ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

THE APPLICATION OF CONSTRUCTIVIST STRATEGIES IN THE TEACHING OF UPPER-PRIMARY SCHOOL SCIENCES

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THE APPLICATION OF CONSTRUCTIVIST STRATEGIES IN THE TEACHING OF UPPER - PRIMARY SCHOOL SCIENCES

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ABSTRACT

The purpose of this study was to assess the application of elements of constructivist strategies in the teaching and learning process of the upper primary school sciences in the Addis Ababa Administrative Region government schools. The sources of data were grade seven science (Biology, Chemistry, and Physics) teachers and their classrooms. Three data collection instruments were used: classroom observation, questionnaire, and interview. Accordingly, 12 classrooms were observed, 48 teachers (including those observed) filled questionnaires and 4 teachers (from those observed) were interviewed.

The results of the study revealed that the teachers lacked the necessary knowledge base to use elements of constructivist strategies in their classrooms. About 30% of the respondents rated 'strongly disagree' and' disagree' on very important issues related to the strategies with only 24.8% strong agreement. Therefore, it can be said that most of the teachers are guided by traditional philosophies and theories of learning. However, it is found out that these teachers have the necessary attitude to use the strategies. About 98% (with mean value 2.68) rated that the strategies/techniques as 'very much useful' and 'useful' for the teaching and learning processes in their classrooms

The assessment regarding the extent of use of these strategies have also shown that the strategies are only rarely and sometimes used in most upper-primary science classrooms. Among the observed teachers, only 5.83% of them found applying them very well. The other 28.33% applied them moderately and 36.66% not applied them at all. . The analysis of the data collected through questionnaire has also revealed that about 50% of the respondent teachers are only rarely and sometimes applying, and about 10% do not apply them at all. However, about 30% of them applied frequently and always.

The most serious factors affecting the use of elements of constructivist strategies are found to be: the lack of facilities such as the laboratories and laboratory resources; the classroom conditions, in general, and also the large number of students in a class; student's lack of interest and the textbook/the curriculum.

Thus, urgent in-service training through workshops, and also small-scale training programs should be given to the upper-primary science teachers on modern theories of learning, particularly on the philosophical bases to teach science and also on how to incorporate elements of constructivist strategies into their classroom teaching. The stakeholders, the government and also the general public should seriously think upon providing the necessary facilities. Science teaching should also focus on student's developments of knowledge, skills in science and also attitudes and interest in science. The serious considerations the textbook designers give to modern theories and models of learning during the designing of the textbooks will also be very crucial.

CHAPTER ONE

I . INTRODUCTION

1.1 Background Of The Study

These days, constructivist strategies are very much emphasized in the teaching and learning processes. These strategies have their roots in the philosophical paradigm, constructivism.The paradigm emphasizes that, individuals based on their prior experiences in their effort to sense their environment, actively construct meanings. For instance, scholars say:

> Effective learning does not occur when information is transmitted from the teacher or textbook to the child. To the contrast, each child constructs his/her own meaning by connecting and combining prior information so that this new knowledge gives personal meaning to the child (Dobey, Beichner and Raimondi, 1999: 29).

Many scholars discuss the relevance and importance of these strategies to science education. For instance, Carr et. al (1994: 158) argued that classroom teaching and learning should address the process of construction and reconstruction of scientific knowledge.

Martin (1997: 54), after defining constructivism as " The notion that people build their own knowledge and their own representations of knowledge from their own experience and thought, " argued that learning in science occurs best when approached from the constructivist point of view. Poole (1995: 45) also noted that there is much about the practices of constructivism in science education, which are commendable. Some of which are:

1. Its accents on starting where the pupils are, and understanding their conceptual schemes;
2. Stressing active rather than rote learning using dialogue and argument;
3. Emphasizing the importance of the social milieu within which learning takes place.

The constructivist strategies, above all, stress the centrality of the individual learner for his/her own learning, putting the pupils own knowledge at the forefront of teaching and planning.

Constructivism has got many implications for the teaching and learning processes in the classroom. Eggen and Kauchak (1997:22), for instance, pointed out " Constructivism is becoming increasingly influential in curriculum development, instruction and assessment."

Constructivist strategies are also developed into model or approach to teaching and learning by different scholars. From the perspectives of constructivism, teaching is the act of facilitating learning. The teacher's role is to monitor student's understandings and guide discussions. To the student, the teacher is a mediator, guide, provocateur and co-learner.

Enquiry, small group discussions, the guided-discovery method and process-oriented strategies are the major agents for teaching and learning from the constructivist point of view. Moreover, other teaching and learning strategies such as concept mapping and meta-cognitive skills are considered as the major tools from the constructivist perspectives.

In the Ethiopian context, developing students' cognitive abilities and problem solving skills are among the major educational goals stated in the policy (TGE, 1994). These abilities and skills are partly to be achieved through educating children science. According to recent developments in the field of cognitive science and current theories of learning, these abilities can be best developed in the learners when the teaching and learning processes are approached from the constructivist perspectives. The effort that is being made in science classrooms in Ethiopia in this line is a virgin area for assessment to be made. Indeed, constructivist teaching is both that comes about naturally and something that can be improved (Yager, 1995).

This study, thus, focuses on assessing the application of elements of constructivist strategies in the teaching of upper-primary school sciences and the factors that may hinder their practicability.

1.2 Statement of the Problem

Today, science programs in many countries are entangled with many problems. They remain content oriented. The tasks in which student's engage in science classes have low cognitive demand and emphasize learning of facts and memorization of algorithms.

Martin (1997:xviii) argues: -

> ... in spite of children's natural fascination with exploring on their own, for many years the teaching of science has consisted of the skillful impartation of scientific knowledge to students. Textbooks have contained information for children to learn, and it has been the job of the teacher to interpret the textbook and augments in such a way that every child learns the material presented.

The traditional roles of teachers such as the transmission of the logical structures of their knowledge and directing students through rational enquiry towards discovering the predetermined universal truths expressed in the form of law, principles, rules and algorithms is today a common characteristic of science teachers in teaching science. In general, as Tsai (1998) indicated, it is safe to say that science curriculum and teaching lag far behind the development of the philosophy of science, indicating an urgent need of improving science curriculum and science teaching.

In the Ethiopian context, a summary of research works done in this line by Esayas (1995) have shown that acquisition of process and enquiry skills are missed by students and the teaching of science is also dominated by lectures resulting passivity in students. Dereje (1997:190-191) discussing on the general conditions of the teaching and learning processes in Ethiopia said that teachers spend most of the time to enable students to pass exams by fostering test taking strategies in students. He further said, " this promotes passive learning and attempts at mastering higher order thinking skills are marginalized."

Experiences and observations also tell us that content coverage is one of the teachers highest priorities regardless of the extent to which students have learned what have been covered. In fact, it is unusual to find teachers, who require students to generate questions, actively involve in discussions, celebrate students points of views, emphasize hands-on experiences in their classrooms.

Many factors could be hindrances to the teaching of science in general and to the use of constructivist strategies, in particular. For instance, the textbook design in fostering the student's interaction with the materials to be learned is among the major hindrances (Fensham, 1992). The in availability of resources in general could also be among the major hindrances.

The teacher's knowledge base and skills in using elements of constructivist strategies to foster the teaching and learning processes in science classrooms is also another aspect under question. Above all, the teachers beliefs, understandings on how knowledge is best acquired and concepts are best developed in students can be put under question. The students' beliefs about teaching and learning could also be another problem.

However, it became very clear that under situations that are detached from the constructivist view of teaching and learning, learning is almost impossible, developing cognitive abilities such as critical thinking, problem solving, etc. through educating children science are unthinkable.

Hence, to either improve the existing practices or identify the major factors that hindered the use of elements of constructivist strategies in the science classrooms, rigorous study needs to be made. It is on this solid ground that this research is based.

Objectives Of The Study

The major purposes of this study are:

1 Assessing the application of elements of constructivist strategies in the teaching of upper primary school sciences

2 Identifying the major factors that influence the use of elements of constructivist strategies in the teaching of upper primary school sciences.

Research Questions

In order to address the major purposes of the study, the work is devoted to answering the following questions.

1 To what extent are elements of constructivist strategies used in the teaching of upper primary school sciences?

2 Do upper primary school science teachers have the necessary knowledge base and attitude to teach using elements of constructivist strategies?

3 What are the key factors that hinder the use of elements of constructivist strategies in the teaching of upper primary school sciences?

1.3 Significance Of The Study

Today, many countries including Ethiopia, have concentrated on creating a population with broad cognitive competencies and problem solving abilities. Thus, it is no wonder that particularly in the upper-primary school level, science covers the widest portion of the curriculum. However, in addition to allocating much space in the curriculum, all the development processes of the curriculum and the teaching and learning processes in the classroom need to be seriously considered.

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Incorporating modern practices and research findings from the field of curriculum and teaching, in general and science education, in particular into the existing practices of science teachers and effective use of them in the science classrooms, for instance, are among the areas that deserve serious considerations. Identifying the hurdles in the effective use of these modern practices is also another very crucial aspect in the effective use of the practices.

This study, thus, by way of assessing the extent of use of elements of constructivist strategies by upper-primary school science teachers and by way of identifying the major factors that may hinder the use of these strategies is believed to have the following potential contributions.

1. Its findings are primarily helpful to the upper-primary school science teachers so that they reflect on their practices leading to the improvement of science teaching at the level

2. The constructivist strategies are relatively an emerging and widely accepted paradigm in science education. Thus, assessing the teachers capability to use elements of these strategies can serve as a feedback to science teacher educators leading to the improvement of both the pre-service and in-service training of science teachers.

3. Because the researcher believes that there are no significant differences in the practices of the different regions and also grade levels viewed in this context, the findings of this may give directions to the improvement of science programs in other regions and all grade levels.

4. This study may also give direction on how teachers can effectively incorporate elements of constructivist strategies into their classroom practices.

5 Identifying the hindrances in the application of the elements of constructivist strategies may also serve as a feedback to educational administrators in the region to curve the problems

6 Constructivist strategies are not specific to science education. Many educators such as, Fosnot, 1996; Treagust, Duit and Fraser, 1994 in Tsai (1998) have highly recommended to the instruction process in other school subjects. Therefore, it can serve as a background and a good initiator for this kind of research to be conducted in these areas.

1.4 Delimitation Of The Study

In order to make the study manageable within the limit of time constraints, it was delimited to one region, Addis Ababa Regional Administration government schools. It also focused only on the upper-primary and in particular the grade seven sciences.

Thus, although their contributions may extend to other contexts, the results of the study should not be generalized to other regions, levels and subjects.

1.5 Limitations Of The Study

The study has got some limitations. Because of time and financial constraints, it was impossible to use larger number of samples. Particularly, it was impossible to observe much more classrooms as compared to the large number of classrooms and sections. This, the researcher believes, somehow influenced the reliability of the data gathered through classroom observation. However, the results obtained through classroom observation, questionnaire and also interview indicated very much consistent results indicating reliability in the data collected.

The research would have also been greater in depth and quality had it focused on one of the sciences (Biology, Chemistry or Physics). However, because this work is the first of its kind in the Ethiopian context, the researcher believes that it is very important to see the feature of science teaching in general from the point of view of the aims of this research than to focus on one of them.

1.6 Definition of Terms

Upper- Primary- refers to grades seven and eight in the second cycle of the primary.

Constructivism- is a model of learning, which emphasizes active involvement of individuals in meaning construction in a given context during the teaching and learning processes.

Constructivist strategies- strategies to teaching in line with the ideals of constructivism that gives importance to the activation of students prior experiences, active involvements of the students in the learning process, making of students activities realistic, application of learning, etc.

Elements of constructivist strategies- teaching, which is informed with some characteristics, features, and techniques of constructivist strategies with major emphasis on activation of prior experiences and current knowledge of learners; active involvement of students in the learning process through explorations, discussions, etc.; students propositions of explanations, solutions etc.; and application of learning.

Grade seven science- refers to Biology, Chemistry and Physics.

Science teacher - Any teacher teaching Biology or Chemistry or Physics or any combination of the two or the three in grade seven and eight.

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Processes of science - These include all scientific activities such as identifying problems, hypothesizing, predicting, collecting data, organizing data, interpreting data, communicating findings, etc.

Open-ended Activities/Tasks - Activities in which students are free to discover or explore or search for solutions in their own ways. More briefly, students' activities in which there are no prescribed procedures and students are not required to find right answers or direct solutions.

Close-ended Activities/Tasks- students' activities in which there are prescribed procedures and students are required to find right answers or direct solutions.

1.7 Organization of the Study

The content of this research is organized into five chapters. The first chapter presents the background to the study, the statement of the problem, significance, delimitation, and limitation of the study and also definition of some terms/phrases. The second chapter presents the review of the related literature. The third and fourth chapter, respectively, present the methods and procedures of the study, and the presentation and analysis of data. The last chapter summarizes the whole work and also presents conclusions and recommendations.

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CHAPTER TWO

2. REVIEW OF THE RELATED LITERATURE

This chapter presents review of the relevant literature and research findings that are considered to be related to the research problems under consideration. The first part deals with constructivism as a model of learning, constructivism and the teaching and learning of science and some constructivist strategies in the teaching and learning processes. Part two presents the application of constructivist strategies in the teaching of some concepts in science. Some of the factors that hinder the practicability of constructivist strategies in the science classrooms are discussed in the last part.

2.1 Constructivism As a Model of Learning

Cobern (1996:304) stated "... constructivism is a model of learning that implies a student is always an active agent in the process of meaningful learning." Another scholar defines constructivism as a perspective of teaching and learning in which a learner constructs meaning from experience and interaction with others and the teacher's role is to provide meaningful experiences for students (Arends, 1997). And it places learners in the center of the learning process (Eggen and Kauchak, 1996).

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Many scholars provide the following arguments about the emergence of the paradigm. According to Martin (1997) "although the term constructivism is relatively new, many constructivist ideas can be traced back to John Dewey and Jean Piaget and some go back at least as far as Socrates" (p.397). It is also argued that constructivism, as a perspective, is grounded in the research of Piaget, Vygotsky, the gestalt psychologists, Bartlett and Bruner as well as the educational Psychology of John Dewey (Woolfolk, 1997). It is also an idea that is nearly 300 years old with literally thousands of research reports to support its validity and to develop it as a useful theory of learning (Yager, 1995).

Constructivism is a view that emphasizes the active role of learners in building understanding and making sense of information. This perspective, Lauritzen and Jaeger (1997) point out, shifts the emphasis from the teacher to the learner. The core idea in constructivism is, thus, students develop new knowledge through a process of active meaning construction.

Constructivists emphasize the importance of relating new content to the knowledge the students possess, as well as providing opportunities for students to process and apply the new learning (Good and Brophy, 1997). They also argue that teachers need to go beyond information transmission models. Brooks (1993), in Good and Brophy (1997), discusses constructivism as it involves structuring reflective discussions of the meanings and implications of content and providing opportunities

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As is the case for other models of learning, constructivism is based on certain assumptions. These assumptions are the following:

- Learning is constructed from experience and results in an internal representations of knowledge;
- Learning is a personal interpretation of the world perhaps no two people share the same reality;
- Learning is collaborative;
- Learning is an active process in which meaning is developed from experience;
- Learning is situated and reflective of real world contexts; and
- The assessment of learning must be integrated with instruction in order to be valid (Bednar et al., in Duffy and Jonassen, 1991:147).

Constructivism is regarded as having the following characteristics (Eggen and Kauchak 1997:275-8)

- Learners construct understanding,
- New learning depends on current understanding,
- Learning is facilitated by social interaction,
- Meaningful learning occurs within authentic learning tasks.

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Collision (1991) also mentioned the following characteristics of constructivist learning (in Lauritzen and Jaeger, 1997:53-54):

- Learners come to school with a wealth of prior knowledge. Leaning is an interaction between the learner's use of prior knowledge and school experiences;
- What learners know is constructed meaning which did not exist before the learning created it;
- Learners make meaning about the world by logically linking pieces of knowledge, communications and experiences;
- These belief systems are often incomplete explanations or misconceptions;
- Belief systems are held until they are modified or replaced by a more satisfactory explanation;
- Direct instruction is unlikely to change belief systems;
- Learning takes place when confrontation with new experience creates dissonance;
- Learning is facilitated by social interaction; and
- Learning takes place best in a meaningful context.

Constructivism as perspective of teaching and learning has the following features according to Driver and Bell (1986) in Capel, Leask and Turner (1995:222):

- Learners are not viewed as passive but are seen as purposeful and ultimately responsible for their own learning. They bring their prior conceptions to the learning situation;

- Learning is considered to involve an active process on the part of the learner. It involves the construction of meaning and often takes place through interpersonal negotiation;
- Knowledge is not 'out there' but is personally and socially constructed: its states are problematic. It may be evaluated by the individual in terms of the extent to which it fits with their experience and is coherent with other aspects of their knowledge;
- Teachers also bring prior conceptions to learning situations in terms of not only their subject knowledge but also their views of teaching and learning.
- Teaching is not the transmission of knowledge but involves the organization of the situations in the classroom and the design of tasks in a way, which promotes learning;
- The curriculum is not that which is to be learnt, but a program of learning tasks, material and resources from which pupils construct their knowledge.

Another scholar has also forwarded the following features of constructivism, which are according to him Constructivism-informed pedagogical schemata. It includes expressing current conceptions, sharing and learning new conceptions, and Applying and testing conceptions (Bencze, 2000). Constructivists view knowledge as personally and socially constructed rather than objective. In addition to individual constructivism, social constructivism has also become a dominant influence in education (Eggen and kauchak, 1997).

Robert Yager (1991) as it is cited in Gega and peters (1994:48) developed the Constructivist Leaning Model (CLM). Another very similar approach developed is what Dobey, Beichner and Raymond (1999:30) call the four steps towards a constructivist approach to teaching. The model/ approach they developed in that order is:

1. Invitation/ Teacher presents an invitation to learn;
2. Exploration/ Teacher gives students the opportunity to explore, discover,and create;
3. Proposing explanations and solutions/students propose explanations and solutions;
4. Taking action/ Students take action on what they have learned.

According to McNeil (1999:5), the constructivist strategy for learning has three phases. The preparation for learning phase, the enquiry phase and the application and Integrative phase

In the preparation phase, students think about the problem, phenomenon, or topic to be studied. This includes students' discussions about their present knowledge and prior experiences related to the topic under consideration. Observation of discrepant events, provocative questions, the making of predictions, and dialogue and debate about the phenomenon are used. Often conflicting student preconceptions become the starting point of inquiry. Discussion of where to obtain data, information, and resources for resolving the problem is part of the preparation phase.

In the inquiry phase, students attempt to answer their questions and clarify their views through exploration, experimentation and through comparing the new ideas with previously held concepts. Both students and the teacher process the information and attempt to understand its meaning.

The application and integrative phase is characterized by Judging whether the goal of learning has been met. The new information is summarized and criticized, a problem is solved, and old ideas are contrasted with the new. The newly generated knowledge is applied in other situations especially to tasks in everyday contexts and to other tasks in the same subject field. The constructivist model/approach for teaching and learning is in general accepted as a promising model /approach for learning (Yager, 1991 in Gega and Peters, 1994 and Biehler and Snowman, 1993).

According to Lauritzen and Jaeger (1997), the constructivist perspective is a departure from what educators have commonly practiced-the transmission model of learning. They contrast constructivist with transmission model of teaching as in the following (p.51)

Transmission	Constructivist
• Closed ended instruction	• Open ended instruction
• Teacher directed learning	• Student directed learning
• Ignores prior Knowledge	• Utilizes prior knowledge

• Transmits Knowledge	• Generates knowledge
• Extrinsically motivated	• Intrinsically motivated
• Isolates skill instruction	• Capitalizes on context

Constructivism and discovery are also differentiated as in the following (Ibid: 71).

Constructivism	**Discovery**
• Learners invent their own realities instead of discovering the teachers reality, • The teacher expects that learners make meaning about experiences, • Students may invent visions, which may never have been before.	• The teacher sets up the experience and circumstances such that when the first domino falls the rest fall in a predictable pattern, • Learners can arrive at only one possibility, • The teacher expects that all of the students will arrive at the predicted and point at the conclusion of a lesson.

On the other hand, authorities in the field of constructivism argue that constructivist teaching and learning has strong relations with other teaching and learning models: to Fensham, Gunstone and White (1994), all learning involves construction whether the knowledge is discovered or received; behaviorism, which has the greatest impact on the teaching and learning process in schools until now, and constructivism are not mutually exclusive (Victor and Kellough, 1997); the student-centered instruction, in general, can be characterized as one of the characteristics of constructivist teaching (Discroll in Woolfolk, 1995).

The constructivist strategies have got much significance to the students. Yager (1995b), for instance, discusses the advantages of the constructivist approach over the traditional approaches to the learners as in the following. In the constructivist approach the learner:

- demonstrate a superior understanding of basic science concepts,
- use and understand basic processes of science better,
- can apply science concepts and processes in new situations,
- have more positive attitudes of science, science study, and science teachers,
- develop better creativity skills including questioning, proposing solutions, and predicting consequences, and
- have more complete views of the nature of science

And he further argues, "Many of the most perplexing problems of science education are resolved when teachers use constructivist procedures"(p.57).

The most important characteristics of a constructivist teacher, however, lie in the stimulation and coaching of the learners. His or her role will be helping learners actively construct and reconstruct their own ideas. Such instruction would therefore be slower since they involve more discussions, debate, and recreation of ideas. As a consequence, less content may be covered and fewer ideas may be memorized and tested (Watts, 1994, Victor and Kellough, 1997; Roelfs and Terwel, 1999). Teaching from a constructivist perspective thus recognizes that both practical activities and the discussions of these may be interpreted by students in ways, which differ from those intended. According to Scott et al(1994) even when arguments have apparently been clearly developed through classroom discourse, this does not mean that individuals have made sense of them.

2.2 Constructivism And The Teaching And Learning Of Science

> The learning of science is a process of construction and reconstruction of personal beliefs. It is a process of continuously refining existing knowledge and constructing concepts in intricate or organized networks which are unique to each child and which provide explanatory and predictive power (Martin, 1997: 102).

The learning of science by children and older students, no less than scientific research itself (Hawkins, 1994). It involves designing experiments, building models and in fact all the processes of science. Martin (1997: 102) argues, " the way children learn science is through doing science; the way children do science is through the processes of science in personally constructed inquires." Students ask their own questions about phenomena that interest them and seek their own answer to their questions through doing activities, which they themselves design. The theory-laden and conceptual change nature of scientific knowledge acquisition necessitates the use of the constructivist strategies in the teaching and learning of science (Tsai, 1998).

CHAPTER FOUR

4. PRESENTATION AND ANALYSIS OF DATA

In this chapter, the analysis of data and the major findings are presented. The analysis of the data on the whole is made as in the following.

In the tables (table 6,11, 12,15,16,17and 18), the total (the summation of the products of frequencies and the respective values for each of the items i.e. $\sum$vxf) is indicated. The mean value is also indicated by dividing the total ($\sum$vxf) by the total number of respondents.

i.e. $\overline{X} = \frac{\sum vxf}{N}$ where,

$\overline{X}$ = mean, $\sum$ = the summation of, V= Value, f = frequency and N = number of respondents. The percentages of the frequencies for all items using the rating scales are also calculated.

4.1 Presentation And Analysis Of Data Obtained Through Observation

The analysis and presentation of data collected through classroom observation is presented as in the following. To fulfill the purposes of the observation, 12 randomly selected teachers in 3 schools were observed. The data, based on the requirement of the Classroom Observation Checklist (see appendix D) were collected. They are analyzed as in table 6. Among the observed teachers, there were seven male teachers and five female teachers. The other characteristics of the observed teachers are presented briefly in the following tables.

Table 2 - Distribution of Observed Teachers by Age

Sex	Year							Total
	Below 30	31-35	36-40	41-45	46-50	51-55	Above 55	
M	4	1	1	-	1	-	-	7
F	4	-	-	-	1	-	-	5
Total	8	1	1	-	2	-	-	12
%	66.66	8.33	8.33	-	16.66	-	-	100

As it is indicated in table 2 above, 66.66% of the observed teachers are below age 30. And there is no teacher with age above 50 among those observed.

Table 3 - Distribution of Observed Teachers Experience in the Teaching Profession

Sex	Year							Total
	0-5	6-10	11-15	16-20	21-25	26-30	Above 30	
M	4	1	-	2	-	-	-	7
F	3	-	1	-	-	1	-	5
Total	7	1	1	2	-	1	-	12
%	58.33	8.33	8.33	16.66	-	8.33	-	100

Table 3 indicates that 58.33% of the observed teachers have teaching experience of only 0-5 years. Thus, most of the teachers are newly qualified teachers. However, it is seen that there is no teacher with teaching experience below two years.

Table 4- Distribution of Observed Teachers Experience in Teaching Grade Seven Science

Sex	Year							Total
	0-5	6-10	11-15	16-20	21-25	26-30	Above 30	
M	6	1	-	-	-	-	-	7
F	4	-	-	-	1	-	-	5
Total	10	1	-	-	1	-	-	12
%	83.33	8.33	-	-	8.33	-	-	100

As Table 4 shows, 83.33% of the teachers have taught science in grade seven for only 0-5 years. As most of these teachers are also new to the profession (Table 3), it is reasonable to expect that these teachers are more exposed to modern methods of teaching science.

Table 5 - Distribution of Observed Teachers Level of Education

Sex	Level					Total
	TTI	12 + 2	Diploma	12 + 3	Other	
M	-	1	6	-	-	7
F	-	-	5	-	-	5
Total	-	1	11	-	-	12
%	-	8.33	91.66	-	-	100

Table 5 indicates that almost all (91.66%) of the teachers are diploma holders. Their qualification is sufficient to teach at the level according to the New Education and Training Policy of Ethiopia (TGE-1994).

The table below presents the major analysis of the data obtained through observation.

Table 6: Frequency Distribution of Data Collected through Observation

Category	Sub Category	Applied very Well = 3		Moderately applied =2		Note at al l applied=1		Not Applicable =0		∑ vxf	$\bar{X} = \frac{\sum vxf}{N}$
		f	%	f	%	f	%	f	%		
1	1.1	1	8.33	6	50	5	41.66	-	-	20	1.66
	1.2	-	-	1	8.33	8	66.66	3	25	10	1.11
	1.3	4	33.33	5	41.66	3	25	-	-	25	2.08
2	2.1	-	-	2	16.66	8	66.66	2	16.66	12	1.2
	2.2	-	-	4	33.33	8	66.66	-	-	16	1.33
	2.3	-	-	3	25	7	58.33	2	16.66	10	1.42
3	3.1	-	-	5	41.66	5	41.66	2	16.66	12	1.42
	3.2	1	8.33	7	58.33	4	33.33	-	-	21	1.75
4	4.1	1	8.33	1	8.33	-	-	10	83.33	5	2.5
	4.2	-	-	-	-	2	16.66	10	83.33	2	1
Total		7	5.83	34	28.33	44	36.66	35	29.16	133	1.56

Category 1: - Invitation (Activation of Prior Experiences and Current Knowledge)

In the table under category 1 the analysis of the data for three subcategories is presented. For sub-category 1.1 which is about whether students are given opportunity to think about the specific topic to be learned, only one teacher has applied it very well. Five teachers (41.66%) have not applied it at all. A large percentage (50%) of the teachers have moderately applied it. The mean value (1.66), however, is less than the value for 'moderately applied'. This indicates that most of the science teachers do not give chance to their students to think, discuss on the specific topics they are going to teach. The researcher witnessed that most of the teachers directly lead to hot descriptions and explanations of them regarding the specific contents. Those teachers, who try to use the technique mentioned, were not using it properly. For instance, once they ask questions "what do you know about ...?.", "What is...?"about the specific contents they are going to teach, they do not give time to students to think upon the issues. They don't seek responses or elaborations of their students' thoughts or discussions.

Regarding subcategory 1.2 which is about whether students alternative conceptions/multiple conceptions are identified or assessed, the analysis has shown that none of the teachers have applied it very well and only one teacher has moderately applied it. And significant percentage of the teachers (66.66%) has not applied it at all. And the lessons of three teachers were judged not applicable. They were found to be more theoretical. Thus, from the analysis it can be said that almost all the teachers do not apply this subcategory. The mean value (1.11) is also a good indicator of this result.

The findings for this subcategory have also supported the findings for the sub category 1.1 above indicating that the teachers are not caring for the ideas their students present to their classroom. The researcher witnessed that they used their knowledge and experiences, and what is in the students textbook for point of start of their lessons. Students alternative/ multiple conceptions about the topics that are going to be taught in science, however are very much deliberated on by science educators as a good point of start, as a good initiator for discussion and design of experiments by students and their teachers and are generally understood as a point of departure into the students independent and group activities. The researcher wonders if the teachers themselves know how far the science concepts they teach in the elementary grades are very much related to what the students have prior conceptions about them.

The Findings for sub-category 1.3 which is about whether the lesson is related to already taught /learned lessons show some how different result. 33.33% of the teachers applied it very well, 41.66% of them moderately applied it and 25% of them not applied it at all. This sub-category seems to be applied in the upper-primary science classrooms. It is also in agreement with that traditionally teachers start their lessons by revising, summarizing or asking questions about what they taught in their last periods. Yet most teachers are not applying it very well. The mean value calculated for this sub-category is only 2.2.

In general it can be said that category 1, invitation (activation of prior experiences and current knowledge) is not well done by upper-primary science teachers. However, basing instruction on the prior experiences and current knowledge of their students through asking questions, providing analogies, examples, metaphors and through identifying or assessing their students prior conceptions and also relating their lesson to what is already taught /learned lessons (i.e. emphasizing on integration of learning) should be the preliminary step to teach specific contents (concepts, laws, generalizations, etc.) in science.

Category 2 - Exploration and Proposing Explanations and Solutions.

In table 6, category 1and subcategory 2.1 which is 'students are involved in either group or independent experimentation, exploration and the process skills in science,' the following results are indicated. 66.66% of them not applied it at all, only two teachers moderately applied it and none of the teachers applied it very well. This result should not be surprising. Mekuanint(1992) revealed that secondary school biology teachers are not well oriented about the enquiry approach and were very far from applying it. The summary of research works in science teaching made by Esayas (1993) has also presented the same result. As his review indicated enquiry and process skills are lacking in the teaching of science in the Ethiopian schools.

The result of this study has also indicated in most classrooms students are neither involved in-group experiments, discussions nor in independent explorations. Those classes in which the sub category was rated moderately applied are kind of teacher demonstrations with invitation of the students to see and describe things, phenomena, etc.

Regarding subcategory 2.2, which is, whether students are involved in discussions, arguments or debates on ideas or procedures or principles in the lessons, four teachers (33.33%) have moderately applied it, 66.66% of them not applied it at all and none of them applied it very well. And similarly, in subcategory 2.3, which is, whether students are engaged in discussions or negotiations on solutions or findings from experiments by reviewing or critiquing the findings of their peers, 25% of them moderately applied it, 33.33% not applied it at all and none of them were found applying it very well. In this case, however, two of the lessons were found to be in applicable. They were not appropriate for exploration to be done.

In general, the findings (mean values 1.2, 1.33 and 1.42) for category 2, indicate student experiments, explorations, and discussions and arguments on ideas, negotiations on results from experiments etc. are almost absent (or not applied) in the upper-primary science classrooms.

CATEGORY 3 - Taking Action

In the table, regarding subcategory 3.1 that is about whether students make decisions on ideas or on results or solutions from experiments or explorations the following results are found. 4.66% of them moderately applied it and another 41.66% not at all applied it. However, none of them applied it very well. This result is a good indication for students are taught the concepts, generalizations, etc. as facts, not as something to be explored or discovered, and not as students can make that decision about whether the ideas, laws, generalizations, etc. can be accepted or rejected based on evidences from investigations.

Regarding subcategory 3.2 which is 'students are provided with opportunities for the application of learning/opportunities for application of learning are suggested,' large percentage (58.33%) of the teachers have applied it moderately, and it is properly applied only in one classroom. The other 33.33% not applied it at all. Thus, it can be said that although proper use of this category is insignificant, most teachers make effort to extend learning beyond their classroom.

In general the analysis of the result for the third category (Taking Action) also shows that the science teachers are found to be very far from applying it very well.

CATEGORY 4- The Nature of Students' Activities /Tasks

Under this category, there are two sub categories. The first subcategory is about whether the students' activities/ tasks are authentic, and the second category is about whether the students' activities/ tasks are open-ended. The observation has shown that in most classrooms there were no such student group or independent explorations, experimentation or in general activities/ tasks. Students were busy copying notes from the chalkboard. The students were attending to their teachers' explanations, with few teachers' fact oriented questions.

However, very few cases were observed. For instance, in the subcategory 4.1, among the two-activities/ tasks, one is properly applied in one classroom and the other is moderately applied in another classroom. Thus, it can be said that activities (whenever they exist) are somehow related to what exists in the real-life situations. Activities such as small plants in the students' surroundings are used. But, regarding subcategory 4.2 none of these activities were found to be open-ended.

In general in most of the classrooms students are not observed doing activities (or doing science). The so-called activities/tasks are nearly teacher demonstrations, which are again very rare. From among all the 12 classes observed only three teachers were observed supporting their teaching with demonstration and a little bit of student explorations.

Thus, the analysis of the data obtained through observation that is applied very well (5.83%), moderately applied (28.33%) and not at all applied (36.66%) with grand mean (1.56) indicates that the strategies are not applied very well.

4.2. Presentation and Analysis of Data Obtained Through Questionnaire

The questionnaire was administered to all grade seven science teachers distributed in 11 schools, which are located in zone 1 and zone 4 (see appendix A). Out of the 53 questionnaires distributed, 48 questionnaires (90.56%) were returned. Among these 43 questionnaires were analyzed. Five of them were found to be not properly filled and were discarded after edition. Among those discarded, some of them were incomplete and some others were found to be carelessly filled.

Among the respondents, 11 (25.58%) were female and the rest were male. The average load of the respondents is found to be 23.69 periods per week. The average number of students in one classroom is 75.69. The other characteristics of the respondents are presented in the following tables.

Table 7 - Distribution of Respondents by Age

Sex	Year							Total
	Below30	30-35	36-40	41-45	46-50	50-55	Above 55	
M	15	4	7	3	3	-	-	32
F	9	-	2	-	-			11
Total	24	4	9	3	3	-	-	43
%	55.81	9.3	20.93	6.97	6.97	-	-	100

Table 7 shows that 55.81% of the respondents were below age 30, 9.3% between age 30-35, 20.93% between age 36-40, 6.97% between age 40-45 and 6.97% between ages 40-45. Thus, most of the teachers are below age 30.

Table 8. Distribution of Respondents years of Service in the Teaching Profession

Sex	Year							Total
	0-5	6-10	11-15	16-20	21-25	26-30	Above 30	
M	17	3	-	8	2	2	-	32
F	7	1	1	2	-	-	-	11
Total	24	4	1	10	2	2	-	43
%	55.81	9.3	2.32	23.25	4.65	4.65	-	100

In table 8, it is indicated that 55.81% of the teachers have teaching experience from 0-5 years. The table also indicates that about 45% of the teachers have teaching experience of six or more years. As it is already said, most of the teachers are with teaching experiences of five years or below. This indicates that most of them are new graduates from colleges. And they are more likely exposed to modern methods of teaching.

Table 9 - Distribution of Respondents years of Service in teaching grade seven science

Sex	Year							Total
	0.5	6-10	11-15	16-20	21-25	26-30	Above 30	
M	27	1	-	4	-	-	-	32
F	9	2	-	-	-	-	-	11
Total	36	3	-	4	-	-	-	43
%	83.72	6.97	-	9.3	-	-	-	100

In table 9, it is indicated that very significant percentage (83,72%) of the respondents have taught science in grade seven for less than five years, for the same reason that is discussed above.

TABLE 10 - Distribution of Respondents' Level of Education

Sex	Level					Total
	TTI	12 + 1	Diploma	12 + 3	Other	
M	1	2	29	-	-	32
F	-	1	10	-	-	11
Total	1	3	39	-	-	43
%	2.32	6.97	90.6	-	-	100

Table 10 shows that 90.6% of the respondents are diploma graduates and only 2.32% and 6.97% of the respondents are TTI level and 12 + 1 level, respectively. Thus, most of the respondents fulfill the requirement to teach science at the level according to the New Education and Training policy (TGE: 1994) of Ethiopia.

In the questionnaire item number 2 (from 2.1-2.13) was to collect data related to the upper-primary science teachers knowledge base in using elements of constructivist strategies. Item number 3(3.1-3.11) was to collect data regarding the application of elements of the strategies. Item number 4 (4.1-4.4 with all the sub-items) was to gather data regarding the factors affecting the use of elements of constructivist strategies in the science classrooms. Item 4.3 - 4.6 were to collect data regarding the authenticity of the students' activities and the student's interest in learning through interactive discussions and explorations in the science classroom. The last part, item number 5(5.1 - 5.12) was to gather data related to the attitude of teachers towards elements of constructivist strategies. In almost all the items rating scales with values were used.

The analysis of data obtained through questionnaire and discussions of them are presented in the following tables.

Table 11. Frequency Distribution of the Responses Given to Upper-primary Science Teachers Knowledge Base about Constructivist Strategies

Item. No	Rating Scale With value										Total $\sum vxf$	$\bar{X} = \frac{\sum vxf}{N}$
	1 = Strongly Disagree		2 = disagree		3= agree		4=strongly agree		O = Undecided			
	F	%	F	%	F	%	F	%	F	%		
2.1.	2	5.26	6	15.78	25	65	2	5.26	3	7.89	97	2.55
2.2	12	30	18	45	7	17.5	1	2.5	2	5	73	1.83
2.3	2	5.26	7	18.42	21	55.26	6	15.78	2	5.26	103	2.71
2.4	5	12.19	8	19.51	18	43.9	9	21.95	1	2.43	111	2.7
2.5	1	2.56	8	20.51	13	33.33	14	35.89	3	7.69	112	2.87
2.6	4	10.25	21	53.84	8	20.51	4	10.25	2	5.12	86	2.2
2.7	6	14.28	15	35.84	11	26.19	10	23.8	-	-	109	2.59
2.8	1	2.7	2	5.4	14	37.83	19	51.35	1	2.7	123	3.32
2.9	2	5.26	2	5.4	17	44.73	17	44.73	-	-	125	3.28
2.10	2	4.87	6	14.63	23	56.09	10	24.39	-	-	123	3.00
2.11	4	10.25	5	12.82	17	43.58	10	25.64	3	7.69	105	2.69
2.12	3	7.5	5	12.5	18	45	11	27.5	3	7.5	111	2.77
2.13	1	2.5	5	12.5	18	45	14	35	2	5	121	3.02
Total	45	8.78	108	21.09	210	41.01	127	24.8	22	4.29	1399	2.73

Table 11 shows that item No. 2.1, which is about new learning depends on current understandings, the large percentage (70.26%)of the respondents have agreed and strongly agreed on the issue. However, The mean values (2.55) shows that the responses are almost in between the values for 'agree' and 'disagree'. Regarding item number 2.2, which is 'learners come to school with a wealth of prior knowledge,' the analysis shows significant percentage (75%) of the respondents have disagreed and strongly disagreed on the issue. The mean value (1.83) for this item also indicates as it is below the value for 'disagree'. This clearly indicates that the respondents critically lack the necessary inputs for the use of elements of constructivist strategies in their classroom lessons. Most of them have the assumptions that their students know nothing about the science lessons they are going to teach. It can also be said that most of respondent teachers are guided by traditional philosophies, assumptions, and theories of learning.

Concerning item numbers 2.3, 2.4, and 2.5, which are about learners should get unified learning or integrated learning, learning is facilitated by social interaction and learning is an active process in which the learner actively constructs meanings, mean values 2.71, 2.7 and 2.87 are indicated respectively. The values are nearly equal (or below) 'the agree' value. When we see again item number 2.6, which is about knowledge should not be seen as it is transmitted from the teacher or textbook to the learner, 64.09% of the respondents have disagreed and strongly disagreed with 30.76% agreement and strong agreement. The mean value (2.2) calculated for this item is very nearer to the value for 'disagree'. This again clearly indicated that most teachers' beliefs about learning are transmission model of learning oriented. The teacher's assumption that knowledge is transmitted (not constructed) from the teacher or textbook to the children's mind is clearly reflected.

Regarding item number 2.7, which is the central word in student centered instruction that is the learner should direct learning; about 50% of the respondents disagreed and strongly disagreed. This is again a good indicator for the lack of important in put in the use of elements of constructivist strategies among most of the teachers.

On the other hand, when we look at item numbers 2.8, 2.9, 2.10 and 2.13 with their mean values 3.32, 3.28, 3.00,and 3.02 respectively, in all cases the value is above the value for 'agree'. This indicates the teachers beliefs are not purely transmission (traditional method) oriented. Some constructivist ideas and beliefs are some how held in most teachers if not all.

Most teachers also seem to lack the knowledge on what kind of experiences for the children are appropriate in schools. The analysis of item number 2.12 which is about students' experiences in schools should be very related to the students experiences at home and in the society, indicated this. The mean value (2.77) calculated for this item is below the value for 'agree'. This gives an answer to the suspicion raised before in the presentation of the findings of observation that most of the teachers may not know what kind of activities are appropriate for their learners.

In general, the analysis of data on the science teacher's knowledge base necessary for the use of elements of constructivist strategies in their classroom has shown that most teachers lack the necessary knowledge base to use elements of constructivist strategies. The mean value for total (all the items), which is 2.73, should have reached at least 3.00 that is the value for 'agree'. Or else one can argue most teachers are in a state of confusion regarding the issues as 4.29% of them also rated 'undecided'. This indicates as they lack solid philosophical and epistemological bases to teach science to their students. The findings of item number4.9 indicated that none of the respondents have heard about or known constructivism or constructivist strategies.

Table 12. Frequency Distribution of the Application of Elements of Constructivist Strategies in the Upper- primary Science Classrooms

Item. No	Rating Scale With value										Total ∑vxf	$\bar{X} = \frac{\sum vxf}{N}$
	0=Never		1=Rarely		2=some times		3=frequently		4 = Always			
	F	%	F	%	F	%	F	%	F	%		
3.1	-	-	1	2.77	7	19.44	22	61.11	7	19.44	109	3.02
3.2	-	-	2	5	3	7.5	20	50	15	37.5	128	3.2
3.3	4	10	6	15	20	50	7	17.5	3	7.5	79	1.97
3.4	14	33.33	9	21.42	15	35.71	4	9.52	-	-	51	1.21
3.5	3	7.31	8	19.51	12	29.26	10	24.39	8	19.51	94	2.29
3.6	7	16.66	8	19.04	15	35.71	8	19.04	4	9.52	78	1.85
3.7	2	4.87	7	17.07	17	41.46	10	24.39	5	12.19	91	2.21
3.8	3	7.5	4	10	18	45	7	17.5	8	20	93	2.32
3.9	5	11.62	14	32.55	10	23.25	11	25.58	3	6.9	79	1.83
3.10	-	-	3	8.33	11	30.55	12	33.33	10	27.77	101	2.8
3.11	7	17.94	6	15.38	19	48.71	5	12.82	2	5.12	67	1.71
Total	45	10.22	68	15.45	147	33.4	116	26.36	65	14.77	970	2.2

In table 12, Item number 3.1 which is about how often do you assess your students' prior experiences or current knowledge by asking questions, providing analogies, examples or any other means, the teachers response is rarely (2.77%), sometimes (19.44%), frequently (61. 11%) and always (19.44%). The mean value (3.02) is almost equal to the value for 'frequently'. Item number 3.2 which is about how often do you relate your lesson to the already taught/learned lessons has got the mean value of 3.2 which even exceeds the value for 'frequently'. This is again in agreement with that traditionally teachers start their teaching by revising what is learnt in their last periods. When we see item number 3.3, i.e. 'how often do you use the processes of science in your lessons?' the response shows 10% (never) 15% (rarely) and 50% (sometimes) and the mean value for this item is 1.97, which is below the value for 'sometimes'. This indicates that science is not done by most students /classes. Students are taught facts (or information) from the textbook or the teacher.

Item 3.4 that is about how often do you organize your students in to groups so that they can discuss, argue ideas or results from experiments also supported this finding. 33.33% of the teachers are not involving their students in such activity and 21.42% of the teachers only rarely involve their students. The mean value (1.21) for the item, in general, indicated students almost rarely involve in such activities.

The analysis of the data for items 3.6, 3.9, and 3.11 which are about: how often do you encourage your students to discuss, argue on ideas or negotiate on findings with one another, how often do you engage your students in open-ended activities (Item no 4.3), and how often do you use other evaluation/assessment mechanisms other than paper and pencil tests respectively supported this finding. The mean values for these items as indicated are 1.85, 1.83, and 1.71 respectively. These show that the application of the strategies is only some times or rare. This is again consistent with the findings of the classroom observation.

One the other hand, Item. Numbers 3.7, 3.8, 3,10 which are about: how often they provide or suggest opportunities for the application of learning, how often they relate students' activities or tasks to their tasks / activities at home or in the society, and how often they make effort so that their students can get unified learning, respectively indicated there are uses of elements of constructivist strategies sometimes and also frequently. The mean values calculated for these items are 2.21, 2.3.2, 2.8, respectively.

In general, the total mean value (2.2) and also the total percentages for each i.e. never (10.22), rarely (15.45), sometimes (33.4), frequently (26.36) and always (14.77) indicate that large percentage (about 50%) of the respondents used the strategies rarely and sometimes. And about 10% of them do not use them at all.

Table 13 - Percentage Distribution of the Most Serious Factors Affecting the Use of Elements of Constructivist Strategies such as the Use of the Processes of Science, Explorations and Discussions in the Science Classrooms.

No	Factor	f	%
4.1.1	Student lack of interest	21	51.2
4.1.2	Teachers lack of interest	4	10
4.1.3	Teacher education and Training components do not promote this	11	26.19
4.1.4	Lack of resources (Teaching aids)	22	55
4.1.5	The textbook/the curriculum	21	50
4.1.6	Lack of administrative support	8	20
4.1.7	Students are less interactive & are not willing to cooperate.	8	20
4.1.8	Rigidity of time table	1	2.56
4.1.9	The nature of tests and examinations	2	5.12
4.1.10	Lack of reward to students after involving in the process skills.	-	-
4.1.11	The Classroom size/large no of students in one class	24	60
4.1.12	In availability of facilities such as the laboratories	33	76.74
4.1.13	Students beliefs about teaching and learning	13	31.7
4.1.14	Teachers beliefs and attitudes about teaching and learning	7	17.07
4.1.15	Classroom environment not conducive.	25	62.5
4.1.16	Diversity of students interests	1	2.56
4.1.17	Lack of materials in the field or in the community.	9	24.32
4.1.18	Some Students dominance during group activities	_	_

Table 13 indicates the six most serious (key factors) affecting the use of these strategies such as the use of the processes of science, explorations and discussions in upper-primary science classrooms. The factors are selected because large percentage (more than 50%) of the respondents rated each of them as most serious and also the percentage calculated in all cases exceeded the respective percentages calculated for other scales showing that most of the respondents rated the factors as most serious. These factors according to their rank are:

1 The in availability of facilities such as the laboratories ----------76.74%

2 Classroom environment not conducive ---------------------------- 2.5%

3 The Classroom size /large number of students in one class----60%

4 Lack of resources (Teaching aids)-----------------------------------55%

5 Students lack of interest --51.2%

6 The textbook/ the curriculum --50%

There is no question that science laboratories are very crucial for effective science teaching at any level. Without them the teaching of science will face difficulties. This seems the case encountered the teaching of science in the upper-primary schools in Addis Ababa government schools. 76.74% of the respondent teachers responded that the lack of facilities such as the laboratories are most seriously affecting the use of the processes of science, explorations, and discussions in the teaching and learning process. In the laboratories students not only acquire scientific knowledge and skills but also scientific attitudes. In the schools where there are no science laboratories one can think the kind of attitudes, beliefs and expectations the students have to the teaching and learning of science. The researchers' observations of the school conditions have also witnessed the problem and its extent. In most of the schools, there are no science laboratories.

For the application of elements of constructivist strategies in science classrooms, in addition to the laboratories, the classroom environment should also be as conducive as possible. The seating arrangement of students, the tables and desks of the students, for instance, are very crucial in this respect. However, in the classrooms observed the seating arrangement of the students is very traditional (all students facing the board). It is also impossible to move the tables and desks of the students from place to place as the classrooms are very narrow and also overcrowded. In addition to the physical environment, the social environment is also equally important in this respect.

Again, it is no wonder that students lack of interest to learn science is indicated as one of the major problems. The findings of classroom observation and also the analysis of the questionnaire indicated it is rare that students involve in the processes of science and, explorations. It is also revealed that it is rare that students involve in discussions arguments on ideas, principles, etc. in their classroom. Under such situations, thus, it is very much difficult to expect interest in students.

The textbook/the curriculum is also mentioned as one of the most seriously affecting factors for the use of processes of science, explorations and discussions in the science classrooms. This can put under question many aspects of the curriculum. For instance, the organization of the curriculum, the scope of the curriculum and the selection of experiences for the learners above all could be the major problems in this regard.

The average number of students in one classroom is found to be the third most serious factor affecting the use of the processes of science, explorations and discussions. It is so hard to teach science to this large number of students (with average 75.69) in a very narrow and suffocated classroom. In addition to these, student disciplines, lack of incentives to teachers, were also mentioned by the respondents as the most serious factors.

Table 14. Percentage Distribution of the Most Serious Factors Affecting the Use of Authentic and Open-ended Student's Tasks / Activities in The Science Classrooms

No	Factor	f	%
4.3.1	The design of text book/ the curriculum	20	50
4.3.2	Students lack of interest	20	47.6
4.3.3	Teachers lack of interest	4	10.25
4.3.4	Teacher education and training components do not promote this	8	20.51
4.3.5	Lack of resources (teaching aids)	24	58.53
4.3.6	Lack of school facilities such as the laboratories.	32	80
4.3.7	Large number of students in one class	28	68.29
4.3.8	Students beliefs and attitudes about teaching and learning	16	38.09
4.3.9	Teacher's beliefs and attitudes about teaching and learning.	7	17.94
4.3.10	Rigidity of time table	1	2.32
4.3.11	Lack of administrative support	5	12.82
4.3.12	Lack of relevant material in the community or in the field	7	17.5
4.3.13	The nature of tests & examinations	4	10
4.3.14	Student diversities	1	2.5

Table 14 indicates the five most serious (key) factors affecting the use of authentic and open-ended students' tasks/ activities in the upper science classrooms. The selection of the factors is done in a similar way as it is done above. These are according to their rank:

1 Lack of school facilities such as the laboratories -----------------80%

2 Large number of students in one class --------------------------- 68.29%

3 Lack of resources (teaching aids) ---------------------------------58.53%

4 The design of the textbook / the curriculum -----------------------50%

5 Students lack of interest --47.6%

The findings for item 4.2, has also shown that the most serious factors affecting the use of authentic (realistic) and open-ended activities /tasks in the upper-primary classrooms are found to be very similar to the findings for item 4.1 except the rank in few cases. It is also an indication for the reliability of the data. The problems mentioned also seem to be the most serious problems to the teaching and learning of science at the level in general.

Thus, the analysis of data obtained through questionnaire have shown that the most serious factors affecting the application of elements of constructivist strategies are the in availability of facilities such as the laboratories and resources, the classroom conditions in general and large number of students in one class, students lack of interest and the textbook/the curriculum.

Table 15 - Frequency Distribution of Responses Regarding the Students' Activities in Relation to Open-ended ness and Close-ended ness

Item No	Rating Scale with values				Total $\sum vxf$	$\bar{X} = \frac{\sum Vxf}{N}$
	0 = close- ended		1 = open-ended			
	f	%	f	%		
4.5	35	87.5	5	12.5	5	0.125
4.6	26	65	14	35	14	0.35

Item number 4.5 (Table 15) was about the kind of activities/ task most of the time the teachers are involving their students in their classrooms. The analysis in dictated 87.5% of the respondents involve their students in close-ended activities and only 12.5% of them involved their students in open-ended activities most of the time. The mean value (0.125) for the item is almost '0' indicating that the students are involved in close-ended activities most of the time. The cause for this can be implied from the analysis of item number 4.6.

Item number 4.6 in the above table is about what kind of activities are suggested in the student textbooks. The analysis has shown that 65% of the respondent teachers (with mean value 0.35) responded that the suggested student activities in the student textbooks are close-ended. This is dangerous to science teaching as the teachers also use the textbooks as a very important resource to their teaching.

Thus, from the analysis of the above item (4.5 and 4.6 one can argue that the activity (when ever they exist) that the students are involved much of their time are close-ended.

Table 16 - Frequency Distribution of the Authenticity of Students' Activities

Item No	Rating Scale with values						Total $\sum vxf$	$\bar{X} = \frac{\sum Vxf}{N}$
	0 = unrelated		1 = related		2 = very much related			
	f	%	f	%	f	%		
4.7	13	32.5	20	50	7	17.5	34	0.85

Item 4.7 (Table -16) was about the extent of authenticity (relatedness to real life) of the activities the students are involved much of their time. The analysis indicated that the student activities are related to real life situations with mean value of 0.85. One can see although the percentage for 'related' is 50%, the mean value is still below the value for 'related'. It has also indicated that the students' activities are not very well related to the existing real life situations. This can also be another cause for the lack of interest in students in learning science. It also indicated that as a constructivist strategy it is not well applied.

Table 17 - Frequency Distribution of the Responses Regarding the Interest of Students to Elements of Constructivist Strategies During the Teaching and Learning Process

Item No	Rating scale with Values						Total $\sum vxf$	$X = \frac{\sum vxf}{N}$
	0= Not Interested		1 = In terested		2 = very Interested			
	f	%	f	%	f	%		
4.8	19	47.5	16	40	5	12.5	26	0.65

Item number 4.8 was designed because during the pilot study student lack of interest was significantly rated by the respondents. Thus, this initiated the researcher to design a separate item regarding this. Just as it was repeatedly rated as the most serious factor affecting the use of elements of constructivist strategies, the analysis of this item is also consistent with the findings. Almost half (47.5%) of the respondents responded that students are not interested.

Table 18 - Frequency Distribution of the Attitudes of Teachers to Elements of Constructivist Strategies

Item No.	Rating scale with Values								Total $\sum vxf$	$\bar{X} = \frac{\sum Vxf}{N}$
	3 = very much useful		2= useful		1= Not useful		0 = neutral			
	f	%	f	%	f	%	f	%		
5.1	35	87.5	4	10	1	2.5	-	-	114	2.85
5.2	24	60	15	37.5	1	2.5	-	-	103	2.57
5.3	27	67.5	13	32.5	-	-	-	-	107	2.67
5.4	31	77.5	7	17.5	2	5	-	-	109	2.72
5.5	31	77.5	8	20	1	2.5	-	-	110	2.75
5.6	28	70	12	30	-	-	-	-	108	2.7
5.7	30	75	9	22.5	-	-	-	-	108	2.7
5.8	31	77.5	7	17.5	2	5	-	-	109	2.72
5.9	26	65	13	32.5	-	-	1	2.5	104	2.6
5.10	25	62.5	15	37.5	-	-	-	-	105	2.62
5.11	28	70	11	27.5	1	2.5	-	-	107	2.67
5.12	23	57.5	16	40	1	2.5	-	-	102	2.55
Total	339	70.7	130	27.13	9	1.87	1	0.2	1286	2.68

Item No. 5 was designed to answer one of the major questions of this study. It was designed to assess the attitudes of the upper primary science teachers towards elements of constructivist strategies to the teaching and learning of science. The analysis (Table 18) has shown that the responses for all the items are significantly greater for ' very much useful '. Thus, although lack of necessary knowledge base was found in the analysis of item number 2.1 (Table 11), it can be said that the teachers are very well convinced on the importance of elements of constructivist strategies to their lessons. The total mean value for all the items calculated is 2.68 which is nearly the value for" very much useful". This the researcher believes is a very good resource for the improvement of science teaching in the future if other necessary conditions such as training is given to teachers and facilities are provided to the schools.

4.3. Presentation And Analysis of Data Gathered Through Interview

The analysis of data gathered through interview has also shown results consistent with the findings from observation and also questionnaire. It has also signified that teachers' behaviors and practices in teaching are very traditional type.

Item number 2, for instance, asks about the strategies the teachers use most of the time to introduce their lessons. For this, the teachers responded that the very common strategies used are revising the already taught lessons (which is consistent with the finding in item 2.2), asking questions about the topic to be taught and sometimes through demonstrations of simple experiments.

The researcher elicited further responses if they might have taken care for students' prior conceptions about the specific content to be learned. But it was concluded that there are no deliberate efforts done in this regard. There is no again deliberate effort that is done to guide/ help students in their constructions of meanings through involving in the processes of science and discussions, arguments, debates, etc., on ideas, concepts, etc. a part from giving their elaborations, descriptions on the specific contents, solving exercises, giving notes, answering students questions, etc. And some times demonstrating simple experiments. There are no deliberate efforts that are done to organize students into groups to encourage group works and group discussions. The evaluation/ assignment mechanisms they used other than objective tests are class works, home works and asking questions.

Item number 7 asks about the competency (knowledge, skill and attitude) of the upper primary science teachers in teaching science at the level. They mentioned that because most of the teachers are diploma holders, they feel they are competent. However they didn't fail to mention some teachers are assigned with low qualification and also teach the subjects they didn't major.

In Item number 8, the major problems that are hindrances to the teaching and learning problem in the upper-primary school sciences were asked. This, again, has shown that the lack of laboratory and resources, the student lack of interest, the large number of students in one class and large material to be covered (i.e. the curriculum) were mentioned as the major problems.

To further see whether the teachers have the necessary knowledge base about elements of constructivist strategies to the teaching and learning of science, item number 9 was prepared and interviewed. The teachers mentioned that the specific contents can be best taught to the students if laboratory equipments are supplied to them and they do the activities suggested in the textbook with their students. However, the importance of activation of prior experience and current knowledge and understandings; the involvement of students in group activities, discussions; the making of students activities realistic, open-ended; etc. were not clearly pointed out by any of them. Constructivists, however, give equal place, for they do not just appreciate student's involvement in the processes of science only to solve the problems in the teaching and learning of science.

However, the respondent teachers were repeatedly mentioning the involvement of the teacher and the students in doing experiments for successful science program. The researcher appreciates that the teachers emphasized on experiments to the teaching and learning of science. However, emphasizing experiments only to the teaching and learning of science, which is also common argument proposed by any layman to science education, indicates that the teachers are guided by the empiricist epistemologies than constructivist ideals. Thus, it can be said without hesitation that the teachers lack the necessary knowledge base to use elements of constructivists' strategies in their classrooms.

CHAPTER FIVE

5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 SUMMARY

The main objective of the study was to assess the application of elements of constructivist strategies in the upper-primary school sciences. In the study it was intended to answer the following research questions.

1. To what extent are elements of constructivist strategies used in the teaching of upper-primary school sciences?
2. Do upper-primary school science teachers have the necessary knowledge base and attitude to teach using elements of constructivist strategies?
3. What are the key factors that hinder the use of elements of constructivist strategies in the teaching of upper-primary school sciences?

In order to get the relevant data three data gathering instruments were used: observation, questionnaire and interview. The sources of data were grade seven science teachers and their classrooms. From among the total population of the teachers and their classrooms, 12 teachers were observed while they were teaching and 48 teachers filled questionnaire. In addition, 4 teachers were interviewed. Accordingly, the following results were obtained.

5.1.1 Regarding the knowledge base of the teachers about elements of constructivist strategies, the summary of the analysis of items related to this indicated the following figure. 8.78%, 21.09%, 41.01%, 24.8% of the respondents strongly disagreed, disagreed, agreed and strongly agreed respectively. The total mean value calculated which is 2.73 has shown that it is below the value for 'agree,' showing that there is lack of knowledge regarding the issues.

5.1.2 The importance of elements of constructivist strategies to the teaching and learning process in science classrooms is very much accepted by the teachers. While 70.7% of the teachers responded, as they are very much useful, 27.13% responded, as it is useful. In other way, almost 98% of the teachers have indicated their acceptance of the strategies.

5.1.3 Regarding the application of elements of constructivist strategies, the analysis of the items of the questionnaire came out with the following results. Where as about 50% of the teachers apply sometimes and rarely, only 40% of them applied them frequently and always, and about 10% of them do not apply them at all in their classrooms. The extent of application of the strategies is also indicated by the analysis of the items for observation. 5.83% of the teachers applied it very well, 28.33% applied it moderately and 36.66% of the teachers do not apply it at all.

5.1.4 The following factors are also found affecting most seriously the use of elements of constructivist strategies such as the use of the processes of science, explorations and discussions and the making of students activities authentic and open-ended. These are: the lack of facilities such as the laboratories and laboratory resources, the classroom conditions in general, the large number of students in one class, the student's lack of interest and the textbook/the curriculum.

5.2 CONCLUSIONS

The relevance of constructivist strategies to the teaching and learning processes of science is widely accepted. It is also discussed for many of its advantages to the learners. The students learn not only the facts or information in science. But also understand the essence of science and how it is done. On the other hand, the teaching of science which is not informed with constructivist ideas, principles, strategies, etc. have got so many crises and abuses. Under such situations, for instance, it is very unlikely to expect students to identify and solve problems, to observe and think critically about things, ideas, phenomena, etc. Therefore, the use of constructivist strategies in teaching science lessons should be the usual practice in the science classrooms.

The purpose of this study, as it is repeatedly mentioned, was to assess the application of elements of these strategies to the teaching of science in the upper-primary schools in Addis Ababa. Based on the major findings of the study, in general, the following major points can be said safely.

5.2.1 The upper-primary science teachers are found to lack the necessary knowledge base to use elements of constructivist strategies in their lessons. In general, they seem to lack solid philosophical and learning theory basis to teach science to their students.

5.2.2 The elements of constructivist strategies are only rarely (or sometimes) applied in the teaching and learning processes in the upper-primary school science classrooms. Yet, they are not applied very well.

5.2.3 Although the lack of necessary knowledge base was revealed, the upper primary science teachers are very much convinced about the importance of elements of constructivist strategies to the teaching and learning processes in their lessons. Thus, it can be said that the upper-primary science teachers have the necessary attitude to use elements of constructivist strategies.

5.2.4 Regarding the key factors hindering the use of elements of constructivist strategies, the following are found to be the most serious one.

i. Lack of facilities such as the laboratories and other instructional resources.
ii. Classroom conditions not conducive and large number of students in one class.
iii. Student's lack of interest.
iv. The textbook/the curriculum.

5.3 Recommendations

Finally, based on the findings of this study, the researcher would like to forward the following recommendations for the improvement of the teaching and learning of science in general, and the upper-primary science, in particular.

5.3.1 An urgent in service training (through workshops, small scale training, etc) should be given to upper-primary science teachers on the philosophy, assumptions and recent models of science teaching and learning in general and on the constructivist strategies, in particular. Teacher education and training programs at colleges/universities should also emphasize on training their teachers based on such current models of learning.

5.3.2 The upper-primary science teachers (or any teacher for that matter) can easily incorporate elements of constructivist strategies into their usual practice easily by using the following strategies/techniques.

i. Emphasizing on pre-assessment of what their students know about the specific content they are going to teach;
ii. Emphasizing on group work/co-operative learning;
iii. Assigning open-ended activities to their students through home works and also through either individual/ group projects;
iv. Emphasizing on use of local resources/materials and drawing out problems, examples from real-life situations;

v. And, gradually encouraging and developing students responsibility for their own learning (planning, doing, assessing, etc), etc.

5.3.3 As it is very difficult to teach science in the absence of laboratories and other facilities, resources and also in a very crowded classroom, the stakeholders the government and also the general public should seriously think upon how to curve the problems related to this.

5.3.4 Science teaching should focus on the development of knowledge, attitude and skills (KAS) of the learners. It should not focus on transmission of facts, information, etc. As developing students interest in science particularly is unthinkable by doing so.

5.3.5 The researcher is very much pessimistic about the textbook/the curriculum designers knowledge on the importance of developing the curriculum by incorporating elements of constructivist principles. Thus, the textbook designers should take serious considerations particularly during the design of the student textbooks,.

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APPENDIX A

List of Sample Schools

Zone	Name of School	Number of grade seven science teachers in subject			Total
		Biology	Chemistry	Physics	
1	Dej. Balcha Aba Nefso	2	2	2	6
	Tesfa Kokeb	3	3	3	9
	Yekatit 23	2	2	2	6
4	Eth. Tikdem Primary School	1	1	1	3
	Dil Betigil	1	1	1	3
	Mekane Hiwot	2	2	1	5
	Miazia 23	2	2	2	6
	Biherawiy Bete Mengest	1	1	1	3
	Dagmawi Menilik Primary	1	1	1	3
	Ureal	1	1	1	3
	Kokebe Tsibah Primary	2	2	2	6
Total	Total number of schools =11	18	18	17	53

APPENDIX B

Distribution of Observed Teachers by zone, School and Subject

Zone	School	Number of Teachers in Subject			Sex distribution		Total
		Biology	Chemistry	Physics	M	F	
1	Tesfa Kokeb	1	2	2	1	4	5
4	Ethiopia Tikedem	1	1	1	3	-	3
	Miazia 23	2	1	1	3	1	4
Total	Total Number of Schools = 3	4	4	4	7	5	12

APPENDIX C

Specific Lessons Observed in subject

Subject	Specific Contents
Biology	1. Mosses (2 times) 2. Lichens 3. Fungi
Chemistry	4. Chemical formula (2 times) 5. Qualitative and Quantitative Significance of symbols and chemical formula (2 times)
Physics	6. Concepts of Temperature (2 times) 7. Effects of heating (2 times)

APPENDIX D

Classroom Observation Check List

Category	Sub Category	Applied very well	Moderately Applied	Not at all applied	Not applicable
1. Invitation (Activation of prior experiences and current knowledge)	1.1.Students are given opportunity to think about the specific topic to be learned				
	1.2. Students' alternative conceptions/ multiple conceptions are identified or assessed				
	1.3.The lesson is related to already taught/ learned lessons				
2. Exploration and proposing explanations and solutions.	2.1 Students are involved in either group or independent experimentation, exploration and the process skills in science				
	2.2. Students are involved in discussions, arguments or debates on ideas or procedures or principles in the lessons.				
	2.3 Students are engaged in discussions or negotiations on solutions or findings from experiments by reviewing or critiquing the findings of their peers.				
3. Taking action	3.1. Students make decisions on ideas or on results or solutions from experiments or explorations				
	3.2. Students are provided with opportunities for the application of what is learned /opportunities for application of learning are suggested.				
4.The nature of students' activities/ tasks	4.1. The students' activities/ tasks are authentic				
	4.2. The students' activities/ tasks are open-ended				

APPENDIX E

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
Department of Curriculum and Instruction

QUESTIONNAIRE TO BE FILLED BY SELECTED GRADE SEVEN SCIENCE TEACHERS

Objective - The Purpose of this Questionnaire is to gather information on the application of elements of constructivist strategies in the teaching and learning processes of the upper primary school sciences. Since the reliability of the information depends on the objectivity of your responses, you are kindly requested to be as frank and honest as possible.

Direction:- 1. Writing name is not necessary

2. Please provide your responses either by writing in your own statements or putting the mark '✓' corresponding to your choice in the box provided in front of the questions.

3. Please read the additional information provided on a separate sheet of paper attached that may help you understand better some of the items of the questionnaire

4. If you may not understand an item, please leave the item unchecked

I. Personal Data

1. Sex ______________________________
2. Age ______________________________
3. Level of Education ___________________

   Major____________
   Minor ____________
4. Years of service in teaching _____________
5. Years of teaching grade seven

   Science _______________________________
6. Total teaching load per week at present _________
7. Average number of Students in Classes you are teaching at present _________________________

II. **Please provide responses appropriately for the following issues in teaching and learning based on your understandings. Your responses could vary from 'strongly agree' to 'strongly disagree' and give your responses by ticking the mark '✓' to the corresponding issues.**

No	Issues	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
2.1.	New learning depends on current understanding					
2.2.	Learners come to school with a wealth of prior knowledge					
2.3.	Learners should get unified or integrated learning.					
2.4.	Learning is facilitated by social interaction.					
2.5.	Learning is an active process in which the learner actively constructs meanings.					
2.6.	Knowledge should not be seen as it is transmitted from the teacher or text book to the learner.					
2.7.	Learning should be directed by the learner.					
2.8.	In the teaching and learning process teachers should serve the role of facilitators or guide.					
2.9.	Learning should take place in a meaningful context					
2.10.	Students may/may not arrive at the same understandings of the concepts taught					
2.11.	Students should be provided with opportunities to process & apply learning					
2.12.	Students experiences in schools should be very related to the students experiences at home and in the society					
2.13.	Evaluation /assessment should be integrated with teaching at every stage, and should not be only through paper and pencil tests.					

III. **The following questions assess the extent of application of the following strategies/ techniques in your classroom. Please provide appropriate responses by ticking the mark '✓' to the corresponding items.**

No	Items	Never	Rarely	Sometimes	Frequently	Always
3.1	How often do you assess your students' prior experiences or current knowledge by asking questions, providing analogies, examples or other means?					
3.2	How often do you relate your lesson to the already taught / learned lessons					
3.3	How often do you use the processes of science in your lessons?					
3.4	How often do you organize your students in to groups so that they can discuss, argue on ideas or results from experiments?					
3.5	How often do you encourage your students to discuss, argue, question in your classroom lessons?					
3.6	How often do you encourage your students to discuss, argue on ideas or negotiate on findings with one another?					
3.7	How often do you provide or suggest opportunities for the application of learning?					
3.8	How often do you relate students' activities or tasks to their tasks/activities at home or in the society?					
3.9	How often do you engage your students in open-ended activities?					
3.10	How often do you make effort so that your students can get unified learning?					
3.11	How often do you use other evaluation/ assessment mechanisms other than paper and pencil tests?					

IV. **Please give your responses for the following items.**

4. 1. In your classroom lessons it may be very difficult to actively involve your students in the processes of science and also actively involve in explorations, discussions because of many factors. Please rate the following factors from 'most serious' to 'not serious' and give your responses by ticking the mark '✓ ' to the corresponding factors. If the factor does not apply in you case, rate 'Not Applicable'

No	Factor	Most Serious	Serious	Not Serious	Not Applicable
4.1.1	Student lack of interest				
4.1.2	Teachers lack of interest				
4.1.3	Teacher education and Training components do not promote this				
4.1.4	Lack of resources (Teaching aids)				
4.1.5	The textbook/the curriculum				
4.1.6	Lack of administrative support				
4.1.7	Students are less interactive and are not willing to cooperate.				
4.1.8	Rigidity of time table				
4.1.9	The nature of tests and examinations				
4.1.10	Lack of reward to students after involving in the process skills.				
4.1.11	The Classroom size/large no of students in one class				
4.1.12	In availability of facilities such as the laboratories				
4.1.13	Students beliefs about teaching & learning				
4.1.14	Teachers beliefs and attitudes about teaching and learning				
4.1.15	Classroom environment not conducive.				
4.1.16	Diversity of students interests.				
4.1.17	Lack of materials in the field or in the community.				
4.1.18	Some Students dominance during group activities				

4.2. A part from the factors mentioned, please list the factors that you think are most seriously hindering the application of the strategies /techniques mentioned in question '4.1' above.

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4.3. In your classroom lessons, it could be very difficult for you to make the students' activities in your classroom authentic and also open-ended because of many factors. Please rate the following factors from 'most serious' to 'not serious' and give your responses by ticking the mark '✓ ' to the corresponding factors. If the factor does not apply in your case, rate, 'Not Applicable'

No	Factor	Most serious	Serious	Not Serious	Not Applicable
4.3.1	The design of text book/ the curriculum				
4.3.2	Students lack of interest				
4.3.3	Teachers lack of interest				
4.3.4	Teacher education and training components do not promote this				
4.3.5	Lack of resources (teaching aids)				
4.3.6	Lack of school facilities such as the laboratories.				
4.3.7	Large number of students in one class				
4.3.8	Students beliefs and attitudes about teaching and learning				
4.3.9	Teacher's beliefs and attitudes about teaching and learning.				
4.3.10	Rigidity of time table				
4.3.11	Lack of administrative support				
4.3.12	Lack of relevant material in the community or in the field				
4.3.13	The nature of tests & examinations				
4.3.14	Student diversities				

4.4. A part from the factors mentioned, please list the factors that you think are most seriously hindering the application of the strategies /techniques mentioned in question '4 -2' above.

4.5. What kind of activities / tasks are your students involved much of their time?

1. Open -ended ☐ 2. Closed ended ☐

4.6. How do you see the suggested student activities in the student's textbooks in terms of open-endedness and close-endedness most of the time?

1. Open -ended ☐ 2. Closed ended ☐

4.7. What do you feel about the student activities in the science lessons you are teaching in terms of their relatedness with real-life situations and real problems of the student and the society?

1. Very much related ☐
2. Related ☐
3. Unrelated ☐

4.8. How do you rate your students interest in learning science through the process skills in science and also through involving in discussions, arguments, debates on ideas and solutions or findings from activities?

1. Very interested ☐
2. Interested ☐
3. Not interested ☐

4.9. Have you heard anything about constructivism or constructivist strategies in the teaching of science in the teacher education or training program or from any other source?

1. Yes ☐

2. No ☐

4.10. If your response for '4.9' above is 'yes', would you please briefly describe your knowledge about it and your attitudes towards it ?

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V. **Please rate the following items from 'very much useful' to 'Not useful' based on your feelings for the items.**

No	Item	Very much useful	Useful	Not useful	Neutral
5.1	Activating students' prior experiences and current knowledge when introducing lessons.				
5.2	Assessing students' prior experiences and multiple responses or alternative conceptions when introducing concepts (or lessons).				
5.3	Entertaining students' multiple responses, questions, ideas, etc,				
5.4	Relating teaching / learning to what is already taught / learned				
5.5	Involvement of student's in discussions or arguments with their teacher.				
5.6	Involvement of students in discussions or arguments among themselves.				
5.7	Involvement of students in group activities				
5.8	Guiding students in the process skills either in the laboratory or in the field.				
5.9	Relating student's experiences to their experiences in real life.				
5.10	Providing or suggesting opportunities for students for the application of learning.				
5.11	Engaging students in open-ended activities.				
5.12	Integrating evaluation and assessment with teaching at every stage.				

APPENDIX F

Items For The Interview

1. Would you please tell me briefly the strategies you most of the time use to teach the concept, laws or specific contents in your lessons.
2. When you introduce your lessons, what common strategies do you use?
3. How do you help / guide your students in their understandings or constructions of the meanings of the concepts, laws or specific contents in your lessons ?
4. How do you usually organize your students to foster the teaching and learning processes ?
5. Apart from giving tests and examinations, how do you check / know your students understandings of the concepts, laws or specific contents you teach?
6. What efforts do you make to relate students' experiences at school with their experiences at home or in their environment and to the real problems of the students and the society?
7. How do you judge the competency of upper primary science teachers in your school in their knowledge, skills and attitudes to teach science by way of actively involving students in the teaching and learning processes?
8. From your experiences what major problems do you think are hindrances to make the teaching and learning process in science active and also interactive?
9. How do you think students' best learn the concepts, laws or specific contents in science?
10. How do you think the teaching and learning processes of science in your school can be improved?

Appendix G

The Constructivist Learning Model (CLM) (By Yager, 1991 in Gega and Peters 1998:48)

Invitation - Observe surroundings for points of curiosity
Ask questions
Consider possible responses to questions
Identify situations where student perceptions vary

Exploration - Engage in focused play
Brainstorm possible alternatives
Look for information
Experiment with materials
Observe specific phenomena
Design a model
Collect and organize data
Employ problem-solving strategies
Select appropriate resources
Discuss solutions with others
Design and Conduct experiments
Evaluate choices
Engage in debate
Identify risks and consequences
Develop parameters of an investigation
Analyse data

Proposing Explanations and Solutions
Communication information and ideas
Construct and explain a model
Construct a new explanation
Utilize peer evaluation
Review and critique solutions
Assemble multiple answers/solutions
Determine appropriate closure
Integrate a solution with existing knowledge and experiences

Taking Action -Make decisions
Apply knowledge and skills
Transfer knowledge and skills
Share information and ideas
Ask new questions
Develop products and promote ideas
Use models and ideas to elicit discussions and acceptance by others

Appendix H

Steps Toward A Constructivist Approach to Teaching (By Dobey, Beichner and Raimondi, 1999:30)

1. Teacher presents an invitation to learn.
2. Teacher gives students the opportunity to explore, discover, and create.
3. Students propose explanations and solutions.
4. Students take action on what they have learned.

Tsai (1998:32-42) presents eight assertions on the relationship between science learning and constructivism. According to him, science teaching and learning should involve constructivism because of his assertions below. In other way, the assertions justify the use of these strategies for successful science teaching. These are:

- Observation is theory laden,
- Theories (or paradigms) are retained even when encountering apparently falsifying observations or anomalies,
- Scientific knowledge progresses through a series of revolutions or paradigm shifts,
- The scientific theories between two (or more) paradigms are incommensurable,
- Scientific knowledge does not represent the reality and its status is always tentative; Science is invented by humans, imaginative acts of abstractions,
- Scientific knowledge comes from a series of criticism, validation, consensus and social negotiation in the scientific community,
- There is no certain " scientific method" and there is not only one-way to interpret the same natural phenomena,
- Scientific knowledge is the product of a complex social, historical, cultural and psychological activity.

Thus, the teaching and learning of science has no other option but to base itself on the use of these strategies.

Some of the advantages of constructivism in the teaching and learning of science are discussed as in the following (Watts, 1994:56). Constructivism:

- Provide opportunities to explore and elaborate pupils' naïve and developing understandings of science;
- Promote active learning and 'actionable' learning where pupils must put their understandings to practice and use their knowledge;
- Engender shared teamwork and collaborative group activity within an overall social context;
- Work through the use of open-ended investigations, where there are few "right answers" and approaches to any solution where pluralism rules;
- Make science relevant, enjoyable, fruitful, plausible and highly motivating.

Scott et al. (1994:201), pointing out that the constructivist perspective on learning science asserts that learners interpret and interact with the physical world through their conceptualizations of phenomena, argue "From teaching point of view, the question, which arises, is how to organize the physical and social experiences in a science classroom so as to encourage development or change in learners conceptions from their informal ideas to those of accepted school science."

Tsai (1998) presented the summary of his research works and the contribution of other researchers work (Brooks and Brooks, 1993; Duschl and Gitomer, 1991; Rowell, 1989; Vosniadou and Brewer, 1987) that contrasts the empiricist (traditional) epistemology and constructivist epistemology for science education using the following criteria in the following table.

	Empiricist Epistemology	Constructivist Epistemology
Purpose of knowing (for students)	Accumulating a collection of facts	Coping with experiences, relating to prior knowledge
Role of learner	Blank slate onto which information is etached by the teacher Low student input, low student reflection, non active	Thinker with emerging theories about the world. High student input, high student reflection, active scientific meanings negotiated.
Role of teacher	Dissemination of scientific knowledge Lecture presenter or controller to cover science content Strict adherence to prescribed curriculum	Facilitator of students' knowledge construction of science Agent provocateur to trigger students' operation of equilibration Modify and adapt prescribed curriculum
Teaching strategies	Didactic instruction (textbooks, workbooks, lectures) Students primarily work alone Seeking the correct answer to validate students' learning through quantitative assessment.	Socratic dialogues, interactive questioning, analogies, metaphors, and physical models. Students work cooperatively in small groups. Exploring students' in-depth thinking through qualitative assessment.
Goals of Science Curriculum	What we know-scientific knowledge Breadth of knowledge Basic scientific knowledge Curriculum units discrete	How and why we know knowledge about science. Depth of knowledge Contexualized scientific knowledge Curriculum units connected.

Table 1 - Source: Tsai (1998:51), Contrasting the empiricist (traditional) epistemology and constructivist epistemology for science education.

Metz (1991) in Tsai (1998), discusses briefly one consequence of using the empiricist (traditional) epistemology for the teaching and learning of science as "science teachers are teaching one way of knowing the physical world instead of the way of knowing it"(p.44). He further puts argument for the use of the constructivist views that science teachers need to shift their focus for helping students understand explanations expressed by textbooks, and scientists to finding ways to help students construct and revise their own explanations of the physical world through a process of apprenticeship.

2.3 Constructivist Strategies In Teaching And Learning Processes

In this section, constructivist strategies to teaching with suggestions on how to apply them in the teaching and learning processes of specific content areas in science are presented.

2.3.1 Activation Of Prior Experiences And Current Knowledge Of Learners

Classroom instruction from constructivist point of view should emphasize the use of students' prior experiences and should base on current knowledge of students. Upon stressing the importance of prior experiences to the learning process, Ausbel (1998) quoted in Novak and Gowin (1984: 40) argued " if I had to reduce all educational psychology to just one principle, I would say this: the most important single factor influencing learning is what the learner already knows. " Gega and Peters (1994: 172) also argued "the better we are able to relate a new information to what we already know, the easier it is to remember and use it. " Many other scholars also

Some educators have presented methods on how to activate the prior experiences and current knowledge of students. For instance, Good and Brophy (1997:401), after pointing out that activation of relevant background knowledge can make learning of new content easier and more efficient at least if the activated schemas are suited to the instructional goals, presented the following strategies for activating prior knowledge:

- Asking students related questions;
- Helping the students to activate relevant prior knowledge by drawing analogies or suggesting examples that link the new content to familiar ideas or experiences;
- By taking inventory of what students know (or think they know) about the topic before instruction;
- By asking questions that require student's to make predictions about the content or to suggest solutions to problems based on it.

For Lauritezen and Jaeger (1997: 75) "acknowledging that the learners come to school with an array of prior knowledge" is crucial to teach from the constructivist point of views. At this phase, the role of the teacher is that of analyzing and drawing upon the current state of knowledge of the learner. Woolfolk (1995) also stated that constructivist teachers inquire about student's understandings of concepts before sharing their own understandings of those concepts. To teach from constructivist perspectives, firstly, the existing view of the learners that is their alternative conceptions also need to be taken into consideration very seriously (Fensham, 1994a and Tsai, 1998).

2.3.2 Active Involvement Of Students In Meaning Construction

The active involvement of students in meaning construction is another very important constructivist strategy leading to the active construction of meanings by students. Many constructivists believe that the active involvement of students in meaning construction has individual and social categories. Students should involve in individual investigations and also in the social interaction in the classroom during the teaching and learning processes. Fensham (1994:22), for example, says "In the constructivist perspective, teaching becomes a set of events in which the learners are encouraged to engage their own minds actively with the observations of phenomena, with the descriptions and explanations their peers and their teachers provide for them."

Eggen and Kauchak (1997) discussing on the importance of the active involvement of learners in the learning process gives importance to formation of learning communities in the classrooms. They argue, " learning communities encourage students to take responsibility for their own learning through co-operative ventures" (p.277). The importance of dialogue in learning is also highly emphasized. The teachers in such situations assist learning by encouraging dialogue both teacher student and student- student. By doing so, the teacher allows learning to move from the external, socially shared level, to the individual, and internalized level (ibid). Socially shared ideas provide opportunities for students to rethink and reconstruct their internal ideas about the world. Through the process of shared enquiry, students analyze their own and others ideas as the students ideas about nature stem not from the logical processes of which science boasts, but from the common sense attitude that relies on being able to interchange perspectives and meanings with others (Solomon, 1987) in Cobern (1993a).

Good and Brophy (1997: 402) discussed that the social aspect of constructivism (or according to others, contextual constructivism) helps participants to advance their learning in several ways: -

- Expose to new inputs from others makes them aware of things that they did not know and leads to expansion of their cognitive structures,
- Expose to ideas that construct their own beliefs may cause them to examine those beliefs and perhaps restructure them, and
- The need to communicate their ideas to others forces them to articulate those ideas more clearly which sharpens their conceptions and often leads to recognition of new connections.

There are also evidences that co-operative learning results in motivation and academic achievement (Driver, et al, 1994; Slavin, 1986; Watson, 1991; Webb, 1982 in Hadzigeorgiou, 1997).

The guided inquiry methodology is also one of the strategies for good interaction between the teacher and students according to some scholars. Martin (1997) discusses the process oriented guided inquiry methodology as the agent of the constructivist science teaching and argues as it is the most appropriate way of teaching science to elementary children.

In the guided enquiry methodology, the teacher suggests open-ended activities which the children pursue to find out what they are able to find out, inquire into what they don't understand and develop their own conclusions as they construct their own conceptualizations. The children check their conclusions against further investigation to see if they possess validity, and they discuss their conclusions with one another and with the teacher to confirm validity or to embark on further investigation to develop revised conclusion and reconstructed conceptualizations.

Martin (1997:201) discusses the following characteristics of constructivist guided inquiry teaching in relation to the active involvement of students in the learning process in the following ways. It:

- Provides for hands-on learning; students handle materials,
- Asks open-ended, inquiry-oriented questions,
- Encourage children to ask questions,
- Encourage children to initiate ideas,
- Encourage children to investigate their own questions and ideas,
- Uses children's questions and responses to develop topic,

- Encourages the use of many sources of information, including printed material, multimedia and people,
- Avoids supplying answers or explanations,
- Encourages children to suggest causes for what they observe,
- Encourages children to discuss and challenge each others conceptualization,
- Encourages children to reflect,
- Responds to individual need,
- Relate topics to children live.

Brooks and Brooks (1993) cited in Woolfolk (1995:487) lists teachers' constructivist practices to involve in active meaning constructions. These are: -

- Constructivist teachers encourage and accept student autonomy and initiative;
- Constructivist teachers encourage students to engage in dialogue both with the teacher and with one another;
- Constructivist teachers encourage students inquiry by asking thoughtful, open ended questions and encouraging students to ask questions to each other;
- Constructivist teachers engage students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion;
- Constructivist teachers allow wait time after posing question;
- Constructivist teachers seek elaboration of students in initial responses;
- Constructivist teachers provide time for students to discover relationships and create metaphors.

Children are also encouraged to involve in the processes of science to construct knowledge by asking questions, making observations, taking measurements, collecting, organizing, analyzing data, deriving conclusions, communicating findings, etc. And of course students should involve in all the processes of science. These and others make teaching in the constructivist perspective a highly demanding task for science teachers but eventually rewarding.

Moreover, science teachers have to learn to listen carefully to children's language and their thoughts about some experiences they present to their students. Effective science teacher also needs to take time to prepare new experiences for students by way of showing the advantages of keeping an open mind and by acknowledging heterogeneous experiences (Anderson, 1977) cited in Tsai (1998).

2.3.3 Engagement Of Students In Authentic Tasks/ Activities

Many constructivists believe that instruction in the classrooms should be modeled as much as possible on the learning processes that occurs in natural settings. Authentic tasks are good for transfer of learning to take place and also justify the inclusion of a task in the curriculum. Good and Brophy (1997: 404) argue, "If we want students to learn and retain knowledge in a form that makes it usable for application, we need to make it possible for them to develop in the natural setting".

Watts (1994:53) emphasizing the importance of authenticity of tasks for learning in science says "The most powerful impact of problem solving is in the motivation it gives through tackling real problems, of taking ownership for the issues so that, in the full flash of activity, youngsters are barely conscious of the points when they articulate their 'alternative conceptions'." He further argued, " The search for a solution (their solution) becomes a deriving force behind their need to construct, reconstruct and fine tune their theories (Ibid). It is also argued that " students must be provided with experiences that make sense to them, or else current understandings are unlikely to mature or change" (Eggen and Kauchak, 1997:276). Another educator discussing on the same issue pointed out that science education is successful only to the extent that science can find a niche in the cognitive and socio-cultural milieu of students (cobern, 1993a).

According to Eggen and Kauchak (1997), meaningful learning occurs within authentic learning tasks. It requires a classroom learning activity that leads to understanding similar to understanding that would be used in the world outside the classroom. It also requires the science teacher to stimulate real-world problem situations and provide students with practice in thinking in realistic and life-like situations. And also through providing the practices by posing problems that are embedded in realistic situations. Woolfolk (1995) also points out that problems and learning situations, which mimic the ill- structured nature of life, should be designed for students.

Other educators have also suggested the following strategies for teachers.

- Focus on application rather than verification
- Involve engagement in meaningful problems relating to children's experiences or to real events (Good and Brophy, 1997: 418).

2.4 Application Of Constructivist Strategies In Teaching Some Concepts In Science

These days in most developed countries the application of the major constructivist strategies in the science classrooms is becoming a common practice.

Victor and Kellough (1997), for instance, presented a comparison made by Brooks and Brooks (1993) between two methods of teaching seventh graders about photosynthesis: a traditional and a constructivist approach. In the traditional classroom, as it is the usual case, students were taught through a combination of textbook work and teacher demonstration. Students read a seventh-grade science textbook that provides a brief definition and description of photosynthesis followed by a careful presentation and explanation of the chemical equation for photosynthesis by the teacher. In the end, students prepare themselves for test that is usually objective type.

In the constructivist science classroom, on the other hand, the teacher used the following strategies to teach the concept.

> Ms. B (the teacher) asked her students to think of systems with which the students might have some experience and familiarity and to indicate the product created, the energy source needed, and the raw materials used. She asked her students to consider, for example there art classes and what they create there. Several students taking a home technologies class at the time were making malted shakes. They combined ingredients (malt, milk and cocoa) in the presence of external energy source (and electric blender) to produce a product (the milk shake)...Another student, thinking of health education class, described exercise as a system consisting of ingredients (a human body, weights, and exercise making acted on by and energy source (One's muscles) to generate a product (increases strength and muscle tone) and a by -product (a sense of well-being).... the students are engaged in interdisciplinary discussions with each other and with Ms.B (their teacher). Brooks and Brooks, (1993) in Victor and Kellough (1997:39).

The term Photosynthesis was not mentioned during the initial lesson. The teacher simply asked her students to think photosynthesis as a system in which certain ingredients (Carbon dioxide and water) are changed by an outside energy source (sunlight) to produce a product (sugar) and a bi-product (oxygen).

Brooks and Brooks finally argued that:

> Although the students did not construct a bio chemical understanding of photosynthesis, and their examples were not completely analogous to the system of photosynthesis in terms of reversibility and complexity, they did begin to appreciate that one way of understanding photo synthesis is to see it as a system process yielding both a product and a by -product. (In Victor and Kellough, 1997:39)

In the lesson, the teacher's analogical activity served as an invitation for students to look at photosynthesis as a whole system. The students own creating of analogies helped them to construct a framework. Through the development of the lesson students were actively involved in discussion, arguments. And as it is reported, because the lesson was related to student's activities in their areas of life, it was sensible and interesting to them (Ibid).

Finally, the in appropriateness of learning through the traditional approach is discussed as follows:

> ... is the mimetic approach to learning, whereby students commit new information to short-term memory for the purpose of mimicking an understanding of photosynthesis on an end-of-chapter test. ... both the way in which the content is presented and the manner in which learning is assessed ... encourage rote memorization of a symbolic chemical equation (Ibid: 39)

Scott, et al (1994) considered the application of constructivist strategies in the teaching of rusting with mixed-ability class of 12-13 year-old students. The concept 'rusting', in the lesson, was to serve as and introduction for the teaching of chemical change. In the lesson, initially, student's ideas about rusting and the causes for it were assessed. The most common suggestions of students about what rust is included " mixing of air and water", " reaction of cold and wet, " " something covering the surface. " And, a small number of students suggested the rust was under the metal coating, and others used an analogy suggesting rust was a mould, or 'metal rot' or metal 'wearing out'.

After these all discussions, the students were given home assignments to do their own activities. They were made to put nails in various place and bring them for the next time. By next time, as the lesson started, the teacher drew attention to the nails display and asked the students with the rustiest, medium rusty and least rusty nails to tell the others about where they had put them. Finally, after many independent and group activities and discussions between teacher and students and also student-student discussions, what rust is, the causes for it were identified and the class agreed upon the issues.

Scott et al. (1994: 218) say the following about the lesson: -

> In developing the lesson, arguments are drawn on evidence from both the students and his [the teacher] own experiments and deals with a alternative proposals in a logical and open way. It was notable that during the class discussion on 'factors', the teacher was drawing on suggestions from the class and in this way obtaining so many feedback as to whether they followed the argument. He also used 'checking ' questions such as 'do we all agree that...?

In the lesson, elements of the constructivist strategies seem to be applied. The student's prior conceptions were identified through questions, analogies, etc. Students were also actively involved in independent and group investigations, and also discussions, arguments among themselves and their teachers in constructing meaning. The activities can also be said realistic or life like. Student's enthusiasm in performing the activities is also witnessed (ibid).

Tracey's lesson (presented in Eggen and Kauchak, 1997) has also applied elements of constructivist strategies in the teaching of science. Her lesson focused on the teaching of the 'sources of heat'. At the beginning of her lesson, her students understood clothing to be a source of heat. The students believed that heat was generated not only by the sun and other common heat sources but also by coats, jackets, and sweaters. These understandings guided the design of their experiments, caused their confusion and uncertainty about the results, and directed new experiments. This lesson also underscored the importance of social interaction in learning. Designs for the experiments, their results, and interpretations of the students' findings all resulted from shared thinking and decision-making.

She played a critical role in the process of development of the lesson, and provided only enough guidance to keep on track, and encouraged their interactions with each other as well as with her. She also attempted to create learning communities by forming groups that were responsible for problem solving. At the end of her lesson, most students thought that clothing-trapping heat was a more sensible idea than clothing generating heat. It is mentioned that the lesson used an authentic task. The students were dealing with a " real " problem-how do coats and sweaters keep people warm (Ibid: 277).

2.5 Factors Affecting The Practicability Of Constructivist Strategies In Science Classrooms

Different factors affect the practicability of the constructivist strategies in science classrooms. For instance, Taylor (1994) recognized that teachers are under severe time constraints to cover material and the objectives of imposed curricula and that state mandated competency tests, achievement tests, college entrance tests, and the like impose further pressures. And he argued that rather than accept these constraints as justifications for traditional, teacher-centered methods in which students become passive recipients of knowledge, recent developments in learning theory should under grid the practice of teachers (p.150).

The curriculum climate in which teachers carry out their science teaching is another major determining factor that is, in many ways, more pervasively influential (usually constraining) than other physical limitations (Fensham, 1994). He further argues "The physical contexts in which many science teachers and teacher educators work often impose quite severe constraints"(p.263).

Teacher's incapability to use the strategies is also one of the major problems mentioned by different scholars. Watts (1994:53), for instance, discusses "While there have been a number of reports on classroom work within a constructivist framework, they have focused some but not all of these aspects. Moreover, they stop at the point when learners begin reaching understanding, rather than the points of transfer and application of ideas."

Stressing on the importance of teachers understanding of the constructivist strategies for teaching of science, Victor and Kellough (1997:37) said that "in addition to a solid understanding of science and sciencing, teachers of science should have a firm grounding in learning theory, understanding how learning occurs and how it is facilitated."

The way curriculum is organized and the organizational structure in schools are another major hindrances according to some scholars. As reported by Brooks and Brooks (1993),

> Constructivist teachers have discovered that the prescribed scope, sequence, and time line often interferes with their ability to help students understand complex concepts. Rigid timelines are also at odds with research on how human beings form meaningful theories about the ways the world works, how students and teachers develop and appreciation of knowledge and understanding, and how one creates the disposition to inquire about phenomena not fully understood. Most curriculums simply pack too much information in too little time-at a significant cost to the learner. (In Victor and Kellough, 1997:180)

Fensham (1994: 263) also pointed out "If there are no rewards for extended investigations by students of open-ended scientific problems, it is hard for teachers to allow students the time these sorts of learning's of the nature of science require". And again, he further discusses "If the knowledge worth learning is defined by an externally set examination consisting of multiple-choice items, then it is particularly difficult for teachers to encourage their students to achieve deeper understanding of concepts and phenomena." (P.263)

Students study behavior and conceptions of teaching and learning is another factor that influence the practicability of the constructivist strategies in the science classrooms. For instance, Gunstone (1994:133) quoted the following students sayings that influence the teaching of science from constructivist point of view.

"We are having a discussion because you can't be bothered teaching, that is, discussion is not teaching, I do not expect to learn any thing because the teacher is not doing this to help me learn,"" We are doing an experiment because it's Friday afternoon and you don't want to teach." (P.133)

Gunstone (1994) generally discusses ideas and beliefs about learning, teaching and roles seen to be appropriate for learners and teachers all impact learning.

Educational research also revealed that science curriculum, science teacher's beliefs and their teaching practice were usually guided by empiricist tradition (Dusch, 1995; Alderman, 1992 Cited in Tsai (1998). Other researchers have also shown that students' epistemological views about science are related to their beliefs about learning and knowing as well as their actual learning strategies and outcomes (Edmondson and Novak, 1993; Tsai, 1996 and 1997) cited in Tsai (1998). It is also argued that traditionally school curriculum has induced an inappropriate belief that the study of science seeks absolutely right answers while the study of literature and the humanities encourage creativity (Tsai, 1998), little attention has also been given in the science curriculum to stimulate students' imagination and creative thinking (Brooks and Brooks, 1993; Mc McCormack in Yager, 1998).

Hewson and Hewson (1984) and Shiland (1997) also pointed out that traditional teaching activities or curriculum materials, in general, spend most of the instructional efforts making the new conception intelligible; as a result, students may understand the new conceptions but they do not really believe them (in Tsai, 1994).

The learning environment is another major factor, which influence the use of the constructivist strategies in the classrooms (Ibid, 1998). It is also recognized that students learn effectively and meaningfully in favorable environment where their ideas are explored, compared, related and reinforced talking and listening to others (Major and Taylor, 1995; Solomon, 1987; Ibid, 1998).

CHAPTER THREE

METHODS AND PROCEDURES OF THE STUDY

This chapter presents the research design employed, the sources of data, the sampling procedures used, the instruments of data collection, and the procedures of data collection.

3.1 Research Design and Sources of Data

The research design that is employed in this study is the descriptive survey. The sources of data were selected grade seven science (Biology, Chemistry and Physics) teachers in the Addis Ababa Regional Administration government schools and their classrooms.

3.2 Sampling Procedure

The study involved the government schools only assuming that the samples from the government schools can best represent the total population of the schools in the town. There are six zones and 54 upper primary level government schools. These schools are widely scattered. Because of these reasons it was thought that it would be difficult to complete the work under the limit of time, if all zones are included in the study. Accordingly, only two zones namely, Zone 1 and Zone 4 were randomly selected.

The selection of sample teachers was made as follows. First, the lists of the schools in the two zones were obtained from the Addis Ababa Regional Administration Education Bureau. For the administration of the classroom observation, twelve teachers located in three schools of the two zones (one school from zone 1 and the other two schools from zone 4) were randomly selected. The teachers selected for observation were four from each of the sciences (Biology, Chemistry and Physics) based on quota sampling.

All grade seven science teachers located in 11 schools in the two zones (three from zone 1 and eight from zone 4 depending on the number of the schools in the zones by the quota sampling) including those observed teachers were made to fill questionnaire. The total number of teachers who filled the questionnaire was 53 (21 teachers from zone 1 and 32 teachers from zone 4).

And again four voluntary teachers were randomly selected and interviewed. The teachers interviewed were located in the two schools of the two zones (one teacher from zone one and three teachers from zone four).

3.3 Instruments and Procedures of Data Collection

The instruments used in this study to get the relevant data on the application of elements of constructivist strategies in the teaching of the upper-primary sciences were classroom observation, questionnaire and interview.

In order to meet the objectives of the study the data needed were data related to:

1. The knowledge base of teachers regarding elements of constructivist strategies,
2. The attitude of teachers towards elements of constructivist strategies,
3. The extent of application of elements of constructivist strategies,
4. The factors hindering the use of elements of constructivist strategies.

It is important to explain how the data gathering instruments are developed before directly going to discuss the procedures of data collection.

The classroom observation checklist that was developed had 4 categories and 10 sub-categories. To develop the data gathering instrument for classroom observation, the Constructivist Learning Model (CLM) in Gega and Peters (1998) developed by Yager (1991) (see Appendix G) and the constructivist strategies for teaching developed by Dobey, Beichner and Raimondi(1993)(see Appendix H) were used with a little bit of modification and re categorization of the elements of the models for the purpose of coding. The two constructivist teaching and learning models developed above are very similar except one has more subcategories. Again, these models are never in conflict in their approach to any of descriptions and characteristics which other educators present regarding the strategies. Besides, the main reason to select the models is their appropriateness to science education. Furthermore, based on the findings from the pilot study it was reviewed and modified. (See Appendix D for the finalized sample copy).

In order to see the extent of application of elements of the strategies in the classrooms, a checklist having four point scales 'properly applied,' 'moderately applied,' 'not applied at all' and 'not applicable' with values, 3,2, 1 and 0 respectively was designed.

Questionnaire (both close-ended and open-ended with five major items and 76 sub items) was also designed for selected seventh grade science teachers. The purpose of the questionnaire was to gather data regarding the knowledge base of the teachers, their attitudes, their classroom practice and also the factors that hinder the use of elements of constructivist strategies as it is viewed by the teachers themselves.

To develop the items in the questionnaire that are related to knowledge base and attitude, the assumptions, characteristics or features of constructivist teaching strategies presented in the review of related literature (chapter two) are used. In particular the one presented by Eggen and Kauchak (1997), Collisson(1991) in Lauritzen and Jaeger (1997), Driver and Bell (1986) in Capel, Leask and

Turner(1995) and Lauritzen and Jaeger (1997) are summarized, modified to serve the purpose of the study and used. Other items in the questionnaire related to the extent of application of elements of the strategies and the factors that hinder the use of elements of the strategies are developed based on the information in the review of the related literature. The items in the questionnaire are also reviewed, modified based on the findings from the pilot study. In addition, to avoid vagueness in the questions and to develop more reliable items the items were reviewed and critiqued by peer and colleagues.

To show the extent of the teachers knowledge base, attitude, application of the strategies and also the seriousness of the factors, very much widely used scales with values such as strongly disagree, disagree, undecided, agree, strongly agree; very much useful, useful, not useful, neutral; never, rarely, sometimes, frequently, always; and; most serious, serious, not serious, not applicable were respectively used. Other close-ended and open-ended items were also designed. (See Appendix C for the finalized sample copy).

To further elicit response from the teachers, interview items were also prepared. The items for the interview were somehow general and were indirect questions. (See Appendix F for the finalized copy). This is because the major purpose of the interview was just to supplement the data that were gathered through observation and questionnaire.

3.3.1 Classroom Observation

The reliability of the Classroom Observation Checklist was tested during the pilot study by using the formula developed by Emmer and Millet (1970) in Good and Brophy, (1997:50). That is;

$$\text{Agreement} = 1 - \frac{A-B}{A+B} \times 100\%,$$

Where, A= Number of events coded by the first observer, and

B= number of events coded by the second observer

Based on this, the researcher and his co-observer observed three lessons. The average 'agreement' calculated for each of the lesson observed was respectively 88.2%, 86.6% and 92.5% with a grand agreement of 89.1%. According to Good and Brophy, observers should achieve general agreement from 60-90% to get reliable data. To make the checklist more reliable, strict considerations were also given to make the sub-categories mutually exclusive and also to avoid personal judgments.

The nature of sampling of the classroom interaction used for the purpose of coding was event sampling. Accordingly, the kind of behavior and information to be recorded was already identified, the observer waited for the selected behavior to occur and recorded. The time range for one session of observation was one period (40 minutes).

The observer has also strictly considered the nature of constructivist teaching that it is procedural. First, the learners experiences and current knowledge should be activated. Second, the learners should involve in explorations, discussions, etc. Third, the learners should propose explanations, reach on consensus on ideas, findings, etc. And fourth, the learners should take action (apply learning).

To conduct the observation of the classrooms, classes to be observed were arranged with the help of the school administration and the observed teachers. The appropriateness of the lessons to be observed to the purposes of the observations (for example, the teacher should start a new topic) was tested before the actual observations. Based on these, the classes of twelve teachers were observed that is four teachers from each subject. Because of the shortage of time, initially it was thought to observe the classes of eight teachers twice. However, because it was repeatedly observed during the pilot study that the method/strategy a teacher uses somehow remained the same, it was found to be important to observe the classes of larger number of teachers than to observe the classes of few teachers repeatedly. In the schools the researcher has also tried to observe the classroom conditions, the laboratories and school conditions in general.

3.3.2 Questionnaire Administration

The questionnaire was distributed to all grade seven science teachers (53) in the eleven schools, which were randomly selected from the two zones. The questionnaires were filled by 48 teachers and then collected. From among the collected questionnaires five of them were not properly filled. They were found to be carelessly filled. Thus, 43 of the questionnaires filled were used for analysis of the data.

3.3.3 Interview

To conduct the interview, four teachers from among those observed were randomly interviewed based on their voluntariness. The interviewed teachers were located in the two schools of the two zones (one from zone 1, and three from zone 4). The responses from the interview were further categorized to serve the purposes of the study and then discussed qualitatively.