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Physics Knowledge Representation in the Ethiopian General Secondary School Textbooks in Facilitating Conceptual Understanding

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Abstract: The purpose of this study was to explore the way general secondary school physics textbooks introduce physical concepts with respect to their appropriateness in enhancing students' understanding of physical concepts. The study used qualitative content analysis design for obtaining and analyzing data. In order to judge the appropriateness of each activities criteria were developed by the researcher and validated by experts. Data was obtained through a systematic content analysis of textbooks. Grades nine and ten students' textbooks were used as data sources in order to find evidence about the ways physics concepts were presented. From each textbook two units were selected randomly. From the units selected, the entire topics were analyzed. Thus, a total of 28 concepts were analyzed. It was found from the study that most of the concepts were not presented in enhancing conceptual understanding. Generally based on the findings of the study it can be concluded that the Ethiopian general secondary physics textbook concept presentations were not appropriate to enhance students' understanding of the concepts of physics. Based on the conclusions made the study suggested the need for revising physics textbooks in such a way that they help students develop conceptual understanding.
Key words: Physics, Knowledge construction, knowledge representation, conceptual knowledge

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I. THE PROBLEM AND ITS APPROACHES

1.1. Background of the study

Concept learning is a direct application of the constructivists theories of knowledge and learning. Learning from the constructivists' perspective is seen as an active construction of meanings on the part of learners (Bodner, 1986; Packer &Goicoechea, 2002; Glasersfeld, 1990). From the constructivists' perspective individuals are assumed to construct their own meanings and understandings, and this process is believed to involve interplay between existing knowledge and beliefs and new knowledge and experiences (Yilmaz, 2008). Thus, learning is considered as taking place as individuals are trying to integrate new knowledge with existing relevant concepts and propositions in their cognitivestructure (Novak, 2002; Windschitl, 2002; Duit&Rhoneck, 1997; Libarkin&Kurdziel, 2001; Duit, 1996). Inherent in this approach is a shift away from the traditional behavioral proposition in which science is seen as a codified body of knowledge that can be transmitted to the learner towards the view that learning as requiring learners to be engaged in the process of learning (Cobern, 1993; Irzik, 2001). This view of meaning-making through previously constructed knowledge implies that learners are intellectually generative individuals; rather than empty vessels waiting to be filled (Rockmore, 2005; Bichelmeyer& Hsu, 1999). From this perspective learning is not seen as the transfer of knowledge but as an active construction of on the part of learners (Duit, 1996; Windschitl, 2002).

Regarding the ways physics concepts are presented simply providing physics theories, laws or principles in textbooks doesn't necessarily enhance students' understanding of physics concepts unless they are structured in a constructivists' manner that help learners first make sense of the physical phenomena and interpret the physical world using scientific laws and principles (Mbjiorgu& Reid, 2006; Horwood, 1988). Science education researchers argue that physics like the other science disciplines, operates at three thought levels: the macro, the micro and the symbolic. The macro refers to the phenomenological/experiential: what can be perceived by the senses without the aid of instruments and is often concrete. The experiential knowledge is the knowledge that students bring to the class as a result of their life experiences they have had during their lives and the thinking that they have done to organize the knowledge to help them operate in their world (Mbajiorgu& Reid, 2006; Wesel, 2005). Experiential knowledge is theoretical in nature and is formed in the mind as a result of reflection about experiences and generally has principles that can be used to explain a number of experiences (Mbajiorgu& Reid, 2006).

The micro or the relational represents the physical concepts using scientific laws and principles. Therefore, after students have introduced experiential knowledge it is essential to introduce the theoretical concepts laws and principles that help them interpret physical phenomena. After students are able to describe and interpret physical phenomena using physical laws and principles, it is important to introduce the mathematical representations that could represent concepts symbolically. Generally, the symbolic refers to symbols, models and equations and these are often representational. The symbolic emphasizes on the mathematical formulae thereby giving quantitative descriptions of relationships between the phenomena/macro and the relevant theoretical explanations of the phenomena/interpretation (Mbajiorgu& Reid, 2006; Wessel, 2004). The symbolic require an understanding of the process of mathematical representation of physics concepts well enough to apply the process to new concepts and situations. At the symbolic level physics formulae act as part of algorithm which can be manipulated correctly to understand the relationships expressed by the theories, laws etc. Generally, the experiential knowledge is concrete and the microscopic and symbolic are the abstract part of knowledge. If used at all physics would be the end point of concept development rather than the starting point.

In physics education, although several studies conducted in science education provided some important results that could help educators to identify and solve problems associated with students' learning problems, there are also other important variables that have sought less attention and should be studied because they have a bearing on students' learning. One of the factors that could affect students understanding of physics concepts is the way physics concepts are provided in curricular materials such as textbooks (Trumper, 2006; Appleton &Asoko, 1996; Goodrum et al., 2000). It was also found significant to conduct this study due to the belief that understanding would help us our efforts in developing appropriate science education in general and physics education curricula in particular. Hence, doing research on school physics curricula is significant in understanding the root causes of students' learning difficulties thereby helping the development of appropriate physics curricula and teaching and learning strategies that could facilitate students' construction of scientific knowledge (Redish et al, 2004; Dal, 2007; Lising and Elby, 2005; Kirschner, 1992). This study focuses on how well concepts are presented in helping students develop conceptual understanding. Therefore, this study would help to develop new insight regarding the sources of students' learning difficulties in physics.

1.2. Rationale of the study

The major purpose of teaching physics is conceptual understanding. Despite this, research findings reveal that many students have serious difficulties in understanding the basic concepts pf physics. In this regard, research results revealed that many students often hold ideas that are quite different from the scientific concepts and principles (Hynd et.al, 2005; McDermott, 1986). It was also found that although students scored good results in exams they often pass examinations without understanding the fundamental concepts of physics (Osborne and Freyberg, 1985b; McDermott, 1993). Research results on students learning difficulties in school physics also show that the problem is prevalent throughout the world (Idar&Ganiel, 1985). In this regard, science educators argue that as a result of lacking to focus on conceptual understanding, which is the major goal of physics, and the relative emphasis on procedural knowledge many students often hold misconceived ideas that are quite different from the concepts and principles they have learned (Hynd et al, 2005; McDermott, 1986). This led the development of conceptual change strategies. However, conceptual change strategies have not been confirmed to improve conceptual understanding due to the difficulty inherent in putting them in actual classrooms (Libarkin, 2001). In Ethiopia, despite the efforts made by the government in introducing learner-centered curricula and teaching practices, research results reveal that students' achievement to science subjects especially in physics was very poor (Temechegn, 2002). Based on the national learning assessment results of 2010 it was found that students' achievement to science subtexts was very low as compared to other subjects (Joshi &Adriaan, 2013). Similarly, the ministry's strategy for improving science and mathematics education in Ethiopia also indicates that the basic indicators of quality of mathematics and science teaching and learning were disappointing (MOE, 2010).

Science education researchers have tried to understand the very sources of students learning difficulties in physics. for the purpose of developing appropriate curricula, teaching strategies and assessment tasks that help students improve students' conceptions. The researcher argues that the use of conceptual change strategies doesn't work effectively or the presence of several activities doesn't necessarily ensure conceptual understanding unless the concepts and activities are provided in such a way that they help students develop qualitative understanding by activating students' experiential knowledge that is needed for dealing with the scientific theories and principles. One of the strategies that was found significant in improving conceptual understanding in physics and eliminate students' misconceptions to the physics concepts.in this approach in introducing physics concepts teachers and textbooks should start from describing everyday observations or phenomena that students are familiar with followed by qualitative description and explanation before dealing with the quantitative aspects of physics (Duit, 1996; Duit&Rhoneck, 1997; Trumper, 2006; Novak, 2002). Research reports on students' learning in science show that when students understand the qualitative relationship between the concepts (be able to explain the physical situation using principles and theories) they would determine the means of representing the qualitative relationship using mathematics (Mbajiorgu& Reid, 2006). At the school level physics is assumed to assist the students not only to make sense of their world but also to enable them develop scientific attitude and method of knowing that would help them describe and explain scientifically natural and physical phenomena (Horwood, 1988). It is in this way that we can make physics learning meaningful and they are able to organize knowledge using laws and theories.

This study presumes that unless the textbooks provide physics contents and experience in supporting knowledge construction it is difficult to enhance conceptual understanding (Tai & Tuan, 2005 in Trumper, 2001). The researcher argues that simply providing as many activities as possible doesn't necessarily enhance students' understanding of physics concepts unless learning activities are provided appropriately in enhancing conceptual understanding (Trumper, 2006). Therefore, in order that students benefit from curricula of physics, educators argue, attention should be placed on the way physics progresses from one level to the other and the emphasis given for each level depending on the nature and complexity of the concept being discussed and students' ability of understanding the concepts in designing curricular materials, teaching strategies and assessment tasks. On the contrary when students are simply introduced physics formula without relating the concept to their daily experience or simply introducing the physical laws and principles without relating to their experience they tend to seek all-purpose algorithm without understanding the basic concepts of physics. Therefore, when introducing physics concepts teachers and textbook writers should consider the ways physics concepts are represented by first helping students make sense of the physical phenomena before introducing the laws and principles of physics concept and to introduce the equations that represent the concept symbolically. The researcher also argues that due to the traditional practice of directly introducing concepts starting from symbolic or introducing directly the theoretical laws and principles without relating to students' experiences understanding becomes virtually impossible and students resort to memorization to pass examinations and they tend to manipulate mathematical algorithms correctly without understanding the relationship that exists between the concept and the formula that represents the concepts (Idar and Ganiel, 1985). Therefore, it is important to study the appropriateness of concept presentations in facilitating students' construction of physics concepts. In the Ethiopian context the researcher couldn't find any effort made by science education researchers to assess the appropriateness of the ways of physics concepts are provided. Thus, understanding the ways textbooks structure physics knowledge is significant in determining the extent to which curricula are developed in supporting students' construction of scientific knowledge.

1.3. Basic questions

The study attempted to find answer to the following basic questions.

- How do textbooks introduce physics concepts?
- What are the dominant ways of concept presentations in secondary school physics textbooks?
- To what extent do physics textbooks introduce concepts in helping students develop conceptual understanding?

1.4. Purpose of the study

The major purpose of the study to examine the strategies textbooks, use in introducing physics concepts.
More specifically:

- To examine the extent to which physics textbooks introduce the physical concepts in facilitating conceptual understanding.
- To explore the dominant strategies textbooks, use in introducing concepts in such a way that they enhance students' understanding of physics concepts

1.5. Significance of the study

This study is not a mere repetition of what have been studied in certain contexts; rather it has raised new issues in science education research that could be used as a starting point for further investigation. Most physics education researches have also took the planned curriculum for granted. As a result, they have focused directly on the transacted curriculum; rather than the planned curriculum. However, this study has made attempts to provide evidence of the appropriateness of physics textbooks in facilitating conceptual understanding. The results of this study are believed to help curriculum developers and textbook writers in introducing concepts and designing appropriate curriculum activities.

1.6. **Limitations**

One of the limitations that I felt is absence of studying the beneficiaries of curricula i.e. students and the developers of the documents analyzed. I have also shown that the ways physics knowledge is provided in the textbooks affect students' understanding the concepts of physics. Moreover, the researcher didn't find research done in this area in the Ethiopian context. Therefore, I was forced to rely on what have been found in other countries.

1.7. Scope of the study

In studying physics curricula, it was important to consider both the planned and the implemented curricula. However, this study focused on assessing the appropriateness of the ways physics concepts are presented in textbooks. Moreover, the study only focused on general secondary school physics textbooks. Therefore, the concussions that are drawn by this research only reflects the specified grade levels.

II. METHODOLOGY OF THE STUDY

2.1 Research design

Qualitative content analysis design due to the following reasons. The first one was the purpose the study aimed at. The purpose of the study was understanding rather than establishing relationships among variables that demands going through relevant data and give meaning to raw data subjectively. Thus qualitative content analysis was chosen due to its appropriateness in helping to understand and make inference about the way concepts are introduced in the textbooks (Hsieh & Shannon, 2005; Cohen et al, 2000). The freedom it gives to purposely focus on certain statements or paragraphs that could provide relevant data; rather than gathering evidence from large amount of data using random sampling was the other reason to select qualitative content analysis design (Kreuger and Neuman, 2006). In this regard, it is very difficult to understand and make inference by relying on randomly selected statements or activities. Focusing on certain statements or activities to find evidence and making inference is only allowed in qualitative content analysis design than in quantitative designs. Due to the above mentioned reasons a qualitative content analysis design was found important in revealing the meanings communicated in the textbooks by engaging the researcher in the processes of data production, analysis and interpretation

2.2 Sampling

Physics textbooks were used as the major sources of data because regardless of other curriculum materials school textbooks are the major curriculum resources that could serve as important tools for understanding the epistemological basis of the Ethiopian school physics curricula (Hottecke& Silva, 2010). In this study both the general secondary i.e. grades 9 and 10 and preparatory level i.e. grades 9 and 10 physics textbooks were used as data sources. For the analysis two units were selected randomly from each grade level. From the units selected, the entire topics were taken. Thus, a total of 28 topics were included in the study.

2.3 Method of data analysis

Data analysis and interpretation in qualitative content analysis requires coding raw data and generating certain analytical categories followed by interpretation or giving meaning to raw data (Starks & Brown, 2007; Given, 2008; Elo&Kynga, 2007). Content analysis can consist of descriptive coding which involves simple tallying the concept presentations based on each category. The occurrence of each category in the textbooks was tallied to know to which category each concept belongs. After the data is tallied analysis was made to each variable using percentages. In order to determine the appropriateness of the ways textbooks introduce physics concepts the data presented from the textbooks were brought into each category. In textbook analysis evaluations the categories were made based on the way the concepts have been introduced based on the three levels of thought as either starting from macro /descriptive to micro (relational) and finally to symbolic (representational/mathematical) or starting from micro to symbolic explaining qualitative relations and then giving mathematical equations to represent the concepts.

2.4 Validity and reliability

2.4.1. Internal validity

One of the key criteria addressed by positivist researchers is that of internal validity, in which we seek to ensure that whether a certain study measures what it actually intended to measure (LeCompte&Goeth, 1982). Internal validity in qualitative research focuses on establishing a match between the constructed realities of respondents and those realities represented by the researcher (Merriam, 1998; Guba and Lincoln, 1989)). In qualitative content analysis this means that the extent to which the researcher is able to present data as it is stated or implied in documents. In this regard, attempts were made to present the data presented in the materials analyzed without distortion. In doing the statements were directly quoted from the textbooks were so that one can judge how consistent is the discussions and conclusions with the data that appears in the textbooks.

2.4.2. External validity

One of the criticisms from quantitative researchers to qualitative studies is the issue of external validity. The notion of external validity, which is concerned with the ability to generalize from the research sample to the population using the principle of randomization and applying statistical tests is one of the key criteria of determining the quality of good quantitative research (Merriam, 1998, Shenton, 2004, Mays & Pope, 1995).

However, in qualitative content analysis because the sampling is purposive the researcher cannot extrapolate from the sample to the population (White and Marsh, 2006). On the other hand, since the major purpose of qualitative research is to understand than to generalize, external validity is not so much concerned. However, this doesn't mean that the results of qualitative inquiries are not totally used because they can be applied to similar cases. Thus, in order to ensure that the results of qualitative studies be applied to similar cases or contexts qualitative researchers developed another terminology i.e. "transferability" (e.g. Morrow, 2005; Shenton, 2004). In order to improve transferability attempts were made to describe the whole process of data collection, data coding and interpretation in order to allow other researchers follow the same procedure to repeat the research process so that they can apply it in other situations and contexts. This would enable other researchers to analyze the same data in the same way and come to essentially the same conclusions (Mays & Pope, 1995)

2.4.3. Reliability

Reliability is related to objectivity and is measured in quantitative content by assessing inter-rater reliability. However, in qualitative research findings are confirmed by looking for if the data support the conclusions (White and Marsh, 2006). Hence, attempts were made to be objective by linking the data with the interpretations and the conclusions. In other words, it is concerned with reporting the findings from the perspectives of the data sources rather than from the researcher's point of view (Thomson, 2011). To ensure reliability the researcher attempted to show how the necessary relationships that exist between the raw data, the discussions and the conclusions. I have also provided the data together with the analysis and interpretation by clearly establishing links between research questions and existing data that enabled to arrive at conclusions (Bashir et al, 2008; Thomson, 2011; Thomas, 2006). Reliability in qualitative research can also be done by providing evidence how the researcher accounts for changing conditions in the phenomena. Because this study used published documents and one of the strengths of documents as a data source lies in the fact that they already exist in the situation they do not alter the setting and also they cannot be distorted (Merriam, 2002; Morrow, 2005).

III. RESULTS AND DISCUSSION

In order to give answer for the research questions the data obtained from grade nine and ten physics textbooks were analyzed both quantitatively and qualitatively based on the categories made followed by discussion of the findings. The quantitative data includes presenting the frequency and percentage of concepts, examples and problems under each category. In order to give meaning the analysis was made by referring to the criteria set by the study. Moreover, in order to give meaning to the categories typical examples taken from the textbooks were presented.

Many findings of research in physics education revealed that students are likely to develop better understanding if they learn more about the structure of physics knowledge and the process of mathematical representation than is currently expecting secondary school curricula (Wessel, 2004). In order to make physics meaningful, the best strategy that should be adopted by textbook writers is starting with the 'macro' and then to the submicroscopic and finally to the symbolic. The experiential knowledge is the knowledge that students bring to the class as a result of their life experiences they have had during their lives and the thinking that they have done to organize the knowledge to help them operate in their world (Mbajiorgu& Reid, 2006; Wesel, 2005). After this has been done giving precise qualitative explanations for that phenomena related to direct experience and finally mathematical representation of the qualitative concepts is essential (Trumper, 2006; Idar and Ganiel, 1985). It is in this way that we can make physics learning meaningful.

The way textbooks provide the physical concepts they were grouped into three major categories based on how they progress from one level of thought to the other. While in the first category concepts presented in a proper path way (i.e starting from qualitative concrete experience of the phenomena to qualitative explanation of laws, principles etc, and finally to mathematical representations) were coded, in the second category, which can be labeled as improper path way are those concepts presented in a way that starting from qualitative explanation of laws, principles, etc to mathematical representations. In the third category were coded concepts presented directly from symbolic to either descriptive or relational. This way of introducing physics concepts, which have been highly criticized by science educators, is starting with the mathematical expressions before dealing with the descriptive and the interpretational aspects of the concepts. When concepts are introduced in this manner, students learning approaches might be dictated in a way to manipulate formulae without understanding the relationship between the formula and the concepts which the variables represent (McDermott, 1990). In this regard, it was found that no physical concepts were found that begin its presentation just from the symbolic/representational and then to the phenomenological and relational.

Attempts were also made to evaluate the way the textbooks employ conceptual change strategies in promoting students understanding to the physical concepts. In order to promote conceptual understanding among students there are two major approaches that have been suggested by science educators. The first one isthe conflict approach that focuses onpromoting situations where the student's existing ideas about some phenomenon are made explicit and are then directly challenged in order to create a state of cognitive conflict and attempting to resolve the conflict provide the first steps to any subsequent learning. According to this approach, conceptual change may occur following student's realization that their existing beliefs can longer satisfactorily explain their observations, and provided that a new belief is plausible and proves fruitful is its further application (Hewson, 1981). Although this approach is believed to enhance students' learning in physics, no attempts have been made to employ it in any of the concepts. In order to assess concept presentations in the textbooks, a total of four chapters were taken from the textbooks randomly and all of the concepts included in these chapters were analyzed. Thus, a total of 28 physical concepts i.e. 11 (39.28%) from grade nine and 17 (60.72%) from grade ten were included. In the table below the number and percentage of concepts are presented under each category.

Grade	No. of Concepts	Category I	Category II	Category III
		Micro to macro and symbolic	Macro to micro then symbolic	Symbolic to micro
		Qualitative to quantitative	Qualitative to quantitative	Quantitative to qualitative
9	11	7 (63.36%)	4 (36.36%)	No
10	17	16(94.11%)	1 (5.88%)	No
Total	28	23 (82.14%)	5 (17.85%)	No

Table 1- Summery of number and percentages of physics concept presentations by grade level and category.

The data presented on the table above shows that only **5 (17.85%)** of the concepts are provided in a proper way i.e. by considering students' experiential knowledge as a starting point for concept presentation or by considering the experiential knowledge of students or trying to make associations between the concepts being introduced and students' prior experiences.

Regarding the use of the conceptual change strategies, all of the concepts being considered adopt the approach of "building the scientific concepts on pupils' existing ideas." without trying to elicit what students have known and challenge their intuitive notions in order to bring about conceptual change. This strategy assumes that conceptual change can be encouraged by providing opportunities for students to build up qualitative-intuitive understandings of phenomena before mastering quantitative principles. It also assumes implicitly that the students have already possessed the requisite knowledge.

The other consideration for helping students understand the physical concepts is providing opportunities for students to represent qualitative explanations with quantitative formulae by themselves. Science educators argue that when students understand the qualitative relationship between the concepts (be able to explain the physical situation using principles and theories) they would determine the means of representing the qualitative relationship using mathematics. They also contend that students are not going to adopt a new concept unless they can first represent it to themselves (Scott et al, 1991). In this regard, there were no attempts made to give opportunities for students to represent the concepts by their own rather all of the representations were made by the textbooks.

The concept taken from page 69 of grade 9 text book is a typical example of the second category

Topic- Linear momentum
"Think of a slowly moving bus and a fast moving car. Which one do you think requires more force to stop its motion? …. A stone is thrown from a stretched catapult, and another stone is thrown by hand. Which one has a more penetrating power? The former has more penetrating power, even though both stones have the same mass"
"The physical quantity that describes this aspect of the motion of an object is called momentum"
"Momentum is the product of mass of a moving body and its velocity"
"The equation for momentum is "P = m v"

The way the concept of linear momentum is introduced is a good example of concept presentation that describe the physical phenomena qualitatively based on observable experiences and provided what this experience means in science, and then described the relationship between the variables of the concept qualitatively and finally provided mathematical representation of the qualitative relationship. The textbook also tries to introduce the concept of momentum starting from the macro/experiential and then provide what that experience mean in physics and finally what comes next is to inform students the meaning of their experiences.

This form of presentation is often termed as "idea first and name after" This means that when introducing a new concept, it is a feasible to begin a discussion by using everyday language to describe common experiences and only then introduce formal physics terminology to represent the concepts being discussed. The philosophy helps build patterns of association between concepts students are trying to learn and knowledge they already have. It also helps students reinterpret their experiences in a way that is consistent with physical laws.

In introducing the concept of momentum it is a better strategy to make appropriate links between the concept being introduced and some other laws of physics which have direct or indirect applications. The concept of linear momentum is a direct application of Newton's second and third laws of motion. Newton's Laws of Motion describe only motion of a body as a whole and are valid only for motions relative to a reference frame. It is important to note that these three laws together with his law of gravitation provide a satisfactory basis for the explanation of motion of everyday macroscopic objects under everyday conditions.

The First Law of motion which is often expressed as the law of inertia is stated as follows: "A body at rest remains at rest, and a body in motion continue to move in a straight line with a constant speed until an external unbalanced force acts upon it. The Second Law of motion is stated as: "The rate of change of momentum of a body is directly proportional to the impressed force and takes place in the direction in which the force acts. The Third Law of motion is stated as follows: "To every action (force applied) there is an equal and opposite reaction (equal force in the opposite direction). In other words, if an object A exerts a force on another object B, then object B exerts a force of the same magnitude on A, in the opposite direction. Therefore, when introducing the concept of momentum, the text should start at least by trying to make a conceptual link between the two laws mentioned above and move to the meaning of the new concept and its mathematical representation. Moreover, it is better to give opportunities for students to establish mathematical representations by themselves and finally providing the formulae or equation that could represent the concept.

The dominant way of concept introduction which constitutes about 23 (82.14%) of the concepts being considered is starting with the qualitative explanation of laws, principles etc. or that starts from the micro or relational before the symbolic or representational. This kind of presentation, Mbajiorgu& Reid (2006:6) argue, is not appropriate for school students because the micro, which is readily used by the expert, is not often understood or used by the students readily for it lacks to consider not only students' experiential knowledge but also never considers the importance of associating the concept being presented with its phenomena (macro) that is a key for understanding. Therefore, this approach doesn't help students to make sense and then interpret the physical phenomena using scientific laws and principles in a qualitative manner.

The example given below represents this category.

"A mass suspended from a spring is under the action of elastic force of the spring and its weight. The mass remains at rest under these two forces. The mass is said to be in equilibrium." *"The body is in equilibrium is either at rest or moves with a constant speed in a given direction. For a body in equilibrium, the vector sum of all the forces acting on it is zero. The statement is called first law of equilibrium"* *"If the sum of the forces acting on a body is zero, the sum of the component forces along X and along Y axes must each be zero. Therefore, the first condition of equilibrium is expressed as $\sum Fx = 0$ & $\sum Fy = 0$"*

The example given above is a typical example of concept introduction that attempts to provide a qualitative description of laws, principles etc, without referring to students' experiential knowledge. On the other hand, the example given below taken from page 116 of grade ten physics textbook though could represent the first category; the textbook even doesn't tell students the meaning of the law of reflection. It is provided without providing the meaning of the relationship in actual situations or there is no description of what the variables mean in reality.

Topic- law of reflection *The normal line, incident ray and reflected ray are all lie on the same plane i.e. they can all be drawn on a flat sheet of paper and the angle of incidence equals an angle of reflection (r)"*

IV. SUMMARY OF FINDINGS

The study was intended to examine general secondary school physics textbooks as to the ways the concepts have been presented in enhancing conceptual understanding. In this section the data obtained from textbooks will be summarized in order to give answer for the research question posed by the study.

With regard to the nature of the concepts of physics presented in the textbooks, it was found that most i.e. 82.14% of the concepts in the textbooks of are presented starting with the qualitative explanation of laws, principles etc. or that starts from the micro or relational before the symbolic or representational. It was also found that only 5 (17.85%) of the concepts are provided in a proper way i.e. by considering students' experiential knowledge as a starting point for concept presentation or by considering the experiential knowledge of students or trying to make associations between the concepts being introduced and students' prior experiences.

With regard to the conceptual change strategies employed by the textbooks, though using the "conflict approach" to concept learning is feasible to enhance concept development, it was found that the dominant approach the textbooks adopt was "the development of scientific ideas consistent with the science point of view." The other consideration in introducing physics concepts is instead of providing mathematical representations of concepts by the textbooks directly, giving opportunities for students to represent or establish quantitative relationships by their own is a feasible strategy in promoting students' understanding. However, this has not been observed in any of the concepts presented in the textbooks.

V. CONCLUSIONS

The aim of physics at the Ethiopian general secondary schools is primarily to develop understanding so that students can interpret and make sense of the physical world. In designing textbooks, it is important to allow students' time to experience the physical phenomena or describe everyday observations or phenomena and give precise explanations for single phenomena closely related to direct experience from the everyday-world that students are familiar with before launching into the interpretation and representational aspects.

The study revealed that the dominant curriculum strategy in introducing physical concepts is starting from a qualitative description of physical laws, principles, theories etc and then to representing the qualitative relationships using mathematical formulae or equations. Therefore, it can be concluded that despite presenting physics concepts in the way described above, most of the concepts in the textbooks have not been presented in a way that could help students understand the physical concepts.

Generally based on the findings of the study it can be concluded that the Ethiopian general secondary textbook concept presentation are not appropriate to enhance conceptual understanding which is a key for the development of problem solving students

One of the purposes of this study was to determine the appropriateness of the structure of physics contents and activities provided in the textbooks in supporting knowledge construction. Based on the discussion made in the preceding sections I have made the following conclusions. Regarding the ways the physics concepts are introduced in the textbooks, I observed that some attempts were made by the textbook writers to introduce physics concepts in a constructive manner. However, instead of facilitating students' construction of the physical concepts by leading students arrive at the established laws and principles of physics by their own inquiries they typically focus on providing the end products of physics. Therefore, it can be concluded that although there are some attempts to enhance students' understanding of the concepts of physics at the same time they do not assist students in constructing the laws and principles of physics

VI. RECOMMENDATIONS

In the light of the findings of the study it seems reasonable to forward the following recommendations. As has been found in the study most of the concepts in the textbooks have not been presented in a way that could help students understand the physical concepts. Therefore, textbook writers should provide concepts starting from students' experiences before dealing with abstract concepts and try to establish what students' real-life experiences about a particular phenomenon before dealing with the theoretical and symbolic aspects of physics.

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