retention was possible due to the fact that during training students spent more time learning how to formulate questions and perhaps study passages more carefully before attempting to answer the questions.

CHAPTER SUMMARY

In this chapter a discussion of the findings was provided, and related research to support these findings was presented.

CHAPTER VI

SUMMARY, CONCLUSION, RECOMMENDATIONS

This chapter is divided in four sections. The first section is a summary with conclusions drawn from research results. Section two includes the limitations of study and generalizations. Section three contains implications for classroom application of future research to extend the issue of question generalization and the study of science materials. Section four suggests appropriate classroom instructional techniques based on the results of this study.

Conclusions

The purpose of this study was to investigate the effectiveness of instruction on self-generated questions using Bloom's Taxonomy on poor comprehenders, acquisition and maintenance of comprehension skills when studying science material. There were three research questions.

1. Will self-generated questions increase the level of reading comprehension of poor readers?
2. Will instruction of self-generated questions using Bloom's Taxonomy increase the level of reading comprehension of poor readers and their ability to answer high level questions?
3. Will the change observed in comprehension maintain over time?

From the results the following conclusions were made.

1. The results of the data collected during Intervention #1 indicated that self-generation of questions alone does not seem to improve the reading comprehension of poor readers. A general low performance below 50% comprehension that ranged from $\bar{x} = 19.97$ to $\bar{x} = 44.95$ was observed for all subjects.

2. The results of the data on Intervention #1 when groups means on comprehension were compared with those of Baseline, although below 50% comprehension, indicated a moderate improvement for Group #3 ($\bar{x}_B = 27.1$, $\bar{x}_1 = 44.95$).

3. The higher the number of questions generated, the lower the comprehension exhibited, except for S_2, S_4, S_9 where comprehension increased but the number of questions generated was low (Table 6).

4. The greatest number of questions generated in Intervention #1 were knowledge or comprehension type [Total = 118, Knowledge 103 (87.2%), + Comprehension 8 (6.77%) = 111 (95.04%)] (Table 6).

5. The greatest number of questions answered correctly were knowledge or comprehension type both in Baseline and Intervention #1 (Table 9, Table 10).

6. The results of the data collected during Intervention #2, when group means were compared with those of Intervention #1, indicated that instruction in question generating using Bloom's Taxonomy increases the level of reading comprehension and the ability to answer an array of question types including high level questions.

   (Group #1 = $\bar{x}_1 = 29.7$, $\bar{x}_2 = 52.9$) (Group #2 = $\bar{x}_1 = 19.97$, $\bar{x}_2 = 69.0$) (Group #3 = $\bar{x}_1 = 44.95$, $\bar{x}_2 = 85.6$).

7. The results of the data collected during the maintenance one week after the end of training, when group means were compared with those of Intervention #2, indicated that change observed in comprehension was maintained for a short period of time (Group #1 = $\bar{x}_2 = 52.9$, $\bar{x}_M = 84.9$) (Group #2 = $\bar{x}_2 = 69.0$, $\bar{x}_M = 94.9$) (Group #3 = $\bar{x}_2 - 85.6$, $\bar{x}_M = 94.9$) (Table 5, Table 12).

In summary, the use of self-generated questions alone does not seem to improve the reading comprehension of poor readers and an overall low performance was observed and maintained from Baseline except with moderate improvement for students in Group #3. The instruction in question generation using Bloom's Taxonomy seems to markedly increase the level of reading comprehension and the ability to answer all kinds of questions, especially questions requiring application of higher order thinking skills. In addition, the results of the data collected one week after the end of training during the Maintenance period showed that the improvement in comprehension seems to increase and was maintained through the end of this phase. It indicated that the students not only benefited from instruction but they seemed to have acquired a routine for monitoring comprehension of science materials. This routine remained and was available to them throughout Maintenance period and may account for improvement gains shown.

Limitations of Study

Several limitations of the research (and their potential implications) need to be mentioned.

First, the nature and size of the sample selected for this study limited the generalization of the results. The implications for research that were obtained from these data can only be generalized to students under similar circumstances in the school where the data were collected. Only the continuous replication of this study will provide results ample enough to generalize to larger populations of readers.

Second, the results of the data during Baseline showed there were only two instances where S_9 and S_{10} performed above 50% comprehension. S_9 demonstrated 70% comprehension and S_{10} demonstrated 65% and 60% comprehension. One may speculate that this was due to higher motivation, attention to the reading at hand and/or the degree of difficulty of the passage read. A look at the passages read showed that in both cases the complexity in content of the material read varied to a less difficult one. In S_9 the content of the material changed from cells to vertebrates. In S_{10} the content of the material varied from cell to new directions in science. In addition, in Intervention #2, the phase in which the students were trained in the use and generation of higher order questions (application, analysis, synthesis), there was a high degree of variability among subjects and groups. A certain degree of variability is expected, but the data suggest that the difficulty of the content in some science passages may account for at least part of the variability observed in performance. Overall, the percentage of comprehension increased during Intervention #2 and Maintenance phase; however, it was observed during training that passages about the structure of the cell were more difficult for subjects to understand by simple reading of them without the additional classroom discussion or laboratory activity in a science classroom. A sample of the passages used is provided here in Appendix F.

Third, high student absenteeism was a factor limiting the researcher in the number of days of suggested training she could schedule, thereby restricting the accuracy of the results.

Fourth, possible contamination of results could have occurred due to experimenter bias. The fact that the subjects remained with the experimenter for a prolonged period of time may have influenced the results to a certain degree, as well as working with the experimenter in small groups in a quiet environment, where attention to a student increased when compared to a regular classroom.

Implications and Future Directions for Research

This study focused on the investigation of the effectiveness of the instruction of self-generated questions using Bloom's Taxonomy on the acquisition and maintenance of comprehension skills of science material by poor comprehenders.

It has been observed and reported here that self-questioning is a useful strategy to assist poor readers monitor their own comprehension process.

However, questioning in general is a teaching strategy that may be used in addition to regular science class activities to assist poor comprehenders. It has been observed by this researcher and commented on by some of the science teachers that questioning in itself occurs very seldom in the sciences, especially the use of questions beyond those of the comprehension type (Appendix H) and that many other types of laboratory activities and films complement science instruction and assure satisfactory comprehension of material at hand. Therefore, the applicability (to a regular science class) of the questioning technique using Bloom's Taxonomy should be investigated to observe its effects on the comprehension and overall achievement of students in a science class.

In addition, the use of a self questioning technique should be extended to other content areas like social studies to determine its effectiveness on the learning of these materials. Last it would be interesting to compare the effects of the use of this technique with average readers to determine its utility in assisting the comprehension of other groups of students and to observe whether they can benefit as well from the use of this questioning technique.

This study was an exploratory one in the sense that it attempted to apply a known, successful reading technique beyond the reading class to observe its effectiveness in another content area. Further research is needed to establish whether its findings are universal. Also, further research is needed to establish the long-term effects of the self-questioning technique, and generalization measures need to be taken to establish the generalization of results across settings.

Finally, science teachers commented on their lack of use of higher level questions (represented by Bloom's Taxonomy) and suggested that they should use these in their science classes. Perhaps further research in training teachers in the use of these types of questions may bring a positive outcome and increase the overall level of comprehension of science students.

<u>Implications for Classroom Teachers</u>

The results of this study have shown that the self-questioning technique structured using Bloom's Taxonomy promoted the ability to answer questions that require high thinking skills. When used with science materials they have shown to be compatible with the problem-solving discovery methods frequently used in science. The questions structured this way clearly specify what behaviors are expected from the students as a consequence of a unit of instruction, in this case science instruction. Science teachers could greatly benefit from the use of this questioning technique with their students. Science teachers that were met through this study commented on the lack of use of higher level questions in their science class. They suggested and encouraged their use, especially those teachers who were able to notice improvement in their students. It would be advantageous to science teachers to learn and use this technique for the following reasons.

1) It would allow teachers to instruct the students in how to think analytically, how to apply science information in a problem-solving situation; how to interpret scientific information.

2) It would assist the students, all stduents, in carefully monitoring their comprehension over the scientific material at hand, being able to focus their attention on the important pieces of information.

3) Eventually, students will be able to formulate other questions relevant to scientific methods or principles in a more strategic way.

4) It would assist the students once the strategy has been assimilated to exhibit better retention of scientific material, improve ability to evaluate scientific material and the capacity of applying these strategies successfully to other content areas also.

Chapter Summary

In this chapter, a summary with conclusions was given. Limitations of this study were discussed. At last, considerations and implications for future research was discussed.

APPENDIX A

Date ______________

Dear Mr. and Mrs. ____________________:

This letter is a request for permission to include your student ____________ in an extra reading comprehension study designed to reinforce your child's reading skills and hopefully help him/her to succeed in science.

The goal is to help students to gain more meaning from what they read. The supplemental activities will take place during the english and science classes. This is entirely a voluntary activity which we feel could greatly benefit your child.

I approve the participation of ____________ in the extra reading activities.

____
parent signature

If you have any questions or suggestions please contact me at 355-3953 or Mr. Lopez Garcia at Dwight Rich 374-4357.

APPENDIX B

RESULTS OF SCREENING

Name	Oral Reading Rate	Mistakes	% Comprehension
Beatriz (S#1)	55 wpm	3	15%
Humberto (S#2)	138 wpm	2	50%
Vicente (S#3)	102 wpm	none	35%
Federico (S#4)	55 wpm	2	20%
Carol (S#5)	92 wpm	2	45%
Antonio (S#6)	138 wpm	3	25%
Jeronimo (S#7)	64 wpm	2	40%
Laura (S#8)	204 wpm	none	45%
Alfredo (S#9)	96 wpm	4	30%
Roberto (S#10)	136 wpm	none	45%
Celia (S#11)	102 wpm	1	30%

*Gronlund Norman
Stating objectives for classroom instruction
2nd Edition. McMillan Pub. Co., New York, 1978
Chapter 3, pg. 28-29.

VALIDATION OF QUESTIONS

Level	Definition	Sample Words Used
Knowledge	Remembering/Recall of wide range of materials from specific facts, theories, concepts, literally, exactly.	define, identify, label, list, match, name, outline, selects, states, describes
Comprehension	Ability to grasp meaning of material. This may be shown by translating material from one form to another, by interpreting material (explaining or summarizing) and by estimating future trends (predicting consequences or effects).	converts, defends, distinguishes, explains, extends, generalizes, gives examples, infers, paraphrases, predicts, rewrites, summarizes
Application	Ability to use learned material in new and concrete situations. Applies concepts and principles to new situations. Applies laws and theories to practical situations. Solves math problems. Constructs graphs and charts. Demonstrate usage.	changes, computer, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses, draws

Analysis	Ability to break down material into its component parts so that its organizational structure can be understood. This may include identification of the parts, analysis of the relationships between parts and recognition of the organizational principles involved.	breaks down, diagrams, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, points out, relates, separates, subdivides
Synthesis	Ability to put parts together to form a new whole. Involves the production of a unique communication (theme or speech) a plan of operations (research proposal) or a set of abstract relations (scheme for classifying information). Learning stresses creative behaviors, new patterns or structures. Integrates learning from different areas into a plant for solving a problem.	categorizes, combines, compiles, composes, creates, devices, designs, explains, generates, modifies, organizes, plans, summarizes, reorganizes, rewrites

QUESTION VALIDATION

I. QUESTIONS - KNOWLEDGE LEVEL

Preview of Life Science Yes/No

1. Define science.
2. What is biology?
3. How many steps are there to follow when you investigate?
4. List the steps to follow when you investigate.
5. Define hypothesis.

Chapter I Part II - Vascular Plants With Seeds

1. Define vascular plants.
2. List the types of vascular plants with seeds.
3. Define angiosperms.
4. Define gymnosperms.
5. List some types of gymnosperm plants.
6. What is the meaning of conifers?
7. Name the two types of cones by conifers.
8. What are the types of angiosperms according to their life patterns?
9. Name two types of angiosperms plants.
10. Enumerate the different families of angiosperms plants.
11. What are the two things all living things depend on?
12. Name the two groups of vascular plants.

Chapter 7 - Cells

1. Define cells.
2. What is the cell theory?
3. What is cellullose?
4. Define membrane.
5. Define cytoplasm.
6. What is the nucleus?
7. What is the function of the cytoplasm?
8. What are vacuoles?
9. What is the function of the vacuoles?
10. What is the endoplasmic reticulum?
11. What is the function of the endoplasmic reticulum?
12. What is the function of the ribosomes?
13. What is a mitocondria?
14. What is diffusion?
15. What are enzymes?
16. What is the function of enzymes?

Yes/No

17. What are the names of the processes involved in cell reproduction?
18. Define mitosis.
19. What are the names of the stages involved in mitosis?
20. Define meiosis.
21. What are specialized cells?
22. Define cell.
23. List the parts of the cell.
24. Describe one function of the cell.

Chapter 8 - Seed Plants

1. What are the names of the main groups of seed plants?
2. Define angiosperms.
3. What is a gymnosperm plant?
4. What is a conifer plant?
5. What are the parts of the plant?
6. Describe some of the functions of the roots.
7. How many types of root cells are there? Identify them.
8. What is the stem?
9. Define stolon.
10. What is rhizome?
11. What is a tuber?
12. What is a bulb?
13. What are the parts of the leaf?
14. What are the types of leaves that exist?
15. Describe the characteristics of a simple leaf.
16. Describe the characteristics of a compound leaf.
17. Define deciduous tree.
18. What are the two structures most plants have?
19. What is the function of pistils?
20. What is the function of stamens?
21. What are some functions common to all living things?
22. What is the function of the vascular tissues or xylems?
23. Identify the two gases that plants need in order to survive.
24. What are the names of the two openings in the leaves that allows gases to come in and out of the plant?
25. What is photosynthesis?
26. Where is food made?
27. What is the function of the guard cell?
28. What are the elements needed for food making by plants?
29. Name the parts of a plant.

Yes/No

30. What are some of the products the seed plants produce?
31. What are some of the plant's functions?

Chapter 3 - Vertebrae Animals

1. What are vertebrae?
2. List the three major groups of fishes
3. What are jawless fishes?
4. What is a scavenger fish?
5. Name the largest fish that exists today.
6. Tell how many species of fishes there are.
7. Describe the characteristics of bony fishes.
8. What is an air bladder?
9. Define metamorphosis.
10. Describe the characteristics of amphibians.
11. Define hibernation.
12. Define herbivores.
13. Define carnivores.
14. Describe the characteristics of salamanders.
15. Describe the characteristics of reptiles.
16. Describe the characteristics of snakes.
17. Define fangs.
18. Describe the characteristics of turtles and tortoises.
19. Describe the characteristics of lizards.
20. Define camouflage.
21. Describe the characteristics of birds.
22. Name the types of feathers that birds have.
23. Describe the characteristics of crocodiles and alligators.
24. Define migration.
25. When does it occur? (migration)
26. Who is an ornithologist?
27. What are the two characteristics that differentiate mammals from other species?
28. Describe the characteristics of mammals.
29. List the types of mammals that exist.
30. What is echolocation?
31. What is the most abundant mammal?
32. Describe the characteristics of rodents.
33. Describe the characteristics of carnivores among mammals.
34. Describe the characteristics of elephants.
35. What are primates?
36. Name the five groups of vertebrae.
37. Describe the characteristics of fishes.
38. Name the three types of mammals.

Yes/No

Chapter 18 - New Directions in Science

1. What are today's sources of energy?
2. What are some future sources of energy?
3. What is tidal energy?
4. What is geothermal energy?
5. What are the two ways to improve quality and quantity of food production?
6. Define aquaculture.
7. What is a krill?
8. Define land areas.
9. What are the two ares now uninhabitable for men?
10. What is a space lab?
11. What are bionics?
12. What are transplants?
13. Define biological engineering.
14. What are genes?
15. Define genetic engineering.
16. What is DNA?
17. What are the fields related to space medicine?

Chapter 1, Part II

1. Describe the characteristics of gymnosperm plants.
2. Describe the characteristics of cycads.
3. Describe the characteristics of ginkoes.
4. Describe the characteristics of gnetales.
5. Describe the characteristics of conifers.
6. Describe the characteristics of angiosperms.
7. Describe the characteristics of monocots.
8. Describe the characteristics of dicots.

II. QUESTIONS - COMPREHENSION LEVEL

Preview of Life Science

1. Explain the difference between zoology and botonics.
2. Explain the meaning of the word Biology.
3. What is the difference between identification of problems to be investigated and a hypothesis.

Chapter 7 - Cells

1. What is the difference between multicellular and unicellular?
2. Explain in your own words what Robert Hooke saw through his microscope.

Yes/No

3. Give an example of a cell that can be seen through the microscope.
4. How does the function of the cell wall differ from that of the cell membrane?
5. Explain in your own words what robosomes are.
6. What activities do you think cells use energy for?
7. How is a cell metabolism important in the functioning of an entire organism?
8. Explain in your own words the different stages of mitosis.
9. What are some examples of specialized cells?
10. What would happen if you didn't have robosomes?
11. What would happen to humans if there were no cells?
12. What would happen if there were no leaves on the plants?

Chapter 8 - Seed Plants

1. What are some examples of angiosperm plants?
2. What are some examples of gymnosperm plants?
3. What are the differences between an angiosperm plant and a gymnosperm plant?
4. Explain in your own words the function of the epidermal cells.
5. Explain some of the benefits that plants can provide us.
6. Explain in your own words some of the functions of the stem.
7. Give an example of a plant with tendrils.
8. Give an example of a plant with stolons
9. Tell some reason why leaves are made of different types and shapes.
10. Are the functions of some leaves different from one another? Why?
11. How do a deciduous tree and an evergreen differ?
12. Give an example of an evergreen tree.
13. Explain the reproductive process of gymnosperms.
14. Explain in your own words the reproductive process of angiosperms.
15. Give examples of flowers with pistils only; with stamens only; with both.
16. Explain the process of water and mineral transplants.
17. Why is it important for plants to have those two gases?
18. How do the plants obtain these two gases?
19. Explain the process of food transport and storage by plants.

Yes/No

20. How do the plants grow?
21. Where do the plants get their energy from?
22. Explain the process of respiration by plants.
23. What would happen if plants didn't have water?
24. What would happen if plants didn't have minerals?
25. What would happen if plants didn't have light?
26. What are some of the responsibilities of foresters?
27. What is the difference between the function of the stem and the leaf?
28. What are some indirect ways that seed plants are important to people?
29. What would happen if the plant did not have root hairs?
30. If the plant had roots, stems and leaves but not reproductive parts, what would happen to the plant?

Chapter 3 - Vertebrae Animals

1. Give examples of jawless fish.
2. What would happen if you had no backbone?
3. What is one difference between bony fishes and rays?
4. Explain how a fish can breathe under water.
5. What is the use of fins by a fish?
6. What advantages offer a fish their shapes?
7. How does the air bladder function?
8. Explain how fishes reproduce.
9. Explain in your own words the meaning of the word amphibians.
10. Give examples of amphibians you know.
11. Explain what happens to amphibians during winter months.
12. Why are they all called amphibians?
13. Give some examples of giant reptiles.
14. Explain the difference between reptiles and amphibians in the way they lay their eggs.
15. Give examples of poisonous snakes.
16. How do the snakes use their fangs? Explain.
17. How can snakes eat animals bigger than them? Explain.
18. Explain some of the ways lizards have to protect themselves from the enemy.
19. Give examples of lizards.
20. Explain how it is possible for birds to fly.
21. How do birds reproduce?
22. How do birds use the songs they sing?
23. Why are mammals called that way? Explain.

Yes/No

24. Explain how egg-laying mammals reproduce themselves.
25. Give an example of an egg-laying mammal.
26. Why are pouched mammals called this way? Explain.
27. Give examples of placental mammals you know.
28. Give an example of a flying mammal that uses echolocation.
29. What is the most abundant mammal?
30. Give examples of rodents you know.
31. Give examples of carnivores mammals.
32. Give examples of hoofed mammals.
33. Which mammals are sea mammals? Explain.
34. What is the main difference between primates and humans.
35. What does a zookeeper do?

Chapter 18 - New Directions in Life Science

1. Explain in your own words what nuclear fission is all about.
2. Explain in your own words what nuclear fussion is all about.
3. Give examples of tidal energy.
4. Explain in your own words what solar energy is all about.
5. Explain in your own words what selective breeding is all about.
6. Give examples of selective breeding in crops and live stocks.
7. Explain how aquaculture is practiced in laboratories.
8. Explain some alternatives of food in the future.
9. Give examples of foods in the future.
10. Why are land areas important to man? Explain.
11. Explain some of the uses of space shuttles.
12. Explain in your own words a close agricultural system.
13. What are some ways of improving health care?
14. Give an example of bionic parts available today.
15. Give examples of organs that can be transplanted today.
16. Explain in your own words what factors need to be considered before attempting a transplant.
17. Explain the difference between genetic engineering and genetic therapy.

Yes/No

Chapter 1, Part II - Vascular Plants With Seeds

1. Indicate the main difference between angiosperms and gymnosperms.
2. Give examples of angiosperm plants.
3. Give examples of gymnosperm plants.
4. Give examples of cycads.
5. Give examples of ginkoes.
6. Give examples of gnetales.
7. Give examples of conifers.
8. What is the meaning of conifers?
9. Give examples of annual flowers.
10. Give examples of monocots.
11. Give examples of dicots.
12. What does a horticulturist do?
13. Describe the difference between gymnosperms and angiosperms.

II. QUESTIONS - APPLICATION LEVEL

Preview of Life Science

1. Classify the following ares and show with a line whether they belong to the study of biology or not.

Biology

Chemistry   Microbiology   Geology

Botanics   Physics   Zoology

2. Look at the two cells. Show which one is an animal cell and a plant cell by writing their names in the space below.
3. Draw an animal cell and its parts.
4. Given these two pictures of plants, decide which one is an angiosperm plant and which one is a gymnosperm plant.
5. Given the following illustration of a root, substitute the letters A and B for their correspondent names.
6. Draw a plant with all its parts.
7. Show the plant with the tap root and the plant with the fibrous root in the spaces below.
8. Circle the part of the stem that identifies the tendrils. Write the name in the space below.
9. Given these two plants, indicate which one shows the bulb structure and the tube structure. Write the names on the lines below.

Yes/No

10. Demonstrate which leaves are simple leaves and which are compound leaves by writing them on the spaces below.
11. Show which parts of the flowers are stamens (male parts) and pistils (female parts). Write A (stamens) and B (pistils).
12. Show in the picture which arrow indicates the route of water and mineral transports by the xylem tissues.
13. Name five plant foods that you eat. Show which of these plant foods are the roots of plants, the stems of plants, the leaves of plants, the seeds, etc.
14. Draw a plant with all its parts and write the names.
15. Show which of these is a jawless fish. Write the name on the space below.
16. Look at the fish. Decide whether it is a cartilage or bony fish. Write the name on the line.
17. Look at these two fishes. Show which one is a bony fish. Write the name under it.
18. Look at the picture. These are eggs laid by an amphibian. Show which it is by writing its name under it.
19. Look at the pictures. Show which of these is a reptile by writing the name under it.
20. Look at the pictures. Show which is a lizard by writing its name under it. Also, write an R next to the one(s) you consider reptile.
21. Look at the picture. Show which is a countour feather and which is a quill feather. Write their names on the lines below.
22. Show in which of the two pictures the birds migrate. Write the word migration under it.
23. Demonstrate which of these animals in the picture are mammals by writing the word under it.
24. Look at these two animals. Show which of these is a placental mammal by writing the word under it.
25. Look at these two pictures. Show which of these is a primate and which is a sea mammal. Write the names under each picture.
26. Look at these two pictures. Classify the animals according to the group they belong (fish, amphibian, reptile, bird, mammal).

Yes/No

Chapter 18 - New Directions in Science

1. Choose an object which you know can be recycled and could be used as solid waste energy. Explain how.
2. You have a land in Arizona and another in the south pole. Decide where the use of solar energy may be an advantage and where not. Explain.
3. Select which of these sources of food would be most likely to survive in the desert environment provided there is a source of water to allow men to use it to be able to live there. Explain how.
   -cows -vegetables -corn
4. A spacesuit is the outfit astronauts wear while they are out in space due to the difference in air, light, gravity. Choose one of these three and explain how it protects them.
5. Choose an organ that could be replaced or assisted with the use of bionics. Explain what considerations would need to be made to use bionics.
6. Show by writing its name which of the two pictures that can be transplanted today.
7. Show one use of genetic engineering that would benefit men.

Chapter 1, Part II - Vascular Plants With Seeds

1. Look at these two pictures. Show which is a cycad and which is a ginkoe. Write their names under it.
2. Look at these two pictures. Show which is a conifer and which is a gnetal. WRite their names under it.
3. Look at these two pictures. Show which is a male cone and which is a female cone. Write M or F under it.
4. Look at these two pictures. Show which is an annual, biennal and perennial plant. Write A, B or P under each.
5. Look at the picture. Show which plant is a monocot and which is a dicot. Write the names on the lines.
6. Look at these pictures. Show which of them belong to the legume rose, grass, lily and palm families. Write their names under each.

Yes/No

7. Count the petals in these flowers. Show whether they are monocot or dicot. Write their names under it.

III. QUESTIONS - ANALYSIS LEVEL

Chapter 7 - Cells

1. Compare the cell membrane with the nuclear membrane and explain their similarities and differences.
2. What is the relationship between cells, tissues, organs, systems and organisms?
3. Explain the similarities and differences between mitosis and meiosis.
4. How do mitosis and meiosis differ?

Chapter 8 - Seed Plants

1. Explain the similarities and differences between an epidermal cell and root hairs.
2. What are the similarities and differences between tap roots and fibrous roots?
3. Compare a root and a stem. How are they alike? Different?
4. How do stolons differ from other stems?
5. Explain the similarities and differences between rhizome, stolon, tendril, tubers, and bulbs.
6. Compare these two leaves. Write down their similarities and differences.
7. Explain the similarities and differences between the function of the vascular tissues phoem and xylem.
8. Compare the process of growth and reproduction. What are their similarities and differences?
9. If you were to compare two plants, one grown in darkness and one grown in light, what effect would the presence or absence of light have on the plants? Explain.
10. What are some of the advantages that plants give to men?

Chapter 3 - Vertebrae

1. Compare a shark and a lamprey. How are the different and alike?
2. Compare a shark and a ray. Explain their similarities and differences.

Yes/No

3. What are differences between the sense of the humans and those of fishes?
4. Explain some similarities and differences between frogs and toads.
5. Explain some similarities and differences between amphibians and reptiles.
6. Why do turtles lay eggs on the sand if their home is on the sea?
7. Compare a bird with an alligator. What are their similarities and differences.
8. What is the relationship between the bird's bill, body and feet to their eating habits?
9. Explain your reasons for birds to migrate.
10. Compare a pouched mammal, like the kangaroo, with a placental animal, like a cow. Explain their similarities and differences.
11. Compare sea mammals with other mammals. Explain their similarities and differences.
12. Compare birds and mammals. Write their similarities and differences.

Chapter 18 - New Directions in Life Science

1. Explain the similarities and differences between nuclear fussion and nuclear fission.
2. Discuss the advantages of nuclear fusion over nuclear fission.
3. Discuss some of the advantages and dis-advantages of tidal energy.
4. Explain why solar energy may be useful in some areas but in others.
5. Explain some of the advantages of geothermal energy.
6. Discuss the similarities and differences between selective breeding and raising animals indoors.
7. Explain some of the advantages of laboratory food over real food.
8. Compare ocean food with new foods in the future. Explain their advantages and disadvantages.
9. Explain some of the alternatives for life in the desert.
10. Explain some considerations for living in the arctic environment.
11. Discuss some considerations for life in outer space.
12. Discuss the materials necessary for life in outer space. Explain some of the advantages and disadvantages of bionics.
13. Explain some of the advantages and dis-advantages of genetic engineering.

Yes/No

14. Discuss some advantages and disadvantages of transplants.
15. Why is space medicine necessary? Explain.

Chapter 1, Part II - Vascular Plants With Seeds

1. Compare a cycad with a ginkoe. Explain their similarities and differences.
2. Compare gnetales and conifers. Explain their similarities and differences.
3. Explain the differences between angiosperms and other types of plants.
4. Compare monocots and dicots. Write their similarities and differences.
5. Explain which of the families of angiosperms plants is most useful to man. Give reasons.
6. Explain some of the advantages in the field of horticulture.

IV. QUESTIONS - SYNTHESIS LEVEL

Chapter 7 - Cells

1. Propose plans for experiments to be investigated.
2. Summarize what you have learned about science and scientific knowledge.

Chapter 8 - Seed Plants

1. Design your own garden. Decide what plants you would include for what uses.
2. Write a few paragraphs about those roots you consider nutritious for men. Give your reasons.
3. Summarize everything you have learned about stems and leaves.
4. If you were to live in the desert, what types of plants would you have? Explain.
5. Summarize what you have learned about water and mineral transport.
6. Summarize in one paragraph what you have learned about gas exchange.
7. Summarize in one paragraph how plants elaborate their food.
8. Summarize in one paragraph what you have learned about the effect of water, mineral and light on plants.

Yes/No

Chapter 3 - Vertebrae Animals

1. Summarize in one paragraph the characteristics of bony fish.
2. Design a plant to suggest others about the importance of fish in the world today and the future.
3. Make a sketch or drawing of the life cycle of a frog from egg to adult. Write 2-3 sentences explaining each stage.
4. Explain some ways in which certain reptiles (snakes, crocodiles) can be useful to men.
5. Summarize what you have learned about snakes, lizards, turtles.
6. Tell some of the things humans can do that no other mammal can.

Chapter 18 - New Directions in Life Science

1. Design a meal plan in the future. Explain your reasons for selecting that food.
2. Design a plan to develop a city in the desert. Explain what things need to be considered and how it would be made suitable for men to live there.
3. Given the moon as a place to live in outer space, design what a city would be like. Consider environment, food, shelter, etc.
4. Today, although transplants can be done, organs are not easily available. Suggest ways to improve shortage of organs for transplants.
5. Elaborate on how life would be like in the future as compared with the one today.

Chapter 1, Part II, Plants With Seeds

1. Summarize what you know about plants with seeds.
2. Choose two plants you know. Describe their characteristics. Decide what family they belong to.
3. Suggest ways in which plants can be advantageous to all living things.

Additional Questions - Knowledge Level

1. Describe a method for providing fresh water for irrigation.
2. Describe the reproduction process of placental mammals.

Yes/No

3. Describe the function of the nucleus.
4. Describe the process of metabolism.
5. What is the function of the leaf?
6. What is the function of the flower?
7. Describe the characteristics of jawless fishes.
8. Describe the characteristics of sharks.
9. What do scientists spend most of their time on?
10. What are the names of the two types of tests that scientists do?
11. What type of cell is longer than your arm?
12. Describe the function of the nuclear membrane.
13. Where does meiosis occur in people?
14. When does wilting occur?
15. What tissues carry the minerals throughout the plant?
16. What do plants need in order to carry out their life functions correctly?
17. Where are the gills located on a fish?
18. What are some characteristics of science fiction?
19. What is science fiction?
20. What are some areas inhabited by animals but not by men?
21. What are some needs that scientists have to consider for life in outer space?
22. What is the name of the institute that sets guidelines for genetic research?
23. What is the meaning of conifers?
24. Name the two types of cones by conifers.
25. What are the most numerous and highly developed plants today?
26. Describe the leaves of monocot plants.
27. Describe the distribution of petals in monocot plants.
28. Describe the characteristics of the plants in the legume family.
29. Describe the characteristics of plants in the beech family.
30. Name the two groups of flowering plants.
31. Name the two groups of plants that produce seeds.
32. What is the meaning of cell reproduction?

Additional Questions - Comprehension Level

1. Explain in your own words what microbiology is all about.
2. Explain the reasons for scientists to do an experiment more than once.
3. Explain the reasons for scientists to be able to identify a problem correctly.

Yes/No

4. Explain in your own words what chromosomes are.
5. What is the basic difference between mitosis and meiosis in cell reproduction?
6. Give examples of some activities technicians do.
7. Explain the difference between vacuole and citoplasm.
8. Explain the process of respiration in plants.
9. What is the main difference between plants and humans in relation to the food they eat?
10. What would happen if plants didn't have minerals?
11. What would happen if plants didn't have light?
12. Explain the difference between bony fishes and cartilage fishes.
13. What is one difference between bony fishes and rays?
14. Explain how a fish can breathe under water.
15. Explain the difference between reptiles and amphibians in the way they lay their eggs.
16. Give examples of reptiles you know.
17. What is the difference between a turtle and a tortoise?
18. What is the difference between egg laying and placental mammals?
19. What is the difference between fishes and amphibians?
20. Explain what raising animals indoors is all about.
21. Explain how you could use selective breeding for plants.
22. Explain some advantages of fertilizers.
23. Give an example of an animal whose feeding conditions have been changed to produce healthier meat.
24. Give examples of land areas that you know are good for men to live in.
25. Give examples of planets that could provide life for humans. Explain.
26. Explain how the deaf could hear with the help of bionics.
27. Explain how people with heart problems could be helped with the use of bionics.
28. Explain how the blind may be able to see with the use of bionics.
29. Give the example of a T.V. show that talked about bionics.
30. Give examples of biennal plants.
31. Give examples of perennial plants.
32. Give examples of plants in the grass family.
33. Give examples of plants in the palm family.

Yes/No

34. Explain the difference between a palm family plant and a rose family plant.
35. Give an example of gymnosperm.
36. Provide examples of areas where the use of solar energy may be an advantage and others where it may not be so. Explain.
37. Give examples of food that may be available in the arctic environment.

Additional Questions - Application Level

1. Look at this cell. Show what you know about it by writing the names of its different parts.
2. Look at the pictures. Show where cells with cloroplasts are located by drawing a circle around it.
3. Look at the pictures. Show what stage of mitosis it may be. Write the name next to it.
4. Look at the picture. Show whether it is mitosis or meiosis by writing its name under it.
5. Look at the picture. Show the parts of the cell by writing their names on the space below.
6. Solve. There are three plants. Plan A receives enough light and soil but not water. Plant B receives enough water and soil but not light. Plant C receives enough water, light and soil. Which of these plants will grow healthier. Explain.
7. Demonstrate some uses of nuclear energy in the world today.
8. Solve. You have 20 chickens and two procedures, fertilizers and selective breeding. Decide which one to use to improve the quantity of chickens. Explain.
9. Select which of these foods are produced through aquaculture.
   - dried foods
   - seaweed
   - salmon
   - dried meats

Additional Questions - Analysis Level

1. Compare the steps of "design an experiment" and "interpret observations." Write their similarities and differences.
2. Look at the two cells again. Compare the animal cell with the plant cell. Write down their similarities and differences.

Yes/No

3. Compare ribosomes and vacuoles. Explain their similarities and differences.
4. Compare the process of cell diffussion and cell respiration in metabolism. Explain their similarities and differences.
5. Compare the stages anaphase and metaphase. Explain their similarities and differences.
6. Explain the similarities and differences between the function of the vascular tissues "phoem" and "xylem."
7. Compare the process of growth and reproduction, their similarities and differences.
8. If you compare two plants, one grown in darkness and one grown in light, what effect would the presence or absence of light have on the plants? Explain.
9. Explain some advantages that plants give to men.
10. Compare a bird with an alligator. What are their similarities and differences?
11. Explain the reasons for birds to migrate.
12. Compare a mammal with a bird. Explain their similarities and difference.
13. Discuss the similarities and differences between selective breeding and raising animals indoors.
14. Compare ocean food with new foods in the future. Explain their advantages and disadvantages.
15. Why is space medicine necessary? Explain.
16. Compare annual plants with perennial plants. Explain their similarities and differences.
17. Explain some of the advantages of the field of horticulture for life of men.

Additional Questions - Synthesis Level

1. Plan an experiment you would like to investigate, with identification of the problem, find out what's already known about it, hypothesis, experiment itself and results of it.
2. Summarize in one paragraph what you have learned about the cell.
3. Summarize in one paragraph what you have learned about he process called mitosis.
4. Design your own garden. Decide what plants you would like to include, for what uses.
5. Write a paragraph about those roots which are nutritious for men. Explain.
6. Summarize everything you have learned about stems and leaves.

Yes/No

7. If you lived in the desert what plant would you have? Explain.
8. Summarize in one paragraph everything you have learned about leaves.
9. Summarize what you have learned about water and mineral transport.
10. Summarize in one paragraph what you have learned about gas exchange.
11. Summarize in one paragraph how plants elaborate their bood.
12. Summarize in one paragraph what you have learned about the effect of water, minerals, and light on plants.
13. Design your own garden. Decide what plants to have in it and explain why.
14. Summarize in one paragraph what you have learned about fishes.
15. Summarize in one paragraph the characteristics of bony fishes.
16. Make a sketch or drawing of the life cycle of a frog from an egg in to adulthood. Write two to three sentences explaining each.
17. Explain some ways in which certain reptiles (snakes, crocodiles) can be useful to men.
18. Summarize in one paragraph what you have learned about snakes, lizards and turtles.
19. Elaborate on reasons for birds to migrate.
20. Summarize in one paragraph what you have learned about mammals.
21. Tell some of the things that humans can do that no other mammal can.
22. Summarize in one paragraph what you have learned about vertebrae.
23. Summarize in one paragraph what you have learned about new sources of energy.
24. Design a house that would run assisted by solar energy. Explain how this would happen.
25. Summarize in one paragraph everything you have learned about new agricultural methods.
26. Summarize in one paragraph what you have learned about bionics.
27. Summarize in one paragraph what you have learned about genetic engineering.
28. Elaborate on how life would be in the future as compared with today.
29. Summarize in one paragraph what you have learned about gnetales and conifers.
30. Summarize in one paragraph what you have learned about angiosperms.
31. Summarize in one paragraph what you have learned about monocot and dicot plants.

Activity
Lesson Outline

Bloom's Taxonomy - Cognitive Domain - Question Generation

1. Knowledge - Definition of question type level

- Information that can be obtained (facts, concepts, methods, etc.)
- Students read facts, concepts, methods. Student Members.
- Students ask questions that need to be answered by rote memory.

Discuss

Words to look for yourself	Questions you can ask yourself
- List exactly # of steps	what is ______? meaning of?
- Describes exactly # of steps	which is __________?
	where is __________?
- Names of parts, elements groups of objects, animals, plants, organism	Describe exactly?
	Define exactly?
- Define exactly an object, animal, plant or mineral	Identify, tell, repeat exactly
	List, select exactly?

Important: Strategy will make you understand material better and learn science material faster.

Show a list of questions to distinguish knowledge questions from others (teacher/student).

Circle key words to knowledge questions.

Make model of how to make a knowledge question (teacher).

Practice making knowledge questions (teacher/student).

(Assessment)

Read passage silently.

Answer questions.

Review what has been learned today.

Activity
Lesson Outline

Bloom's Taxonomy - Cognitive Domain - Question Generation

2. Understanding - Definition of question type level.

- Information that can be obtained (facts, concepts, methods)
- Student reads facts, concepts, methods. Student Remembers.
- Student asks questions that need to be answered with own words.

Discuss

Words to use/remember	Questions you can ask yourself
- Describe, explain	Describe in your own words....
- Give examples	Explain _______ using your own words.....
- Distinguish	Distinguish A from B.....
- Re-write	Define using your own words...
- Own words, own way	Give example of.......
- Define own words	

Important: Question strategy will make you understand material better and learn science material faster.

Show list of questions to distinguish understanding questions from others (student/teacher).

Circle key words to understanding questions.

Make model of how to make understanding question (teacher).

Practice making questions of understanding (teacher/student).

(Assessment)

Read passage silently.

Answer questions.

Review what has been learned today.

Activity
Lesson Outline

Bloom's Taxonomy - Cognitive Domain - Question Generation

3. Application - Definition of question type level.

- Information that can be obtained - use information read to demonstrate how to apply it in a new situation, to be able to solve a simple problem, put into practice a concept or principle learned or read about.
- Student reads, remembers, unite information with personal experiences.
- Students demonstrates a principle orally or written.
- Student demonstrates with examples, map interpretation or drawing.

Discuss

Words to concentrate on	Questions you can ask yourself
- Demonstrate	Demonstrate that.....
- Determine use of ______ (one concept, principle)	Give example of the principle of.......
- Show how ______ (with a drawing, graph, etc.)	Classify according to ________
- Solve ____________.	Select ________ given this concept _________.
- Classify _______ according to concept, principle, etc.	

Important: This question strategy will make you understand material better and learn science material faster.

Show a list of questions to distinguish questions of application from others (teacher/student).

Circle key words to application questions.

Make model of how to make an application question (teacher).

Practice making application questions (student/teacher).

(Assessment)

Read passage silently.

Answer questions.

Review what has been learned today.

Activity
Lesson Outline

Bloom's Taxonomy - Cognitive Domain - Question Generation

4. Analysis - Definition of question level.

- Information read needs to be broken down into pieces to be able to solve a problem or to understand the components of scientific process, concept or principle. Information may/may not be in book.
- Requires to re-organize information read on a specific format.
- Student reads, reasons to break down into pieces information read.
- Student organizes information.

Discuss

Words to concentrate on	Questions to ask yourself
Separate Compare and Contrast. Discriminate Determine similarities and differences Establish advantages and disadvantages Provide reasons for ______ process occurs	Determine the..... - similarities and differences - advantages and disadvantages - pros - cons Compare and Contrast - 2 plants - 2 soils - 2 organs - life styles - 2 animals Give _____ reasons for _______ occurrence

Important: Question strategy will make you understand material better and learn science material faster.

Show a list of questions to distinguish analysis questions from others (teacher/student).

Circle key words of analysis questions.

Make model of how to make analysis questions (teacher).

Practice making analysis questions (student).

(Assessment)

Read passage silently.

Answer questions.

Review what has been learned today.

Activity
Lesson Outline

Bloom's Taxonomy - Cognitive Domain - Question Generation

5. Synthesis - Definition of question level.

- Information read leads student into creative thinking.
- Information read may provide ideas for problems that require creative answers, more than one is possible. Propose a plan.
- Information read allows to use own experiences to solve problems.
- Answers to questions are not necessarily in the text.
- Student reads.
- Student relates information to his own experience.
- Student responds by providing a solution, variety of possibilities.

Discuss	
Words to look for yourself/ to concentrate on:	Questions to ask yourself
Design a plan for......	Design a plan for.......
Elaborate	Elaborate........
Suggest _____ of.....	Suggest ______ of.....
Given this......consider	Given this....consider
Estimate a way to.....	Estimate a way to ....

Important: Strategy will make you understand material better and learn science faster.

Show a list of questions to distinguish that of synthesis from others (teacher/student).

Circle key words to synthesis questions.

Make model of how to make synthesis questions (teacher).

Practice making synthesis questions (teacher/student).

(Assessment)

Read passage silently.

Answer questions.

Review what has been learned today.

APPENDIX E

QUESTION SAMPLE LIST

Application Level

1. What is the function of the leaf?

2. Suggest ways in which plants can be advantageous to men.

3. Look at these two pictures. Classify the animals according to the group they belong (fish, amphibian, reptile, bird, mammal).

4. Draw a plant with all its parts and write the names.

5. Compare ocean food with new foods in the future. Explain their advantages and disadvantages.

6. Where does meiosis occur in people?

7. Count the petals in these flowers. Show whether they are monocot or dicot. Write their names under it.

8. Explain in your own words what microbiology is all about.

9. What is the meaning of cell reproduction?

10. Select which of these foods are produced through aquaculture:

    - dried food
    - seaweed
    - salmon
    - dried meats.

Analysis Level

1. Define cytoplasm.

2. What are the two things all living things depend on?

3. Design your own garden. Decide what plants you would like to include, for what uses.

4. Compare annual plants with perennial plants. Explain their similarities and differences.

5. Demonstrate some uses of nuclear energy in the world today.

6. Explain the similarities and differences between the function of the vascular tissues "phoem" and "xylem."

7. Explain how a fish can breath under water.

8. Compare monocots and dicots. Write their similarities and differences.

9. Discuss the similarities and differences between selective breeding and raising animals indoors.

10. Look at these two pictures. Show which of these is a male cone and which is a female cone. Write M or F under it.

Note: Those with ✓ are the ones appropriate for that level.

VASCULAR PLANTS WITH SEEDS

The vascular plants which reproduce by seeds are the most common and widespread plants on the earth today. Scientists classify these plants into two major classes: the gymnosperms (JIM-nə -spermz) and angiosperms (AN-je-ə -spermz). Angiosperms are all those plants which produce flowers. Roses, daisies, and tulips are just a few common examples. What are some others you know of? Others are vegetables, fruits, flowering trees, shrubs and grasses.

On the other hand, gymnosperms do not produce flowers. Instead, most gymnosperms produce cones. And most are evergreen trees, such as the pine trees, spruce trees, and redwood trees. Evergreen trees, just as the name suggests, keep their green leaves throughout the year.

Gymnosperms

Gymnosperms are the "naked seed" plant. That is, their seeds are not enclosed in protective covers. Scientists believe gymnosperms were the earliest of the two groups of seed plants to appear on the earth. At one time, there were many more gymnosperms living on the earth than there are today. A large number of species are extinct and are known only through fossils. Now, only four orders of gymnosperms exist.

Cycads. These tropical palmlike evergreens are represented by only a few living species. Scientists believe cycads (SI-kadz) to be the most simple of the seed plants. Cycads are treelike plants in which the stem or trunk is usually unbranched. The leaves form a crown at the top. This crown makes the cycads look very much like palm trees, and they are commonly mistaken for them. However, palm trees are flowering plants. Cycads produce their seeds within cones.

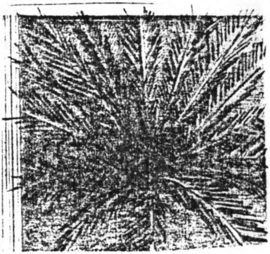
An American cycad that grows in Florida is the Zamia. It is usually less than one meter tall. Other kinds of cycads may brown to a height of 10 meters!

Ginkgoes. The maidenhair tree, or ginkgo (GING-ko), is the only living representative of what was once a common group of plants. For this reason, the ginkgo is known as a "living fossil."

At one time, ginkgoes were considered to be sacred. Monks in China planted them around their temples. This practice may have saved the gingko from extinction, for none have been found in the wild in recent times.

The ginkgoes are now planted widely around the world as shade and ornamental trees. The leaves are shaped like wedges or fans and grow in bunches along the branches. Ginkgoes are not evergreens. They are deciduous (di-SIJ-yoo-w ə s). That is, they lose their leaves in the fall. Ginkgoes are also either male or female trees. The female trees produce fleshy, berrylike seeds that have a strong odor after they ripen and fall to the ground. The male trees produce small, conelike parts.

1. Define vascular plants.
2. Define angiosperms.
3. Indicate the main difference between angiosperms and gymnosperms plants.
4. Give examples of gymnosperms plants.
5. Describe the characteristics of gymnosperms plants.
6. List some types of gymnosperms plants.
7. Give examples of cycads.
8. Describe the characteristics of ginkgoes.
9. Compare a cycad with a ginkgo. Explain their similarities and differences.
10. Look at these two pictures. Show which is a cycad and which is a ginkgo. Write their names under it.



11. Summarize what you learned about plants with seeds.

The diversity is great in the more than 20,000 species of bony fishes. There are more species in this class than in any other class of vertebrates. Each species is adapted for life in a particular habitat. The smallest of the fishes are tiny gobies that live in the mountain streams of the Philippines. It may require 2,000 of them to equal a kilogram! On the other hand, some of the largest fish, such as ocean sunfish, may measure more than three meters long!

A fish's shape gives some clues as to its habitat. Those that live in open water are fast swimmers. They have streamlined bodies. Those that live and feed close to the bottom of the sea have flat bodies. Eels, as an example, are slim and snakelike. This shape enables them to hide in holes and crevices deep in the ocean.

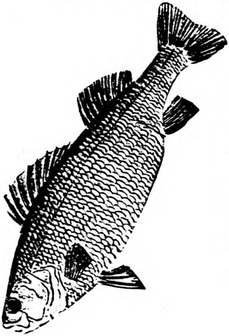
Inside their bodies, most fishes have an air bladder filled with gases. By regulating the amount of gas in the bladder, a fish can raise or lower itself to different levels in the water. Some fishes, like the shark, have no air bladder. These fishes sink to the bottom whenever they stop swimming.

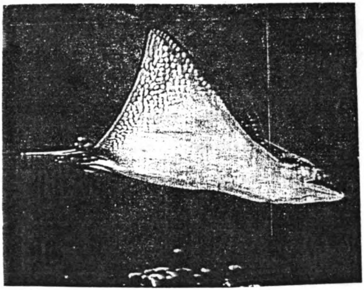
Sense organs in fishes are much more developed than in the other organisms you have studied so far. But they function differently from your own sense organs. Fishes have two large eyes, but no eyelids. Their tongue is used for touch rather than taste. Their nostrils are used for smelling, not for breathing. And they can detect vibrations in the water or the direction of current flow by a line of specialized scales located along each side of the body. Why is it important for fish to be able to detect vibrations? To detect movement around them that may indicate possible food sources and predators.

Fishes that lay many eggs--and some may lay a million --do not protect either the eggs or the new hatchlings. The survival rate of these eggs and young is low. However, fishes that lay fewer eggs usually make a special nest. They may also guard the eggs and protect the young. How can the different species of fishes survive when one type of parent is protective and the other is not?

Fishes are one of the world's major food resources. They are rich in protein and low in fat content. Which types of fish do you like to eat?

1. Tell how many species of fishes there are.
2. Describe the characteristics of bony fishes.
3. What is an air bladder?
4. What's the use of fins by a fish?
5. What advantages offer a fish their shapes?
6. How does the air bladder function?
7. What are the differences between the senses of the human versus fishes?
8. Why is it important for a fish to detect vibrations?
9. Explain how fishes reproduce.
10. Look at these two fishes and show which one is a bony fish. Write the name under it.





11. Design a plan to suggest to others about the importance of fish in the world today and in the future.

Most of the time you can tell an animal from a plant. But if someone asked you to name the differences between plants and animals, how would you answer? You might say that most plants are green and therefore can make their own food. Animals cannot make their own food. You might add that most animals can move about. Most plants cannot move about. These answers would show that you have a good understanding of the differences between plants and animals.

There are more than one million kinds of animals living on the earth. So it's probably impossible to learn the names for all of them. It is really more useful to learn the major features of each animal group. In that way you will learn how animals differ one from another. You will also be able to identify the group to which an animal belongs.

Animals are classified into two large groups: those with backbones and those without them. Animals without backbones are called invertebrates (in-VER-tə-brits). This groups includes sponges, jellyfishes, clams, worms, insects, and others. Animals with backbones are called vertebrates (VER-t -brits). Among this group are birds, cats, humans, and others. Make a list of 10 animals. Which are vertebrates? Which are invertebrates?

Sponges

Sponges belong to the phylum known as Porifera (P - RIF-ə -rə). This name means "pore-bearer" and refers to the many pores, or holes, in the body of a sponge. How are household sponges similar to animal sponges? They are both porous.

Sponges vary in color, size, and shape. They may be black, white, red, blue, orange, or yellow. They may be microscopic or as much as two meters wide. Some are slim and branched, while others are thick and tubelike.

There are about 5,000 species of sponges. Most live in warm seas, but a few kinds live in colder waters. All sponges grow attached to some underwater object. Some attach themselves to the backs of crabs or snails. In this way the sponges are carried to new sources of food. In turn, the crabs or snails are hidden from their enemies. But because sponges do not more on their own from place to place, they were once thought to be plants.

Study the illustrations on the following pages. Try to become familiar with the varied structures and colors of the different kinds of sponges. How are their appearances similar to plants? How are they unlike plants? Like plants, sponges are stationary. Unlike plants, sponges do not have roots, stems or leaves, and cannot make their own food.

1. What are the two kinds of animals that exist?
2. Define invertebrates.
3. Give examples of invertebrates.
4. Explain the main difference between vertebrate and invertebrate.
5. Look at these two pictures. Show which is a vertebrates and which is not by writing each name under it.

6. Compare a sponge with a plant. Show how they are alike and how they are different. Explain.
7. Summarize everything you learned about sponges in one paragraph.
8. What is the meaning of the word porifera?
9. Explain the similarity between house sponges and animal sponges.
10. What number of species of sponges are there (approximately)?

Good science fiction movies about he future are entertaining for many reasons. They are filled with action. They have exciting special effects. They usually have intriguing plots. And they help us to "escape" from everyday matters.

But such movies are also interesting for another reason. They show a vision of what life could be like in the future--food, clothes, houses, transportation, and many other subjects. Think about a science fiction movie you have seen recently. How did it differ from like around you today? Do you think life in the future will really be like what the movie pictured?

It may be. The futuristic inventions you see in movies come from someone's imagination. So have all the inventions on earth today. They have resulted from human creativity, which is unpredictable but very valuable. Tomorrow's advances will also come from the hunches and ideas people have and the experiments and investigations they undertake.

Resources of the Future

No one can predict what life will be like in the future. But given the present trend for population growth, energy and food may become limited. Alternate sources, then, must be found. This section describes some of the ideas that may provide resources for the future.

New Sources of Energy

People depend on energy sources to run machines, heat homes, and cook meals. Certain mineral fuels are presently used as energy sources for these purposes. They include natural gas, coal, and oil. However, the earth has only a limited supply of these fuels. For this reason, scientists are looking for alternative energy sources.

Nuclear Fusion. Presently, nuclear energy is being obtained by way of nuclear fission (FISH- ə n)--the splitting of the nucleus of the element uranium. However, the use of this type of nuclear energy can be dangerous. An accidental discharge of radioactivity from a nuclear energy plant could have harmful effects on organisms.

An alternative nuclear energy source still undeveloped involves fusion (FYOO-zh ə n). Fusion means "putting together." When the nuclei of two elements are fused, or combined under specific conditions, energy is given off. Scientists are working on ways of combining the element deuterium and lithium to produce nuclear energy. One of the advantages of fusion over fission is that only a small amount of radioactivity is involved. Thus, the danger of accidents is greatly reduced.

1. What are some of today's sources of energy?
2. What are some future sources of energy?
3. Explain in your own words what nuclear fission is all about.
4. Explain the similarities and difference between nuclear fusion and nuclear fission.
5. Discuss the advantages of nuclear fusion of over nuclear fission.
6. Demonstrate some of the uses of nuclear energy in the world today.
7. What are some characteristics of science fiction?
8. What is science fiction?
9. Summarize in one paragraph what you have learned about new sources of energy.

Cotton, flax, and hemp plants provide important fibers. The fibers of a cotton plant are part of the plant's ripe fruit. Flax fibers come from the stem of a plant. Hemp, used for making rope, comes from the stem of another plant.

Seed plants are also a source of medicines. Quinine, for example, is a medicine made from the bark of the cinchona tree. This medicine was once the only thing known to cure malaria. Now, however, quinine has been replaced by even more effective laboratory-made medicines.

Other products obtained from plants include some perfumes and soaps. Rubber is obtained from several kinds of trees. Even dyes can be made from many plants.

But seed plants do more than give us useful products. They give us parks and forests in which to play and camp. The roots of seed plants also hold the soil in place, and thus they help prevent erosion and floods. Their trunks, branches, leaves, and flowers provide shelter and food for birds and many other wild animals. What other ways can you think of in which plants are important? Some ways are from coal, as natural gas deposits as an oxygen source of living things.

Plant Structures

A seed plant has four main parts: roots, stems, leaves, and reproductive parts. Each of these has important functions to perform. Roots, stems, and leaves provide th day-to-day needs of the plant. Without them, a seed plant would die. The reproductive parts--cones, in gymnosperms, and flowers, in angiosperms--enable the plant to create more plants of the same kind.

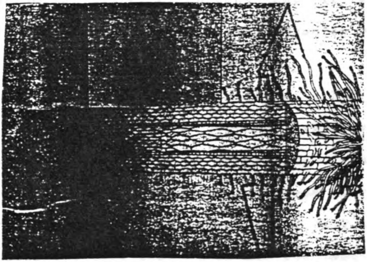
Roots

Roots anchor the plant in the soil. They also absorb water and minerals from the soil. The roots of some plants may grown 15 meters down into the earth to find water. In some plants the root system is larger than the above-ground portion. In measuring one rye plant, biologists found that the roots measured 609 km in length!

The tip of each root is capped with special cells, like a thimble on a fingertip. These are called edpidermal (ep--DER-m əl) cells. These cells protect the root cells from being injured as the root grows and forces its way through the soil. Just above the growing tip of the root are tiny extensions of the epidermal cells called root hairs. It is through the root hairs that the plant absorbs water and minerals.

The water and minerals are then transported from the roots to the stem of the plant and finally to the leaves. Here, in the green parts of the plant above ground, food making occurs. The food is then transported back to the roots. Some of the food is used then to provide energy for the roots.

1. What are the parts of the plants?
2. Describe some of the functions of the roots.
3. Explain in your own words the function of the epidermal cells.
4. Explain the similarities and differences between an epidermal cell and root hairs.
5. Given the following illustration of a root, substitute the letters A and B for their correspondent names.



6. What would happen if the plant did not have root hairs?
7. If the plant had roots, stem and leaves but not reproductive parts what would happen to the plant?
8. Explain some of the benefits that plants can provide us.
9. Draw a plant with all its parts.
10. Design your own garden. Decide what types of plants you will have there and give your reasons for them.

Meiosis. The other kind of cell reproduction is meiosis. This is the process by which reproductive cells are produced. In people, meiosis occurs in the reproductive organs of the body. Reproductive cells are different from body cells in that they have half the normal number of chromosomes. This is important for reproductive purposes. When a reproductive cell from the mother joins with a reproductive cell from the father, the resulting organism will have the normal number of chromosomes. If reproductive cells formed by mitosis, the resulting organism would have double the normal amount of chromosomes.

In some ways meiosis is like mitosis. But there are important differences. First, two cell divisions occur in meiosis instead of just one, as in mitosis. As a result, four cells are produced in meiosis, instead of two cells. Second the chromosomes duplicate themselves only once during meiosis, despite the fact that there are two cell divisions. Thus, each new cell has only half the number of chromosomes. Third, the chromosomes line up on either side of the spindle and randomly assort into new cells. They do not line up in pairs, because at this stage the chromosomes haven't duplicated themselves. Because of these differences between mitosis and meiosis, each new reproductive cell produced by meiosis is unique. It is not exactly like the cell from which if was formed. On the other hand, the cells produced by mitosis are usually identical.

Cell Specialization

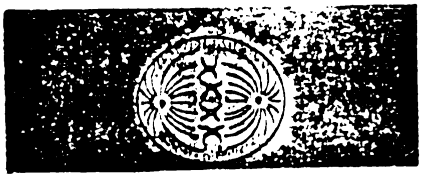
Though individual cells can perform all life functions, some cells are specialized and can perform specific functions. The shape of a cell is usually associated with its special function. For example, blood cells are specifically shaped to carry oxygen throughout the body. Nerve cells are specially shaped to relay messages from one part of the body to another. What are some other cells that you can think of that perform special functions? Muscle, bone, skin, reproductive cells.

In multicellular organisms, cells that look alike and that perform similar functions are organized into tissues (TISH-ooz). The human body, for example, is made up of many kinds of tissues: bone tissue, skin tissue, and muscle tissue, to name a few.

Tissues can function alone or together with other tissues. Two or more tissues working together form an organ. Your heart is an organ. It is made of muscle, nerve, and blood tissues. What other organs can you name? What tissues make up these organs?

Organs usually do not work alone. They function together with other organs to form a system. Each system has a special function. For example, you circulatory (SER-kyə-lə-tor-e) system moves blood through the body. It is made up of your heart, blood, and blood vessels. Your skeletal (SKEL-ˊ -t 1) system supports your body. It is made up of bones and cartilage. What other systems can you name?

1. Define meiosis.
2. Explain in your own words the process of meiosis.
3. What are specialized cells?
4. What are some examples of specialized cells?
5. What is the relationship between cells, tissues, organs, systems and organisms?
6. What would happen to humans if there were no cells?
7. Explain the similarities and differences between mitosis and meiosis.
8. Look at the picture. Show whether it is mitosis or meiosis by writing its name under it.



9. Summarize what you have learned about the cell in one paragraph.
10. Where does meiosis occur in people?

APPENDIX G

Carol

BASELINE

1. The smallest thing living.
2. Multicellar is what you can see cells under microscope, and unicellar.
3.
4.
5.
6.
7.
8.
9.
10.

Carol

INTERVENTION #1

Questions

1. What do stemsns produce?

2. What part of the flower is the pistils? Is it the female or male part of the flower?

3. What do the root hairs transfer to get its the vascular tissues in the root?

4. What part of the plant can you find xylem tissues?

Answers

1. They produce flowers.

2. Angyosperms produce flowers and gymnosperms don't produce flowers.

3. Xylem tissues and vascular tissues.

4.

5.

6. Cells

7. They to the sail in the plant.

8.

A	B
stigma	Anthen
style	filoment
ovary	petal

9.

10.

Carol

INTERVENTION #2

1. Tital energy is an energy that makes electricity.

2. Tital energy is the fall of the streams water that makes the electricity.

3. Advantages of tital energy is non pulluting energy. Disadvantages are the streams of the oceans.

4. Solar energy comes form the suns rays.

5. Because in some areas you may need light and some other areas you may not.

6. Geothermal energy is the source of electricity deep under the earth.

7. Some advantages of geothermal energy is to heat the water and to heat homes.

8. Arizona would be the solar energy advantage because it is more sunnier in Arizona.

9. I could use pop bottles to be recycled because when you return in your pop bottles in the store they recycle them so they can use the pop bottles over again.

10. I would build my house such as by putting the windows facing the sun's rays because it would help my house be warm. And I would be saving money because I wouldn't have to pay electricity.

Carol

MAINTENANCE

1. Genetic engineering is a process which involves the changing of the DNA cells.

2. DNA is a chemical it contains hereditary information within the cells.

3. Some advantages are that they are trying to improve on the animals and humans traits in the bacterium cells. Some disadvantages are that they can make a healthier person sick by putting bad traits.

4. A benefit of genetic engineering is if a person were sicke they would change the traits and make them healthier.

5. Genetic engineering is as information in the cells. Genetic therapy is

6. I have learned about genetic engineering that they are trying to improve on animals and humans traits and is a processs which involves the changing of the cells.

7. Space medicine is related to food improvement.

8. It would be the same needs food, livestock and housing.

9. NIH - National Institute and Health care.

Jeronimo

BASELINE

1.

2. Angiosperms produce flowers.

3. Angiosperms produce flowers and gymnosperms produce cones.

4. gymnosperm is a evergreen.

5. Of example the evergreen is green all year long.

6. Evergreen, pinetree, redseder.

7.

8.

9.

10. Cycad, gynkoe.

11.

Jeronimo

INTERVENTION #1

1. How does cotton and flax, hemp plants provide important fibers?

2. What is the source of medicine?

3. What is medicine nand from?

4. What is perfume and soap made out of?

5.

Jeronimo

INTERVENTION #2

1. The parts of the plant are the roots and the root hairs.

2.

3.

4.

5.

6. The plant would die out if the didn't have root hairs.

7.

Jeronimo

INTERVENTION #2

1. Some of the consideration for you to live in outer space is oxgen, food, water, gravity, and a place to live.

2. A space bed is were scientists study outerspace.

3. The space shuttle is important to scientists because so that they can send people to the moon.

4. Some uses of the space shuttle is to send satelites in to space.

5.

6. The necessary materials for out space is food, water oxygen, and gravity.

7. The first thing I'll do is to build a glass bubble to provide oxgen, food, gravity, heat and I'll need machines to build buildings that are strong. And people with clothes like astronats were's. The portect them sun rays, and the coldness. The kind of food I'll take is vegetables.

8. A spacesuite is used to help them breath air and they don't have oxgen in otuerspace that is why they use space suit to help them breath in this way is that they have a tube going throw the hellmet and they have oxgen tanks on there back.

9. The scientists have to consider for life in outer space is how the people would live in outer space.

10. The planets that could provide life for humans is the earth and the moon, mars.

Jeronimo

MAINTENANCE

1. The two kinds of animals that exist are vertebrates and invertebrates.

2. The invertebrates are the animals that don't have back bone.

3. The main difference between vertebrate and invertebrate are the vertebrate has a backbone and the invertebrate doesn't have a backbone.

4. An examples of invertebrates sponge, jellyfish.

5. A invertebrates B vertebrates

6. A sponge and the plant are alike they both stay stationary and the both live in water sometimes. They are different in this way. The plant makes it own food and the sponge doesn't.

7. The sponges in the paragraph I had learned about is that they change colors and they don't make there own food.

8. The word porifera means that the have holes in the sponge.

9. The similarity between the house sponges and the animal sponges are they absorb the water and they both can clean.

10. There are about approximately 5,000 species of sponges.

Name ________________________ Class ___________ Date ___________

CHAPTER 14 TEST

CHAPTER 14: HEREDITY

A. Write the letter of the correct answer in the space provided.

_______ 1. The trait in a genotype that may be hidden by another trait is called

a. dominant. b. recessive. c. homozygous.

_______ 2. The number of hereditary factors for each trait is

a. two. b. four. c. three.

_______ 3. The threadlike parts that carry the genes are called

a. DNA. b. chromosomes. c. nuclei.

_______ 4. The chains, or sides, of the DNA molecule are formed by

a. sugars and zinc.
b. base chemicals called A, T, C, and G.
c. phosphates and sugars.

_______ 5. Reproductive cells are called

a. gametes. b. zygotes. c. genes.

_______ 6. The genotype represented by Bb is said to be

a. homozygous. b. recessive. c. heterozygous

_______ 7. A person having one gene for brown hair and one for red hair will normally have hair that is

a. red. b. brown. c. black

_______ 8. The presence of an extra chromosome in a fertilized egg cell results in a condition called

a. mongolism.
b. Turner's syndrome.
c. incomplete dominance.

_______ 9. Polyploidy is a term used to describe

a. the breakdown of a gene.
b. an increase in the normal number of chromosomes.
c. a decrease in the normal number of chromosomes.

_______10. Females have

a. two Y chromosomes.
b. an X and a Y chromosome.
c. two X chromosomes.

B. Using the following list of words, complete each of the statements on the lines provided at the left.

dominant	hybrids
genes	mutations
genotype	nucleus
Gregor Mendel	sperm
heredity	three

_______ 11. The passing of traits from parents to offspring is known as _______________.

_______ 12. __________ was the first person to work out the basic ideas of heredity.

_______ 13. When two purebred plants with different traits are crossed, the offspring produced are called _______________.

_______ 14. A trait that expresses itself more strongly than another is a ____________ trait.

_______ 15. The heredity factors that determine the traits of an organism are called ____________.

_______ 16. The genetic make-up of an organism is called the _______________.

_______ 17. Genes are located in the ____________ of a cell.

_______ 18. When two heterozygous individuals mate, __________ genotypes are possible.

_______ 19. Changes in genes that result from natural or environmental causes are called ________________.

_______ 20. The ______________ is the reproductive cell that determines the sex of a child.

C. Answer each of the following as completely as possible.

21. Describe the steps that must occur in the production of reproductive cells.

22. What would be the possible genotypes and phenotypes born to a homozygous brown-haired parent and a homozygous red-haired parent?

23. Suppose that the father is colorblind and the mother is a carrier for the colorblind trait. How will their sons and daughters be affected?

24. Why would plant breeders try to produce polyploidy plants?

25. Explain how you would find out if the seeds in a packet of round pea seeds were heterozygous or homozygous.

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