

**ADDIS ABABA UNIVERSITY  
SCHOOL OF GRADUATE STUDIES**

**THE ETHIOPIAN GENERAL SECONDARY EDUCATION  
SCIENCE CURRICULUM: DOES IT CHALLENGE OR  
BURDEN STUDENTS?**

BY

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Curriculum: Does it Challenge or Burden Students?**  
(The Case of Shashamanne General Secondary School)

A Thesis Presented to the School of Graduate Studies, Addis  
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the Degree of Masters of Arts in Curriculum and Instruction

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## Abbreviations and Acronym

AAU	Addis Ababa University
EMPDA	Educational Material Production Distribution Agency
ERGESE	Evaluative Research on the General Education System of Ethiopia
ESDP	Educational Sector Development Program
ESR	Education Sector Review
FDRE	Federal Democratic Republic of Ethiopia
ICDR	Institute for Curriculum Development and Research
MoE	Ministry of Education
NETP	New Education and Training Policy
SGSS	Shashamanne General Secondary School
TGE	Transitional Government of Ethiopia
TIMSS	Third International Mathematics and Science Study
TV	Television
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USA	United States of America

## Abstract

*The main purpose of this study was to understand whether students' view the current science curriculum as challenging or a burden. In line with this their hopes and expectations to learn science were explored. Moreover, science curriculum materials were also examined in accordance with the intentions of the NETP to promote learning through problem solving approaches. To these end, qualitative case study research was employed. Data were collected from Shashamanne General Secondary School in a one month and two weeks period. It was largely based on semi-structured interviews done with purposively selected participants from science curriculum expert in ICDR to students in the school. Beside this, documents like the NETP and science curriculum materials were also analyzed, and lesson presentations were also observed. Results and discussions were made using thematic approach, and the study was reported in a narrative text. The study revealed that there is a contradictory initiative underpinning the NETP (constructivism) and the science curriculum (reductionist behavioral approach). The implementation of science curriculum driven by fact based, 40 minutes and classroom bounded, teacher- electronic device- and nobody-centered instruction, and paper- pencil based summative assessments reinforced superficial learning, and featured unappealing learning experiences. These in turn robbed students' interest and the tone of science learning, though their hopes and expectations were to learn science for deep understandings. Consequently, these pressurized students to consider science as a burden to get rid of. Therefore, science curriculum need to be designed around concepts, acknowledge and appreciate students' preconceptions and indigenous achievements of the oral culture about how the world works, romanticize it through questions. This accordingly, will inspire, challenge, and intrinsically motivate them to explore more, evaluate their preconceptions, and then move towards scientific understandings. Hence, the people involved in the system of education need to reexamine the process of science curriculum planning and the way it is being taught in school in accordance with what students are saying and the intentions in the NETP.*

In this section of the thesis, the main things to be studied in this research or the conceptual framework were dealt. Hence, the motivation behind conducting this research, the problem to be studied, purposes of the study, research questions, significance, scope and limitation of the study were discussed.

### **1.1. Background of the Study**

Modern education in Ethiopia, since its introduction hundred years back, has experienced various educational and curricular reforms. However, many of them, for instances, Education Sector Review [ESR] in 1972, and Evaluative Research on the General Education System of Ethiopia [ERGESE] in 1983, remained short-lived and unimplemented. This could be either because they were proposed late and/or were little emphasized, and soon followed by dethronement. Thus, they contributed little to the education sector and to the overall development of the country in their respective historical periods.

Apart from this, curriculum and its implementation at different times of our country's education was noted for reinforcing factual knowledge through academic, content-centered curriculum, teacher-dominated classroom instruction, and rote memorization oriented assessment. These situations fostered superficial learning which consequently contributed insignificantly in changing the overall situation of our country socially, economically, politically and culturally, and to the lives of each individual as desired.

Cognizant of the above facts, the New Education and Training Policy [NETP] was published by Transitional Government of Ethiopia [TGE], in 1994. The NETP document (TGE, 1994) has reviewed as the past education practices were non-considerate of the society's needs in their objectives, and inadequate to indicate future direction. Absence of interrelated contents and mode of presentation that can develop student's knowledge, cognitive abilities and behavioral change by level, to adequately enrich problem-solving ability and attitude were also major problems of the education system (TGE, 1994: 2).

Subsequently, the Policy aimed at addressing access, equity, quality, relevance and efficiency of the education in the country. It has identified five general objectives (TGE, 1994: 7-8) but, three of them which are listed below were considered as more relevant to the topic under investigation:

- Develop the physical and mental potential and problem-solving capacity of the individuals by expanding education and in particular by providing basic education for all.
- Bring up citizens who differentiate harmful practices from useful ones, who seek and stand for truth, appreciate aesthetics and show positive attitudes towards the development and dissemination of science and technology in society.
- Cultivate the cognitive, creative, productive and appreciative potential of citizens by appropriately relating education to environmental and societal needs.

As the general objectives listed above portray and as it is further explained in the Policy, the intent was to develop curriculum materials that would improve the problem-solving capacity of the students and to enable them become more productive members of the society (TGE, 1994; FDRE, 2004). This in turn made it explicit that the NETP has recognized the wholly expository styles of teaching of factual information in preparation for examinations which themselves emphasize pure recall may be poor development of citizenship. Hence, curriculum was defined as an educational program grounded on a clearly stated educational Policy addressing a country's developmental problems and needs, and which contains relevant knowledge, skill and attitude (MoE, 1993 cited in Solomon, 2008). Accordingly, it was a major area of reform and appeared to be a central element in an attempt to achieve the purposes of education in the country.

Moreover, strategies like changes in educational structure, 4-4-2-2 (4 years of first cycle primary, 4 years of second cycle primary, 2 years of general secondary education on which this study will focus, and 2 years of preparatory education respectively), educational measurement and evaluation, educational administration, language of instruction, approaches to teaching and learning, etc were also emphasized for the successful implementation of the Policy.

In views of realizing the intentions of the NETP and its strategies, the Ministry of Education has initiated, prepared and enacting the Education Sector Development Programs [ESDPs] beginning from the year 1997. To date, two ESDPs have been implemented and the third is on going (FDRE, 2004).

Accordingly, improving the quality of education and expanding access with special emphasis on primary education were aims of ESDP I (1997-2002) (MoE, 2002). ESDP II (2003-2005), however, provided detailed measures that were necessary to improve education at all levels. Particularly, at the secondary level, it adopted a dual pronged strategy of expansion and quality assurance in which measures like evaluating and improving syllabi for grade 9 and 10 were few among the others (MoE, 2002). ESDP III (2005-2010) focused on improving quality at all educational levels. In this regard, what the Ministry of Education is undergoing these days, through General Education Quality Assurance Package could be mentioned under the efforts to improve quality of education, which is actually the primary intention of ESDPIII (MoE, 2005).

While acknowledging the importance of curriculum as a means to achieve the intentions of education identified in the NETP, and once it is agreed that the aim of the curriculum for the future should be the development of the ability to solve problems, we need to be certain that the written curriculum materials and its enactment at the school level reinforces meaningful or transferable learning. Thus, citizens can solve real life problems of the country.

Perhaps, it seems that as far as modern education is concerned, it is hardly possible to think of school curriculum exclusive of the influence of Western culture originated scientific knowledge. It is true that science and technology is not dominantly our culture, but the culture of Western world. Hence, simple adoption of alien culture originated enormous amount of scientific knowledge and attempts to transmit it through the curriculum, without contextualizing it could end up without bringing significant changes as desired.

Hopefully, curriculum and pedagogy in our schools are expected to respond to it by looking for mechanisms that enable to bring development from within by valuing our cultural heritages in the schools. In other words, the huge amount of scientific knowledge can be wisely used as enrichment, if we are meticulous in reconciling the domestic culture with the foreign strands (Amare, 1998) in our curriculum rather than expecting students to know it all or carry around masses of contents in their heads.

However, from the vantage point of history of modern education in Ethiopia, as it is summarized for science education in the next chapter, curriculum at different times was largely characterized by academic subject-matter centered designs, in which the primary focus is acquisition of Western culture originated scientific knowledge. This was actually criticized for having little relevance to Ethiopian citizens.

In his review of 'What Research says about African Science Education', Temechegn (2000: 15-18) has also reviewed that science education has been criticized from several points of view: it did not take in to account the intellectual and cultural milieu of the children, concerned more with information than with thought that led to an alienated response to science from the majority of learners, less relevant to the African children.... He has also put that the chemistry curriculum and textbooks for grade 9 and 10 Ethiopian students were influenced by a body of facts, lower order cognitive skills, little inquiry activities, and little everyday life related topics.

Consequently, if subject matter is presented merely as a collection of truths, centering on topics and related facts, emphasizing on lower level cognitive outcomes, students will be encouraged to use rote memorization and teachers may not have time to cover prodigious amount of course materials through rapid instruction (Linder, 1992). Hence, curriculum and learning will appear to be less powerful to challenge and intrinsically motivate students. Do not you think this could be the reason why people in our society say, “አይዘን ትገላገላህ!” *i.e.* “learning as a burden to get rid of!”, when they ‘sympathize’ a student learning in school?

The current Ethiopian General Secondary Education (*i.e.* grades 9 and 10) curriculum consists, Amharic, English, biology, chemistry, physics, geography, history, civic and ethical education, health and physical education and one optional regional language: Afan Oromo and Tigrigna in Oromia and Tigray regions respectively. However, of these courses, these days, the Ministry of Education has given more value to science education. This is evident at least in the “70/30” Plan in which it was envisaged that as of 2008/09 academic year where 70% entrants to higher education institutions (Universities) will be natural science / technology students, and 30% will be social science or humanities students (Amdissa, 2008:53).

The Ministry of Education might have valued science education more because science by its nature requires relating learning to real life through practice-oriented inquiry. It involves constructing an understanding of how the natural world works. Hence, students can observe what is around them, ask questions, and seek answers. It also calls for the importance of having students engaged in scientific inquiry in the context of authentic and sustained scientific investigations in which they not only learn the content but also the language and the ways of inquiry in science (Millar & Osborne, 1998). Hence, problem solving capacity of citizens can be enriched by experiencing problems related to our natural environment that could be dealt through science education.

However, with the implementation of secondary education new curriculum that started in 1999/2000 and completed fully in 2002/2003, the evaluative study of the General Secondary Education Program conducted in 2003 has shown that students scored far below average (35.8%) on profile attainment tests. In the study, the weaknesses observed regarding the quality of curricular materials for instances, include non realizable nature of some of the objectives stated, lack of clear instructions for exercises, lack of variety of assessment techniques and activities; and inadequacy of the allotted periods to cover contents were some among the others (Woube, 2005: 71).

If the curriculum materials appeared to reinforce only content knowledge at lower levels, classroom instruction remained teacher dominated and assessment promoted only rote memorization and lower level objectives it is difficult to expect meaningful learning that can be transferred to solving real life problems as intended in the Policy.

Hence, it is this idea that initiated the research under investigation to question whether the Ethiopian general secondary education science curriculum challenges students for deep learning or burdens them with massive amount of content to be carried in their heads.

### **1.2. Statement of the Problem**

Very broadly, curriculum or what students are taught in science lessons, might either nurture students' deep learning through offering intrinsically motivating experiences or stifle it requiring them only to go superficially through the Western culture originated scientific understandings. The former reinforces students' deep approach while the later promotes surface approach to science learning.

Science curriculum that nurtures transferable learning provides a variety of appropriate challenging experiences that have actual incorporation to the students' world of experiences (Erickson, 1998). This in turn makes science learning challenging to students for it stimulates students' interests and sets the tone for science learning by relating new concepts to what they already know. This is consistent with theorists who have argued that traditional subject-matter centered curriculum promotes memorization of factual information and the development of superficial understanding of concepts, knowledge that is not transferable and that will be forgotten soon after the tests (Ramsden, 2003; Erickson, 1998), which I considered as a burden to students in this research.

In other words, curriculum that offers challenging experiences, require students to demonstrate the underlying conceptual understandings of science lessons through questions like "why", "how", and "what will happen if..." Conversely, curriculum that might be regarded as a burden to students requires them passive learning and rote

memorization of science facts through questions like “what”, “when”, “who” and “where”. In this regard, exploring how the science teaching-learning process is going on in our general secondary schools is so important. Hence, questioning the experiences science curriculum materials offer to students and seeking for how they could view them in accordance with the intentions in the NETP is crucial to reach at better understandings.

Moreover, it has to be noted that the age range of students who follow their general secondary education *i.e.* grades 9 and 10 is in adolescence, a time of intense and vivid emotional life, and also a time of deepest boredom and depression. Students at this age level are curious about a thing that interests them, capable of mature thinking, and concerned about the quality of their lives (Egan, 1997). This in turn indicates that unless science lessons provide opportunities and guidance for students to discover science in what is around them and in what they do, it is hardly possible to expect that they can intrinsically be engaged in what is less meaningful and alien to them just as in Western culture originated scientific understandings. Hence, it is important to understand how students' could view science learning, and describe their hopes and expectations to learn science meaningfully taking the case of one general secondary school.

Research on science education often addresses the need for science, and how it is taught in classrooms. Moreover, the available studies in this regard are done through the traditional quantitative research approach in which questionnaire, content analysis, check lists and the like were largely used. In other words, as to my knowledge, a number of studies conducted in this regard are predominantly in accordance with the proposed plans and intentions in the curriculum, which are largely taken for granted. Curriculum was barely questioned from how the users, specifically students at school could view it. Hence, the perspectives of the ‘researched’ are hardly addressed. What Carey & Stauss (1970:366) as cited in Chin-Chung Tsai (1998:31) noted also seem to support my argument “two tremendous influences on the science curriculum, and how it is taught at any given period in time, are prevailing psychological or learning theories and the current philosophy of science”.

Obviously these works are so vital that they imply the importance of science and what learning theories help more to achieve desired outcomes in science education. Yet they happen to be less valuable to understand how students could view science curriculum from their own perspectives, either for enhancing their intrinsic motivation to learn science that enables them reach at deeper conceptual understandings or inhibiting their natural curiosity to explore the natural environment around them and remaining burden to them.

Again, at least to my knowledge, besides reflection by Ministry of Education in the General Education Quality Assurance Package document which overviews the current general education curriculum as inadequately based on the competencies expected of students, pressurized by vast contents that are incompatible with the period allotted and irrelevance of the content to the age and ability level of the students and the existing conditions of the surrounding environment ( MoE, 2007:40-41), there are not in-depth local studies which are directly relevant to the problem at hand.

Hence, there is real paucity of research work in questioning the planned science curriculum from how students' could view it; whether it provides them adequate challenging learning experiences or indicates pressure to learn which in turn burdens them with huge amount of alien culture originated scientific knowledge.

As a result, there exists a cloudy observation on the General Secondary Education Science Curriculum in helping to the success of the Education and Training Policy (TGE, 1994). How students could view the science curriculum they are experiencing in secondary school happen to be an attractive area for in-depth empirical educational investigation. This in turn, makes it difficult to be certain whether or not graduates of grade 10 will have necessary knowledge, skill and attitude up to the expectations of the Education and Training Policy and in the long term respond to the demand of the rationale behind '70/30' Plan in particular.

Therefore, I found it timely and crucial to question whether the General Secondary Education Science curriculum provides challenging experiences to foster meaningful learning or burdens students requiring them to go through surface of things, without reaching at the underlying conceptual understandings in the context of Shashamanne General Secondary School.

### **1.3. Purpose of the Study**

As this gap is so pressing and has to be investigated so that timely correcting measures, if needed, could be taken, I determined to study whether the Ethiopian General Secondary Education Science Curriculum provides adequately challenging experiences that intrinsically motivates them to learn more or burdens them in the learning process. Therefore, this study seeks to:

- Illuminate the process of general secondary education science curriculum making and its materials in accordance with the intentions of the Policy for promoting learning for problem solving.
- Explore students' experiences in learning through the current general secondary education science curriculum in the school context.
- Contribute to the body of knowledge through questioning science curriculum in light of intentions of education as in the NETP, and from students' perspectives.

### **1.4. Research Questions**

To this end, the following research questions are formulated as a guiding and to be answered by the researcher at the end of the study. These are:

1. Does the process of developing the science curriculum and its developed materials as in the NETP reinforce deep learning for understanding?
2. Does the implemented science curriculum engage students in intrinsically motivating and deep science learning?
3. How do students describe their hopes and expectations to learn science better in the Shashamanne General Secondary School?

### **1.5. Significance of the study**

It is hoped that the primary beneficiaries of this study could be students and teachers of the school under study and the science curriculum expert in ICDR. This study could also serve as a base for the research community interested in conducting a particular investigation on the topic from the 'researched' point of view since this qualitative research addresses many issues from holistic perspectives.

### **1.6. Scope of the Study**

This study describes about whether the current Ethiopian general secondary education science curriculum presents challenging learning experiences or burdens them with unappealing learning experiences at Shashamane General Secondary School from the students' own view. It then explores their hopes and expectations to learn science meaningfully. Science curriculum was also examined whether for reinforcing deep learning in light of the intention of the NETP.

Hence, this study intends to look at the 'planned curriculum' that is primarily concerned with the official textbooks and largely the 'implemented curriculum' that is concerned with what actually takes place in classrooms. Of course, the planned or the implemented curriculum encompasses a number of aspects. However, in order to make this study manageable, the curriculum materials that were used were biology, physics and chemistry curriculum guides and students textbooks for grade 10 of the three subjects. Moreover, the nature of assessment tools, classroom observation of science lessons and interviews with, students and science teachers in the school, and a curriculum expert in ICDR were the sources of data for this research.

Only grade 10 students are made to participate in the research because it is believed that they have better experienced science learning in the general secondary school and have better understanding of the learning environment than grade 9 students, for they stayed there for about two years. Previous science teachers and now graduate students of Curriculum and Instruction, and Physics Education in AAU were also invited to take part in analyzing the nature of learning experiences in the three science subject textbooks in their own respective fields.

Apart from this, the notion “curriculum” by itself can apparently be interpreted in different ways, from a subject to be taught to all experiences of learners both with in the and outside an educational institution (Streuner & Tuijnman, 1994). This is to mean that there is a myriad of definition of a concept in the literature (as with curriculum), thus it is often difficult to keep a clear focus on its essence.

However, for me the definition given by (Marsh & Wills, 2007) can work well, which says “curriculum is an interrelated set of plans and experiences that a student undertakes under the guidance of the school” (p.15). Here, the phrase ‘an interrelated set of plans and experiences’ is to refer to the fact that the curriculum implemented in schools typically are determined in advance but almost inevitably, include unplanned activities that also occur.

Therefore, the curricula enacted consist of planned and unplanned activities. This definition leaves primarily to the school the type of guidance to be provided (the planned curriculum), primarily to teachers how that guidance is provided (the enacted curriculum), and primarily to students how guidance ultimately is received (the experienced curriculum). Hence, it is possible to identify three typologies of curriculum representations: the ‘intended’, ‘implemented’, and ‘attained’ curriculum as outlined in table 1.

**Table1: Typology of Curriculum Representations** (Adopted from Akker, 2008)

Intended	Ideal	Vision (rationale or basic philosophy underlying a curriculum)
	Formal/Written	Intensions as specified in curriculum documents and/or materials
Implemented	Perceived	Curriculum as interpreted by its users especially teachers
	Operational	Actual process of teaching and learning (curriculum in action)
Attained	Experiential	Learning experiences as perceived by learners
	Learned	Resulting learning outcomes of learners

Similarly, the phrase ‘that a student undertakes’ is to emphasize the room for students to flexibly experience as different from the phrase ‘that a student completes’. The later suggests that the curricula are created on the assumption that students will complete certain tasks and activities over a period of time.

At last the phrase ‘under the guidance of the school’ is intended to include all persons associated with the school who might provide some input into planning curriculum, such as teachers, administrators, members of school boards and the like. In this paper, challenging learning experiences is referred to as a learning situations like curriculum materials, teaching learning styles, assessment, materials and resources, location (where students learn science) and time, which promote students’ science learning for understanding. Conversely, students’ burden is to refer to the learning situations that promote superficial learning, a kind of learning that can not be transferred to day to day life of an individual.

### **1.7. Limitations of the Study**

This study has not been completely free from any constraints. Though it is believed to be better if I have analyzed the nature of science textbooks, lack of subject matter mastery in the field required me to invite previous science teachers who are now graduate students in the department of Curriculum and Instruction, and Physics Education at Addis Ababa University. Of course, it was not done in my absence, the discussions we made while analyzing the textbooks helped me to reach at better understanding and to consequently analyze the data related to it.

## 2. Review of Related Literatures

Here attempts have been made to review and summarize fundamental concepts related to science curriculum, pedagogy and how students could view them. Accordingly, six general themes have been dealt. The first two are related to meaning and purpose of science education. Following these, major types of learning orientation commonly used in school science, the approaches students' might take to learn science and factors that are identified by research to influence students learning approaches in the context of science learning were discussed. Lastly, the summary of science curriculum in the history of modern education in Ethiopia is presented in line with how students could learn it.

### 2.1 The Nature of Science Education

Science (from the Latin *scientia*, meaning “knowledge” or “knowing”) is the field of study and the effort to discover, and increase human understanding of how the physical world works (Martin, Sexton & Gerlovich, 2001). Prior to 18<sup>th</sup> century, the preferred term for the study of nature was natural philosophy, while English speakers most typically referred to the study of human mind as moral philosophy. By contrast the word “*science*” in English was still used in the 17<sup>th</sup> century to refer to Aristotelian concept of knowledge which was secure enough to be used as a sure prescription for exactly how to do something (Patrick, 2007).

Well in to the 18<sup>th</sup> century, science and natural philosophy were not quite synonymous, but only become later with the direct use of what would become known formally as the scientific method, which was earlier developed during the middle ages, and early modern period in Europe (during what is known as the scientific revolution of the 16<sup>th</sup> and 17<sup>th</sup> centuries) and Middle East. Over the course of the 19<sup>th</sup> century, there was an increased tendency to associate science with the study of the natural world (that is, the non-human world) following the beginning of separation of natural philosophy from the philosophy in the early 1800s. The study of human thought and society has also come to be called social science by the end of the century and into the next (Patrick, 2007).

Science education is the field concerned with sharing science content and process with individuals not traditionally considered part of the scientific community (Mc Comas, 1998). The target individuals in this case are students. The concern of science education, therefore, can not only be the provision of scientific body of knowledge about how the natural world works, but also a process of knowledge generation. Science education completely devoid of the concepts or the process by which knowledge is generated becomes merely organized common sense which is neither science nor education (Gott & Mashiter, 1991 cited in Bekalo & Welford, 2000). Thus, it is expected that science education provides students with both the conceptual and procedural knowledge about the natural world.

Traditionally science education was conceived as containing static body of scientific knowledge. This situation requires students to absorb the static knowledge and encourages rote learning rather than meaningful learning (Irez, 2006 cited in Irez, 2008). Teaching has become a transmission of content knowledge, and a successful and effective teacher is perceived as one whose students perform well in the examination (Cimer, 2004 cited in Irez, 2008). Practical work, field trips, and social facets of schooling have been neglected (Cimer, 2004 cited in Irez, 2008). Arguably, this has led many students and science teachers to associate the study of science subjects at school with memorization of the vocabulary of science, with little emphasis on understanding the underlying scientific processes.

One of the central concept of science, however, is that all scientific knowledge, including, “facts”, “theories”, and “laws,” is tentative (Irez, 2008). Reasons for this stem from several other aspects, such as (a) scientific knowledge has a basis in empirical evidence, (b) empirical evidence is collected and interpreted based on current scientific perspectives as well as personal subjectivity due to scientists’ values, knowledge, and prior experiences, (c) scientific knowledge is the product of human imagination and creativity, and (d) the direction and products of scientific investigations are influenced by the society and culture in which the science is conducted (Schwartz & Lederman, 2002: 207).

The nature of science, therefore, requires practical, investigative and problem solving activity which encourages students to pose questions about the natural world and investigate phenomena; in doing so, they can acquire knowledge and develop richer understanding of concepts, principles, and theories. These situations typically have a higher level of ambiguity and uncertainty than one would experience in learning new concepts or using existing concepts in conditions similar to those one has experienced before (Stones, 1994: 166). However, the widely held view of teaching as 'delivering curriculum' by teacher talk ignores its complexity and thereby renders teaching apparently less problematic. This apparent reduction in complexity, however, is possible only by taking an extremely simplistic view of teaching to which the idea of attempting to teach pupils approaches to problem solving would be quite alien. The logic of argument so far leads me to suggest that the least problematic aspect of a delivery approach to teaching is that the pupils' learning will be limited and likely to be rote. This situation, inevitably, affects the profile of science education as well.

## **2.2 Aims of Science Education**

A variety of opinions exist in the goal of science teaching by various science educators. According to Duschl (1990: 8-11) the goals of science education emphasize the products of science - the facts, principles, laws and theories that make up the knowledge base and set the standards of science - the methods employed in the collection, analysis, synthesis and evaluation of evidence. This seems similar to what Bekalo & Welford (2000: 188) state when they say, for science education to cater for all students, without assigning priority to either immediate interest or future opportunity, it should aim to achieve two goals - to provide students with sufficient knowledge of concepts required to make sense of the world around them and of procedures required to understand how concepts are investigated.

Scientific literacy, according to Matthews (1994: 32-33) is what enables students (1) understand fundamental concepts, laws, principles and facts in the basic sciences, (2) appreciate a variety of scientific methodologies, attitudes and dispositions, and appropriately utilize them, (3) connect scientific theory to everyday life and recognize chemical, physical and biological processes in the world around them, (4) recognize the

manifold ways that science and its related technology interact with the economics, culture and politics of society, and (5) understand parts of the history of science, and the ways in which it has shaped, and in turn been shaped by, cultural, moral and religious forces.

Aims of science education, to Osborne (2000: 225-240) can be described from four arguments: (1) the utilitarian argument - that learners might benefit in a practical sense from learning science, (2) the economic argument - that an advanced technological society needs a constant supply of scientists to sustain its economic base and international competitiveness, (3) the cultural argument - that science is one of the great cultural achievements of our culture - the shared heritage that forms the backdrop to the language and discourse that permeate our media, conversations and daily life, and (4) the democratic argument - that (because) many of the issues facing our society are of a socio-scientific nature ... a healthy democratic society requires the participation and involvement of all citizens.

Though not exclusively described, the above discussed aims of science education seem to have emphasized different aspects. For instance, aims of science education by Duschl centered highly on the nature of science, on concept and process of science, which students are expected to acquire in school. While, Osborne focused on making sense of the nature of science and its relationship to the economic, political and cultural aspects of the society and the benefits an individual possess from learning science. Matthews however, seems elaborating what is provided by Duschl and associating science education to technology, the socio-economic and culture of a society. Thus, possibly one can say that Matthews's aims of science education seem to be more comprehensive of what is forwarded by Duschl and Osborne.

Thus, at least for science education to cater for the above discussed intentions, it should aim beyond the traditional emphasis on understanding facts and concepts, by emphasizing also on the process by which science knowledge can be acquired.

## **2.3 Science Learning Orientations and Curriculum**

There are three major types of learning orientations that are commonly used in school science: the didactic approach, the process approach and the constructivist approach (Millar & Driver, 1987 in Tsai, 2003: 29). Each approach is based on specific philosophical assumptions, and offers implications for curriculum and classroom practice though not one is necessarily exclusive of the other.

### **2.3.1 The Didactic Approach**

A didactic approach is supported by behaviorism, associationist theories of learning. Consistent with positivist philosophical thought, and associationist theories, the approach assumed that reality is absolute and external to every day existence, that it can be discovered by experts through objective analysis of experience, and that it can be transmitted to novices through careful manipulation of the learning environment (Houser, 2006).

In the same frame, positivists believe that knowledge acquired from observable data can represent ultimate reality; similarly, our thinking is supposed to correspond to 'the manipulation of concepts, which receive their meaning via correspondences to reality' (Roth & Roychoudhury, 1993: 28). Consequently, they would view the teaching-learning process simply as a transfer of knowledge from one person to another person; *i.e.*, learners passively receive a body of scientific knowledge transmitted by teachers. This reinforces an authoritarian perspective of teaching science-a factual orientation, textbook dependency and lack of inquiry.

Positivists focus on how to prove or falsify scientific knowledge. When this philosophy is applied to the practice of science education, teachers would mainly focus on students' "right" or "wrong" answers. Hence, under the didactic teaching, learners are encouraged to get the "right" answers in frequent paper-and-pencil examinations. This clearly shows that the didactic instruction often ignores learners' response that is inconsistent with the desired scientific conceptions.

The emphasis on content in science learning is consistent with the didactic approach, and curriculum decisions flowed from the top down, beginning with national and state level planners, proceeding to district and local administrators, and ending with teachers who are expected to implement these decisions in the classrooms. Thus, teachers were considered technicians whose job was to follow the procedures developed by the central planners (Houser, 2006). Subsequently, one can possibly argue that teachers have little 'make or break' role in all curricular activities beyond attempting to implement successfully as planned or intended centrally. Science curriculum, therefore, remained a body of knowledge in which learning tasks are organized in a step-by-step fashion so that teachers can deliver it accordingly.

### **2.3.2 The Process Approach.**

The process approach places less emphasis on the content of science; instead it focuses on science as a process, a way of finding out. Hence, it acknowledges that learning is an active process, without taking into account the learners' prior knowledge. It also assumes that people can discover scientific "facts" if following proper procedures.

The process approach was particularly advocated from about 1960 to 1970, a transitional period from empiricism to constructivism (Tsai, 2003). Because of the crisis stimulated by the Soviet Union's launching of Sputnik on Oct. 4, 1957, numerous scientists in USA devoted themselves to the urgent reformation of science education, the period was also known as 'the Golden Age of Science Education' (Kyle, 1984 cited in Tsai, 2003). The process approach was one of the results of the reforms. Science - A process Approach [SAPA], a project developed by AAAS [American Association for Advancement of Science] in 1967, can also be categorized as this type of instruction.

The process approach is also based on empiricist philosophy, viewing that science begins with observations and then progresses logically to the formation of science theories (Hodson, 1996). That is, it assumes that scientific knowledge actually represents the reality, while the truths are always, available there for people to discover.

However, according to Tsai (2003: 32) the process approach encounters various difficulties in actual school science teaching. First, if process approach means applying certain modes of scientific inquiry, and then students carefully follow the “scientific processes” but, in turn, obtain some scientific view, how do teachers, explain away the discrepancy? In order to justify the inconsistency, can they simply claim that children are not observing accurately or not thinking logically about the patterns of data (Driver, 1983 cited in Tsai, 2003)? Secondly, realists assume that if we can follow proper methods, we can get the scientific knowledge, which is a body of truths always around there waiting for us to find out. This implicitly assumes that the mind is like a blank tablet: it must be capable of learning directly (mainly inductively) from our experiences, observations or experimentations, even with out the assistance of prior knowledge (Strike & Posner, 1982).

Therefore, teaching by a process approach does not necessarily mean that learners are actively engaged in meaningful knowledge construction. In contrast, one may hypothesize that a process approach, which asks students to employ codified steps with in the scientific method in doing science, without taking in to account students’ prior knowledge, would implicitly lead students to rote learning.

Curriculum in this approach involves an elaborate hierarchy of process skills viewed in a linear relationship in which basic skills *i.e.*, observation, inference, classification, prediction, collecting, recording data and measurement are learned before integrated skills *i.e.*, controlling variables, interpreting data, defining operationally, formulating hypothesis and experimentation (Duschl, 1990). Teachers of the process approach do not present ideas and accept what learners find on their own. In fact, research has shown that discovery under guidance is more effective and produces greater retention and transfer than purely autonomous discovery (Prez & Torregrosa, 1983 cited in Tsai, 2003).

### **2.3.3 Constructivist Approach**

According to the constructivist approach optimal instruction should include a proper balance of didactic teaching and process approach (Linn, 1986 cited in Tsai, 2003) and further take into account the prior knowledge of learners. In the constructivist

framework, teachers should help students engage in meaning construction and progressively guide them for an intuitive interpretation of science to accepted scientific conceptions.

The constructivist approach recognizes that science is a human activity, and knowledge is personally and socially constructed. This approach, on the one hand, as didactic teaching, stresses the need to present the desired scientific conceptions to students, while on the other hand, as the process approach, acknowledges that learners actively construct their own knowledge. Constructivist curriculum is a set of educational experiences jointly developed by teachers and students. Constructivist teaching, however, is different from the other two in that the former two often ignores learners' response that are inconsistent with the desired scientific conceptions, but the later views these as important in the learning process and encourages students to explore these ideas deeply.

A constructively oriented curriculum presents an emerging agenda based on what children know, what they are puzzled by, and the constructivist learning is based on the active participation of learners in problem-solving and critical thinking- given real and authentic problems. Hence, in constructivist classrooms, curriculum is generally a process of digging deeper and deeper into big ideas, rather than presenting a breadth of coverage. While the former two approaches advocated top-down curricula and quantifiable assessment, constructivists preferred bottom-up approaches designed to utilize student agency and context - specific form of assessment (Houser, 2006). The role of the teacher in constructivist classrooms is to organize information around big ideas that engage the students' interest, to assist students in developing new insights, and to connect with their previous learning.

## **2.4 Deep or Surface learning *vis-à-vis* Student Burdens or Challenges in learning**

Meaningful learning which Martin *et al.* (2001) contrasts with rote learning allows students to see new knowledge in the light of what they already know and understand; hence, they can find new meaning. If these connections are missing, learners may regard the ideas they are taught as useless abstractions that only need to be memorized for test

(Martin *et al.*, 2001). Rote learning, therefore, is arbitrary, lacks affective commitment on the part of the learner to relate new and prior knowledge so that memorization without understanding and without connection to the previous knowledge characterizes it, and thus learning will only remain a burden to student.

The nature of students' learning - that is, meaningful or rote - is related to deep or surface learning and broadly to the construct "approaches to learning" (Chin & Brown, 2000). Approaches to learning, therefore, refers to "the way students go about their academic tasks, thereby affecting the nature of the learning outcome" (Biggs, 1994).

In essence, the deep approach to learning is associated with intrinsic motivation and interest in the content of the task, a focus on understanding the meaning of the learning material, an attempt to relate parts to each other, new ideas to previous knowledge, and concepts to everyday experiences. There is an internal emphasis where the learner personalizes the task, making it meaningful to his or her own experience and to the real world. In contrast, surface approach is based on extrinsic or instrumental motivation. The learner who uses the surface approach perceives the task as a demand to be met, tends to memorize discrete facts, reproduces terms and procedures through rote learning, and views a particular task in isolation from other tasks and from real life as a whole (Ramsden, 2003).

When considered in terms of Bloom's Taxonomy of Educational Objectives (1956), deep learning requires higher order cognitive thinking skills such as analysis (*i.e.* compare, contrast) and synthesis (students are required to integrate components in to a new whole, *e.g.* what is the relationship...). Surface learning, on the other hand consists mainly reproducing knowledge which is often forgotten by students shortly after the course has ended.

Moreover, Entwistle and Ramsden (1983; 172) in their research reported that a meaning orientation and deep approach to learning correlate with deeper understanding, personal satisfaction, and good performance as measured in tests and exams; conversely,

unfavorable attitudes to studying, lack of interest and, significantly, surface approaches, were related by students to deficiencies in the assessment system ..., restricted opportunities for self direction and excessive workload.

The approaches to learning adopted by individual students is primarily affected by their perception of the task requirements, which is influenced by two main factors - students' orientations to studying and the context of learning within individual subjects (Ramsden, 1992: 83). Students' orientations in this case are preferences to use a particular learning approach, which Ramsden (1992) related it to students' previous educational experiences. A number of contextual factors that influence the learning approach adopted by students that can be identified from the summary of the above researches are: the nature of the curriculum, instructional style, assessment, and workload levels. Student burdens or challenges in learning, therefore, is related to the extent the curriculum, instructional style, assessment and workload levels reinforce students to adopt the surface or deep approach in learning science which I believed to lead to rote or meaningful learning respectively.

Learning that challenges students, consequently allows them to take a deep approach in pursuing through the task so that deep understanding or meaningful learning can be fostered. Conversely, as a response to situation (lengthy syllabus, transmissive mode of teaching, assessment that requires memorization and excessive workload) students may adopt the surface approach to learning, learning that cannot be transferred to real life situation because of its superficiality and easy exposure to forgetting, and thus remains a burden to student. This can be summarized by what Laurillard (1979) in Chambers (1992: 143) puts: 'the natural' approach to learning is a deep one: that an approach to learning should not be seen as characteristic of a student, but as a response to situation. Thus, educators, as Ramsden (1992: 52) puts it believed that it is possible to manipulate the learning context by providing a window of opportunity to influence the approach students adopt, and therefore, the quality of student learning.

## 2.5 Student Burdens and Challenges in Learning Science Education

### 2.5.1 The Nature of Curriculum

One of the most long-lived and contentious conflicts in science education concerns the optimal degree of content coverage in science courses (Anderson, 1995 cited in Schwartz, Sadler & Tai, 2008). At one extreme is the emphasis on “full coverage” or “breadth”, a view that students are best served by encountering a great number of topics relevant to a particular science discipline, which Erickson (1998) termed as “topic-centered” curriculum. The alternative view is the “concept-based curriculum” (Erickson, 1998), which is typified by the terms “deep-coverage”, “understanding at many levels” (Schwartz *et al*, 2008).

The original argument for “breadth” may well have been Aristotle’s who argued for a broad curriculum (Schwartz *et al*, 2008), at a time when a person could - and ideally should - learn everything there was to know about the natural world (Newmann, 1988 cited in Schwartz *et al*, 2008 ). However, the explosion of scientific knowledge during the 20<sup>th</sup> century resulted in huge amount of science knowledge which forced the consideration of the alternative view. Educators subscribing to this view argue for the importance of studying a fewer topics in greater depth, rather than aiming for maximum coverage, claiming that mastery of a few topics trumps the failure to master any (Perkins, 1992).

Traditional design of curriculum emphasizes coverage and center around a myriad of facts. The assumption here is that teachers know and are drawing out the key conceptual understandings (principles and generalizations) from topics (Erickson, 1998: 5). In fact it is difficult to be certain that this is usually happening. A follow-up study with the National Center for Improving Science Education that reviewed the Mathematics and Science Curricula for 50 countries for instance, concluded that; comparatively, the “American Science and Mathematics curriculum is a mile wide and an inch deep (Erickson,1998:5).” In the study researchers used the comparison that American students often lug around science textbooks of approximately 800 pages, covering more than 65 topics; yet students in Japan or Germany typically use 150-to-200 pages textbooks with as few as five topics (Viadero, 1997 cited in Erickson, 1998:6).

The 1996 Third International Mathematics and Science Study [TIMSS], the largest comparative international study of education ever conducted, measured the mathematics and science achievement and shown that American students scored slightly above average in science; the study also described the U.S science curriculum as covering too many topics at each grade without sufficient depth (Martin *et al.*, 2001). The question, however, here is that, how is it that other industrialized nations such as Japan or Germany can score better than the United States on international exams when they focus on far few topics?

Erickson (1998:6) indicated that Japan, Singapore, and other higher-scoring nations center both curriculum and instruction around the understanding of discipline based concepts and principles, using topics and facts as tools to help students develop deeper understanding. Thus, in this case we can say that it is the conceptual focus that allows them to reduce the number of topics covered, because many topics can exemplify the same concepts and conceptual understandings. As cited in Schwartz *et al* (2008:6) Sizer's (1984) pronouncement, "*less is more*" – students exposed to "less" coverage would have a greater chance of developing a "more" thorough understanding of topics encountered also seems to justify the experiences of these countries.

Moreover, teachers in the United States as Erickson (1998) puts it feel compelled to "cover" the abundant subject area content in the textbooks and curriculum guides, the coverage pressure in turn reduces the amount of time available for students to solve problems and think beyond the facts for it burdens them with a huge amount of content coverage. Such curriculum is characterized by encouraging didactic lecture, pressurizing teachers to cover more topics, which their students have to memorize on national exams so as to ensure their success. Consequently, through hearing about historically significant inquires, watching a teacher conduct practical investigations, or carrying these out for themselves, students are expected to develop an understanding of the kinds of evidence and reasoning used to build up the scientific knowledge. Often such learning, however, is taken to be tacit (Millar, 1997).

On the other hand, in school science, the textbook is accepted as the ultimate source of knowledge, provides the majority of instructional support beyond the teacher, and as Stake & Easley (1978) indicated in many cases actually becomes the curriculum. However, textbooks themselves, without teacher modification usually do not promote or encourage the development of scientific thinking or attitudes; nor do they engage students in applying the cognitive processes that are basic to understanding the content covered (Martin *et al.*, 2001). This is because the process of constructing an understanding in science is done through activities, not merely through words. Thus, concrete experiences should be the basis for insight in to the science concepts.

Reliance on a single science textbook, therefore, also promotes an authoritarian approach to teaching and learning, for the text or the teacher becomes the authority with the textbook becoming the principal determiner of what is taught, usually to the extent of selecting the science topic because it is “in the book” (Staver & Bay, 1987). Therefore, it does not come as a surprise to say curriculum of this kind burdens students. Hence, it does not offer them science as a challenge, centering on concepts so that there will be time and opportunities to experience and understand science concepts and processes through hands-on, minds-on and authentic real-life related problem solving activities.

Consequently, educators often assume that a curriculum is either deep or broad, which means that deep can only be achieved at the expense of breadth; that is, by covering fewer topics. According to this assumption curriculum that has fewer topics has a higher degree of depth. In other words, a curriculum is deep if it includes a small number of topics. However, having fewer topics does not necessarily translate to a deeper curriculum, and having more topics does not necessarily translate to a shallower curriculum. Hence, the topics in the curriculum materials should be covered in a way that “is more likely to modify students’ beliefs system by providing integrated understanding of a science topic” (Linn, 1987 cited in Murdock, 2008:1138).Depth, therefore, in this research can be characterized by increased emphasis on problem-solving and linkage of different topics (Linn, 1987 cited in Murdock, 2008), or as depth of student understanding (Raizen, 1998 cited in Murdock, 2008).

### 2.5.2 Teaching and Learning Style

In the past teachers and many school curriculum have adopted the principle that the pupils come to lessons and the school in general with no knowledge at all of science. The science learning process was characterized by absorbing science knowledge: students are “students” of their teachers and their prepared materials, and learning is often perceived as hardworking to achieve external rewards and avoid punishment (Cheng, 2000). Science learning activities in this case were only school - bounded and teacher based (Parkinson, 1994). This image of science is seen, with some justification, as responsible for turning many young people off science (Millar, 1997).

This transmissive mode of learning ignored the fact that even as babies everyone starts to investigate the world in which she/he lives and start to build up a picture of why things happen the way that they do. Students develop ideas about natural phenomena before they are taught science in school (Driver, Squares, Rushworth & Wood-Robinson, 1994). If students’ prior knowledge or naïve conceptions and scientific or disciplinary knowledge do not connect and intertwine, learning of scientific concepts is reduced to rote memorization of facts (Roth, 1990). Moreover, the natural curiosity of students, eager to understand their surroundings, is often diminished by such instruction for it discourages inquiry and discovery, which the nature of science itself requires (Martin *et al.*, 2001).

However, at a very general level, an emphasis on inquiry is seen as a means of avoiding the aridity of portraying science in the classroom as a body of established knowledge which can not be contested and to which the learner can make no critical or creative input, but must merely assimilate. Science is not a catalogue of facts that have to be fed to the pupils so that they can regurgitate it at the next examination. Rather it is so close to the life of every boy and girl that there is no need to confine its study to the reading of textbooks or listening to lectures (Martin *et al.*, 2001). Thus, if it is to be learned effectively science must be experienced; it must be learned and not learned about. Science learning, therefore, should involve hands-on, minds-on and real-life related problem solving activities through inquiry teaching and learning processes, all in an interconnected manner (Martin *et al.*, 2001).

Hence, students are able to inquire when they are given hands-on learning opportunities, appropriate materials to manipulate, puzzling circumstances or problems for motivation, enough structure to help them focus or maintain a productive direction, and enough freedom to compare ideas and make personal discoveries. Students learn science, when they are interested in it, when they can see that it makes some difference to them, when it is graphic, involves some manipulation on their part, when it is not too hard but hard enough to make them think, and when it gives them the satisfaction of having found out some thing they wanted to know. This is what challenging learning calls for. Providing science as a challenge to students to foster their science literacy is consistent with the goal of inquiry-based science instruction for it engages students in the investigative nature of science through hands-on, minds-on and problem-solving activities.

Inquiry teaching and learning can be effective, only if it connects the mind's thinking with what the hands do (Martin *et al.*, 2001). To realize meaningful science learning in part, science lessons should feature four phases: engaging, exploring (or experiencing), evaluating and extending which might last for a number of class periods, and activities are expected to form the core of each phase in this lesson planning framework (Martin *et al.*, 2001). "*The engaging phase* ties the science curriculum to students' prior experiences, and to students' interests and needs. Hence, it is possible to explore, clarify and state students' conceptions at this phase. *Exploring* in turn involves the investigation of questions during the engaging phase of the lesson, which may involve student-designed investigations or activities suggested by teachers. *The evaluation phase* involves two levels of evaluation: students must evaluate the results of their research and investigations, and their understanding of the concepts in light of the results of their explorations. This stage is identified as a critical phase of science learning. *The extending phase* gives students a chance to take the results of their evaluation and put those results to the test, which accordingly enhances their understanding of what surrounds them "(Martin *et al.*, 2001: 11-19).

Consequently, this form of learning will make students engaged in intrinsically motivated learning, and understand the real world of science which is not typically represented in the classroom (Driver *et al.*, 1994). Hence, it is possible to argue that

problem solving and constructive approach oriented science learning need to reflect this kind of lesson planning framework.

However, research has shown that the way in which science is traditionally delivered in most schools relies heavily on transmissive modes of teaching with a heavy emphasis on practical work, but such approaches as Millar (1997) puts it, fail to develop neither critical thinking skills nor metacognitive abilities.

Challenging science learning, therefore, is not presenting a vast amount of science knowledge that students have to know, or providing them with too hard problems to solve, as these can not make students scientifically literate, rather it is putting them in a real-life related puzzling circumstances that are hard enough. Science challenge is a way of giving students the maximum opportunity to extend their learning in a direction of their choosing or in a style of their own. There is no set formula for what science challenge is or what must be done during science challenge. The starting point may be something that intrigued a student during the exploration phase or evaluation phase of the lesson. It may be the extension part of the lesson.

In short, science challenge encourages students to step outside the traditional confines of science lessons and get away from asking the question ‘what do we have to know for the exam?’ to ‘how does ...?’ Thus, science teaching can arouse their curiosity and motivation to think, act, investigate, explore, and learn. Hence, learning can be enjoyable, self-rewarding and life-long (Cheng, 2000). Therefore, science lesson can not by itself become the end, but a means for educating the ‘mind’, the ‘hand’ and the ‘heart’ which are the desires in education across all levels of education.

### **2.5.3 Assessment**

According to Ritter and Wilson (2001:5) ‘Assessment is an area of on-going scholarly debate and there are neither absolutely risk-free process nor perfect outcomes.’ They also point out that assessment ‘is a dominant determinant of learning behavior, an integral part of the teaching and learning process, and a significant contributor to learning outcomes’ (Ritter & Wilson, 2001:5). If, therefore, students are motivated more

by need to pass an assessment task than by a hope to understand concepts, then it stands to reason that how we assess these students will impact directly on the type of study strategies they adopt.

Assessment practices communicate what is important and what is valued in science education. For example, assessments that emphasize the acquisition of factual knowledge imply the facts are important, where as inquiry centered assessments indicate that scientific inquiry is important (Hein & Price, 1994). Hence, the assessment methods used to gain educational information should mirror the way teachers teach and should define what students learn.

According to Earl (2003) assessment becomes a major element in the learning process when teachers use it to become aware of the knowledge and beliefs that their students bring to a learning task, use this knowledge as a starting point for new instruction, and monitor students' changing as instruction proceeds, and termed it *assessment for learning*, which others commonly call it formative assessment.

Thus, *assessment of learning*, which traditionally involves tests, such as multiple-choice and short-answer tests given at the end of a chapter or unit of study, can not measure all that goes on in an inquiry-centered science curriculum. Hence, these tests can not effectively evaluate whether students have learned how to design an experiment, make accurate observations and measurements, analyze data, and reach reasonable conclusions.

Of course, an on-going assessment which involves diverse methods and which emphasizes higher order learning objective need to be used so that more can be learned about each student.

More importantly, it is commonly thought that assessment is the most powerful influence of all on how students approach learning in a subject and where they decide to put their energy. According to Entwistle (2001:23) assessment techniques that encourage students to think for themselves - such as essay questions, applications to new contexts, and problem-based questions - all shift students toward a deep approach; assessment perceived by students as requiring no more than the accurate reproduction of information

lets students rely on surface approach. Thus, if the assessment tasks reward memorizing and rote learning then that is what students will do in order to succeed in assessment.

When higher-order learning objectives are specified, it then follows that, the assessment must mirror and test those objectives. For example, if the objectives require students to apply principles and solve problems, then the assessment tasks must test to see if they can do these things, not just write about them. Conversely, where exam questions or assignment tasks elicit factual or descriptive responses, students will tend to adopt a surface approach to learning as deeper learning is relatively unrewarded (White, 1992). This has implications for course design as assessment instruments should be developed which require a greater degree of analysis and synthesis.

#### **2.5.4 Work-load**

Research reveals that students believe they are taught most effectively (that is, they learn best) when what they are taught is perceived as interesting and relevant, is presented in a well-organized, clear and coherent way, openly and with enthusiasm, is assessed appropriately, and when there is not too much of it (Entwistle & Tait, 1990). For learning to be meaningful it should be built on interest of students, relevant content, reasonable work-load and the like so that understanding and application to real life will be promoted.

Conversely, when the learning situations overload students, it may be said to cause them to take a surface approach to learning. Entwistle & Tait (1990; 183) have also noted a correspondence between “feeling overloaded and using memorizing without understanding”, and between poor performance and “attributing difficulty in exams to an over- demanding course and bad teaching”. Here, excessive work-load is associated to the adoption of surface approach to learning (Chambers, 1992; Entwistle & Tait, 1990).

However, the nature of this association seems uncertain. Are we to interpret the fact that as Ramsden (1992) puts it that students who have adopted surface approach to learning most often perceive courses as having a heavy-work-load, and this as a cause of poor performance, as a further defining feature of a reproducing orientation: that is, these students perceive the work-load as heavy because they are not attempting to distinguish

between matters of central and marginal significance, for example, but are trying to commit every thing to memory? Or, conversely, should we take it that among other things a heavy work-load 'forces' students to take a surface approach to learning and is indeed responsible for poor performance in exams? In so far as Entwistle and Tait reach a conclusion, it seems to be that if enough students agree that a course is overloaded, then we can take it that the latter interpretation is the correct one (Chamber, 1992), and one can also see implications for syllabus or course design in that it suggests that teacher may need to teach less and reflect more carefully about what they teach.

Moreover, Chambers (1992) argue that, if the challenge of the content or task is too high students will be put off by it and will learn at a surface level; similarly if it is too low they will become bored by it and will adopt the same approach. Rich understanding manifests itself as the ability of the students to critically analyze new ideas, link them to already known concepts and principles, which will lead to their long-term retention that can be used for problem solving in unfamiliar contexts. For students to achieve this kind of transferable learning, they must (logically must) have sufficient time to devote to their studies. If they have no time to do so, discussion about what might constitute 'good' learning is simply irrelevant. This is because, if students' workload is perceived by them to be heavy, they will often attempt to cope by adopting a surface approach to learning.

Thus, when teachers overburden students, demanding more work of them than they have time to do; they create conditions in which what is to be learned is likely to be unintelligible, an environment in which students can not possibly learn well. If students do not have time to learn through deep approach, if they are always driven on by the demands of the lengthy syllabus, we leave them little choice but to skim along on the 'surface' of things, which does not promote understanding or long term retention of knowledge and information. Therefore, for students to be engaged in deep learning, 'having sufficient time' to do the tasks should be seen as necessary, though not sufficient, precondition of meaningful learning.

## **2.6 Science Education in Ethiopia: A Historical Perspective**

Modern education in Ethiopia was a recent phenomenon that appeared to have its foundation only in the first decade of the 20<sup>th</sup> century. The reign of Menelik (1889-1913) and the establishment of Addis Ababa as the capital of Ethiopia towards the end of the 19<sup>th</sup> century were highly pointed out for offering opportunities for its foundation.

Accordingly, modern education began with the opening of public school in 1908, which of course was not welcomed with enthusiasm by the clergy or the aristocracy as there was a fear that it could serve as a vehicle for the penetration of alien religion and introduction of sinister ideas to rock the statuesque (Solomon, 2008), despite the fact that emperor Menelik overcame it by adopting a reconciliatory policy like hiring expatriate teachers who are Coptic Christians from Egypt (Teshome, 1979). Hence, it was during this time that science appeared as part of the curriculum together with French, English, Arabic, Italian, Amharic, Ge'ez, mathematics, physical training and sports (Teshome, 1979: 29). Since then the teaching of science remained part of the school curriculum in Ethiopia. However, curriculum during this time stressed the teaching of foreign languages. Besides offering science as subject in the curriculum; its wider importance was not considered.

The development of education in Ethiopia was further enhanced after Emperor Haileselassie's coronation in 1930, the earlier regent Teferi Mekonnen. Accordingly, in the period 1920-1935 several primary schools were opened during which French or English were used as a medium of instruction. The curriculum varied from school to school and the subjects taught during this time included: mathematics, physics, chemistry, civil engineering, language, home management, drawing, and physical training (Solomon, 2008). Science education was still part of the curriculum through its sub-fields.

However, the modest attempt to modernize the country through western education was disrupted by Italian occupation (1935-1941). After liberation from Italian occupation in 1941, with the reorganization of the education system from the scratch, the first secondary school; Haile Sellassie I Secondary School was established. Hence, the

teaching of foreign languages which was essentially the objective of the pre-war Ethiopian education was later proved not adequate for there was severe shortage of resources and man power in the post-liberation period (Teshome, 1979).

Moreover, curricula and textbooks used in the schools were identified as not oriented toward *the Ethiopian World* in view of the fact that the teaching staff was overwhelmingly foreign (Woube, 2005). Similarly, Teshome (1979: 69) noted that the curriculum during this time was not well thought out, nor was it tailored to the fundamental wishes of the people or to the characteristics of Ethiopian children. These were mainly attributed to the lack of organized curriculum and expatriate dominated teaching staff (Solomon, 2008).

Science education and curriculum development during Haileselassie's regime in the post-liberation period was highly influenced by British and American Education systems. Moreover, there was also changes in the education structure which Woube (2005) identified as: a) The first curriculum (*6-6 structure*), b) The second curriculum (*8-4 structure*), c) The third curriculum (experimental, *6-2-3 structure*) and, d) The fourth curriculum (*6-2-4 structure*). All of them have in common the intention to Ethiopianize the education system.

In an attempt to Ethiopianize the curriculum and solve the lack of uniformity in the previous curriculum which created difficulty to transfer from one school to another, the first uniform elementary curriculum was formulated in 1947 (Solomon, 2008). Amharic was the medium of instruction only for grade 1 and 2, and was taught as a subject from grade 3 to 6. The curriculum in which science was part consisted of subjects like Amharic, English, arts, geography, history, arithmetic, music, handcraft, and physical education (Maaza, 1966 as cited in Solomon, 2008). Although the *first curriculum* made it possible for students to transfer from one school to another, the intention to Ethiopianize education, however, was not realized for curriculum remained foreign in both approach and content (Teshome, 1979). Ethiopianization in later years of the regime was reflected-mainly in the language of instruction, Amharic.

The *second curriculum (8-4 structure)* was formulated in the year 1949 with the intention to overcome the learning difficulty created by English, the medium of instruction from grade 3, through extending primary education up to grade 8, so that students will have good background of English before joining secondary schooling. However, science education together with other subjects in secondary education was entirely geared toward the requirement of London matriculation for secondary graduates with no regard to the Ethiopian reality (Maaza, 1966 as cited in Solomon, 2008).

With the assumption that the school curriculum and imported textbooks were not adapted to the national needs and the use of English in the early grades was absolutely unsound, the *third curriculum* was proposed in 1957 and tried out in experimental schools. However, it was left unimplemented nation wide (Solomon, 2008). The inclusion of too much irrelevant content, the use of too much technical or scientific terminology and the like were among the inadequacies of the curriculum at the moment (Ayalew, 1964 cited in Woube, 2005). Thus, one can deduce that the teaching of science was teacher – centered, examination oriented and emphasized memorization. Though these and others were noted for necessitating the change of *8-4 curriculum* to the *fourth curriculum (6-2-4 structure)*, it remained less connected with the Ethiopian reality and was criticized for incorporating wider program of activities from the old school curriculum (Ayalew, 1964 cited in Woube, 2005).

This was the time the American education system prevailed over the Ethiopian education system, mainly between late 1950s and 1974. Science education in the country gradually changed from the influence of British type curriculum to American type curriculum reflecting the changes of the respective countries. Hence, the event of Sputnik in 1957 which consequently led to process and skill movements in science education in USA in 1960s and Science A Process Approach [SAPA], the Nuffield Science Projects in the UK in 1970s was found to influence the science education teaching in Ethiopia as well (Berhanu, 1999 cited in Akalewold, 2001).

This is because the previous Socialist and Imperial Governments' education legislation had advocated that science was to be taught, at least partially, as a process of practical inquiry (UNESCO, 1961; MoE, 1980/4/6; EMPDA, 1987/8 cited in Bekalo & Welford, 2000). However, such rhetoric was rarely translated in to a workable curriculum or active classroom practice and the focus on rote learning of factual information in preparation for examination persisted (Bekalo & Welford, 2000). Solomon (2008: 46) has also argued that routine lecturing and rote learning dominated the teaching learning practice in our country and most teachers taught and still teach for the examination but not for the inherent values of the subject of the curriculum. Hence, it is such nontransferable learning and educational experience that contributed for education to be less responsive to solve real life problems of our country.

Though various measures were taken to improve the education system during the Imperial regime, it was highly criticized for being elitist, highly academic-oriented curriculum, for failure to accommodate secondary graduates, unequal access, irrelevance, highly centralized administration and for its failure to progress towards universal literacy pledged by the year 1980 on the conference of African Education in Addis Ababa (Tekeste, 1990; Seyoum, 1996; Marew, 2000 cited in Solomon, 2008: 47). This accordingly led to the dissatisfaction of parents, elites, even the church and the nobility. Secondary school and University students also began to stage demonstration and boycott classes (Solomon, 2008). Soon, the Government felt that there was the need to make a complete review of the education sector through a study known as Education Sector Review [ESR] in 1972.

Subsequently the study identified six major conclusions based on which 13 broad aims of education were recommended to guide the development of education at all levels in Ethiopia. However, the study was not made public until 1974. Hence, little public participation and lack of transparency of the process were suggested for contributing to resistance and opposition (Solomon, 2008). This became reason for the collapse of the imperial system in 1974. The recommendations of the ESR were also aborted.

Education during the Socialist Government in Ethiopia from the time of the revolution in 1974 until 1991 was characterized by many policy pronouncements, but there was no officially published educational policy statement. However according to Feleke (1990) cited in Woube (2005: 64) the process of development of curriculum during this time was not founded on the evaluation results of the old curriculum, rather it was characterized by more inclusion and exclusion of content in the same old curriculum of the day.

On the basis of the different proclamations issued, three familiar general objectives of education, which were slogan-like, were formulated: *Education for production*, *Education for scientific consciousness*, which some how reflected the importance given to science and *Education for socialist consciousness*. Accordingly, the Ministry of Education [MoE] developed a new curriculum known as “General Polytechnic Education” in 1980. However, it was decided to experiment the new curriculum before nation wide implementation as of 1981 (Solomon, 2008).

Although the experimental curriculum was on progress in sample schools, a decision was made to conduct an evaluative research known as the Evaluative Research on the General Education System of Ethiopia [ERGESE] in 1983, which was completed in 1986. Some of the reasons for conducting this evaluative research were: the expansion of secondary education beyond the capacity of the economy (particularly creating unemployable graduates), the deterioration of quality of education, the existence of meager educational resources, shortage of qualified teachers etc (Seyoum, 1996: 10).

Though the study came up with useful findings that could contribute to the reform, since the Government had already launched its Ten Year National Plan in 1984, the recommendations of ERGESE were not implemented, rather the study was simply shelved (Tekeste, 1990; Seyoum, 1996). After 8 years of experimentation the General Polytechnic Education was also left unimplemented nation wide, because of the Government’s shift in policy towards a ‘mixed’ planned and market economy (Solomon, 2008).

Despite the decrees and directives tried to bring change to the national curriculum, the Dergue Government left office with out bringing education change. Tekeste (1990) also described education during this period as being in crisis due to irrelevant and in appropriate methods, including failure to incorporate relevant practical experience. This accordingly led to the formulation of the current Education and Training Policy in 1994.

In a nutshell, the history of modern education and specifically science education in Ethiopia revealed that curriculum at different times was too academic and little based on the felt needs of the country's citizens. Teaching was also characterized as examination centered, and the system of evaluation emphasized memorization and rote learning in which reproduction of facts and lower levels of learning outcomes were considered as learning areas of high significance.

Hence, science education as part of the general school curriculum was noted for emphasizing factual information that the classroom teachers were expected to transmit to students traditionally. However, learning through fact based or content centered curriculum that reinforced the delivery of factual information, teacher dominated instruction and paper-pencil based summative assessments is identified for promoting rote learning - learning that can not be transferred to the real life situation due to its superficiality.

Superficial or rote learning, accordingly, will not continue as part of possessed knowledge of someone for it is easily exposed to forgetting after an exam. This, therefore, indicated that science education in Ethiopia was not made to reinforce transferable learning but superficial learning that contributed little to students. Hence, one can possibly say that this culture of superficial learning could have affected education for being less responsive to change social, economic, and political conditions of the country.

### **3. Research Methodology**

In this chapter I provided my readers with the approach that guided this study, the strategy and procedures I employed while conducting this study. I have also tried to show as to how all these are relevant to my research questions so that the audience could be clear about the research procedure I employed and justify the authenticity and credibility of the research results.

#### **3.1. Research Approach**

This study relied on qualitative research approach. This is because; it is believed that qualitative research approach has the strength to answer my research questions. Maxwell (2005: 22), for instance, described the strength of qualitative research as follows:

*The strength of qualitative research derives primarily from its inductive approach, its focus on specific situations or people and its emphasis on words rather than numbers.*

This research approach is traced to its philosophical foundation namely constructivism, which assumes that reality and truth is subjective, interpretive and social construct (Creswell, 2003). Hence, they can never be complete and be discovered objectively in a detached manner from the 'researched' – as the philosophical foundation of quantitative approach, positivism, assumes to be so. The methodological implication of qualitative research approach, therefore, is that the social researcher is able to discover knowledge through interaction with the subjects not via distinct, in a detached or objective position from the sources of the data.

In a qualitative study, the interest is not only in the physical events and behavior that are taking place, but also in how the participants in the study make sense of these, and how their understanding influences their behavior (Maxwell, 2005). Therefore, using this research approach not only allows me to come into contact with participants at their natural setting where I could grasp the complex, constructed and subjective reality but also to capture the meanings each participant attaches to what he/she is experiencing through science curriculum from his/her own perspective, and how what he or she is experiencing affected his or her own behavior.

### **3.2. Research Strategy**

Under the umbrella of qualitative research approach, there exist different research strategies which share much in common, yet get different in points like focus of study, place of theory in an enquiry, and styles of analysis and reporting (Creswell, 2003). These varying strategies are: case study, ethnography, phenomenology, narratives, and grounded theory (Creswell, 2003).

Hence, in order to understand the problem understudy and answer the research questions, I employed qualitative case study. Of course, the type of research and the appropriate strategy to be employed by and large could be influenced by the nature of its research question (Creswell, 2003). A basic categorization scheme for the type of questions is the familiar series “who”, “what”, “how”, and “why”. Qualitative case study in general is the preferred strategy when “how” or “why” questions are being posed, when the investigator or the researcher has minimum control over events, when the focus is on process than outcome, and when the focus is on a contemporary phenomenon with in some real-life context (Yin, 2003: 1).

We conduct qualitative case study research when we want to understand the contexts or settings in which participants in a study address a problem or issue, we can not separate what people say from the context in which they say it (Creswell, 2007). Hence, case study enabled me to study for a variety of evidence and provided me the means of getting the experiences of students about science curriculum they are experiencing in Shashamanne General Secondary School.

Survey research on the other hand, typically assesses a few variables across a large number of instances, where as case study concentrates on many, if not, all the variables presented in a single unit. Survey studies are deductive in nature in that, variables are selected for investigation from theory before the study, and thus do not suit this study. Hence, I found case study appropriate to describe whether students of Shashamanne General Secondary School view the general secondary education science curriculum as a challenge or a burden from their own perspectives.

### **3.3. The Researcher's Role**

Traditionally, what a researcher brings to the research from his/her own background and identity has been treated as "bias," something whose influence needs to be eliminated from the design, rather than a valuable component of it. However, Putnam (1990) as cited in Maxwell (2005:38) argued that there can not, even in principle, be such a thing as "God's eye view," a view that is the one true "objective" account. Any view is a view from some perspective, and therefore is shaped by the location (social and theoretical) and "lens" of the observer. Hence, in qualitative research, the investigator's contribution to the research setting can be useful and positive than detrimental (Creswell, 2003).

Therefore, in the entire process of this study, I have tried to keep a focus on learning the meaning that the participants hold about the problem and at the same time by having reflective and interpretive stances in the results of the enquiry. Hence, I have turned out to be not only crucial research tool but also a practitioner in meaning construction. Generally speaking, all possible efforts were made to set aside intentional influences of my own presuppositions, theoretical knowledge and common senses about the case through out the data collecting and analyzing process.

Regardless of the approach to inquiry, gaining access to research sites requires an individual to get permission from a "gatekeeper", a group or an individual who has insider status of the research setting (Creswell, 2007). Hence, I was able to secure a letter of permission from the Shashamane Town Education Bureau and subsequently from Shashamane General Secondary School principals to conduct this study in the school context. This accordingly, allowed me to establish rapport with the participants in the school so that they disclosed detailed perspectives about the problem under study.

### **3.4. The Research Setting and the Participants**

The research site is Shashamane General Secondary School (SGSS) which is one of the government-owned high schools in Ethiopia. It is named after the town, Shashamane. The town is located 25kms North-east of Hawassa and 250kms South of Addis Ababa, and is the seat of West-Arsi Zone Administration in Oromia Region. The total population of inhabitants living in the town is estimated to be around 150,000.

Shashamanne General Secondary School was previously named as Biftu Elementary and Junior High School which was from grade 1-8. After, the then high school which served as a Technical and Preparatory School for few years grown to Technical Vocational Education and Training College, and following the completion of construction of buildings for preparatory school in the place adjacent to it, Biftu Elementary and Junior High School was renamed as Shashamanne General Secondary School in the year 2003 G.C. However, there was also a recently upgraded elementary school to general secondary school in the year 2000 E.C., which is renamed as Millennium General Secondary School. But due to the fact that the school is new, not well furnished and has only one year's age it was not selected for the study.

There were a total of 3802 students registered in the academic year 2008-2009 in the Shashamanne General Secondary School of which 2016 are males and 1786 are females enrolled in both grade nine and ten. There were 30 and 27 sections for grades 9 and 10 respectively. The school was working in full time in double shift (morning and afternoon). At an average, there were 90 students in each section. Usually four students sat on a single desk. The seating arrangement was in the traditional way *i.e.* in rows where all students faced the blackboard and the satellite TV screen and each student could see the back of other students. There were also a plasma box and TV case to keep in the TV screen. There were 72 teachers in the school of which 63 were males and 9 were females, and the maximum load for a teacher is 30 periods per week.

Eleven different subject areas were offered in each grade as any other General Secondary School in the region. These subjects include biology, chemistry, physics, mathematics, English, civic and ethical education, history, geography, Afan Oromo, Amharic, and physical education. The first six subjects were offered through the satellite TV instruction while the rest five subjects were taught on face-to-face bases without being televised.

Participants of this study were science curriculum expert in Institute for Curriculum Development and Research [ICDR], students and science teachers of Shashamanne General Secondary School. Accordingly, a total of 15 participants comprising one senior

science curriculum expert, eight grade 10 students and six of their science teachers were purposively participated in the study. Three previous science teachers and now graduate students of Curriculum and Instruction, and Physics Education, were also participated in the study though not directly but through invitation to take part in analyzing the science curriculum materials in their respective fields so as to enhance attempts of collecting appropriate data for the research under investigation.

The idea behind qualitative case study research is to purposefully select participants that will best help the researcher understand the problem and the research questions (Creswell, 2007). But it has to be noted that this does not necessarily suggest random sampling or selection of a large number of participants, as typically found in quantitative research. Accordingly, participants involved in this study were identified using purposive sampling based on their expressiveness, cooperativeness, responsibility and concern. Hence, what they inform enabled me to understand the problem and answer the research questions.

In the course of the interview, participants involved in the study have also contributed in suggesting possible key informants which I also later confirmed for allowing me to better understand the problem under study. For instances, classroom teachers were able to indicate a possible student participant besides what I determined based on my observation in the research site. Therefore, participants' selection in the research was a process. It proceeded selectively until I ensured no new data was obtained from every added participant, of course, by respecting the commonality of their views also.

### **3.5. Ethical Considerations**

First and for most, the researcher has an obligation to respect the rights, needs, values and desires of the participant(s). Therefore, as a qualitative researcher I have given due attention to ethical matters throughout the enquiry process-from field entry to reporting phase-as a necessary condition to come up with credible findings. Accordingly, as recommended by Bassey (1999) and Creswell (2003) the following safeguards were employed to protect the participant's rights (see also appendix-A).

- i. The research objectives were articulated verbally so that they are clearly understood by the participant (including a description of how data will be used);
- ii. Research participants real names were kept anonymous; and thus they were ensured confidentiality and thereby establishing mutual trust with them;
- iii. The participants were informed of data collection devices and activities.
- iv. Being faithful to the participants by avoiding distorting and/or deleting of their views and, in line with ontological assumption of the research approach, I adopted multiplicities of perspective through unreserved efforts to see things through the eyes of the participants. Hence, adequate description of the case that portrays how they view the curriculum was provided.

### **3.6. Data Collection Tools**

The research questions of the study seek multiple forms of data gathered from a natural setting through interactive and communicative tools. In case study it is also believed that more clarified responses (data) about what experiences the science curriculum presents to students and the way they could view it can be obtained by using a combination of different methods (Yin, 2003). Accordingly, in this case study, multiple forms of data were collected through semi-structured interviews, unstructured observation and relevant documentary evidences.

#### **3.6.1. Semi-structured Interview**

Semi-structured interviewing is necessary to get deep feelings, values or how people interpret the world around them (Wilkinson & Bhandarkar, 1999). It allowed the process of interview to be flexible and some what conversational. Thus, senior science curriculum expert in ICDR, science teachers and students of Shashamanne Secondary School were interviewed.

Interviews were recorded for later transcription, and this allowed maximum attention to be given to the interviewee rather than concentrating on taking notes. However, I also took notes while the interviews are underway and immediately after the interview sessions. Every effort was made to minimize the effect of using audio recording up on the interviewees' responses, and it was explained to the participants that the recorded interview were to remain in the author's possession.

The interviews were conducted in Afan Oromo and Amharic; in a language the participants mainly students feel ease to express their feelings, and translated to English. After transcribing of translations, an educator who had no knowledge of the participants listened to the audio recordings to check the accuracy of my translations.

### **3.6.2. Unstructured Observation**

In observation the researcher takes field notes on the behavior and activities of individuals at the research site. In these field notes, the researcher records, in an unstructured or semi structured (using some prior questions that the inquirer wants to know) way, activities at the research site (Creswell, 2003). It helps to actively, carefully and self-consciously describe and record what people do whilst one may be, one self, part of the action (Merriam, 1988: 102). Moreover, it is a check, enabling the researcher to verify that individuals are doing what they believe they are doing (Le Compte & Preissle, 1993).

Accordingly, unstructured observation was employed using a form of recording observational data that contains spaces for descriptive notes (portraits of the participants, a description of the physical setting, accounts of particular events, or activities) and reflective notes (my personal thoughts) was used. As a result, I spent about one month and two weeks time with the research participants in the research site, school environment. Thus, as a participant observer, I watched what the participants did, I listened to what they said, and I interacted with them.

The overall fieldwork study lasted from January 20<sup>th</sup>, 2009 to March 10<sup>th</sup> 2009. During my field study I observed classroom interactions while grade 10 students were learning Biology, Physics and Chemistry. As a participant observer, I was hunting and looking for students own feelings, expressions, and views about what they learn mainly science in the school under study.

### **3.6.3. Document Analysis**

During the process of research, the qualitative investigator may collect: public documents such as newspapers, minutes of meetings, official reports or private documents such as personal journals and diaries, letters, *etc* (Creswell, 2003: 188). Hence, NETP document, science curriculum guide and textbooks for grade 10, nature of science assessment tools at the school and other relevant documents were analyzed.

### **3.7. Data Analysis Procedures**

In qualitative study, data analysis usually starts immediately after the first interview, the first observation, and the first document record. This idea is also represented by Maxwell (2005: 95) when he states:

*...the experienced qualitative researcher begins data analysis immediately after finishing first interview or observation, and continues to analyze the data as long as he or she is working on the research stepping briefly to write reports and papers.*

This simultaneous data collection and analysis is the best way of doing case study because one does not know whom to interview, what to ask, or where to look next without analyzing data as they are collected.

Moreover, after conducting the interview by using an audio recorder, the recorded responses and the field notes taken by hand were transcribed. The first version of the transcription has contained almost all of the information, including the details, given by the participants. I tried to take notes and remember the feeling of the participants in order to not focus only on the spoken aspects of the interview when transcribing. Data reduction or condensing the data was carried out later. Codes were used to signify themes drawn from the interviews and observation.

Moreover, by spending much time in the field, I tried to grasp the ideas, understandings and practices of the participants, which could lead me to an honest representation of their views.

### **3.8. Reporting Style**

Although data collection and analysis strategies are similar across qualitative methods, the way the results of the study are reported is diverse (Creswell, 2003: 205) maintains creating a data display and narrative text has been the most frequent form of display for qualitative data. However, since this study is a naturalistic study, a study that tend to collect data in the field at the site where participants' experience the problem under study (Creswell, 2003), the results were presented in descriptive narrative form rather than as a scientific report.

Hence, the final result of this project was the construction of the participants' own views and meanings. The themes developed from the study were based on participants' experiences, meanings and my subsequent understanding of the problem.

### **3.9. Strategies for Validation**

In ensuring the trustworthiness and authenticity of the finding, the following strategies (as recommended by Creswell, 2003: 202) were employed:

- i. Triangulation- in answering the research questions raised, the researcher used different forms of data that were gathered through semi-structured interview, observation, and other relevant document.
- ii. Long terms and repeated observations at the research site-so as to get enough time and opportunity to collect extensive data and there by understand the meaning participants attribute to the science curriculum, the researcher spent about one month and two weeks period of time in the field.
- iii. Use of rich, 'thick' description- in communicating the finding of the study, each interpretive theme was extensively described using direct quotes from the participants.
- iv. Member checking- The participant have served as a check throughout the analysis process. An ongoing dialogue regarding the researcher's interpretations of the participant's reality and meanings ensured the truth value of the data.
- v. Critical considerations to ethical issues were also taken into consideration as a pivotal step towards ensuring the credibility of the finding.

## **4. Results and Discussion**

This chapter critically examines the data I collected and read thoroughly to capture the meanings underlying the science curriculum documents and the views of each research participants about science curriculum and its teaching. This is done to develop an understanding, and answer the research questions. Looking for the emerging themes from each participant, I revisited the data again and again to check if I have grasped the views of each participant. Hence, while seeking for uniqueness of views (still respecting the commonly shared ones), I constructed three umbrella themes: the intended curriculum, the implemented curriculum, and students' hopes and expectations to learn science curriculum, under which sub themes were discussed. While doing so, extensive direct quotes from each participant and research results from literature have been cited throughout the descriptions and discussions of the results.

### **4.1. The Intended Curriculum**

Curriculum can be represented as the 'intended', 'implemented' and 'attained'. The intended curriculum is primarily concerned with the official curriculum materials from policy papers to official textbooks. Hence in this section the New Education and Training Policy document, science curriculum guides, and science textbooks were utilized in analyzing the intended curriculum.

#### **4.1.1 Constructivist oriented Education Policy *vis-à-vis* Reductionist Curriculum**

It seems after recognizing wholly expository styles of teaching of factual information in preparation for examinations which emphasize pure recall or memorization may be poor development of citizenship that the New Education and Training Policy [NETP] was formulated in 1994. Consequently it emphasized the development of problem solving capacity of individuals.

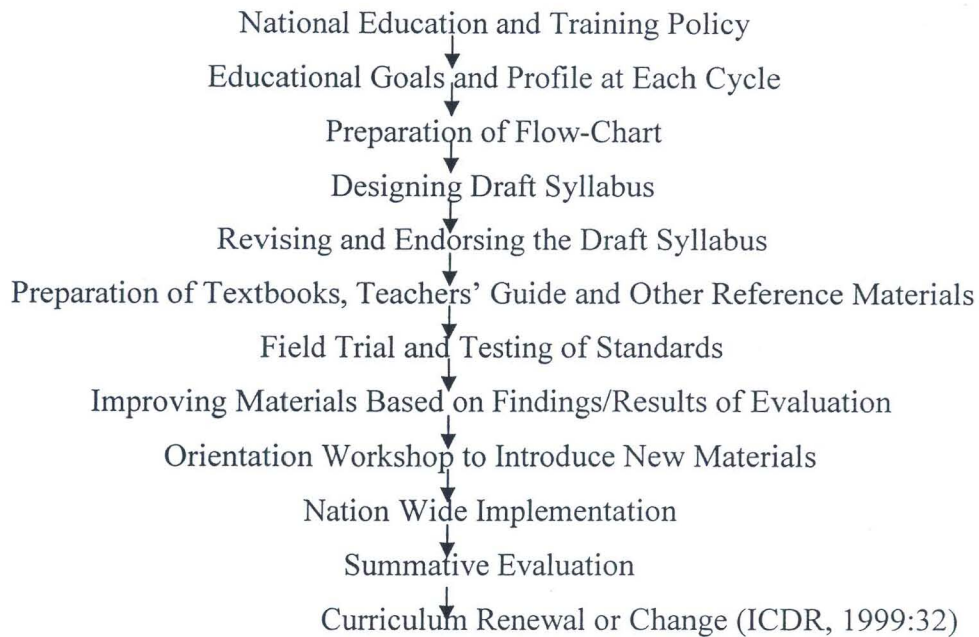
Accordingly, five general and fifteen specific objectives together with overall strategies at the broader level such as curriculum, educational structure, educational measurement and examination, and the like were identified as a means to achieve the intentions of the Policy. It was stated that the preparation of curriculum materials should be based on

developing problem solving capacity among students, reinforcing student-centered approach. The utilization of continuous-assessment in the academic and practical subjects was also advocated so as to appropriately relate education to environmental and societal needs (TGE, 1994).

Therefore, it is possible to say that the philosophical foundation of the Ethiopia's Education and Training Policy most closely seem to match the constructivist approach. Hence, the Policy documents and its strategies largely raised the issues of problem solving, student-centeredness of instruction, continuous assessment and decentralization of education. Theoretically, it is believed that philosophy is the beginning point in curriculum decision making and is the basis for all subsequent decisions regarding curriculum. This is to mean that the philosophy underpinning the Policy will help to answer what schools are for, what subjects are of value, how students learn, and what methods and materials to use and the like (Ornstein & Hankins, 2004). This in turn implies that the theory of knowledge our education Policy embraces is fundamental to the view we take of curriculum and must provide the starting point of curriculum planning.

However, though the New Education and Training Policy seems to be grounded in constructivist approach, in the latter sections of this chapter it is evident that many aspects of the education system — the curriculum, textbooks, examination, and classroom practices strongly reflected the reductionist behavioral approach to curriculum planning and implementation. Unlike the constructivist approach knowledge in reductionist behavioral approach is viewed as external and absolute. But the constructivist approach regards knowledge as tentative, contextual, and that can actively be constructed by students. Thus, my question is don't you think the initiatives in the Policy and curriculum contradictory? Perhaps this might be attributed to the differences of group of authors. But it is logical to ask the question: can we fire the gun using inappropriate bullet?

In Ethiopia curriculum development processes and its materials as discussed also in Solomon (2008) were based on technical-rationalist, Tylerian linear approach or the Objectives model. The linear approach to curriculum planning is also evident in the model adopted and used by ICDR. The model consisted of 12 steps of curriculum development as indicated bellow:



As the model above shows, the Ethiopian secondary school curriculum is more centralized. This in turn indicated that Ethiopia is still following a top down tradition of curriculum design processes. The top down curriculum designs as in Tylerian rationalist approach adheres to the traditional, academic, content-rich curriculum designs. It is also based on the view that the more rigorous the means, that more likely the desired ends will be attained (Ornstein & Hankins, 2004). Now hopefully it is obvious that curriculum planning in Ethiopia tends to be guided by quite clear and specific statements of intended learning outcomes, and defined in terms of measurable changes in student's behavior. By assuming the mastery or attainment of specific objectives turn by turn leads to the realization of broader objectives.

Important is the fact that curriculum planning of such kind is highly susceptible to simplification of the complex nature of scientific knowledge. This in turn makes teaching and learning less problematic and the opportunities for problem solving quite

alien as in the didactic approach. Textbook dependency and lack of inquiry characterize such kind of curriculum. Efforts made are accordingly related to ensuring whether students are presented with opportunities to gain such a large body of knowledge.

Despite the intentions of our education Policy, learning is subjected to simplifying or breaking down broader issues in to discrete facts so that students can acquire them one after the other. This is also evident in the curriculum guides or syllabus (ICDR, 2005a, b, c), where general objectives are broken down into specific observable behavioral objectives for students to attain them through time.

However, the approach our country's curriculum planning assumes is not suitable for most of the learning that goes on in and outside the school. This is because we don't acquire knowledge and then, at some later stage attain understanding as Bloom's Taxonomy offers us - a hierarchical model of relationships between the objectives with in the three domains *i.e.* cognitive, affective and psychomotor. Rather they must go hand in hand.

Concentrating only on observable behaviors in writing objectives trivializes learning. It encourages surface approaches by giving exactly the wrong messages to students: that achieving the signs of learning is more important than achieving the changes in understanding that should underlie them (Ramsden, 2003). It is also equally mistaken to think that every important objective, particularly less concrete ones concerning changes in attitudes, can be pre-specified. Specific objectives written in the science curriculum guides (ICDR, 2005a, b, c) also made it explicit that the learning objectives are largely cognitive in nature (see *figure 1* in page 54).

Hence, it is possible to say that the intentions of the New Education and Training Policy seem to remain obsolete in the process of curriculum development. Though problem solving, abstract/ creative thinking, cooperative learning and positive affects are found better achieved in research through child-centered, constructivist approaches (Woolfolk, 1993), the model adopted to plan the curriculum, the written curricular materials, and its implementation largely, made it explicit that learning is viewed from the perspective of

the acquisition of factual knowledge. This consequently promoted only superficial level of understanding, or a kind of learning which can not be transferred to real life situation.

As discussed earlier, it is clear that what the Policy demands (*pages 47 and 48*) and what the actual curriculum (*pages 48-58*) tries to address do not correspond. And it is possible to argue that contradictory policy and curriculum can create a dilemma for the delivery of educational services in school hence they are grounded in different and contradictory philosophical initiatives. Attempting to implement conflicting initiatives in the education system where the Policy emphasized constructivism and curriculum guided by the reductionist behavioral (Tylerian type) approach, makes the realization of the intentions of meaningful educational reform difficult.

Apart from this, science classrooms center on curricular content coverage. Opportunities for conceptual understandings of science contents and processes through deep learning are rarely considered. As a result science lessons fail to develop learners who are intrinsically motivated and who will go much further. Students in the class will remain those who wait to be told what to learn and those who are less likely to pose questions about the natural world. They rarely investigate and try to find things on their own. They rather rely on what their peers or teachers provide them. Hence, it is possible to say curriculum of the kind will rarely lead them to coherent conceptual understandings or deep learning. Science education in turn, dooms susceptible to superficial learning which can not be transferred to real life situation.

As discussed above, a typical consequence of failures to achieve meaningful educational reform initiatives could be tensions and frustrations among those who are involved in the overall process of curriculum development. Curriculum planners blame school teachers for not enabling students attain the necessary profile. Students blame the immediate individuals – teachers, for not enabling them reach at meaningful learning that will allow them understand what they are learning. Like wise teachers attribute failures to realize improvements to students' "poor" background and inability to understand what they are learning, and blame the Ministry for attributing failures to them when in reality they are made less responsible in the context of rigidly prescribed and live plasma transmission dominated science lesson instruction from the center.

An important implication here is, the tensions between the conflicting initiatives and the subsequent blaming games among the curriculum planners and implementers (teachers and students) could be some how reduced when one avoids all too common 'one size fits all' approach. More adaptive and flexible strategies will avoid detailed elaborations and over-specifications of central curriculum frameworks. Thus, there need be substantial options and flexibility to school, teachers and students. Although struggles about priorities in aims and contents will remain inevitable, the principle of 'less is more' a quote subsequently taken as a motto for minimalist design needs to be pursued.

#### **4.1.2 Analysis of Curriculum Guides**

The general curriculum objectives for secondary science as depicted in the curriculum guides (ICDR, 2005a, b, and c) and the interview responses of the curriculum expert in ICDR indicated that science subjects offered in general secondary schools should help students to acquire:

- a thorough foundation of knowledge
- practical skills in application of Knowledge
- conviction of the value of knowledge

The curriculum guides set out general and specific statements that the students achieve in the science teaching by the end of the secondary school in terms of cognitive, psychomotor and affective behaviors.

Of course, curriculum guides typically included not only desirable general and specific objectives but also listing of contents, specific materials, and possible methodological experiences and forms of evaluation. However, besides prescribing the entire components in a detailed manner it says little on how teachers and students can experience it flexibly with diverse situations of the school.

However, in analyzing curriculum guides, objectives were used as a reference, on the basis of Benjamin Bloom's taxonomy of objectives: whether they reinforce higher level thinking skills or not. Accordingly, objectives were a unit of analysis in analyzing curriculum guides. This is because other aspects of the curriculum guides were seen in a detailed manner under the implemented curriculum in the science teaching and learning sessions of the selected general secondary school.

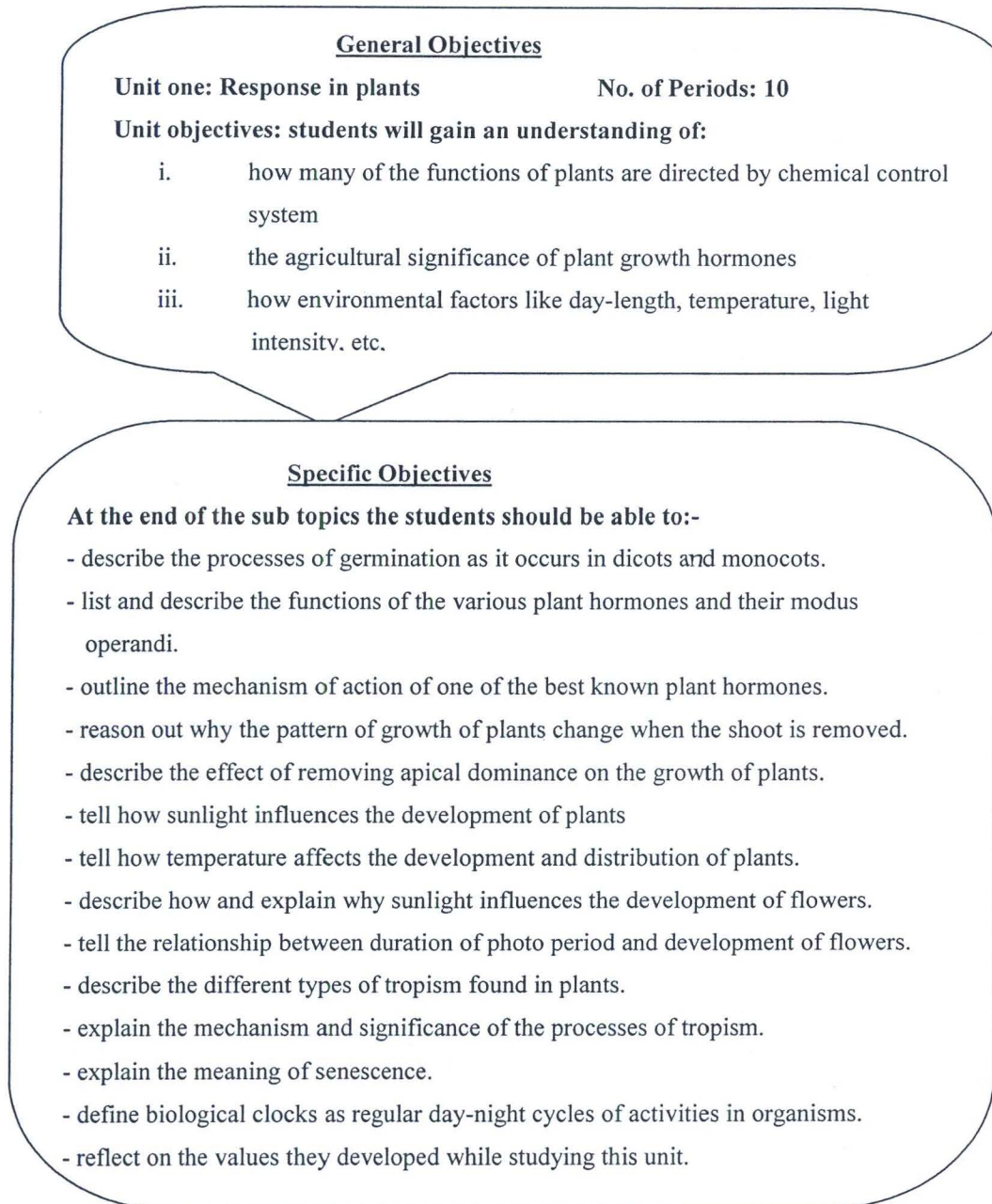
**Table 2: Statements of the general objectives of science education- extracts from the biology, physics and chemistry curriculum guides for grade 10.**

In terms of knowledge (cognitive behavior)	In terms of skill (psychomotor behavior)	In terms of the development of convictions (affective behavior)
Knowledge of biological, chemical and physical phenomena, facts, principles, laws and regularities	Interpreting experimental results, making correct deductions from tested hypotheses;	Develop consciousness, carefulness and neatness in observing and experimenting.
Knowledge of procedures and techniques for carrying out experiments;	Handling scientific equipment carefully and setting apparatus for experiments;	Participate in working in a society.
Mental operation like imagining, analyzing, realizing, comparing, reasoning, classifying, grouping	Measuring physical quantities and using SI units	Perceive the laws of nature act independent of our consciousness
Knowledge of the application of the disciplines in daily life.	Observing processes and phenomena carefully.	Appreciate scientific views, natural processes and phenomena.
Developing inquisitiveness, critical thinking and scientific evaluation, eagerness for learning.	Observing processes and phenomena carefully.  Using experimental methods in every day life to acquire more knowledge.	

The general educational objectives in the science curriculum guides (as summarized for grade 10 physics, chemistry and biology curriculum guides in *table 2*,) appear at first glance to emphasize higher order science learning. The statements are evidence of the desires to make science learning for deep understanding.

However, in the specification of educational objectives, it is possible to understand that science learning is reduced only to acquiring of lower level factual knowledge. This in turn mainly reinforces surface learning, a kind of learning that can not be transferred to solving real life problems.

**Figure 1: Lists of general and specific objectives as adopted from Biology Curriculum Guide (ICDR, 2005 b)**



As it is clearly seen from *figure 1*, science learning intentions, unlike what is broadly indicated in *table 2*, seem reduced to acquiring of lower level science facts. The specific objectives in the figure above predominantly address lower level learning outcomes. They require students to master only what is assigned in the textual material.

Students were not required to go beyond the material or form some kind of “processing” of the information that is not already in the textbooks, just as in the higher level learning outcomes. Thus, it is less likely to reinforce practice oriented science learning, but memorization of information about science. Put simplistically, this kind of learning will not enable students to solve problems and renders less helpful in bringing conceptual change on the part of students. It has also little effect on challenging students’ common sense understandings.

#### **4.1.3 Analysis of Textbooks**

Following the implementation of the 1994 New Education and Training Policy, the first publications of science curriculum for General Secondary Education was done in the year 1999 and 2000. Nevertheless, the current science curriculum in use was revised in 2005 based on the following rationales (EMPDA, 2005a):

- there was a great demand by students such that the volume of the textbook is within the learning limit of the learner and be coverable in a year.
- it was required by the students and teachers that the contents of the units need simplification
- it was essential to check the relevance of the content in relation to the desired civic and ethical values to be learnt by the students
- there was also a need for horizontal integration of science curricular contents.

It seems that, it was by taking these facts into account the volume of the textbooks were minimized to the desired level without decreasing the actual content of lesson, but only the details (science curriculum expert in ICDR). In line with this the current biology, physics and chemistry textbooks are seen for having a total number of 240, 183 and 261 pages respectively.

Of course, it was indicated in the textbooks that successes in studying science subjects will not be achieved as a result of sheer memorization of formulas and the like. But it should be through solving problems, experimentations and close observations (EMPDA, 2005a). However, as can be discussed below such intentions seem less materialized, as the classroom realities and analysis of certain science learning practical activities show.

Actually, in each unit of the biology, physics and chemistry textbooks they commonly begin with lists of learning objectives and proceed with, scientific description and definition of the concepts, present practical activities, exercises (check points), and towards the end of the chapter involving project work.

The total numbers of practical activities in each of the textbooks are: 70, 25 and 23 for biology, chemistry and physics respectively. This shows that, as compared to what is presented in biology there is limited numbers of practice oriented science learning activities in physics and chemistry textbooks.

So, again, as science teachers of the school commented, textbooks are relatively better designed when compared to the previous science curriculum materials and their old school day experiences as students. However, they commonly felt discontent that science teaching through plasma TV robbed the opportunities of using such activities in the textbooks for science lessons. At the same time previous science teachers and now graduate students of Curriculum and Instruction, and Physics Education at AAU also shared similar feelings. While added the inadequacy of the time allotted in the curriculum guides for practical activities to be experienced as planned in the textbooks. Students in their part commented it is better if science textbooks are used to teach science in place of plasma TV dominated lesson presentation. Similarly, science curriculum expert in ICDR added “the condition in which science is taught in secondary schools does not allow teachers and students to properly utilize textbooks.” “ምንም ወርቅ የሆነ ካሪኩለም ቢዘጋጅ መምህራንና ተማሪዎቹ በአግባቡ ሊተገብሩት ዘንድ ሁኔታዎች እስካላስቻሉ ድረስ ጠቀሜታው ሊታይ አይችልም።” (Curriculum expert, March 8, 2009)

From the above quotation it is possible to understand that the way plasma TV is used currently for teaching science in general secondary schools of Ethiopia was not considered during the science curriculum planning by ICDR. This is also some how evident in the mismatch of the period allotted to science subjects in the curriculum guides (4 periods per week) and the number of periods students are learning science in the school (3 periods per week).

The problem is, however, the curriculum developed to be taught in four periods per week couldn't be covered under the three periods' science teaching by the plasma TV, unless rushing through the contents without ensuring students meaningful science learning or either is taken as a possible means.

In addition to this, as shown in *figure 2* and in some of the activities presented in the science textbooks, students were told exactly what they should measure, observe, investigate and conclude. There are detailed instructions which students are expected to follow when doing the activities. However, it is less doubtful that such detailed instructions shift the purposes of the activities from engaging students to seek for learning to the confirmation of taught concepts of science.

**Figure 2: Activity- The Effect of an Acid on Indicators (EMPDE, 2005c:100)**

**Apparatus:** knife, test-tubes with rack.

**Chemicals:** Group I: Lemon, orange, and grape fruit;

Group II: Vinegar, milk, and rancid butter;

Group III: dilute HCl, HNO<sub>3</sub>, and H<sub>2</sub>SO<sub>4</sub>.

**Procedure:** 1. Cut, open and taste Group I fruits

2. Taste Group II substances

Caution: Group III substances should not be tasted.

3. In a test tube pour about 2ml of each of the three group substances and test them with litmus paper

**Questions:** What is the color of litmus in each of the substances in Groups I – III?

**Results:** Group I and Group II substances have sour tastes. All the substances in Group I-III turn blue litmus to red. They all contain acids.

As it is possible to understand from *figure2*, such activities do not allow students to make decisions such as to select appropriate instruments, to identify and manipulate variables, accumulate appropriate results or interpret and communicate their findings. Therefore, there are limited opportunities for students to pose questions and seek for engaged learning that enable them challenge their naïve understandings and adopt scientific understandings as intended.

What students learn in science lessons, therefore, should not complicate conceptual understandings in a discipline by focusing too much on the details. It should link to the very every day life. But then it should move beyond the everyday, common-sense understanding to scientific understanding through “analogies, empirical reasoning, and discussion” (Chambliss & Calfee, 1989 as cited in Buckland, 2001: 123). In other words, in order to persuade students to accept the scientific understandings, the way the curriculum and textbooks designed need to identify common-sense or naïve understanding of students. And help them move to the framework of scientific understandings. Consequently, students learning will be intrinsically motivating, deep, meaningful, and transferable to real life of an individual.

A well-designed textbook therefore contains a coherent design and a curriculum that reflects the scientific understandings and enables students to go beyond the information they are given reflecting on what they have read. In other words, the science textbooks can facilitate deep learning, if they are able to serve as a bridge between students’ common sense understandings of how the natural world works and the scientific understandings.

## **4.2 The Implemented Curriculum *vis-à-vis* Student Burdens**

This major theme discusses about the curriculum concerned with what actually takes place in science lessons in comparison with how students of Shashamane General Secondary School could view them. Accordingly the following three major themes were discussed as follows.

### **4.2.1 Fact based Curriculum**

It is indispensable that the centrally planned curricular materials can have the power to either nurture or stifle students’ meaningful learning. In other words what is taught in the classroom might allow students to be engaged deeply and meaningfully in what they are learning, or go through surface of things which can not help them in the school and in their later years of life.

More specifically, curriculum that is developed being rooted in reductionist behavioural approach and guided by the fidelity perspective to its implementation is less likely to engage students in deep understanding of the science concepts. It offers a surface grasp of a shopping list of facts. It regards scientific knowledge as absolute and considers textbooks as a store of knowledge to be memorized. This in turn, indicates that scientific knowledge is presented to students merely as a collection of truths. Hence, it encourages students only to memorize and accept what ever the teacher gives.

Beside this, how teachers are expected to deal with the formal curriculum in the educational settings can also help to determine the way teachers perceive curriculum materials, and students experience them in the school. Of course, there are three possible perspectives in studying curriculum implementation: the fidelity perspective, the mutual adaptation perspective and the enactment perspective (Snyder, Bolin & Zumwalt, 1992).

These perspectives differ in their views on the role of teachers and students in constructing learning experiences, and in their definition, and focus on particular representations of the curriculum. Central to fidelity perspective, is the question of the degree to which a particular curriculum on paper is implemented as planned. The mutual adaptation perspective recognizes that complete implementation is impossible in practice and a curriculum will always be adapted to specific situation. Thus, the later approach considers that real-life situations in the classrooms are always more complicated than can be anticipated in a formal curriculum representation.

In the enactment perspective on the other hand, the curriculum materials are seen as tools for students and teachers, to be used in the construction of enacted classroom experiences. And curriculum is viewed as a set of educational experiences jointly created by students and teachers (Snyder, *et al.*, 1992). Moreover, the creative role and full responsibilities of the teachers and the uniqueness of each situation is stressed. Thus, it is exclusively an operational and experiential curriculum and is not a formally documented one.

More specifically, in the fidelity perspective the teacher's task is to do what is prescribed in the curriculum and implement the curriculum as intended regardless of the situational differences. Here, operational and experiential representations of the curriculum are only relevant in so far as they are compared with the ideal and formal representations. This perspective adheres mainly to the reductionist behavioural approach to curriculum planning.

However, the mutual adaptation perspective has more regard for the responsibilities of teachers and for situational differences. As in the fidelity perspective curriculum is defined in terms of consciously directed experiences. But, unlike the fidelity perspective the impossibility of planning all relevant learning experiences for students in a formal curriculum and teacher's responsibility to consciously adapt the curriculum to real and concrete situations is considered.

Of course the issue of perspectives to curriculum implementation was not raised without purpose. But it is to allow readers to deduce from the onset whether the perspective in which our country's curriculum implementation based offers opportunities for teachers and students to flexibly materialize it in accordance with the suitability of situations in the school.

The fidelity perspective to curriculum implementation is evident at least in the general secondary education level science curriculum. This is because, the centrally planned and rigidly prescribed science curriculum is presented through the plasma TV instruction with little or no intervention by science teachers and students at school level. Thus, science teaching remained '*teacher-proof*' and less responsive to the situational differences in the school.

The top-down centralization and standardization of contents and procedures of educational delivery implies that the role of the implementers is relegated to the secondary position. A centralized control over what teachers do and what students learn could reduce curricula in to easily testable bits. This is done to legitimize unquestionable truths and technical knowledge as the optimal form of human knowledge and inquiry (Fuller, 1991).

Hence, it is possible to argue that the science curriculum for general secondary schools is less susceptible to engaging students in intrinsically motivating science learning. It rather seems to encourage only memorizing of what is given by the televised teacher through the plasma TV screen. Here what one of my interviewees, a student anonymously named Tadesse commented is worth mentioning:

*Unlike enabling students better understand the concepts; teachers wish to teach us how we can better calculate questions that might appear on examinations. But I doubt. Can memorizing formulas and using them to compute questions, regardless of conceptual understanding make me learn science more? ግንዛቤ ሳይኖረኝ ፎርሙላዎችን ሽምድጄ ጥያቄ በሰራ ሳይንስን ተምረሃል እባለሁ?* (Feb.22, 2009)

Tadesse made it explicit that, curriculum does not allow them to try to find things out on their own but to rely on what teachers provide them with guidance to get things right. This is also evident in the lesson observations as the main feature of televised lesson instruction revolved around the transfer of factual information and confirmation of taught concepts. Nevertheless, the science lessons were entirely didactic, and seem designed exclusively to promote learning by rote. Another student anonymously named Abdissa reported:

*We rarely refer to text books. We are not given homework or assignments. What we learn mainly depends on the short notes given either through the plasma TV screen by the televised teacher or on the black board by the classroom teachers* (Feb.24, 2009).

Similarly what student Abdissa reported portrays students were made to passively accept what is written or presented, which is actually contrary to what the true nature of science requires and the intentions of our education Policy. Students were not made to go from the information to understanding that information. But they were only made to rely on the level of the information they were given. This in turn paved the way for the development of students' misconception to consider getting the short notes plus attendance to the lesson presentation as enough to learn science. Beside this, the effect of fact based curriculum in reinforcing students' rote learning was also made justifiable in what one female student anonymously named Hirut lamented:

*Though the medium in which we are now learning is new (English), what we learn is not totally new. But, since we consider that what we have learned and taken exam on in previous grade levels will not come to us again, we forget it soon and it reappeared as new.* ነገር ግን እንደምንም ተጨናንቀን ተምረን በቃ ይህንንም ተገላገልነው ከአሁን በኋላ አይመጣብንም ብለን ስለምናስብ የድሮው ይጠፋናል። (Feb.22, 2009)

From what Hirut lamented, the science curriculum they are learning featured continuity in the organization of curriculum. But it is also evident that continuity in the organization of the curriculum by itself without ensuring students coherent conceptual understanding is less likely effective. Like wise, science teachers also confirmed that science instruction in the school is rarely leading students to deep search for understanding. Regarding this a teacher anonymously named Yadessa explained:

*Previously we had the difficulties of covering the contents, due to the voluminous nature of text books which together with students' expectations and teacher's obsession to learn and teach page by page respectively made it complex. But these days though the science lesson planning and practice appeared in accordance with the plasma lesson broadcast, a vast content if we were teaching that required more than two or three lessons is made to be covered in one period* (Feb.5, 2009).

However, it should be noted that science teaching is not equated with offering a myriad of facts through the curriculum. Science learning is not memorizing of information, rather it is a kind of learning that needs to involve varieties of activities like *hands on* – allowing students to perform activities as they construct and acquire understanding, *minds on* – providing activities that focus on core concepts to allow students develop thinking processes and encouraging them to question and seek answers that enhance their knowledge and thereby acquire an understanding of the world in which they live, and *authentic experiences* – presenting them with problem- solving activities that incorporate authentic, real life questions in a way that encourages collaborative effort, dialogue, and generalization to the broader ideas and application (Driver, *et al.*, 1996).

The nature of science required science lessons to emphasize not only on teaching science concepts *i.e.* facts, principles, laws and the like, but also the process by which these

concepts can be acquired. However, the reality in the science classrooms portray science was offered only as a body of knowledge to be mastered. This is also reflected in what a teacher anonymously named Hailu who teaches physics reported:

*For instance in the chapters “Electronics, Electricity and Magnetism’ you can find terms like capacitor, capacitance, resistor, resistance... beside giving them short notes on these terms that they should read, and summarizing the lesson orally let alone my students, I my self do not know what these things are practically.* ተማሪዎቹ ይቅሩና እኔ ራሴ እነኚህን ነገሮች በተግባር አሳይ ቢባል ወይም መሬት ላይ ተጥለው ባገኛቸው አላውቃቸውም። (Feb.2, 2009)

What is noted by Hailu has also shown, fact based curriculum and rote level learning is what characterized science learning in the school under study. Moreover, what physics teacher anonymously named Mulat pointed out “I feel ashamed of being unable to repair my Television set when it stops working and going to maintenance shops to seek for the services” could also be evidence on how science learning used to reinforce non transferable learning:

However, grounded in the views of behavioral objectives approach some people would argue students can not apply higher-level of thinking processes until they have a wealth of factual knowledge. But I disagree, primarily because, acquisitions of factual knowledge do not necessarily lead to conceptual understanding since questions of ‘how and why’ are rarely raised in fact based curriculums. Secondly, knowledge or information is not an end of our country’s educational intention, it goes beyond that.

I was surprised to realize, as I came to understand more in this work, the generally shallow cognitive level most of us have experienced as students in our educational paths, the feeling which curriculum expert in ICDR also shared “I learned biology more not while I was a university student but after I started teaching the subject in secondary schools.”

Of course this is largely the result of superficial knowledge that emerged from fact-based emphasis in text books and curriculum designs. Therefore, care must be taken here not to

blame the victim that the superficial learning or surface approach to learning is not necessarily the students' fault; it is mainly a problem inherited in the curriculum, text book design; as well as its level of familiarity and interest to students.

#### 4.2.2 Teacher- Electronic device- and No body-centered Instruction

Under fact based science curriculum students who dutifully learn the facts perform the questions or computations given and attend the science lesson demonstrations could be found, but it would be hard to argue that such activities can lead them to deeper conceptual understandings and to be eager learners. This is to say that the impetus to learn generally does not come first from the content only rather because a teacher has learned to make the content appealing.

However, classroom realities of science lesson indicate that classroom teachers have limited role in the science lesson instruction. Teacher participant anonymously named Mesfin also said:

*“Since 30 out of 45 minutes assigned for the period are spent on the live broadcast, how can I cater the needs of the 90 to 95 students in a class, where the first five minutes are for class transfer and lesson introduction, and only with the last remaining ten minutes? ...This is just impossible with this condition”* (Feb.9, 2009).

While he was resisting the way the plasma mode of teaching is administered, its live transmission, and the amount of time allocated to it.

Of course, a classroom teacher needs to be motivated and empowered to carry out his/her task of teaching. A teacher is more responsible for what happens in his/her classroom than a televised teacher in the plasma screen. The apparent shift of science teaching responsibility from classroom teachers to televised lesson presentation through plasma TV robbed student-teacher and student-student interactions, made them more passive than what used to happen. In connection to this student Abdissa felt discontent and explained that:

*There is little or no student-teacher and student-student interaction in the learning process. We have no one who worry about whether we understand what is presented or not. ስለሌሎች ሰዎች ለሰው ሰው የለም:: From about 90 students in the class, there may be only three students who the teacher considers work well, and science instruction also centers only on these three students* (Feb.24, 2009).

The mentality of the students as noted by Abdissa in his last sentence reflects if teachers don't care why should students? This is to mean if teachers showed no interest in getting to know how students are learning or finding out why they are not performing to their full potential, the student would not try to do better.

Science learning in the school was only something that happened to students by televised teacher. Classroom teachers have little time for interaction with students in the class, and it is also not logical to blame them as the only sources of the problems, where the classroom reality made them little responsible. Beside this the televised teacher couldn't read the feelings of the students, and respond how they should progress to learn science. As a result it seems appropriate to argue that there is less concern to refer to how students are learning and need to learn science by the Ministry of Education, despite the intentions in the Policy. This poor student-teacher interaction, lack of feed back and care to students have contributed for the majority to lose hope to learn science. Another student anonymously named Ebissa had also similar feelings:

*I largely dislike subjects like Mathematics, Physics & Chemistry. Teachers do not give us homework's, class work and assignments that might help us to work and understand. Rather they say do the exercises for yourself. ጥያቄያዎችን ለራሳችሁ ስሩ። Our teachers themselves do not have motive to teach in a way that is appealing to us. There are only few teachers who summarize what is presented by televised teacher. Others even do not do so (Feb.20, 2009).*

In addition to the above presented interview based evidences, in each of the lessons observed for the three subjects: biology, chemistry and physics, learning was limited to lecture, lesson demonstrations by the televised teacher and classroom setting only. Never were students observed learning science out side their classrooms and there were no 'hands-on' activities, the live plasma broadcast also do not allow to do so. Except for few (commonly less than four students) active participation in listening, writing, or answering questions were simply absent.

However, from what science teachers are saying on students' lack of motives to learn science, it is possible to identify that one attribution is to students' attitude towards the subjects. This is actually evident in the words of chemistry teacher anonymously named,

Mesfin as quoted below:

*If you want the truth, our students at large do not want to put courageous effort to learn science; rather they say why I worry to learn science, the difficult subject. ሳይንስን እማራለሁ ብዬ ለምን ጭንቅላቴን አፈነዳዋለሁ። They label science subjects with words like science the very difficult, untouchable subject. ከባድ፣ አይነኬ። Our students main concern is to get only 50 marks by hook or by crook that will allow them pass from one grade to another (Feb.9, 2009).*

Apart from this another science teacher has come to point out that even certain teachers themselves do not reflect positive feeling towards their field of study in which they have graduated and now teaching in the school.

*Students relate learning science and other field of study with the benefits they might secure in the world of work, like getting assigned in higher government position which could allow them to secure many advantages. Just like what some of the science teachers say regretting for being science graduate ኤጭ ሳይንስን መማሪ ምን ጠቀመኝ። (Yadessa, Feb.5, 2009).*

From what teacher Mesfin and Yadessa said it is possible to understand that students' lack of motivation to engage deeply in learning science emanated from their negative attitude towards the courses and the benefits they would earn from studying the course in the world of work at least in the present context of the country. A curriculum expert in ICDR in this regard had also commented:

*Students lack motive to learn science because they have negative attitude towards the courses. This is also reflected in their poor results in grade 8 and 10 regional and national examinations respectively (Curriculum expert, March 8, 2009).*

It seems that the only reason students participate in schooling is to receive a pass mark or avoid punishment. In other words instead of gaining competence in what they are being taught, and seeking for challenge that would enable them understand the material through deep learning, the students judgment seems only getting pass marks through avoiding challenging situations. Actually, what student anonymously named Inku reported also seems to support this view:

*Science is difficult to understand only through theoretical presentation, and is not amenable to memorization too. ሳይንስ ለሽምጊቅ አይመችም።*  
*Even reading as in other subjects does not allow you to understand science. That is why I don't want to waste time in reading science textbooks, and wish not to join science fields. I need to choose subjects that are understandable and more likely to lead to better results. ብዙ የማይለፉኝና የተሻለ ውጤት ወደ ማገኝበት ማዘንበል ስላለብኝ ነው።*  
(Feb.25, 2009)

Of course it is critical to note that students' motive is to complete tasks without thinking too hard. Hence, it is possible to say that students' orientation to learning is at a rote-level or superficial. Just like trying to have short notes that can be read and memorized during the exam time.

However this kind of learning is noted for limitation to persuade students in changing their common sense understanding and adoption of scientific understandings. Moreover, the natural curiosity of students, eager to understand their surroundings is often diminished by such instruction for it discourages inquiry, which the nature of science itself required (Martin *et al.*, 2001). A student anonymously named Tadesse regarding this explained:

*Let alone using what we learned in school to solving problems in our daily lives, it is often difficult for us to understand science clearly through theoretical presentations. Some times it even contradicts with what we already know. Since the way we learn science lessons is less convincing I rarely accept them. አሳማኝ ስላልሆኑ ብዙ ጊዜ እኔም አልቀበላቸውም።* (Feb.18, 2009)

It is believed that students learn science concepts and processes meaningfully when the instruction connects science lessons to students common sense understandings, organize activities around a new lesson, allow them reflect strategically around what they are learning, and give them occasions to extend what they have learned to new contexts (Martin *et al.*, 2001). However, Mulat's science teaching experience shows that science is commonly taught in the school focusing mainly on scientific understandings.

*Frankly speaking I teach the way we were taught. I focus on allowing my students acquire science concepts. To this end, I define important terms in the lesson, tell what formula to use and explain the daily lesson using one or two examples. End the lesson with summary* (Feb. 3, 2009).

If students' naïve conceptions and scientific knowledge do not connect and intertwine, learning of science concepts is reduced to rote memorization of facts (Roth, 1990). Science teaching and learning process in the present context of the school is not in a way student can challenge their previous misconceptions and adopt scientific understanding by appreciating it. Science lesson presentation by classroom teacher also focused on the disciplinary understanding.

The qualitative experiences of classroom activities fails to engage the knowledge or ability or stimulation of students, and it is less likely that they will engage in what they learn. These unappealing characteristics of the academic task may consequently lead them to academic disengagement. That is why educators like Millar (1997) underline portraying science in the classroom as a body of established knowledge that students must merely assimilate is regarded as responsible for turning many young people off science.

*The students cannot tell even what they have learned in the previous lesson topic, but if they were asked about the week end match between Manchester and Liverpool Football Club in the English Premier League they can precisely tell who scored the 1<sup>st</sup> goal at what minute. This reminded me what a teacher said last year when speaking to low achieving student, "You came already dead, I will get you buried"*  
“ሞተህ መተሃልና እኔ እቀጠርሃለሁ።” (Yadessa, Feb.5, 2009)

Though good teachers are said to be like good parents; for they offer a secure base and create an environment that lets students' brain function at their best (Goleman, 2006), from what Yadessa reported it is clear that some teachers cursed at the students or disrespected them. These experiences in turn made the student feel uncomfortable in the classroom and discouraged them from learning. Frequently, this relationship is caused by teachers forcing students to learn the material that does not interest them (Passe, 1996). Consequently, they feel they are less significant in that classroom and there is little they can do to be successful any more in that subject (Slavin, 1994). Therefore, if teachers are unable to confront the student in a positive manner the student wouldn't be open to learn and try harder.

Instigated by the issue, the interview I made with other science teachers made it explicit that a feeling of hopelessness is prevalent among teachers of this kind. Nesredin has similar feelings:

*Though we were not paid better salary, we used to feel satisfied on the achievement and success of our previous students. But these days how comes satisfaction when the students we have largely are unmotivated to learn and sometimes even do not know why they come to school (Feb. 7, 2009).*

Teachers' hopelessness is related to difficulties and failure of their students to understand their lesson and achieve better results in the exam.

Of course, the justification for disseminating similar type of education using similar modes of delivery, the televised lesson broadcast seem to provide all secondary schools of the country the opportunity to get uniform and standard instruction and address quality and equitability problems of education. The Ministry of Education [MoE] designed sets of lessons for some subjects of secondary schools i.e. English, Mathematics, Biology, Chemistry, Physics and Civic education to be transmitted via plasma television using satellite technology.

Though science instruction is thought to be advantageous these days by the Ministry of Education for the technology can demonstrate experiments, it appeared to stifle students' meaningful learning too. Learning science through plasma TV in the school portrays that the televised lesson instruction contributed largely in making a dent to students' interest to learn science meaningfully.

*The plasma lesson presentation rushes from topic to topic regardless of the pace at which we learn. The language level and the pronunciation of the plasma teacher are beyond the level at which we can understand. We can not listen properly to what she [the televised teacher] is talking about. አንድን ቃል ከሌላው አጋጭታ ስለምታልፍ አንሰማትም። That is why many of my friends wish if the lesson is finished soon. ቶሎ አልቆ በተገላገልን። (Hirut, Feb.22, 2009)*

It was also observed that students felt uncomfortable to get back to class after they are out for break, and heard saying "how short the break is!" "ውይ ከመቼው አለቀ!" It seems as if only they were forced to go to class when they get back to class in a reluctant

walk. Plasma TV demonstration is another form of teacher-centered instruction. However, though it is said to be better as compared to ‘chalk and talk’ kind of science teaching, it has little contribution to allow students to meaningfully understand science concepts and processes.

Thus, in its present form, learner- centeredness is not working in the school. Rather students remained passive in the science lessons and even do not have motive to ask questions on what they cannot understand. Abdissa also shared similar feelings and commented:

*Students feel frustrated to ask questions when they do not understand the lesson since they have difficulties in English, the medium of instruction. We prefer to keep quite and watch only what is done in the class (Feb.24, 2009).*

Though the students have learned science subjects in the previous grade levels, the science terms were either in Afan Oromo or Amharic. But when they join high school (beginning from grade 9) they encounter new learning media, plasma TV and new medium of instruction, English. Due to this reason as Hailu pointed out “...sometimes the lesson I teach regardless of its intentions is made to focus typically on teaching vocabulary of the discipline.”

If science learning is minimized to teaching vocabulary of science, developing understanding of science concepts and process is severely limited. Science learning will only become memorizing of the definition of terms. Without the underlying concepts teaching science in this way is akin to isolated weeds and seeds that are likely to be blown away by the winds of the time, usually mere hours after an exam.

Hence, the opportunities to learn through intrinsically motivating science lessons remain obsolete. This is also what science curriculum expert in ICDR lamented “Science instruction through the plasma TV is not teaching science but killing science.” This clearly portrays that science lesson demonstration through plasma TV fails to persuade students to change their naïve conceptions. This is also the case in the words of one female student anonymously named Hirut:

*Majority of the students consider learning through plasma TV as watching television at home or looking at picture. They do not seriously take it as a learning medium. When they are unable to go with its pace they ignore it saying, who cares! የራሱ ጉዳይ! (Feb.22, 2009)*

In the interview with student Hirut language was one of the major problems reported. The speed, the pronunciation of the televised teacher and the amount of information presented through the plasma TV worsened the difficulties of students in learning science. It also seems appropriate to argue that the students could understand a learning material better if they had a good skill of English before the language become a medium of instruction.

Accordingly, if students do not have time to learn through deep approach, if they are always driven on by the demands of the lengthy syllabus, as it is also observed and possible to understand from what students and science teachers are saying, the learning opportunities require them only to skim along on the surface of science concepts, which doesn't promote understanding or long term retention of science knowledge and information. This is apparent in the words of Physics teacher, anonymously named Hailu as follows:

*Televised lesson presentation is suitable to cover contents with in the academic year. In all the three periods allotted to teach the subject, there is live plasma transmission. It is too fast that students have difficulties to understand the lesson and even to copy notes from the screen. In that case I try to give them short notes on the blackboard, and use the last 10 minutes time to summarize the lesson (Feb.2, 2009).*

Accordingly the responses of Hailu (the views which other teachers shared) implied the introducing of the plasma lesson instruction as directed to the fulfillment of subject matter coverage, where many contents were made to be covered with in a short period of time. Text books and curriculum guide coverage pressure reduces the amount of time available for students to solve problems and think beyond the facts (Erickson, 1998). Students have little or no room to be engaged in deep or meaningful learning. Beside this students also report being in dilemma of whom to follow as indicated bellow:

*The difficulty we have in learning science is not only the fast flow of televised lesson presentation, it is also confusing whom to listen.*

*Certain teachers give us notes on the chalkboard, while others do the explanation simultaneously with the plasma TV broadcast. When we try to listen to the classroom teacher we miss what the televised teacher is demonstrating and when we shift our attention to the plasma broadcast we miss something of what the classroom teacher is explaining (Mahbuba, Feb.24, 2009).*

Classroom observations of certain lessons also indicated that students are sandwiched between what the televised teacher demonstrates, and the explanations and/or notes classroom teacher's give. This kind of communication, at the same time involved message and noise which can disrupt communication. That is why students lack meaning to what is done to them in the science learning classes and remain in confusion of whom to follow. This was also the case the researcher observed where many of the students sitting at the back ignore what the classroom teacher and the televised teacher present, and do what they wish with the near by student, a kind of nobody-centered instruction. Another student has also said:

*In previous grade levels, I was learning in my language and I had no difficulties to understand the concepts as such. Here, the subjects I learn in English are all difficult for me. Sometimes I get confused of whom to follow when classroom teacher gives note on the chalkboard and the plasma teacher presents the lesson simultaneously. But, I don't restrain from going to school and reading the subjects, whether they are understandable for me or not. ቢገባኝም ባይገባኝም እኔ ማንበብንም ሆነ ወደ ት/ቤት መሄድን አልተወግድም። (Meaza, Feb.19, 2009)*

The New Education and Training Policy [NETP] advocated the use of student-centered or learning for meaningful understanding, but what is practically observed in the school under this study remained the opposite of the intentions. Science learning is reduced to listening to the televised teacher (a lesson presentation that students label not understandable) and copying of the short notes either from the chalkboard or the TV screen. But students learn at an early age that some of these activities do not help them understand science, and have no value outside their classroom. As a result, they lose interest and meaning to what they learn, feel unmotivated and adopt surface approach to learning. "They cut classes and prefer sleeping to learning during lesson presentation by plasma TV" (Hirut).

Therefore, to make learning more challenging and intrinsically motivating science instruction should move from traditional, teacher- electronic device- and textbook-dominated instruction towards more meaningful, activity-based and practice-oriented science learning. If schools teach students for understanding, then they can respond much better to the changes in society, technology and the like. But students taught only by rote to follow only certain concepts and procedures a teacher provides, instead of being taught the underlying governing principles that justify the concepts and procedures, are more likely lost when circumstances change. Their learning will also remain nontransferable and easily forgotten.

#### **4.2.3 Paper-Pencil based Science Assessment**

Science teachers and students who participated in the study said science learning assessment in the school took place twice a semester: when the plasma lesson broadcast is off for a week in the middle and towards the end of a semester. Therefore it is quite possible to say that assessment in the school have a purely ‘summative’ function (serving to report on students) and as having nothing to do with teaching students at all. As one science teacher Nesredin said:

*Frankly speaking, it is said that students should be assessed continuously but there were no cases we assessed our students continuously. It is only through midterm and final examinations. The dominance of the plasma presentation in all three lessons of the subject does not permeate to do so (Feb.7, 2009).*

Another teacher Hailu also reported “let alone assessing students continuously or engaging them in the learning process through student-centered styles, there is no time to know whether students have understood the lesson or not”. Moreover examination papers for all the three subjects (Biology, Chemistry and Physics) which are prepared by each of the department for mid term and final examination involved only multiple choices, true/false, matching and short answer items. However, these tests can not effectively evaluate whether students have learned how to design an experiment, make accurate observations and measurements, analyze data, and reach reasonable conclusions.

*Assessing science through paper-and-pencil tests is akin to assessing a basketball player's skill by giving a written test. We may find out what some one knows about basketball, but we won't know how well that person plays the game (Hein & Price, 1994: 54).*

Students can accidentally give correct answers to questions without understanding why they are correct. For instances, true/false and multiple choice (“multiple guess”) tests are obvious examples of this, but so are tests where a student can answer using enough material they have memorized or remembered, to be able to give an answer that fools a teacher in to thinking they are demonstrating understanding. ‘Learning’ from this perspective, is adding quanta of knowledge to one’s store of knowledge and assessment is seen as an activity that should test how much has been added (Ramsden, 2003:178).

Therefore, assessment in the school remained an external imposition to students to be negotiated in order to earn a grade or pass mark, than a way of learning and of demonstrating science understanding. Student Hirut also explained:

*Students commonly begin reading their exercise books, or library is crowded when it is the time of examination. As a result many of them fail to understand what they have written in their notebooks and even could understand earlier. That is why they decide to cheat during the exam (Feb.22, 2009).*

This portrays that let alone reinforcing students’ science understandings, the process of assessment itself influenced the quality of student’s learning. It affected their approaches to learning specifically to adopt surface approach, and it failed to test understanding. Moreover, the examination papers of the science subjects as noted earlier in the school tested recall of information, knowledge associated with conceptual understandings, and contained some data response items. “After all, it is the quality of what one learns not the quantity. I have bits and pieces of memorized knowledge but no real understanding of the science concepts. From my experience I will soon forget the things I have learned” (Tadesse).

From what Tadesse and other students are saying it is possible to notice especially how they themselves are often painfully aware of the fact that the approach to learning they are using will lead to inferior outcomes. The danger of assessment in the school is not

only for being summative and limited to paper-pencil that accordingly reinforced superficial learning or rote memorization but also how the results of students scores are interpreted when the number of students who passed the exam is reported by teachers made it worse. This is worth mentioning in what one of the research participant anonymously named Nesredin lamented:

*We are pressurized to allow more students to pass [because it is counted in Teachers' Performance based Evaluation] by adding marks regardless of the students effort, which actually might have negative implication to how students might view being engaged in learning to understand science concepts and get better results (Nesredin, Feb.7, 2009).*

This accordingly influenced students to consider getting pass mark or being allowed to pass to the next grade level as a purpose of the academic work regardless of the teachers' intentions or the necessary profile attainment. This misconception in turn influenced students to learn only to pass than to understand the underlying meaning of science concepts. Another teacher anonymously named Mesfin had also similar feelings:

*To tell you the truth, students have developed bad behaviors like waiting to get something with out putting an effort to it. ሳይሰሩ ማግኘትን Even they consider cheating as a right. ከረጃን እንደ መብት ይቆጥራሉ። The number of students who can work on their own do not exceed 4 or 5 in a class (Feb.9, 2009).*

Beside this let alone enabling students to acquire the true nature of science education and using assessment as a way of teaching more effectively through understanding exactly what students know and do not know, the assessment culture in the school under study remained detrimental to students science learning at least in two ways. It reinforced the widespread of the students' use of surface approach to learning, and the development of students' misconceptions about the purpose of learning.

The most important implication here is that teachers need to convince students that learning rather than grades or getting pass mark is the purpose of academic work. This can be done by emphasizing the interest value and practical importance of materials students are studying and deemphasizing grades and other rewards (Slavin, 1994).

Moreover, assessment shouldn't be only for summative purpose but should also occur during the teaching and learning process with its primary focus on the ongoing improvement of learning for all students.

### **4.3 Students Hopes and Expectations to Learn Science**

Very broadly and based on what students are saying, there are four basic hopes and expectations of science learning experiences in Shashamane General Secondary School. These are related to interaction between students and teacher, their understanding (that is, deep as opposed to surface learning), the use of plasma TV as a teaching aid with manageable language and pace of presentation as opposed to the dominant means of science learning and the classroom unbounded science learning setting.

Apart from learning science largely from their classroom teachers students hope if there is good interpersonal relationship between students and teachers in the science learning environment. They want their teachers to worry about how they better learn, the pace at which they learn and the provision of necessary feedback on their attempts to learn science. A student Tadesse explained:

*There is poor student-teacher interaction in the science lessons. Teachers do not know the way we need to learn, and whether we understand the lesson or not. Thus, how a student can put an effort to work better where his/her progress is not monitored and feedback is not given (Tadesse, Feb.18, 2009).*

As a response to these demands students expect the establishment of good rapport between students and teachers in the science learning settings. They, for instance, mentioned the need to get time for student-teacher and student-student interaction so that the students' level of understanding of the contents will improve. In doing so, their communication skills, not only listening, but also speaking skills, and thereby their ability to think critically, have a better opportunity to develop.

Secondly, students want to understand the concepts being taught. Many of the students interviewed stated firmly that there was more to being a successful student than scoring a pass mark in science subjects. They believe that understanding is far better than

memorization. As one student Ebissa explained:

*The teacher gives you the concept, but he doesn't explain how the concept evolved. Of course, teachers do not have time to do that mainly in the subjects taught by plasma TV. So in the exam we are expected to memorize what we are told. We are looking at the results but very good results don't mean that we know (understand) everything. Some times it is very embarrassing when I am asked about something I am supposed to know, but I don't know how to answer because I don't know (understand) the concept (Feb.20,2009).*

Another student had similar feelings: "The main problem in learning science is we are not told the concept we just taught ourselves to remember every thing about the concept, so we just can not use the concept to apply to another context'" (Abdissa), While another commented: "... we might work well in exam, but it doesn't really mean we understand the concept" (Mebratu). Although a rise in test scores is often greeted with public enthusiasm, similarly as students commented, Passe (1996: 22) noted "many educators have long recognized that those results do not necessarily translate in to present and future success; the true goal is student-motivated learning that is sustained over time."

It is critical to note, however, that while these students hope and want to understand science concepts, they do not necessarily expect to do so, acknowledging the difficulties that may prevent this. As one student pointed out:

*The books in the previous grade levels were in my language. I read once, and understand. But here the textbooks are in foreign language, beside this science learning is not through laboratory assisted and practice oriented instruction. Reading text books and listening to lectures only can not help you to understand science (Mahbuba, Feb.24, 2009).*

Another student said, "Even in earlier grade levels teachers spoon-feed us and we just eat and eat and then vomit everything out.... But this is a habit, so it is hard to change it" (Tadesse).

Thirdly, these students hope, and expect if plasma TV is used as a teaching aid and thereby the time given to classroom teacher can increase. They also want if the pace and pronunciation of the televised teacher is in accordance with their level of understanding.

As one student anonymously named Hirut explained “the number of students who can not understand science lesson presentation through the plasma TV is by far more than those who can understand”. And another student pointed out:

I wish if all what I learn is in the language that I better understand” (Mahbuba). While another added, “It is better if the time allotted to the actual classroom teacher is more than for the televised teacher, because the classroom teacher teaches us in accordance with the level and pace at which we learn or understand better unlike what the plasma TV did to us (Mebratu, Feb.19, 2009).

Fourthly, students hope and expect if science learning is practice oriented involving ‘hands-on’ activities and assisted by laboratory experiment in the school. Moreover, they wish if it is also not bounded to 40 minutes lesson in the classroom. One student anonymously named Inku after sighing heavily lamented:

*What I learn in doing and observing in the surrounding, discussions with my friend, what I read from news papers and the like are not easily forgotten unlike what I get from the school, because in these things you are freely engaged, with interest and they are also appealing to you (Feb.25, 2009).*

It is true that science is not what is learned only theoretically in the classroom, it is also possible to extend science learning setting to every where since it is about the natural world, in which we live. It is a subject that is suitable to curiously pose questions about the natural phenomena and seek answers with interest through observation, experimenting, and the like. Another student added that:

*Science contents we learn are not actually what is not related to our surrounding environment but it is only the way we learn bounded only to teacher’s presentation in the classroom that makes it difficult and abstract (Hirut, Feb.22, 2009).*

And another student had similar feelings “It is better if science learning is not limited only to the short notes given by classroom teacher, and we had opportunities for class work, homework, projects that may allow us learn better and extend learning beyond classrooms” (Mahbuba, Feb.24, 2009).

Therefore, curriculum planners need to provide a coherent curriculum, organized around important concepts, rather than a potpourri of isolated facts. They need to connect the curriculum with students' own natural efforts to make sense of the world. This is because students remember familiar and meaningful information much more readily than non-meaningful information. The most usual way of increasing meaningfulness of what is taught therefore is to develop experiences with the things being learned and to relate new information in some way to things that are already known.

Like Brophy & Alleman (1991) cited in Lewis, Schaps, & Watson (1997:135), I believe that curriculum development must be driven by major long-term goals, not just short-terms coverage concerns. Thus a more challenging curriculum is more compelling to students. School that provide an important, challenging curriculum, and help children connect it to their efforts to understand the world, become allies in student's quest for competence – and teachers in those schools have a head start in being seen as supportive, valued adults.

However, faced with a competitive, skill-and-drill curriculum, educationally less-prepared children may preserve their self-esteem by reducing their efforts. They may psychologically withdraw from the school or school community, leaving it powerless to influence their social, ethical, or intellectual development (Nicholls, 1989 cited in Lewis, *et al.*, 1997). Consequently, under such curriculum the teacher teaches and then tests.

The teacher and the class move on, leaving majority of unsuccessful students, those who might not learn at the established pace and with in a fixed time frame and thus finish low in the rank order. This is also some how reflected in what student Meaza commented: "I wouldn't have ranked 1<sup>st</sup> scoring an average of 70% if there were better students in my class." "ከሌሎች ተማሪዎች ውስጥ ኖራለሁ።" This of course reflected dissatisfaction of students with their current level of performance in the school, though they are relatively able to secure better rank from the students in the class.

Thus, to make science curriculum meaningful and appealing to students in part the curriculum materials need to incorporate information about common preconceptions of students in the process of conceptual change, and the means by which the curriculum can bring about conceptual change. Inclusion of structured sequences of science experiences that will elicit challenge and provide opportunities to change preconceptions can also facilitate attempts to make science curriculum materials appealing to students.

If one is interested in enhancing science teaching and learning, it seems only reasonable to begin with an understanding of how students learn science. Beside this curriculum planners and classroom teachers need to consider to this end that students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information, or they may learn them for the purposes of a test but revert to their preconceptions outside the classroom.

Hence curriculum materials should be designed with the knowledge that students' current conceptions may not align with recognized scientific knowledge about how the world works and those current conceptions must be engaged and challenged in order for change to occur. Teachers also need to recognize as students come to educational experiences with preconceptions, engage the learner, facilitate conceptual change, and employ strategies that respond to students' prior knowledge like discussions, empirical reasoning and analogies.

## **5. Conclusions and Implications**

From the data collected and discussions made to understand how students' could view the current science curriculum, and explore their hopes and expectations to learn science in the context of Shashamane General Secondary School curriculum the following conclusions and implications were presented.

### **5.1 Conclusions**

#### **5.1.1 Why a Curriculum Is a Burden and Not-challenging to Students?**

The collected data and its subsequent discussions undertaken revealed firstly that despite the Policy rhetoric that promote students' active involvement in the learning process, science curriculum and its instruction in the school understudy reinforced shallow learning. This is primarily because of the little coherence between the intentions of the NETP and the curriculum materials (curriculum guides and text books). Hence, the initiatives underpinning the NETP (constructivism) and the science curriculum (reductionist behavioral approach) are different and contradictory. Consequently, the planned curriculum materials helped little to materialize the intentions to realize problem-solving citizens at least through science education in the school understudy.

Secondly, the wish to make science learning for problem solving is also left aside in the process of science curriculum implementation. Students remained passive and felt dissatisfied about what they are learning and the way they are learning. Teaching science through plasma TV made the instructional time to end without any live interaction of students among themselves and with their teacher. The high level of English language assumed by the plasma teacher, the speed of its presentation which creates difficulty for students' conceptual understandings and lack of class time to discuss with their teachers and fellow students pressurized them to adopt surface approach to learning.

Moreover, the fact based theoretical presentations of science lessons alienated from students' preconceptions, and the 40 minutes and classroom bounded science lesson presentation together with the paper-pencil based summative science learning assessments made students to study science subjects only for getting pass marks.

Hence, the learning situations, specifically the curriculum, instructional style, and assessment mechanisms were unlikely to challenge students' preconceptions. Rather, they featured unappealing qualitative science learning experiences. These in turn, robbed students' interest and boiled down the tone of science learning through intrinsically motivating lessons. To the contrary, students were to skim through the surface of things in an attempt to respond to the demands of mid-term and final examinations, which exclusively composed of objective items.

Thirdly, the majority of the students in the school under study valued deep and meaningful learning; however, they believed that they are often under considerable pressure from the above mentioned learning situations to reproduce science facts during examinations which might allow them pass to the next grade level. Consequently, students' natural desire to inquire, pose questions and investigate the natural world around them through direct observation, experimenting and the like were underplayed by the above science learning situations.

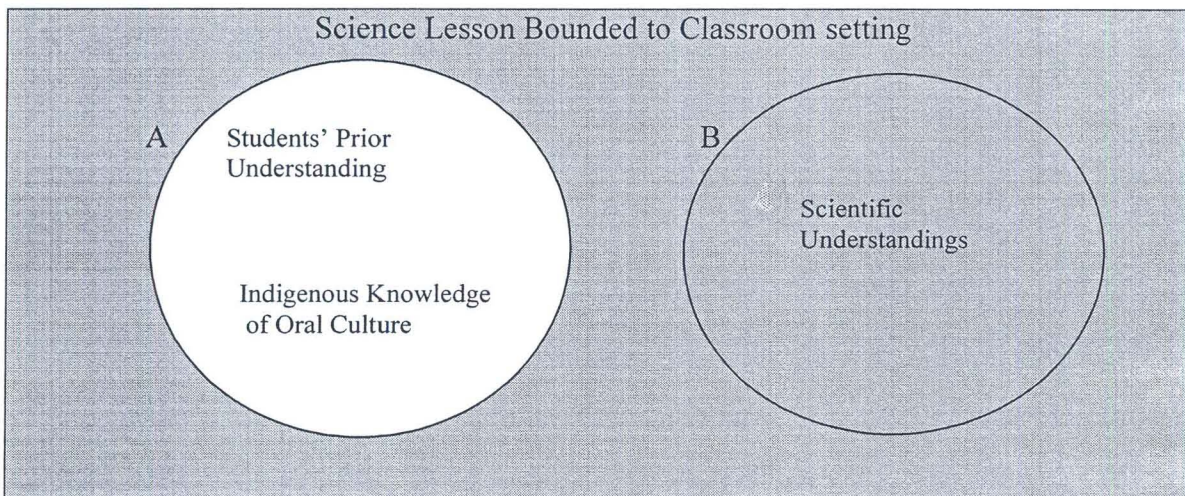
These situations implicitly or explicitly addressed to students as having short notes and attending to the science lesson presentation which would help them to recall during examinations, as the end of education. These situations made students to think of science as a hurdle to pass or having little importance to their later life, and to label it as a very difficult subject. Dewey (1964) as quoted in Passe (1996: 14) also confirmed the subject matter students' view as irrelevant and boring

*causes the child and the curriculum to be set against each other.... The subject matter...has no relationship to the child's present experience. It stands outside of it.... The material is not translated in to life terms, but is directly offered as a substitute for, or an external annex to, the child's present life.... It remains an idle curiosity, to fret and obstruct the mind, a dead weight to burden it.*

This is to justify that exclusive emphasis on teaching of imported Western culture originated scientific understanding, by underestimating students preconceptions made students not to see what is presented as something that makes sense and meaningful. Hence, detached from preconceptions or prior experiences that the students bring with them to the class, teaching of alien culture originated scientific understanding through

surface or superficial approach made students to think of science as having little relevance to them. This featured as science lessons appeared to be unappealing to students and powerless to challenge their preconceptions or incomplete understandings. That is why students viewed science curriculum as least interesting and wish to get rid of with the end of academic year or schooling. This adequately justified the truthfulness of what people traditionally say “አይዘን ትገላገላህ!” to student learning under the above discussed unappealing learning experiences in our schools. The figure bellow also illustrates the above discussed argument.

**Figure 3: A Model showing Traditional and Non-challenging Science Curriculum**



In this figure, the two circles ‘A’ and ‘B’ have no connection. This shows as students’ preconceptions and scientific understandings are alienated from each other in the science lessons. The closed rectangle is to show as science learning is limited to classroom lesson presentation that revolves mainly around scientific understanding only. The shaded part is to indicate what the science learning setting emphasizes on.

Alienated from students’ prior experiences which they develop outside the school and come with them to science lessons, delivering a myriad of science facts mainly through electronic-device centered live transmission of science lessons, bounded to 40 minutes instruction and classroom setting can not make science learning challenging and inspiring to students. This lack of inspiration for the curriculum can be overcome in significant degree by recognizing the importance of what I am calling ‘Romance’ to students’ developing understanding under the next subtopic.

Science learning is not challenging, and appear to be non coherent because the curricula presents predominantly of scientific understandings originated in alien culture, as in science education. And it is taught directly without contextualizing it or relating it to students' preconceptions on how the world works. Of course, there could be opportunities in which local examples may be given while teaching science knowledge, but their purpose does not go beyond confirming the science concepts. Hence, they do not extend students learning through deep approach.

Consequently, despite the Policy rhetoric to engage students through problem solving, the reality in the science lessons required students to passively receive increasingly abstract forms of science knowledge as presented by the plasma teacher or classroom teacher. In other words, though the ideas children bring with them are often believed to influence what and how they learn (Martin *et al*, 2001: 115), for they could have helped to romanticize and initiate students' intrinsic motivation, they are underestimated in the current science curriculum and its instructional process.

Therefore, as shown in *figure 3* science lesson presentations revolved only around imported scientific knowledge. Hence, there could be little or no opportunities to make the teaching-learning process student-centered and utilize continuous assessment to reflect on students' performance continuously. Science learning is only bounded to classroom lesson presentations and memorizing of less meaningful scientific terms for the tests after which they revert to their preconceptions outside the classroom. That is why science curriculum remained a burden to students.

### **5.1.2 How could Science Curriculum and Pedagogy be made Challenging in the Modern School?**

A modern school is expected to respond to three distinctive aims. It is expected to serve as a significant agency in socializing the young, to teach particular forms of knowledge that will bring about a realistic and rational view of the world, and to help realize the unique potential of each child (Egan, 1997). Science education as part of the general school curriculum is expected to respond to these aims.

However, though these goals are generally taken to be consistent with one another, some what overlapping, and mutually supportive, each of these aims is incompatible in profound way with the other two and remain sometimes sources of controversy. For instances, the central task of socialization is to inculcate a restricted set of norms and beliefs - the set that constitutes the adult society the child will grow into. The socializing aim implies curriculum is responsive to changes in society and aims at preparing children as adequately as possible for the life they are likely to lead; focusing on developing the skills and knowledge that are relevant to “real life” outside the school.

Whereas the second aim implies that education is a process of learning those forms of knowledge that would give students a privileged rational view of reality. Here the curriculum aims at initiating students into the forms of disciplined knowledge and into some forms at a significantly deeper level. It focuses on developing familiarity with the culture that has accumulated in the Western literate tradition. However, the third aim is related to the current voices that encourage school to focus on fulfilling the individual potential of each student, that emphasize the students should “learn how to learn” as a higher priority than amassing academic knowledge. Curriculum in this case is more attentive to procedural skills than to any specified privileged content; the content is selected largely on the basis of what is required in extending the student’s every day experience.

However, what is important to mention here is the more is the emphasis and work to achieve one of the schools’ aims; the more difficult it becomes to achieve the others (Egan, 1997). Perhaps this is also one of the long lived challenges in the history of Ethiopian modern school curriculum. This is because our country’s curriculum at different times emphasized on academic subject matter designs and rooted in the objectivist model of curriculum planning that reinforced it still today.

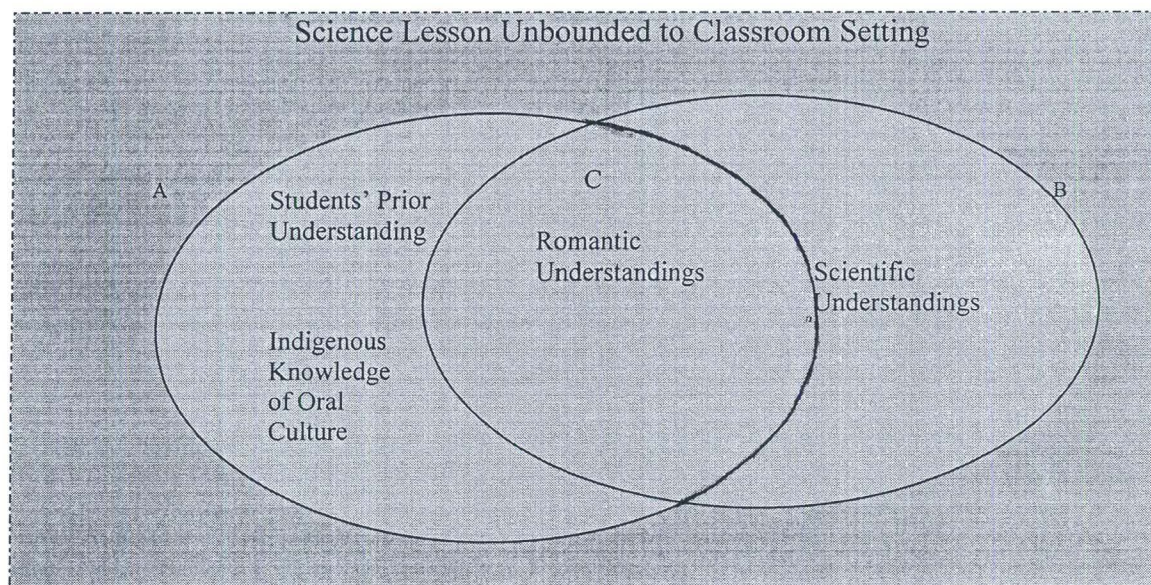
Thus, criticizing the emphasis on the subject matter only (*i.e.* philosophic understandings of scientific knowledge originated in Western culture) as in the objectives model or the behavioral approach oriented science curriculum, and advocating the process approach with primarily focus on the needs of the learner can rarely lead to coherent curriculum and inspiring or challenging science learning.

Therefore, to respond to the students' hopes and expectations to learn science meaningfully and to balance the aforementioned needs in science education, science curriculum planning and instructional practices need to be based on the following two assumptions:

- Students have preconceptions and there are also indigenous achievements of our culture (oral culture) with which students' come to class, need to come first before directly addressing scientific understandings.
- Scientific understanding which we require students to adopt as a result of the lesson, need to be based and developed on the previous assumption romantically.

The assumptions indicate that science curriculum might be coherent, when contents in the curriculum materials and lesson instruction begin by addressing students' preconceptions and present romantic experiences that will allow them to move to scientific understandings. The move can be achieved through challenging their naïve understandings and developing their incomplete understandings. This in turn, stimulates students to explore further and then evaluate their understandings in comparison with the scientific understandings. The figure bellow also demonstrates this argument.

**Figure 4: A Model Showing Coherent Science Curriculum**



The broken lines around the circles are to show as science learning is not bounded only to classroom setting. In other words, science learning is extended to the natural environment surrounding the learner. Moreover, the two circles 'A' and 'B' are seen as having common part 'C'. This shared part 'C' shows the opportunity in which the students' preconceptions or indigenous knowledge of our culture on how the world works are addressed in the lesson as necessary prior step to enable students understand the scientific understanding. Circle 'C' is what I called Romantic experience. The shade is to show the science learning setting under a coherent and challenging curriculum.

Romantic experiences could take the form of analogies, empirical reasoning, and discussions (Chambliss & Calfee, 1989 as cited in Buckland, 2001), initiated by questions that might serve as a bridge to move students to scientific understandings. This will initiate students to be engaged in learning, explore more on the concept and evaluate their previous understandings accordingly in light of scientific understandings. This will make science learning practice-oriented and student-centered, extend it beyond the classroom settings and 40 minutes bounded lesson, and reduces the science assessment culture of the paper-pencil based summative assessments. Hence, there will be rooms to continuously assess students' progress and promote their effort to learn science more. The pedagogical skill required here, therefore, is a matter of selecting questions that have surprising or wonder inducing, and not getting tied down in systematic, detailed coverage of an issue.

So what does science look like when we view it "Romantically"? It is, first a contextualized science, one in which theories, experiments, and facts become meaningful with in the narratives of human lives and intentions, in pursuits of the nature of things. But this could not mean that the theories, laws, factual knowledge, and the systematic investigation of nature will be ignored; the usual purpose of the science curriculum will not be discarded. Central place, however, be given over to the romantic engagement. This is because the romantic focus is prerequisite to and the route toward, scientific understanding of science.

No doubt to the distress of purists, implementation of the above assumptions would increase the more spectacular and dramatic features of scientific activity and reduce the logical sequence of systematically accumulating knowledge. Nevertheless, while arguing against the exclusive emphasis on teaching alien culture originated and imported scientific understandings, it has to be noted that I am not saying such scientific understandings are insignificant for our country, but I am stressing on the need to contextualize it in accordance with the above proposed assumptions to students' preconceptions and indigenous achievements of our oral culture through curriculum and pedagogy.

Therefore, if the above assumptions are considered our country's students can reach more likely at the coherent conceptual understanding of the science concepts which are the intentions of the science lessons; hence, there are rooms for appreciating indigenous knowledge of our culture and developing it together with students' preconceptions. Students' learning can also be made intrinsically motivating, deep and transferable. So that schools will not be where students run away from, but a place that remains memorable in their life time.

## **5.2 Implications**

From the foregoing discussions, it is implied that unlike the constructivist intention in the Policy, what is underpinning in the science curriculum is based and consequently required teachers to apply theories (*reductionist behavioral approach*) dominated by extrinsic motivation, where grades and class rank are emphasized. This consequently dampened intrinsic motivation that might help students to study science through deep approach. Students need to be learning more than "for the tests." Creating an intrinsic desire to know more and be able to use more in the minds and hearts of students need to be the goal of science curriculum in our secondary schools. Thus, there need be curriculum and pedagogy that acknowledges students' preconceptions, appreciates indigenous knowledge, and creates opportunity for students' puzzlement that is consequently believed to reinforce their learning to reach at coherent conceptual understandings of science.

Accordingly, the design of the curriculum need not be “topical” but conceptual (Erickson, 1998). This is because, as the amount of information to be learned increases, topics receive an increasingly shallow treatment in order to cover the course material. However, if the curriculum design is around concepts, which are regarded as higher level of abstractions than facts in the structure of knowledge (Erickson, 1998), it is possible to solve the overloaded curriculum, and bring focus and depths to study. So that it will lead students to the transferable and conceptual understandings. Consequently, the opportunity to link science concepts to students’ everyday life and then move them beyond, through encouraging them to adopt scientific understanding could be created.

Engagement in learning is the visible outcome of motivation, the natural capacity to direct energy in the pursuit of a goal. In other words it is to mean that it is only when students see what they are learning makes sense and important that their intrinsic motivation emerges. Thus, it is not enough to ask whether a new science curriculum increases students’ mastery of imported science concepts of western culture; it needs to be asked also whether the curriculum and pedagogy stimulate their intrinsic interest, and allow them challenge their common sense understandings by valuing their previous understandings of how the natural world works. Moreover, the conceptions students bring to class need to be acknowledged and brought into discussion, and considered during instruction, so that it would serve as a scaffold for the development of student-centered and continuous assessment in the science lessons.

As it is proposed, to make science learning challenging and intrinsically motivating, the most critical teaching activity is - the questions teachers ask while identifying their students’ naïve conceptions developed out side the school. Hence, it is this question that creates the students’ puzzlement and indicate gap in their understanding when they compare their preconceptions to scientific understandings. Therefore, teachers need to value and challenges students thinking, which is believed to stimulate their further exploration of the concept to reach at the coherent conceptual understandings. Accordingly, the teacher must not take over thinking for the learner by telling the learner what to do or how to think, but rather teaching need to be done by inquiring at the “leading edge “ of the students’ thinking (Fosnot, 1989).

Regardless of blaming the “victims”, our students for not demonstrating the expectations or coherent understandings of the lesson taught, I feel it is better if the immediately responsible individuals, we teachers examine and reexamine what we are teaching, the approach (deep or shallow) in which we implicitly or explicitly require our students to learn and generally, the context in which we are teaching scientific understandings of alien culture in origin.

In a nutshell, people engaged in the education system need to reexamine the process of science curriculum planning in accordance with the above discussed assumptions so as to respond to students wish and expectations to learn science and realize the intentions in the New Education and Training Policy, and its mandatory plasma transmission as the only mode of science instruction. The material need not teach, but rather support the learners’ inquiry or performance. It should rather be used as a supplement to the learner centered styles. Science teachers and students need to get more time in the science lessons so that they can make possible choices in an attempt to make science learning deep and ensure coherent conceptual understandings.

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## **Appendix-A**

### **Ethical Principles to be discussed with the research Participants**

Thank you for accepting to participate in the research. The purpose of this research is to understand whether students view the current general secondary education science curriculum as intrinsically motivating (challenging) or a burden. Therefore, the title of my study is “The Ethiopian General Secondary Education Science Curriculum: Does it Challenge or Burden Students?” as a requirements for MA in Curriculum and Instruction from AAU.

Through this research, I want to understand how students’ could view the science curriculum, the teaching learning process and the interactions in the science lessons. The expected benefits associated with this study are the discussion results that may be helpful to improve our educational system. I would be happy to share the results with you after the research is completed or even while in process.

Accordingly, your voluntary cooperation is needed in the following major data gathering activities:

- i. At least two sessions of open ended interview each lasting approximately one hour
- ii. Permission that will allow me to observe science lesson presentations at least three times.

#### **I guarantee that the following conditions will be met:**

1. Your real name will not be used at any point of information collection, or in the written analysis; instead, you will be given pseudonyms that will be used in all verbal and written records and reports.
2. If you grant permission for audio taping, no audio tapes will be used for any purpose other than to do this study, and will not be played for any reason other than the research ends. Thus your confidentiality will be well preserved at all times.
3. Your participation in this research is voluntary; you have the right to withdraw at any point of the study, for any reason, and without any prejudice.
4. You will receive a copy of the transcribed data before it is analyzed, so that you have the opportunity to comment if your professional life-world as expressed in your opinion, suggestion, and shared experiences are correctly cached and transcribed. And,
5. Other ethical issues are to be seriously considered throughout the research process.

Thank you

Aman Sado, The researcher

## Appendix-B

### Guiding Interview Questions for Science Curriculum Expert

1. What are the underlying assumptions in developing General Secondary Education science curriculum?
  - ✦ What is science curriculum about?
  - ✦ How does students are expected to learn science?
2. While developing science curriculum what considerations are made to make science curriculum materials (syllabus, teacher's guide, and textbooks) reflective of the New Education and Training Policy?
3. How are science curriculum materials expected to be used in schools?
4. Does encountering a great number of science topics mean knowing science more? Why?
5. Do the curriculum materials help students to be engaged in learning the material deeply, to explore further and change their preconceptions?
6. Do students enjoy or feel bored about what they are learning in science? Why?
7. When do we say science curriculum is successfully implemented? How?
8. How well do the prepared science curriculum materials support student-centered learning?
9. Are the contents designed in each science subject voluminous or inadequate? Why?

## **Appendix-C**

### **Guiding Interview Questions for Science Teachers**

1. Do you feel satisfied in your profession? Why? What about in the science subject you teach?
2. What is your personal understanding of meaning and purpose of science?
3. How can you describe scientific knowledge, static or changing? Why?
4. Do your students enjoy or feel bored while learning science subjects? Why?
5. Do the curriculum materials available allow you to comfortably use in planning and practicing science lessons to engage students in meaningful learning? How?
  - ↓ How have you been managing science curriculum materials in the teaching learning process?
  - ↓ Do you think it is possible to teach problem solving, higher order or transferable skills in science education? How?
6. What makes an attempt of implementing science curriculum difficult to engage students in learning process? How do you try to manage it (them)?
7. Do the students often use what they learn in school or their common sense understanding? Why?
8. Does teaching many science topics mean allowing students to learn science more? Why?
9. How do you assess science learning?
  - ↓ What considerations do you take into account in assessing science learning?
  - ↓ Do you think the assessment methods you use are congruent to the purposes of the subject you teach? How?
10. what is your overall reflection of the suitability of science curriculum materials to promote meaningful, transferable learning?

## Appendix-D

### Guiding Interview Questions for students

1. Does learning science have importance?
2. Do you feel you have benefited from learning science?
3. Do you enjoy while learning science subjects? Why?
  - Where do you often learn science?
  - What do you want to learn more in science education?  
What you do not like to learn in science education?
4. Are the contents in the science subjects motivating or boring to you?
  - What benefits you earned in your-day to-day life because of learning science? How?
  - How do you do your assignments or presentations? Do you often use textbooks as a reference or relate it to your day-to-day life? Why?
5. Are you comfortable with the way your science teachers teach and assess you? How?
  - Do teachers relate science lessons to your previous knowledge of natural world and use it to expand your understanding further?  
How?
6. Do science teachers give you adequate time to work well on the science learning tasks, home works or assignments? How?
7. Do the science subjects you learn are voluminous or inadequate in their contents?
8. Which subjects you like to learn? Why? Which subjects you do not like to learn? Why?
9. Which subjects are easy and which are difficult for you? Why?

## Appendix-E

### የቃለ መጠይቅ መመሪያ ለሥርዓተ ት/ት ኤክስፐርቶች

1. የአጠቃላይ የሁለተኛ ደረጃ የሳይንስ ስርዓተ ትምህርት አዘገጃጀት ሂደት ውስጥ መሠረታዊ መነሻ ሀሳቦች ምንድን ናቸው?
  - ✦ የሳይንስ ስርዓተ ትምህርት ምንን ያስገኛል ተብሎ ይታመናል?
  - ✦ ተማሪው ሳይንስን እንዴት ይማራል ተብሎ ይታሰባል?
2. ስርዓተ ትምህርቱ ሲዘጋጅ የሳይንስ ሲላብስ፣ የመምህሩ መመሪያና የተማሪው የመማሪያ መፅሐፍ የትምህርት ፖሊሲውን እንዲያንፀባርቁ ተደርጓል? ከተደረገ እንዴት?
3. የሳይንስ ስርዓተ ትምህርት በት/ቤቶች በምን መልኩ እንዲተገበሩ ወይም ስራ ላይ እንዲውሉ ይጠበቃል?
4. ሳይንስን በተሻለ መልኩ መማር የሚቻለው ለአያሌ የሳይንስ ርዕሰ ጉዳዮች ቅርብ ሆኖ በመገኘት ነውን? ለምን?
5. ተማሪው የየትምህርቱን ፅንሰ ሀሳብ ጠለቅ ብሎ እንዲያስብና እንዲመራመር እንዲሁም የነበረውን አስተሳሰብ እንዲቀይር ስርዓተ ትምህርቱ ረድቶታል ወይ? እንዴት?
6. ተማሪው የሚማረውን ትምህርት ይወዳል ወይስ ይጠላል? ለምን?
7. የሳይንስ ስርዓተ ትምህርት ስኬታማ በሆነ መልኩ ተተገበረ ማለት የሚቻለው መቼ ነው? እንዴት?
8. የሳይንስ ስርዓተ ትምህርት ሲዘጋጅ ተማሪ ተኮር የመማሪያ ዘዴን እንዲደግፍ ተደርጎ ተዘጋጅቷል? እንዴት?
9. የየትምህርቱ ይዘት ይበዛል ወይስ ያንሳል? ለምን?

Appendix-F

የቃለ መጠይቅ መመሪያ ለሳይንስ መምህራን

1. በመምህርነት መቃቀስ/ሽ ደስተኛ ነህ/ሽ ወይ? ለምን?  
 በምታስተምረው/ሪው የሳይንስ ትምህርት ደስተኛ ነህ/ሽ? ለምን?
2. የሳይንስ ትምህርት ፅንሰ ሀሳብና አላማ ምንድን ነው ብለህ/ሽ ታስባለህ/ሽ?
3. ሳይንሳዊ ዕውቀቶች ቋሚ ናቸው ወይስ ተለዋዋጭ? ለምን?
4. ተማሪዎች የሳይንስ ትምህርትን ይወዳሉ ወይስ ይጠላሉ? ለምን ይመስልሃል/ሻል?
5. ሲለበስ፣ የተማሪው የመማሪያ መፅሐፍና የመምህሩ መመሪያ ተማሪውን በማከለ መልኩ የሳይንስ ትምህርትን ለማቀድና ለመተግበር ምቹ ናቸው ትላለህ/ሽ? እንዴት?  
 ↓ የሳይንስ ስርዓተ ትምህርትን በመጠቀም የመማር-ማስተማር የሥራ ልምድህ/ሽ እንዴት ነበር?  
 ↓ የሳይንስ ትምህርትን ለችግር ፈቺነትና ለዕለት ተዕለት ነባራዊ ሁኔታዎች ለመጠቀም እንዲያስችል ተደርጎ ማስተማር ይቻላል ወይ? እንዴት?
6. የሳይንስ ስርዓተ ት/ት ተማሪን በማከለ መልኩ የመተግበር ጥረት ላይ እንቅፋት ሊሆኑ የሚችሉ ነገሮች ምንድን ናቸው?  
 ↓ ታዲያ እንዴት ልትቋቋማቸው/ሚያቸው ቻልክ/ሽ?
7. አብዛኛውን ጊዜ ተማሪዎች የተማሩትን ነገር ነው ወይስ በተለምዶ የሚያውቁትን ይጠቀማሉ ብለህ ተስባለህ/ሽ? ለምን ይመስልሃል/ሻል?
8. ተማሪዎች ሳይንስን የተሻለ ተምረዋል ማለት የሚቻለው አያሌ የሳይንስ ርዕሰ ጉዳዮችን ስላስተማርካቸው/ሻቸው ነው? ለምን?
9. ተማሪዎችህ የምታስተምረውን/ሪውን የት/ት ዓይነት በሚገባ መማራቸውን እንዴት ትገመግማለህ/ሽ?  
 ↓ ተማሪዎችህ/ሽ የምታስተምረውን/ሪውን ትምህርት በሚገባ መማራቸውን ስትገመግም/ማሚ ግምት ውስጥ የምታስገባቸው/ቢያቸው ነገሮች ምንድን ናቸው?  
 ↓ የምትጠቀምባቸው/ሚባቸው የመገምገሚያ ዘዴዎች ከምታስተምረው/ሪው የት/ት ዓላማ ጋር ተዛማጅነት አላቸው ትላለህ/ሽ? እንዴት?
10. በአጠቃላይ የሳይንስ ስርዓተ ትምህርት ተማሪዎች በትምህርታቸው ጥልቅ ግንዛቤ እንዲኖራቸው፣ እንዲመራመሩና በተለምዶ የነበራቸውን አስተሳሰብ እንዲቀይሩ በማድረግ ረገድ ምቹነታቸውን ከነበረህ/ረሽ ልምድ እንዴት ታያለህ/ሽ?

Appendix-G

የቃል መጠይቅ መመሪያ ላይ ተጠቅሞቻቸው

1. የላይኛው ትምህርት ምን ጥቅም አለው?
2. የላይኛው ትምህርትን መከፈቅ ለምን ጥቅም አለው? ለምን ትምህርት ለማግኘት ለምን ጥቅም አለው?
3. የላይኛው ትምህርት ያለገለገሉት ላይኛው ትምህርት ለምን ጥቅም አለው? ለምን ትምህርት ለማግኘት ለምን ጥቅም አለው?
4. በላይኛው ትምህርት ውስጥ ያሉት የትምህርት ይዘቶች አላገለገሉት ጥቅም ላይ ያውጥቶ ወይን ምን ጥቅም አለው?
5. የላይኛው መምህራን ለምን ጥቅም አለው? ለምን መምህራን ለማግኘት ለምን ጥቅም አለው? ለምን መምህራን ለማግኘት ለምን ጥቅም አለው?
6. የላይኛው መምህራን ለምን ጥቅም አለው? ለምን መምህራን ለማግኘት ለምን ጥቅም አለው? ለምን መምህራን ለማግኘት ለምን ጥቅም አለው?
7. የምትማራቸው የትምህርት ጥያቄዎች ይዘቶቻቸው ይበዘላቸዋል ወይን ያንላላሉ?
8. የምትወገዱት ምን ጥቅም አለው? ለምን ጥቅም አለው? ለምን ጥቅም አለው?
9. የላይኛው ትምህርት ይከብድላል/ላይኛው ትምህርት ይከብድላል/ላይኛው ትምህርት ይከብድላል/ላይኛው ትምህርት ይከብድላል?

ላይኛው የትምህርት ስልጠና

maali? Akkamitti?

✚ Hojii manaa fi gabaasa daree keessatti akka dhiheesitu yemmu ajajamtu caalatti akka irraa gargaaramtu kan sirraa eegamu kitaaba irraa qofa akka hojattu mo'o muuxannoowaan naannootti argamanillee itti gargaaramta?

5. Akkaataa saayinsii ittiin barattuu fi bifa brachuu kee ittiin madaalamtu irratti gammachuu qabdaa? Maaliif?
6. Barsiisonni gochaalee, hojiimanaa, abbaltiifi yeroo gahaa sii kennuun gadfageenyaan akka barattu si taasisuu?
7. Barnoota barattu keessatti qabiyyeeleen jiran ni baay'atu mo'o muraasa?
8. Barnootni ati jaalattu ykn jibbitu gosa barnoota kamfa'a? Maaliif?
9. Barnootni saayinsii sitti ulfaata mo'o sitti salphata? Maaliif?

**I. Choose the best answer from the alternatives given for each questions**

- 1. One of the following is not related to the other four.  
A/ sexual reproduction B/ budding C/ sporulation D/ binary fission
- 2. Style is to carpel as filament is to. A/ ovules B/ pistile C/ stamen D/ stigma
- 3. Which of the following organs play part in homeostasis?  
A/ skin B/ kidneys C/ liver D/ all of them
- 4. Which of the following is not a function of liver?  
A/ secretes insulin & stores bile B/ builds glycogen & breaks down amino acids C/ detoxification & production of bile  
D/ produce fibrinogen & prothrombin
- 5. Which one is under the controle of micronucleus of paramecium?  
A/ exeretion B/ regulation of water balance C/ digestion D/ reproduction
- 6. A fruit is. A/ a ripened ovary B/ a ripened ovule  
C/ a fertilized egg D/ always edible
- 7. ----- is to blood calcium level as insulin is to blood sugar level.  
A/ Parathyroid hormone B/ Androgen C/ Testosterone D/ Adrenalin
- 8. Which of the following pairs of organs produce both gametes and hormones?  
A/ kidneys & testis B/ testis & uterus C/ ovaries & liver D/ testis & ovaries
- 9. Which of the following is heat producing mechanism of the body?  
A/ shivering of the body during cold B/ vasoconstriction  
C/ vasodilation D/ sweating
- 10. Which of the following organs is a chemoreceptor?  
A/ ear B/ eye C/ tongue D/ nose E/ tongue & nose
- 11. ----- are the structural & functional unit of kidneys.  
A/ Nephrons B/ pelvis C/ afferent arterioles D/ medulla
- 12. The hormone responsible for secondary sexual characteristics in male is  
A/ oestrogen B/ testosterone C/ progesterone D/ A and B
- 13. The hormone that initiates reabsorbition of H<sub>2</sub>O from kidney tubules back in to blood is. A/ aldosterone B/ anti-duretic C/ adrenalin D/ none
- 14. They are essential parts of a flower. A/ carpels & sepals B/ sepals & petals  
C/ carpels & stamens D/ stamens & pericarp
- 15. A flower with both stamen and pistils is known as.  
A/ complete flower B/ perfect flower C/ incomplete flower D/ imperfect flower
- 16. The process by which the liver removes the nitrogen containing part of Amino acids is called. A/ nitrificaton B/ deamination C/ denitrification  
D/ detoxification

**II. Write True or False according to the statement**

- 17. The tube that is used as a passage of both urine and sperm is ureter.
- 18. Pituitary gland is often refered to as "master gland" because it is located at the base of the brain.
- 19. Diabets is resulted due to lack of glucagon hormone.
- 20. Urine is formed in the process of ultrafiltration and selective reabsorbtion.
- 21. Light and gravity affect auxin concentration and determine direction of plant growth.
- 22. A small mammal loses more heat than a large mammal under the same condition.
- 23. Glucagon is secreted when the level of glucose falls below normal.
- 24. Fertilization in humans occurs in uterus

'A'

- 25. Poikilotherms
- 26. Homoitherms
- 27. Homeostasis
- 28. False fruit
- 29. Amniotic fluid
- 30. Placenta

'B'

- A/ the maintenance of a constant internal environment
- B/ animals that can not control their body temperature
- C/ has a constant body temperature
- D/ if the fruit develops from the ovary wall alone
- E/ apple
- F/ protects the foetus from shocks
- G/ produce progesterone

Name ----- Sec. -----Roll NO -----

- |           |           |           |
|-----------|-----------|-----------|
| 1. -----  |           |           |
| 2. -----  | 11. ----- |           |
| 3. -----  | 12. ----- | 21. ----- |
| 4. -----  | 13. ----- | 22. ----- |
| 5. -----  | 14. ----- | 23. ----- |
| 6. -----  | 15. ----- | 24. ----- |
| 7. -----  | 16. ----- | 25. ----- |
| 8. -----  | 17. ----- | 26. ----- |
| 9. -----  | 18. ----- | 27. ----- |
| 10. ----- | 19. ----- | 28. ----- |
|           | 20. ----- | 29. ----- |
|           |           | 30. ----- |

**Set By Department of Biolog**

**Shashemene High School 1<sup>st</sup> Semester Biology Mid Exam for Grade 10<sup>th</sup> 2001E.C**

Name ..... Grade & Sec. .... NO ..... Time 30'

**I. Choose the best answer from the alternatives given to each question bellow**

- 1. One of the following is not external factor that affects plant growth and development. A/ light B/ temperature C/ humidity D/ gene
- 2. The portion of the seed embryo that develops in to root system is. A/ Radicle B/ Micropyle C/ plumule D/ cotyledon
- 3. The factor that is not essential for seed germination is. A/ water B/ light C/ warmth D/ oxygen
- 4. The tissue responsible fro plant growth and development is. A/ conductive tissue B/ epidermal tissue C/ meristematic tissue D/ primery permanent tissue
- 5. The character which is not that of monocot plants is. A/ parallel venation B/ fiberous roots C/ netted venation D/ absence of true secondary tissue
- 6. A hormone that is used to treat dwarf plants is. A/ Auxin B/ Gibberellin C/ Cytokinin D/ IAA
- 7. The response of some plants to low temperature to flower is known as. A/ Germination B/ senescence C/ vernalisation D/ biological clock
- 8. The mesophyll tissue bellow the upper epidermis is. A/ spongy parenchyma B/ guard cells C/ palisade parenchyma D/ phloem tissue
- 9. The portion of a chloroplast where photosynthesis process starts is. A/ Grana B/ thylakoid C/ stroma D/ none of the above
- 10. When light strikes the surface of a leaf the great absorbition occurs in the ---- portion of the spectrum. A/ Red B/ Yellow C/ Blue D/ Blue and Red

**II. Write TRUE or FALSE according to the statement**

- 11. Nitrogen, phosphorous and potassium are the three mineral elements found in Inorganic fertilizers
- 12. A target organ is one that responds to all hormones by bringing about some activity.
- 13. The high concentration of auxins in apical buds promote growth in lateral buds.
- 14. Etiolation can be demonstrated by keeping poted plant in a dark.
- 15. Phototropism is growth response of plant parts to unilateral light.

**III. Match the following items**

- | <u>"A"</u>                  | <u>"B"</u>  |
|-----------------------------|---|
| -----16. Photoperiod        | A/ regulate exchange of gases                         |
| -----17. Tropism            | B/ attractive force between like molecules            |
| -----18. Stomata            | C/ directional growth response of                     |
| -----19. Cohesion           | plant organs to external stimuli                      |
| -----20. Transpiration pull | D/ the driving force behind water transport in plants |
|                             | E/ duration of light with in 24hrs period             |
|                             | F/ attractive force between un like molecules         |

**Bonus:** The removal of one part of a plant to promote the growth of other parts is known as .....

Set By Dep. Of Biology

## I. Choose one best answer and write the letter on the space provided

- 1. The general formula  $R - CH - R$  represents.  
A/ an ester B/ an ether C/ primary alcohol D/ secondary alcohol
- 2. Water consists of hydrogen and oxygen combined in a 1:8 ratio by mass. This statement is the law of. A/ conservation of mass B/ definite proportion  
C/ destructibility of atoms D/ multiple proportion
- 3. Phenol  $\xrightarrow{KMnO_4}$  ..... What is the missing product?  
A/ benzene B/ toluene C/ benzoic acid D/ no reaction occurs
- 4. The molecular formula for. A/  $C_5H_{10}O$  B/  $C_6H_{12}O$   
C/  $C_6H_{10}O$  D/  $C_6H_6O$
- 5. Which of the following linkages represent an ether?
- 6.  $CH_3OH$  and  $CH_3COOH$  in the presence of acid catalyst would react to form?  
A/ an alcohol B/ a ketone C/ a carboxylic acid D/ an ester and water
- 7. The IUPAC name for  
A/ 2,2,4-trimethyl - 3-hydroxy-4-pentene B/ 3-hydroxy - 2,2,4-trimethyl -5-pentene  
C/ 3-hydroxy -2,2,4-trimethyl -1-pentene D/ 2-methyl -4,4-dimethyl - 1-1 pentene
- 8. Among the following which one has the highest boiling point?  
A/ propanol B/ acetic acid C/ butane D/ methoxy ethane
- 9.  $CH_3CH_2OH$  and  $CH_3OCH_3$  can be best described as.  
A/ polymers B/ monomers C/ isomers D/ dimmers
- 10. Ketone  $\xrightarrow{LiAlH_4}$  ? .what is the missing product?  
A/ carboxylic acid B/ ester C/ primary alcohol D/ secondary alcohol
- 11. An alcohol which is used to denature ethanol is.  
A/ methanol B/ formalin C/ butanol D/ acetone
- 12. One is not naturally occurring ester. It is ----- A/ wax B/ fat C/ soap D/ oil
- 13. How many liters of  $O_2$  are produced from 122.5g of  $KClO_3$  at STP?  
/K=39, Cl=35.5 O=16/ A/ 67.2L B/ 44.8L C/ 22.4L D/ 33.6L
- 14. How many grams of magnesium can be burned by 4g of  $O_2$  to form  $MgO$ ?  
/Mg =24, O= 16/ A/ 4g B/ 5g C/ 6g D/ 8g
- 15. What does the formula  
A/ Soap B/ Detergent C/ Ester D/ Aspirin
- 16. Vinegar is a dilute solution of. A/ acetic acid B/ acetone C/ formaldehyde D/ ethanol
- 17. When the equation below is balanced, what will be the set of balancing coefficients?  $H_2SnCl_6 + H_2S \longrightarrow SnS_2 + HCl$ .  
A/ 1,2,2,2 B/ 1,2,1,6 C/ 2,4,2,6 D/ 1,1,1,6
- 18. Hydrogen bonding does not occur in. A/ acetic acid B/ ethanol  
C/ acetone D/ methanol
- 19. What is the correct IUPAC name for  
A/ methyl benzoic acid B/ ethyl benzoate  
C/ benzene ethanolic acid D/ benzene ethanoate
- 20. Which of the following alcohols under goes dehydration reaction most readily? A/ 1-butanol B/ 2-methyl -2-propanol  
C/ 2- methyl propanol D/ 2-butanol

Set By Dep. Of Chemistry

Shashemene High School 1<sup>st</sup> Semester Physics Mid Exam For Grade 10 2001

Name ..... Grade & Sec. .... NO ..... Time 40'

I. Write True if the statement is correct write False if the statement is False

- 1. A neutral body has equal number of electrons and protons.
- 2. When the potential difference increase the energy stored in a capacitor increase.
- 3. The work done to carry the charge through equipotential line is zero.
- 4. The capacitance of the capacitor will decrease if dielectric insert between capacitor plates.
- 5. If the resistors are connected in parallel connection their effective capacitance will be increase.

II. Math the following

- "A"**
- 6. Equipotential line
  - 7. Electric field strength
  - 8. Electric field lines
  - 9. Electric force
  - 10. Electric charge

- "B"**
- A/  $Q = nc$
  - B/ the line joining the points having equal potential
  - C/  $E = \frac{kQ}{r^2}$
  - D/ directed from positive to negative
  - E/ directly proportional to the product of charges and invertly proportional to the square of the distance b/n them

III. Choose the correct answer

- 11. Which one of the following processed with out contact. A/ charging by conduction B/ charging by induction C/ charging by rubbing D/ A and C
- 12. Which one of the following is the function of capacitor.  
A/ to store charge B/ to store energy C/ to store voltage D/ A and B
- 13. Which one the following is the factor of resistance of the conductor.  
A/ area B/ length C/ charge D/ A and B
- 14. Which one of the following not vector quantity. A/ electric force  
B/ electric filed strength C/ magnetic filed strength D/ absolute potential
- 15. A  $20 \mu C$  charge is moved between two points A and B that are 30mm apart and have an electric potential difference of 600V between them what is the work done to carry the charge. A/  $1.2 \times 10^{-2}$  Joule B/  $6 \times 10^{-3}$  joule  
C/  $6 \times 10^{-2}$  joule D/  $1.2 \times 10^{-3}$  joule
- 16. If three equal resistors are connected in series their equivalent capacitance is  $9 \Omega$  and if they are capacitance will be  $1 \mu$  what are there capacitance.  
A/  $9 \Omega$  B/  $3 \Omega$  C/  $2 \Omega$  D/  $1 \Omega$
- 17. Which one of the following is the SI unit of electric filed strength.  
A/  $\frac{N}{C}$  B/  $\frac{V}{M}$  C/ A and B D/  $\frac{N}{AM}$

IV. Fill in the blank space

- 18. Solenoid with soft iron core is called .....
- 19. What are the three factors that affect the magnetic force
  - 1. ....
  - 2. ....
  - 3. ....

V. Work Out

- 20. What is the cost for cooking the 1 kilowatt stove is on 1 hour per day every day for a month.  $1kwh = 27$  cent .....

Set By Dep. Of Physics

## Declaration

This thesis is my original work and that all sources consulted for this work have been properly acknowledged.

Name Aman Sado

Signature 

Date 17/06/2009

## Approval

This thesis has been submitted for examination with my consent and approval as University advisor.

Name AMARE ASGEDOM

Signature 

Date 17/06/2009