THE EXTENT TO WHICH THE CHEMISTRY TEXTBOOK OF GRADE 11 IS APPROPRIATE FOR LEARNER-CENTERED APPROACH

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ABSTRACT

The purpose of this study was to identify the extent to which the chemistry textbook of grade 11 in Ethiopian schools is appropriate for learner-centered approach. The content of the new chemistry textbook for grade 11 was analyzed vis-à-vis the suggested evidence of learner-centered techniques. The analysis covered the components of the textbook such as objectives, texts, activities, questions, and figures and diagrams. The results of content analysis revealed that only the activities given in the text encourage student's involvement in the teaching learning process. *[AJCE, 2(3), July 2012]*

INTRODUCTION

Curriculum is a crucial component of any educational process. Education is unthinkable without curriculum. Curriculum materials are central elements or the main means to achieve the purposes of education. Having appropriate curricular materials (teachers' guide, students' textbook, etc) helps to promote student-centered learning and ensure quality education. Within active learning system curricular materials (syllabus, teacher's guide, and textbooks) are very significant to implement the method. In designing curricular materials, it becomes very important to recognize the inevitability of mixed groups in terms of proficiency and also in terms of preferred learning styles, so that they can be used in variety of ways (1). If students should be critical thinkers and problem solvers, textbooks should be designed in the way they ensure ample opportunities for learners to question, apply and consolidate new knowledge. Hence, there will be opportunities to experience and understand science concepts and processes through hands-on, minds-on and authentic real-life related problem solving activities.

In most cases the bodies of textbooks are texts, activities, exercises and illustrations. When the writer (author) designs the textbook, he/she thus pays attention to the components of learning such as texts, activities, questions and figures which invite active leaning (2) and are described below.

Texts

Romey (3) developed the students involvement index of texts presentation for grades 7-10 science textbooks. According to Romey; facts, conclusions, definitions, and questions answered immediately by the text are taken as "non involvement". Whereas, questions requiring the students to analyze data, statement requiring the students to formulate conclusions, directions requiring them to analyze and perform activities or solve problems and questions designed to

arouse interest are taken as "involvement". The choice of the Romey index of involvement is somewhat arbitrary. However, since the presentation of knowledge in the text influence the implementation of science teaching, it seems appropriate for evaluating the presentation of the texts of science textbooks by using that involvement index (4). Accordingly, the researcher of this study analyzed the knowledge presented in the texts of grade 11 chemistry textbook by adapting the involvement index developed by Romey (3) and latter adapted by Fletcher (4).

Activities

Textbooks can have several purposeful activities that require the learners to work together and gives instructions concerning what to do and how to do it (5). Most learning takes place when we actually try to do something. Learning does not happen efficiently when we merely read about something or listen to someone talk about it. The actual measure of a good learning package is what the students do as they work through it.

Questions

Cotton cited in Solomon (6) defines a question as "….any sentence which has an interrogative form or function. In classroom settings, questions are defined as instructional cues or stimuli that convey to students the content elements to be learned and directions for what they are to do and how they are to do it." This definition makes it clear that questions are not limited to the grammatical form that ends with question mark only. A question is rather understood as any utterance or cue that elicits responses or some kind of human interaction.

There are certain considerations for good questions. For instance, they should be formulated in clear language and one has to avoid questions permitting "yes or no" answers or

one word answers. Good questioning takes into account the pupils' background or experience and their ability to form judgment. It will not be confined to memory or recall questions. Questions can also be classified on the basis of their level of cognitive difficulty such as lower order (lower cognitive) and higher order (higher cognitive) questions (6, 7).

Figures and Diagrams

The term figures or/and diagrams means any drawing that can serve as the condensed visual form of a lesson. Effective methods and means of teaching include figures, diagrams, pictures, graphs, photographs, illustrations, drawings, etc as the types of visual teaching aids (8). Observation may also be recorded by drawing (9). These must not be ideas, copies of drawing but must be made from actual things. Figures/diagrams should not be put only for illustrative purposes. They should also be used for doing activities and exploring something.

The traditional curriculum 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 cannot change the social, economical, political and cultural aspects of the country and to the lives of each individual as desired. Cognizant of these facts, the Education and Training Policy of Ethiopia—TGE (10)—gives due emphasis for strengthening of the individuals' and society's problem-solving capacities at all levels. As stated in the (10) one of the objectives of education is to develop the physical and mental potential and problem solving capacity of individuals by expanding basic education for all. It is also argued that learner-centered approach prepares and enables learners to solve problems, makes them creative and user

information from their environment and other sources to make a better life for themselves, the society and the country as a whole (10).

To make these assertions practical, the government of Ethiopia has recently developed textbooks that encourage the learner-centered method, including chemistry teaching textbook to high school students (11). This study has therefore been designed to give insight into identifying the extent to which the Chemistry textbook of grade 11 is appropriate for learner-centered approach

RSARCH METHODOLOGY AND PROCEDURES

Content analysis was used to identify the extent to which the grade 11 Chemistry textbook is appropriate for learner-centered approach. For this purpose, the content of the new Chemistry textbook for grade 11 was analyzed vis-à-vis the suggested evidence of learner-centered techniques. The analysis covered the components of the book such as objectives, texts, activities, questions, and figures and diagrams.

The objectives outlined in the textbook were analyzed using major categories of the Bloom's educational objectives. The Bloom's cognitive domain includes those objectives that emphasize intellectual outcomes such as knowledge, comprehension, application, analysis, synthesis and evaluation. The first three: knowledge, comprehension and application are categorized as lower level of learning outcomes in cognitive domain. The other three: analysis, synthesis and evaluation are categorized as higher level outcomes.

Texts include facts, conclusions, definitions, questions answered immediately by the text, questions requiring the students to analyze data, statements requiring the students to formulate conclusions and directions requiring them to analyze and perform activities or solve problems.

The students involvement index (SII) of the knowledge presented in the new Chemistry textbook is computed based on the developed procedure of Romey (3) as the ratio of active involvement (AI) to passive involvement (PI). Active involvement is measured by a) skills, b) unanswered in-text questions and c) real examples. Passive involvement, on the other hand, is measured by d) concepts (factual information), e) immediately answered in-text question and f) unreal examples (See Appendix I). Therefore, SII can be described as

$$\text{AI/PI} = \frac{a+b+c}{d+e+f}.$$

According to Romey (3), a value "0" for the ratio AI/PI represents no students involvement'; a value between "0" and "0.4" represents' below average, a value between "0.4" and "1.5" represent average and values above 1.5 represents best for students involvement in texts.

Figures and diagrams were analyzed by using two categories of students' involvement index (8). Accordingly, for this study, figures and diagrams used only for illustrative purposes were categorized under 'passive involvement' and figures and diagrams which require students to perform certain activity to answer questions and exploring something were categorized in 'active involvement (see Appendix I).

In order to analyze the activities suggested in the textbook, the inquiry level index for activities developed by Heron (12) was used. Inquiry level index has four levels depending on the tasks that students have to accomplish.

Level Zero: the question, the method, and the answer are all provided.

Level One: the question and the method are given; the student has to find the answer..

Level Two: the question is given; the student has to design a method and to find an answer.

Level Three: the student is presented with the phenomenon, she/he has to formulate a relevant question, design a method and find an answer to the question.

In analyzing the activities, the first level i.e., "level 0", structured with given (closed) problem, procedure and solution, is categorized as 'passive involvement' and the three levels: 'level 1', 'level 2' and 'level 3', structured with one or more of problem, procedure or/and solution be opened to learners investigation, are categorized in 'active involvement'(see Appendix I)

The following levels of questions were used in evaluating the order of thinking: literal, inferential and critical questions. In analyzing the questions the first level, literal, is categorized under 'passive involvement of learners 'i.e., lower order thinking and the rest two levels: inferential and critical are categorized in 'active involvement of learners' i.e., higher order thinking questions (see Appendix I)

RESULTS AND DISCUSSIONS

Content Analysis of Grade 11 Chemistry Textbook

As mentioned above in this study content analysis of grade 11 textbook covers the objectives, texts, figures and diagrams, activities and questions given in the textbook. The results are therefore presented and discussed in the ensuing paragraphs.

Table 1 shows the distribution (%) of the objectives by categories of cognitive processes.

Table 1: Distribution (%) of Objectives by Categories of Cognitive Processes

Unit	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
1	11	2	4	4	1	0	22
2	18	20	5	2	2	0	47
3	20	30	10	9	1	0	70
4	11	15	9	0	0	0	35
5	9	13	6	1	1	0	30
6	6	16	2	0	5	0	29
Total	75	96	36	16	10	0	233
%	32.19	41.20	15.45	6.87	4.29	0	

Lower order: 32.19% + 41.20% + 14.45%= 88.84%; Higher order: 6.87% + 4.29% + 0% = 11.16%; Lower order: Higher order = 88.84: 11.16

From the above table it can be seen that most of the objectives outlined in the textbook are of the lowest level while very few are higher order objectives. This shows that the Grade 11 chemistry syllabus developers did not give attention to Bloom's taxonomy of educational objectives. The following example was taken from Grade 11 chemistry textbook to illustrate the process of analysis.

Example. 1.1 THE SCOPE OF CHEMISTRY

Objectives: After going through this sub unit, you will be able to:

- define chemistry;
- appreciate the use of chemistry in the study of other fields;
- explain major branches of chemistry;
- identify the scope of different branches of chemistry.

The above objectives are categorized in lower order according to Bloom's taxonomy of educational objectives.

Students Involvement Index for Figures and Diagrams in Grade 11 Chemistry textbook

Description and Rating the Figures and Diagrams in the textbook

a. Description

1. Each figure and diagram was analyzed using the following categories.

a = used strictly for illustrative purposes.

b = requires students to perform some activity or to use data.

c = fits none of the categories.

2. Calculate the index of student involvement for the figures and diagrams:

$$\frac{b}{a}$$

b. Rating the Figures and Diagram

Table 2 shows the rating of figures and diagrams in the textbook.

Table 2. Rating the Figures and Diagrams

Unit	Categories		
	Passive Involvement (a)	Active Involvement (b)	Student Involvement Index (b/a)
1	6	0	0
2	16	0	0
3	23	0	0
4	10	0	0
5	9	0	0
6	10	0	0
Total	74	0	$\frac{o}{74}=0$

As can be seen from the table there is no figure and diagram that involves students in the textbook. This indicates that all the figures and diagrams were drawn for illustrative purpose rather than for performing activities.

Examples

The following figures were taken from grade 11 Chemistry textbook as an example.

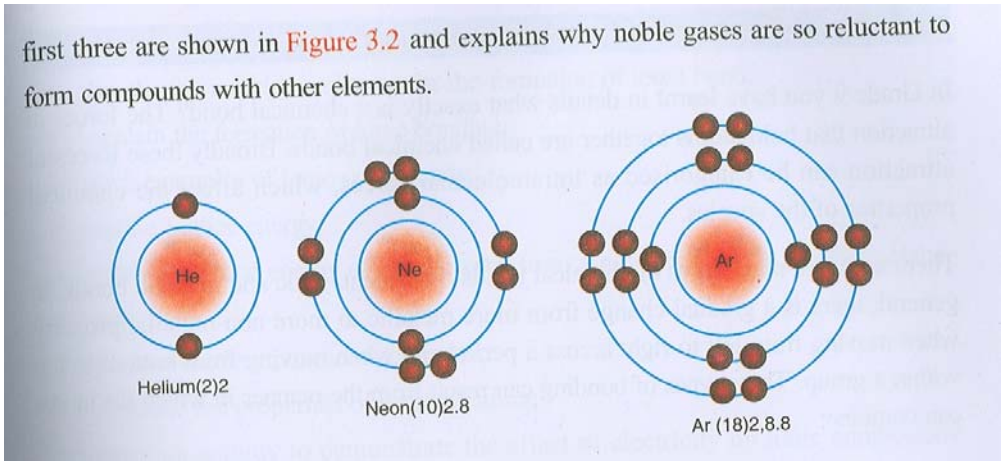
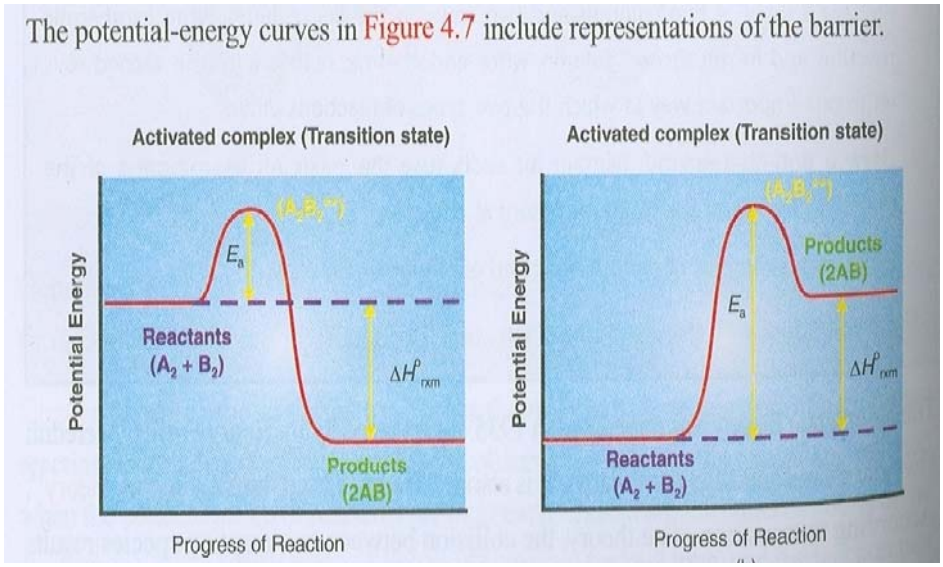


Figure 3.2 in the textbook shows the electronic configuration of the first three noble gases. But instead of arranging the electrons students could be asked to complete the table to involve them in the teaching learning process.

The following figure shows reaction energy diagrams for exothermic and endothermic reactions. Since the students learned about this in lower grades, they could be asked to draw the diagram by themselves.



The involvement level of activities in grade 11 Chemistry textbook

As discussed in the methodology part, in order to analyze the activities suggested in the textbook the inquiry level index for activities was used. Table 3 presents the results of the analysis.

Table 3: The Involvement Level of Activities in Grade 11 chemistry textbook

	Passive involvement	Active Involvement			Total
Unit	Level 0	Level 1	Level 2	Level 3	
1	_	3	7	_	10
2	_	23	5	_	28
3	1	20	1	_	22
4	_	7	2	_	9
5	_	9	1	_	10
6	_	13	1	_	14
Total	1	75	17	_	93
%	1.07	80.65	18.28	_	100

According to Table 3 above, Grade 11 chemistry textbook contains only 1(1.07%) passive involvement i.e. level 0, 75 (80.65%), level 1 and 17 (18%) level 2 activities which are categorized as active involvement. There is no activity categorized as level 3. This shows that even though there is no level 3, the activities in the textbook encourage students' involvement.

Example Activity 2.6 from grade 11 chemistry textbook

Form a group and discuss the following questions and share your ideas with rest of the class.

1. Are neutrons present in all atoms?

2. Can two atoms have same number of electrons but different number of neutrons?

3. Can an atom have unequal number of electrons and protons?

4. Chemical properties of an atom are decided by number of electrons, protons or neutrons?

5. Define atomic number and mass number. Which one can vary without changing the identity of the element?

According to Heron (12), the questions given in activity 2.6 above are categorized under level 2 because only questions are given but procedures and conclusions were left for students. So, the activity involves students.

Students Involvement Index for Texts Chemistry textbook

Table 4 below shows that only unit 4 of grade 11chemistry textbook has average with 0.5 student involvement value. The other five units have below average. This indicates that there is very low students involvement in the knowledge presented in the texts of the indicated chapters. So, they are designed exclusively to promote learning by rote.

Table 4: The Involvement Index of Text of Grade 11 Chemistry Textbook

Unit	Categories						Romey's Involvement Index	
	Active Involvement			Passive Involvement				
	S(a)	UITQ (b)	RE (c)	C(d)	AITQ (e)	URE (f)	SII= $\frac{a+b+c}{d+e+f}$	Remark
1	-	-	7	22	-	-	0.32	Below Average
2		2	-	29	1	-	0.06	Below Average
3	-	3	4	52	-	-	0.13	Below Average
4	-	7	2	17	1	-	0.5	Average
5	-	-	2	21	-	-	0.09	Below Average
6	-	-	6	14	-	-	0.3	Below Average
Total	-	12	21	155	2	-	0.21	Below Average

S= skills, UITQ = unanswered in text questions, RE = real examples, C=concepts, AITQ = answered in text questions, URE = unreal examples, SII = students involvement index

The Involvement Level of Questions in Grade 11 Chemistry Textbook

Table 5: The Involvement Level of Questions of Grade 11 Chemistry Textbook.

	Categories			
Unit	Passive Involvement	Active Involvement		Total
	Literal	Inferential	Critical	
1	10	-	15	25
2	15	11	7	33
3	20	16	-	36
4	21	5	3	29
5	8	2	10	20
6	10	7	-	17
Total	84	41	35	160
%	52.5		47.50	

As can be seen from the table, a total of 160 questions were analyzed. Of the 160 questions, 84 (52.5%) were lateral questions and fall in the category of passive involvement. This shows that more than half (i.e. 52.5%) of the questions in the textbook do not seem to be engaging the students in meaningful thinking since the answers are readily available and explicitly stated in the text. The remaining 76(47.5%) fall in the category "active involvement' which require higher order thinking.

Example. Exercise 3.4 in grade 11 Chemistry textbook

1. Explain the formation of bonds in the following pairs of elements:

a potassium and chlorine,

b magnesium and oxygen and

c sodium and oxygen.

2. Which of the following elements will form a ionic bond with chlorine and why? Magnesium, Carbon, Oxygen and Silicon
3. Why ionic bond is also known as electrovalent bond?

The above questions are categorized as literal questions (see appendix I).

RECOMMENDATIONS

During Chemistry textbook preparation or/ and revision, active learning methods need to be incorporated adequately so as to achieve the aim of chemistry education. Hence, all responsible bodies should deliberately consider the following as benchmark during textbook preparation or/and revision to realize the intentions in the Education and Training Policy.

- To increase students' involvement the knowledge presented in texts should incorporate tasks that require skills telling to analyze and synthesize activities. Unanswered in-text questions requiring data analysis and real examples related with students' lives might help the development of students' knowledge and skills.
- Activities in textbooks which take into account the need for 'level 2' and 'level 3'activities help students exercise their critical and creative thinking skills. Such skills are necessary for solving problems in life and academic situations. Chemistry textbooks are useful if incorporate such activities.

- In addition to inferential questions textbooks should also incorporate critical questions that ask learners to express their views and opinions by using their higher order thinking;
- Figures and diagrams illustrated in chemistry textbooks should enable pupils to engage actively with lessons to develop their thinking and interpreting power.

REFRENCES

1. Nunan, D. (1998). The learner Centered Curriculum. London: Cambridge University Press.pp98-99.
2. Tesfaye Ejigu (2005). Techniques of Writing and Editing Educational Materials. Addis Ababa:Eleni Printing Press.
3. Romey, William (1968). Inquiry Techniques for Teaching Science. London: Printice-Hall.
4. Fletcher, R., 1974. An Application of Romey s Involvement Index and a standard of reading Formula to Representative Modern and Traditional Science Textbooks for Grade7-10. Retrieved on 15/01/2010 from Htt //www.eric.ed.gov/ ERIC Web portal/ record Datail.
5. Robert, A., 1962. The Teaching of Science in the Upper Primary School**:** *African Education Journal .7 (2): pp9-20. Lusaka.*
6. Solomon Amare. (2003). Peer Review of Instructional Practice at Colleges. IER Flambeau. 11(1):43-59.Addis Ababa University.
7. McNamara (1994). Classroom Pedagogy and Primary Practice. London: Selwood Printing Press Ltd.3p.
8. Mehari Yimulaw (2007). Modules and Active leaning. *The Ethiopian Journal of Education.* XXVII (1): pp73-86**.** Addis Ababa**.**
9. Bullington, A. (1962). Teaching of Science in the Upper Primary School. *African Education Journal.* 7(2): 9-20. Lusaka.
10. TGE (1994). Education and Training Policy of Ethiopia. MoE: Addis Ababa pp1-5
11. MOE (2009). Strategies For Improving Science and Mathematics Education in Ethiopia: Addis Ababa (unpublished). Pp.1-5.
12. Herron, M.D., 1971. The nature of scientific inquiry. *School Review*, 79, 171- 212.

APPENDIX I

The description of categories under each of the four components of the text books

A. Texts

1. Active involvement texts: when students engage actively in learning process with skills (procedural knowledge), real examples and unanswered in-text questions.

1.1 Skills: are procedural knowledge demands both in and out of classrooms abilities which include observing, measuring inferring, predicting, classifying, collecting date, recording data, interpreting data, controlling variables, formulating hypothesis, comparison, construction, experimentation, identification and sorting.

1.2 Real examples: are supporting evidences those, most meaningful and relevant to students live, needs and interests and provide opportunities to experience and understand the practical applications of the science concepts and procedures and resulting social applications.

1.3 Unanswered in-text questions: are in-text questions that does not answered immediately in the text and made the learner to stop and think for a moment.
2. Passive involvement texts: when students engage passively with concepts (conceptual knowledge), unreal examples and immediately answered in-text questions.
2.1. Concepts: are conceptual knowledge s which include ideas, principles, laws, facts, rules, generalizations, theories that scientists have developed and accumulated with the procedural inquiries. These concepts are stated in the texts and summaries and learned by rote.
2.2. Unreal examples: are examples that are not relevant with students real life and social applications. These examples do not give opportunities to experience in the practical applications of science concepts and procedures.
2.3 Answered in-text questions: are in-text questions that answered immediately in the text with a formal written answer.
3. None of these: a paragraph or entire of subtitle that not fitting neither of skills nor concepts.
B. Activities
1. Passive involvement activities: activities labeled under level 0 which are structured with given or closed problem, procedure and solutions.
1.1. Level 0: an activity or task where problem, procedure and conclusion is all given and the only task remaining for the student is to collect data.
2. Active involvement activities: Activities labeled under level 1, level 2 and/or level 3 which one or more of problem. A procedure of solution is open to learner s investigation.
2.1. Level 1: an activity or task where problem and procedure are given and the student has to collect the data and draw the conclusion
2.2. Level 2: an activity or task where only the problem is given and the student has to design the procedure, collect the data and draw conclusion.
2.3. Level 3: An activity or task where the student has to do ever thing by themselves, beginning with problem formulation and ending with drawing conclusions.
3. Not clear: activities which are not clear to categorize under either of the above four level of activities.
C. Questions
1. passive involvement questions: are answered by lower order thinking of learners which require them to recall simple facts or information previously taught.
1.1 Literal question: a question which has answer that can be located in the reading selection and require minimal use of prior knowledge and stated facts to be recalled for comprehension.
2. Active involvement question: are answered by higher order thinking of learners and which require students to formulate, evaluate or synthesize an idea and provide logical response.
2.1. Inferential question: Question which has factual answer, even though the answer may not be certain. It requires the two or more facts be considered together in order to produce an unstated (suspected) facts.
2.2 Critical question: a question which has answer that are not facts but that reflect values. It needs synthesizing information from a variety of sources in order to apply it to a new situation, solve problems, identify biased writings etc.
3. Not clear: Questions which are vague questions to categorize under either of the above three levels of questions.
D. Figures and diagrams
1. Passive involvement figures: figure, diagram, picture, drawing, photograph, etc which is constructed only for illustrative purpose

2. Active involvement figures: figure, diagram, picture, graph, drawing, photograph, etc which requires students to perform certain activity to answer question and exploring something.
3. Not clear: Figure, diagram, pictures etc which are not clear to categorize under either of the above two categories.