THE INCLUSION OF SCIENCE PROCESS SKILLS IN YEMENI SECONDARY SCHOOL PHYSICS TEXTBOOKS

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Abstract

The aim of this study is to compare and contrast the science process skills (SPS) included in the 10th-12th grade physics textbooks content utilized in Yemeni schools. The study revealed weaknesses and strengths in the textbooks' content. For instance, a number of science process skills (SPS), such as measuring, predicting and hypothesizing, have been neglected in the 11th grade textbook. For all three textbooks content, the maximum percentage of basic science process skills (BSPS) was devoted to observation. However, the maximum percentage of integrated science process skills (ISPS) was different for each grade: experimenting had the highest percentage for 10th grade, interpreting data for 11th grade, and operational definitions for 12th grade. In conclusion, there are similarities in the percentage of SPS between the physics textbooks' content for the 10th and 11th grades, and both differ from the 12th grade.

Keywords **–** Yemeni physics textbooks, science process skills, basic science process skills, integrated science process skills.

1. Introduction

Among the many factors that can affect students' learning, the role of textbooks has been widely acknowledged as central. Because most teachers rely on textbooks to define both what and how they teach, high-quality textbooks can be a powerful catalyst for improving learning for students and teachers alike (Davis & Krajcik, 2005; Roseman, Stern, & Koppal, 2010; Weiss, Pasley, Smith, Banilower & Heck, 2003).

Because the textbook is one of the most important components of the curriculum, many educators have indicated the importance of its preparation, authorship and editing, ensuring that they are in accordance with the criteria and high specifications (Marei & Al-Hilah, 2003).

A textbook's review, analysis, evaluation, and development are necessary and important for determining its quality and validity, its positive element in the educational process, and its relevance within the context of scientific and technological development. (Al-Zwaid, 2007).

Textbooks must be coherent. According to Roseman, Stern, & Koppal (2010), "to be considered high-quality, textbooks must themselves be coherent and help students make the connections necessary to organize their new knowledge into a coherent and meaningful whole." Because textbooks are powerful catalysts for improving the teaching and learning of science, it is essential to have reliable methods for analyzing important textbook features such as SPS (Roseman, Stern, & Koppal, 2010).

Given the impact of textbooks on learning, the content of science textbooks must be presented as a dynamic process of generating and testing alternative explanations about nature, rather than simply presenting a collection of facts. The authors of the textbooks we studied, however, appeared not to understand SPS well enough to explain them to students and therefore presented various misleading and inadequate descriptions. Furthermore, some important aspects of science were totally neglected by the authors (Ires, 2009; Kanter, 2010).

SPS are important in the development of "big ideas" that are needed to make sense of the scientific aspects of the world and must be actively developed as a part of formal education. They must therefore be included in physics textbooks. Throughout the past three decades, classroom studies on scientific reasoning have centered on basic and integrated science process, with many researchers focusing their attention on these process skills (Beaumont-Walters & Soyibo, 2001).

The importance of SPS has long been recognized. They are a major goal in science education, as these process skills are used not only by scientists, but also by everyone desiring to become a scientifically literate person. Thus, we can say the teaching of science includes the teaching of SPS (Harlen, 1999; Harlen, 2000; Rohaida, 2004).

According to Kanter (2010), "Not only are SPS always exercised in relation to some science content, but they can also relate to the full range of science content and have a central role in learning with understanding about this content."

2. Science Process Skills

Science process skills (SPS) consist of both basic science process skills (BSPS) and integrated science process skills (ISPS). BSPS provide the intellectual groundwork in scientific inquiry, such as the ability to order and describe natural objects and events. Examples of BSPS are observing, classifying, measuring and predicting. The BSPS are the prerequisites to the integrated science process skills. The ISPS are the terminal skills for solving problems or doing science experiments. Examples of ISPS are identifying and defining variables, collecting and transforming data, constructing tables of data and graphs, describing relationships between variables, interpreting data, manipulating materials, formulating hypotheses, designing investigations, drawing conclusions and generalizing information (Beaumont-Walters & Soyibo, 2001; Rohaida, 2004).

3. Research Questions

This aims to answer the following questions:

1. To what extent are science process skills (SPS) included in the content of 10th-12th grade physics textbooks utilized in Yemeni schools?
   The sub-questions will branch from the first question as follows:

   a) To what extent are basic science process skills (BSPS) included in the content of the 10th grade physics textbook?
   b) To what extent are BSPS included in the content of the 11th grade physics textbook?
   c) To what extent are BSPS included in the content of the 12th grade physics textbook?
   d) To what extent is integrated science process skills (ISPS) included in the content of the 10th grade physics textbook?
   e) To what extent are ISPS included in the content of the 11th grade physics textbook?
   f) To what extent are ISPS included in the content of the 12th grade physics textbook?

2. What are the similarities and differences in SPS content among the physics textbooks for the 10th-12th grades?

4. Methodology

To achieve the goals of the study, a measuring instrument was developed, based on content analysis concept, to analyze the content of three physics textbooks (10th-12th grades) in Yemeni secondary schools according to science process skills (SPS). The measuring instrument is a form that includes definitions for each element of the SPS supported by examples relevant to the three physics textbooks' content (10th-12th grades**)**.

In this study the content of three physics textbooks (10th-12th grades) in Yemeni secondary schools represented the study sample, which included all units and topics of the three physics textbooks, but it did not include the goals and questions. To conduct a content analysis on any such text, the text is coded or broken down, into manageable categories on a variety of levels as word, word sense, phrase, sentence, or theme. In this study a theme was adopted as a category to analyse the content of three physics textbooks (10th-12th grades) according to the SPS which was identified, then extracted their frequency and percentages (Al-Ashwal, 2006; Aziz, 2004; Krippendorff, 2004; Shaker, 2005).

5. Findings and Discussion

After assuring the validity and the reliability of the measuring instrument, the content of the physics textbooks was analyzed, yielding the following results:

1. The distribution of frequency and the percentage of BSPS in the content of the physics textbooks for 10th-12th grades are as follows:

   a. Regarding the 10th grade physics textbook, the maximum percentage of BSPS is in observation (38.4%), whereas the minimum is in measurement (2.1%).

   b. Regarding the 11th grade physics textbook, the maximum percentage of BSPS is in observation (63.94%), whereas the minimum percentage is in predicting (0.31%).

   c. Regarding the 12th grade physics textbook, the maximum percentage of BSPS is in observation (30.2%), whereas the minimum percentage is in measurement (2.9%).

Table 1. Frequency and percentage of BSPS in the content of 10th-12th grade physics textbooks

Physics textbooks' content						
	10th grade		11th grade		12th grade	
BSPS	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Observation	279	38.4 %	406	63.94%	258	30.2%
Measurement	15	2.1%	3	0.47%	25	2.9%
Classification	46	6.3%	13	2.05%	132	15.5%
Quantification	99	13.6%	92	14.49%	151.4	17.7%
Inferring	134	18.5%	31	4.88%	117	13.7%
Predicting	38	5.2%	2	0.31%	32.1	3.8%
Relationships	47	6.5%	33	5.20%	72.4	8.5%
Communication	68	9.4%	55	8.66%	66.1	7.7%

For all the three textbooks, the maximum percentage of BSPS is in observation. However, the minimum percentage of BSPS in the content of the 10th and 12th grade physics textbooks is in

measurement. While measurement is rarely presented in the 11th grade textbook, predicting is presented even less frequently.

2. The distribution of frequency and percentage of ISPS in the content of the physics textbooks for 10th-12th grades are as follows;

a. In the content of the 10th grade physics textbook, the maximum percentage of ISPS is in experimenting (41%), whereas the minimum percentage is in hypothesizing (2%).
b. In the content of the 11th grade physics textbook, the maximum percentage of ISPS is in interpreting data (35.53%), whereas the minimum percentage is in hypothesizing (0.66%).
c. In the content of the 11th grade physics textbook, the maximum percentage of ISPS is in operational definitions (46%), whereas the minimum percentage is in controlling variables (4.3%).

Table 2. Frequency and percentage of ISPS in the content of 10th-12th grade physics textbooks

Physics textbooks' content						
	10th grade		11th grade		12th grade	
ISPS	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Interpreting data	5	8%	54	35.53%	57	27%
Controlling variables	9	15%	28	18.42%	9	4.3%
Operational definitions	20	34%	23	15.13%	97	46%
Hypothesizing	1	2%	1	0.66%	34	16.1%
Experimenting	24	41%	46	30.26%	14	6.6%

The maximum percentage of ISPS in the content of the physics textbooks differs with each grade: experimenting has the maximum percentage for 10th grade, interpreting data for 11th grade, and operational definitions for 12th grade. The minimum percentage of ISPS in the content of the physics textbooks is in hypothesizing for the 10th and 11th grade and in controlling variables for 12th grade.

3 In the content of the three physics textbooks, the total frequencies were as follows:

- BSPS: 2215.
- ISPS: 422.

The distributions of frequency and percentage of BSPS and ISPS are shown in Table 3,

As follows:

a. In the content of the 10th grade physics textbook, the frequencies were as follows:

- BSPS: 726 (92.5%)
- ISPS: 59 (7.5%)

b. In the content of the 11th grade physics textbook, the frequencies were as follows:

- BSPS: 635 (80.7%).
- ISPS: 152 (19.3%).

c. In the content of the 12th grade physics textbook, the frequencies were as follows:

- BSPS: 854 (80.2%).
- ISPS: 211 (19.8%).

Table 3. Frequency and percentage of BSPS and ISPS in the content of 10th-12th grade physics textbooks

Physics textbooks' content	BSPS		ISPS	
	Frequency	Percentage	Frequency	Percentage
10th grade	726	92.5%	59	7.5%
11th grade	635	80.7%	152	19.3%
12th grade	854	80.2%	211	19.8%

The highest percentage of SPS in the content of the three physics textbooks focuses on BSPS, while the lowest percentage of SPS focuses on ISPS.

4. The frequency of SPS in the content of the 10th-12th grade physics textbooks is 2637, which includes 2215 BSPS and 422 ISPS. The distribution of frequency and percentage of SPS are shown in Table 4 as follows:

a. The frequency of SPS in the content of the 10th grade physics textbook is 785, and its percentage is (29.77%).

b. The frequency of SPS in the content of the 11th grade physics textbook is 787, and its percentage is (29.84%).

c. The frequency of SPS in the content of the 12th grade physics textbook is 1065, and its percentage (40.39%).

Table 4. Frequency and percentage of SPS in the content of 10th-12th grade physics textbooks

Physics textbooks' content	SPS	
	Frequency	Percentage
10th grade	785	29.77%
11th grade	787	29.84%
12th grade	1065	40.39%
Total	2637	100%

There are similarities in the percentage of SPS between the content of the 10th and 11th grade physics textbooks. They both differ with the 12th grade textbook.

6. Conclusion

The goal of this study is to investigate the science process skills (SPS) in the 10th-12th grade Yemeni schools physics textbooks content. The study results indicated that a number of SPS have been neglected in the 11th grade textbook, including measurement (0.47%), predicting (0.31%), and hypothesizing (0.66%). On the other hand, the study showed the highest percentage of BSPS in the content of the three physics textbooks concentrate on observation, whilst the maximum percentage of ISPS in the content of the physics textbooks focus on experimenting for 10th grade; interpreting data for 11th grade; and operational definitions for 12th grade.

The study revealed similarities in the percentage of SPS between the 10th and 11th grade physics textbooks, as well as how they both differ from the 12th grade textbook. Thus, this study revealed the strengths and weaknesses in the content of the 10th-12th grades physics textbooks in Yemeni secondary schools.

The findings of current study help the teacher in a classroom to recognise the strengths and weaknesses in the physics textbook content, and must not consider the textbook as the only source of reference. Thus, whenever the teacher finds that there is a significant weakness on SPS in a textbook, the teacher has to do something to help students to acquire the neglected SPS.

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