RESEARCH REPORT

AN ANALYSIS OF THE CONTENT AND QUESTIONS OF THE PHYSICS TEXTBOOKS OF THE BASIC EDUCATION LEVEL (AGES 13-15) IN LIBYA

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Abstract – *This study aims at determining the extent to which the physics textbooks contribute to the achievement of the stated objectives of physics teaching at the basic educational level (ages 3-15). The cognitive demand of the content of the textbooks of the 7th, 8th and 9th grades and the questions at the end of each chapter are analysed. Chi-square tests are used to compare the distribution of the textbooks' questions among the levels of Bloom's cognitive domain with a suggested distribution from the literature. The findings show that the contribution of the content to the achievement of the stated objectives is limited to the students' acquisition of facts and basic concepts. Most of the questions (51.6%) require knowledge by simple recall which puts them in the first level of the cognitive domain, while upper levels are only tested by 2.5% of all the questions. There is a significant difference ($p<0.001$) between the observed and the suggested distribution of questions among levels. These results reflect the importance of the objectives concerning the acquisition of specific scientific knowledge given by the content and questions of the textbooks at the expense of other objectives of physics teaching, such as the development of scientific thinking skills, interests and attitudes. In conclusion, some suggestions are made to promote the acquisition of objectives in the higher levels of the cognitive domain.*

Introduction

Textbooks are seen by many educators as the most important and possibly the sole aid to teachers and students. Textbooks certainly play a major role in determining the nature of the implemented curriculum and the quality of education imparted by the schools. This role is more obvious in developing countries where "*textbooks are the major, if not the only, definition of curriculum*" (Lockheed & Verspoor 1991, quoted in Crossley & Murby 1994). In these countries, which are faced with a shortage of qualified teachers, effective teaching is closely associated with the existence of the direct source of instruction, the textbook. This reality prompted the World Bank to recommend that in the 1990s the developing countries *"should focus on providing their schools with good (pedagogically sound, culturally relevant, and physically durable) textbooks and on encouraging teachers to use them"* (Crossley & Murby 1994: 102).

Over the years, changes have occurred in the design and use of science textbooks, reflected partially in their use not merely as sources of information but as tools *"to initiate inquiry and to suggest interesting investigations to be performed"* (Collette & Chiappetta 1986: 244). In spite of these changes, many textbooks are still 'encyclopedic' in their presentation of scientific knowledge (Collette & Chiappetta, 1986: 244). It has also been noted that authors of science textbooks tend to answer all the questions, solve all basic problems, present all steps of the experiments, tell the students what should be observed, and what conclusions should be reached. This approach usually presents unconnected parts of scientific knowledge, pays no attention to the processes of science, and in effect emphasises low level cognitive learning. Such an approach can only make a limited contribution to the achievement of the goals of science education.

Science teachers use textbooks mainly as sources of organised scientific knowledge, and as resources for planning and conducting their instruction. Inexperienced and unqualified teachers usually use textbooks as a course of study, which they follow slavishly page by page in their teaching. Often, this could be overdone in such a way that it *"can be of detriment to the interests, attitudes, and even achievement of science students"* (Collette & Chiappetta 1986: 247).

Because of the influence that the design, content, and use of textbooks has on students' achievement and the achievement of the curriculum goals, many studies have been conducted to analyse and evaluate the different aspects of the textbooks. In a study of the design of Pakistani textbooks, Khan (1990) observed a clear disregard of curriculum objectives and noted that students complain of unclear concepts (Crossley and Murby 1994: 101). Finley (1991) attributed the obstacles that students experience when learning from textbooks to the *"fundamental contradictions between the nature of science textbooks and the educational goals that texts are meant to serve"* (quoted in Tobin *et al.* 1994). These difficulties were the driving force behind many efforts *"to improve the quality of textbooks and reform the curriculum"* (Tobin *et al.*, 1994). Heyneman *et al.* (1981) showed that, compared to other factors such as teacher training, class size, facilities and grade repetition, the availability of textbooks is the most important factor associated with higher levels of student achievement.

Zitoon (1990) analysed and evaluated the content and questions of the 'general science' textbook for the third year of the preparatory level in Jordan. He found that scientific facts represented 49.2% of the scientific knowledge of the textbook, while scientific concepts and principles represented 38.2% and 12.6%

respectively. Furthermore, the scientific knowledge was not presented functionally and did not contribute to the development of the students' scientific attitudes, interests or values. His analysis of the questions in the textbook revealed a clear concentration on the lowest level of Bloom's cognitive domain. In effect, 47.6% of the total number of the questions required answers at the level of knowledge by simple recall, 34.4% at the comprehension level, 10.9% at the application level, and 7.1% at higher cognitive levels (analysis, synthesis, and evaluation). A significant difference was found between these proportions and the theoretical proportions suggested by Zitoon for the distribution of questions among Bloom's cognitive domain levels, which were 25% knowledge, 30% comprehension, 25% application, and 20% higher cognitive levels.

Damerdash (1980) gave the results of a similar study carried out by Zaki in 1973. Zaki analysed the questions of the first and the third years science textbooks of the preparatory level in Egypt using the cognitive domain of Bloom's taxonomy. He found that 73% and 87% of the first and the third year textbooks questions were in the knowledge by recall level, respectively, while the questions in the comprehension level occupied 26% of the first year and 13% of the third year textbooks questions. These findings reflect the great importance given by the textbooks to the acquisition of knowledge and a disregard to the development of the students' higher cognitive abilities.

In this paper we examine the content and the end-of-chapter questions of a set of physics textbooks used in Libya in an attempt to answer the following questions:

1. To what extent do the present physics textbooks of the second cycle of the basic education level contribute to the achievement of the stated goals of physics teaching for this cycle?

2. How does the distribution of end-of-chapter questions in these textbooks among the levels of Bloom's cognitive domain compare with the proportions suggested by Zitoon(1990)?

The educational context

Before going any further, it is important to furnish some information about education in Libya. The current structure of the educational system in Libya was approved in 1984 and implemented at the basic education level in 1986 (Secretariat of Education 1992: 1). The educational system consists of the following levels:

(1) The Kindergarten Level (ages 4-5)

(2) The Basic Education Level (ages 6- 15)

(3) The Secondary Education Level (age 16+) with four divisions:

I – General Secondary Education
II – Vocational Secondary Education
III – Technical Secondary Education
IV – Teacher Training Institutes

(4) University Education.

The basic education level comprises all stages of compulsory education in Libya which caters for all children aged 6 to 15. It is divided into nine grades and ends with a unified examination held at the national or regional level. The holders of the Basic Education Level Leaving Certificate can enroll in any type of secondary education. The education system is centralised, schools are government supported and curricula are uniform in all schools. Goals, objectives, content, textbooks, and other relevant documents are prescribed by the Secretariat of Education, which is the central authority. Teachers operate within the context of a structured set of prepared instructional and assessment materials. They are obliged to follow a certain annual instructional plan consisting mainly of the units or chapters that should be covered in certain time intervals. They are also required to use and follow the textbooks published by the Secretariat – the same textbooks are used by students and teachers – but they are free to choose the methods of teaching, activities, or audiovisual materials. Textbooks are still seen as the main, if not the only, source of knowledge and instruction by teachers, students, inspectors, and parents.

During the nine grades of this level, students study a number of compulsory subjects in each grade. The teaching of science at this level could be divided into two parts. The first part consists of grades one to six (the first cycle of the basic education level), in which science is taught as one subject, namely General Sciences and Health. The syllabus of each grade covers several units in natural and physical sciences. The second part consists of grades seven to nine (the second cycle of the basic education level), in which science is taught as three separate subjects, namely, Physics, Chemistry, and Biology. Each has its own goals, syllabus, textbook, time allocation, and assessment mark in each grade of this cycle. In each of these grades (7th - 9th) two class periods (40 - 45 minutes each) per week are allocated for physics teaching. This time represents about 5.5% of the total time of schooling in each grade.

The following goals have been set for physics teaching at this level (National Centre of Educational Research and Training 1995):

1. Deepening the students' belief in God through their conception of the coordination and harmony of the different physical phenomena.
2. Recognition of the role of scientists , their merit in the field of physics, and to develop students' appreciation of Arabic mentality and creativity.
3. Helping students to arrive at suitable physics concepts that will lead them to acquire belief in causality and recognise the role of physics in the development of human civilisation.
4. Enabling students to relate physical phenomena and concepts together and recognise their contribution to benefit of mankind.
5. Helping students to understand that physics concepts are changeable according to the development of research and measurement tools.
6. Acquisition of physics facts and concepts necessary to continue their studies in the following educational levels.
7. Enabling students to acquire the basic physics knowledge, which will help them to comprehend military knowledge and skills.
8. Accustoming students to be precise in their observations, measurements, and communication of their observations and findings.
9. Developing students' ability of scientific thinking and acquisition of the cognitive skills necessary to exercise socially appropriate behaviour.
10. Encourage students to use the available resources in their surroundings in order to design simple apparata or instruments to be used to carry out experiments, to develop their creative abilities, and to discover the talented students.

Research methodology

This study focuses on the content and end-of-chapter questions of the 7th, 8th, and 9th Grade physics textbooks, which include the following topics:

a – 7th grade: Measurements – Bodies in Motion – Matter
b – 8th grade: Thermal Expansion - Heat Energy – Sound
c – 9th grade: Generation of Electricity – Electric Current
Transformation of Electric Energy – Light – Spherical Mirrors – Light Refraction – Lenses – Analysis of Light

The end-of-chapter questions in the three physics textbooks add up to 312 questions distributed as follows:

a – 7th grade: 68 questions.
b – 8th grade: 67 questions.
c – 9th grade: 177 questions.

A content analysis approach is used to determine the suitability of the content of the physics textbooks for the achievement of each of the stated physics goals for this level. This is achieved through a careful study of the goals and the content of each topic in the three textbooks to determine the aspects which are given clear attention and their relationship to the goals. Bloom's taxonomy of educational objectives in the cognitive domain is used to determine the cognitive level required by each question in the textbooks. Thus, each question in the three textbooks is classified into the knowledge, comprehension, application or higher cognitive processes level according to the cognitive process required. For this study the three higher levels of the cognitive domain (analysis, synthesis, and evaluation) are grouped as one level, called higher cognitive processes level. The number and the percentage of the questions in each level is calculated for each set of textbook questions and for the total number of questions in the set of three textbooks to compare them with the proportions suggested by Zitoon (1990). A chi-square test is used to compare the observed and suggested proportions.

Achieving the stated goals of physics teaching

The results of the content analysis can be summarised as follows :

1. The physics textbooks' content cannot have any contribution to the achievement of the first and the second goals of physics teaching of this level. There are very few, limited and scattered remarks to some aspects associated with these goals, in spite of the suitability of many concepts in the physics textbooks that can be used to achieve them.

2. The third to the seventh goal can be considered together as one general goal as they are related to the acquisition of physics facts and concepts in a functional way and awareness of the importance of the subject to students and society. The textbooks of this cycle give a clear consideration to this general goal. They use the experiment – observation – conclusion approach to present most of the physics concepts, besides the explanation and the examples. The textbooks also give many applications of physics concepts and principles. Regarding this general goal, it is pertinent to remark that:

a. The presentation of observations and conclusions to the students and the teacher, who does not use suitable teaching methods, can lead to the acquisition of inert knowledge. If students are told what to observe or what conclusions should be reached, they will only tend to memorise certain steps or procedures, observations and conclusions mentioned in the texts without really trying to understand.

b. The way 'experiments' are presented in the physics textbooks does not reflect the experimental method. They are, in fact, training students to follow certain steps or procedures to arrive at pre-determined results.

c. The introduction and clarification of the different applications of the physics concepts and principles should be related to the students' environment as much as possible so that they can perceive adequately the practical benefit of physics for the individual and society. This relationship between the applications and students' environment should also consider the personal benefit of students to develop their scientific interests and hobbies.

d. The direct exposition of physics facts, concepts and principles and their applications may hinder students from becoming acquainted with the stages of the development of scientific knowledge, the dynamic nature of science, the interdependence of different branches of science, or the relationship between science and technology.

e. The understanding of physics concepts is related to the students' cognitive development level and their experience. This relationship requires that the concepts should be selected and presented in accordance with the students' level of cognitive development and linked to their experience and environment.

3. The eighth goal is related to the practical side of physics teaching. The achievement of this goal depends on the type of activities carried out by students. If students do not make actual observations and measurements, and do not express their observations and findings, orally and in writing, it would be impossible to achieve this goal. The achievement of this goal requires giving students good models in their textbooks. The seventh grade textbook, for instance, which introduces physics as a new field of knowledge and covers the topic of Measurements and Units in its first chapter, does not present a good model to help students' achievement of this goal. Drawings and figures are neither clear nor accurate. The explanation of some concepts also lacks clarity and is sometimes doubtful, while the eighth grade textbook ignores completely the use of units in solving the problems.

4. The ninth goal is concerned with the development of students' scientific thinking, which is a very important aspect of physics teaching. The analysis of the three physics textbooks shows that none of the physics concepts in the textbooks

to solve the problem or interpret the situation. In spite of the fact that many questions are raised in the texts, many of them are either not clearly stated or they are answered immediately and directly in the text. This eliminates the opportunity for students to practice scientific thinking and the skills associated with it.

5. The tenth and last goal of physics teaching is related, to high extent, to the previous goal. The student's ability to design simple apparatus or instruments and using them to conduct experiments depends on his ability to think, perceive the different components of a problem or a situation and find the relationships between them. This requires a careful preparation of problems and situations that could help students to use their knowledge and cognitive abilities to design simple apparatus, instruments and experiments to solve the problems. The physics textbooks do not give any consideration to this matter, though there are many concepts and situations that could contribute beneficially to the achievement of this goal. The discovery of talented students requires a clear consideration to the principle of individual differences from the curriculum planner, textbook writer, teacher and evaluation personnel in the educational system. The physics textbooks ignore this principle completely. They seem to be prepared to be used by all students in the same way, and do not include any additional activities that could be used to distinguish between students of different abilities and interests.

Analysis of the questions in the physics textbooks

Table 1 summarises the results of the analysis and classification of the end-of-chapter questions of the three physics textbooks. From the table, we can infer the following:

1. Most of the questions are in the level of knowledge by simple recall of Bloom's cognitive domain. The majority of questions (51.6%) fall into this level, while 30.1% are in the comprehension level, 15.7% in the application level, and 2.5% are in the higher cognitive processes level. These proportions show an imbalance when compared with the proportions suggested by Zitoon, except for the comprehension level where the proportions are the same. When a chi-square test is used to compare the observed proportions with the suggested proportions (Table 2), the results clearly indicates a statistically significant difference between the two proportions.

2. There is an increase in the knowledge level questions and decrease in the application level questions between the 7th and the 9th grade textbooks. This is against the expected trend, and it reflects the low consideration given to the students' maturation.

3. The high percentage of knowledge level questions reflects the importance

TABLE 1: Analysis and classification of the "end of chapter" questions according to Blooms's cognitive domain

TEXTBOOK	CHAPTER	KNOW.		COMP.		APPL.		HIGHER COG. PROC.	
		Freq	%	Freq.	%	Freq.	%	Freq.	%
7TH GRADE	measurement	4		4		6		—	
	bodies in motion	12		10		17		1	
	matter	10		2		2		—	
Subtotal	**68**	**26**	**38.2**	**16**	**23.5**	**25**	**36.8**	**1**	**1.5**
8TH GRADE	thermal expansion	9		4		7		—	
	heat energy	10		5		5		2	
	sound	11		11		3		—	
Subtotal	**67**	**30**	**44.8**	**20**	**29.8**	**15**	**22.4**	**2**	**3.0**
9TH GRADE	gen. of elect.	31		13		—		3	
	electric current	10		12		6		1	
	transformation of elect. eng.	16		13		—		—	
	light	12		10		—		—	
	spherical mirrors	15		4		1		—	
	light refraction	5		2		—		1	
	lenses	11		2		1		—	
	analysis of light	5		2		1		—	
Subtotal	**177**	**105**	**59.3**	**58**	**32.7**	**9**	**5.1**	**5**	**2.8**
Total	**312**	**161**	**51.6**	**94**	**30.1**	**49**	**15.7**	**8**	**2.5**

given to the acquisition of the scientific knowledge as the most important – if not the only – goal of physics teaching. Questions are used mainly to measure students' memorisation of this knowledge, and seldom require a real thinking effort or search for answers outside the texts.

4. A consistency is observed in the comprehension level questions in the three textbooks, especially in the 8th and 9th grade textbooks. The average percentage of the questions in this level amounted to 30.1% of the total number of questions in the three textbooks, which is in agreement with the suggested proportion (30%).

5. Besides the low percentage of the application level questions compared to the suggested proportion, it is also observed that most of the questions in this level require an application of certain relations to solve simple problems. This is especially true in the 7th grade textbook which contains the highest proportion of the application questions among the three textbooks.

6. A very low percentage of questions in the higher cognitive processes level in the three physics textbooks is observed. Questions at this level accounted for only an average of 2.5% of the total number of the questions. This low percentage reflects the low priority given to the development of students' thinking and problem-solving skills by the physics textbooks.

7. The 9th grade textbook is the only one that contains some questions that are classified in the psychomotor domain. These questions occupied about 10% of the 9th grade physics textbook questions.

8. There is a complete lack of questions in the affective domain. This is not surprising, but it shows that no feedback is expected about the development of students' attitudes, interests and values especially as regards the first and second goals of physics teaching.

Recommendations

In light of the results of this study, the following recommendations are suggested for further discussion:

1. Serious thinking should be given to a review and re-writing of the content of the three physics textbooks, taking into consideration the accurate nature of science, the physics teaching goals and students' cognitive development level.
2. Teachers, supervisors and science educators should be given a more prominent role in the design of the physics textbooks, enabling them to participate in producing better textbooks for this cycle.
3. Establishing centres for the development and evaluation of science curricula

TABLE 2: Comparison between the observed and the suggested proportions of questions

	QUESTIONS				TOTAL	Chi-square Value
	KNOW	COMP.	APPL.	Higher Cog. Proc.		
Observed Freq.	161	94	49	8	312	146.52 p<.001
Suggested Freq.	78	93.6	78	62.4		

and providing them with the specialised personnel, especially trained teachers and supervisors.

4. Textbooks writing could be done through an open call to interested persons, taking in consideration that:
   a. Writers should be familiar with what is occurring in schools.
   b. Coordination should be stressed between the different writing committees.
   c. A booklet could be prepared containing all the scientific, educational and technical criteria which should be considered by writers.
   d. Textbooks should be tried out for at least one year in a small number of schools before they are used on the national level.
5. Consideration should be given to prepare teacher manuals for the three grades.
6. Thinking seriously of using one physics textbook for the three grades of this cycle of the basic education level, so that the 'Basic Education Level Leaving Certificate' examination in physics contains items from the different topics studied during the three years. This approach will help students to recognise the unity and continuity of the physics knowledge, construct the knowledge in an orderly way during their study and use it to acquire new knowledge.
7. More care should be given to the physics textbooks' questions, so as to consider a balanced distribution of the questions among the cognitive domain levels, and to include questions in the affective and psychomotor domains.
8. Care should be given to identify and develop the students' scientific interests

and hobbies through the content, teaching methods, activities, evaluation and programmes organised by the Secretariat of Education or other agencies.

9. Carry out studies that consider other aspects of the textbooks in the different educational levels, such as, textbook language, the correlation between the physics content in different grades and levels, the suitability of the presented concepts in the physics textbooks to the students' cognitive development.

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