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Science technology and society modules development process and testing on its effectiveness

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Abstract

The use of the Science Technology and Society (STS) teaching and learning modules can provide a vehicle for enhancing students' interest in learning science. In addition, these modules can assist students in seeing the relevance of their science learning in everyday life. This paper outlines the STS modules development process for Palestinian ninth grade science textbooks and discusses the developmental research phases. The current study contributes the ways of developing STS modules for teaching and learning and suggests modifications in science textbooks for ninth graders. The processes and procedures used in developing the current intervention can be used as a framework for similar studies in different parts of the world.

Keywords: Science, Technology, and Society (STS); STS Modules, Palestine

1. Introduction

The main purpose of this research is to contribute ways of creating STS modules for teaching and learning. The study employed the methodological guidelines of development research for designing and developing STS teaching and learning materials (modules) as suggested by Pichayasathit Suvit (2002); van den Akker (1999); van den Akker and Plomp (1993); Plomp (2002); Plomp et al. (2007); as well as the Richey and Nelson (1996) approaches. In addition, this methodological guideline emerges from the models of instructional design theory. Each instructional design model emphasizes the importance of needs analysis, goal specification and design of learning objectives, materials design based on needs analysis and aims, development of appropriate instructional strategies, formative and summative evaluation, and improvement of materials based on results of evaluation.

Literature reveals there are two types of development research. The first one involves the processes of explanation, analysis, and assessment; and the second one typically addresses the validity and/or effectiveness of an existing or newly constructed development model, process, or technique. Type 1 developmental research studies often focus on the production view of the instructional design method (the Analysis, Design, Development, Implementation, and Evaluation). Type 1 developmental research focuses on regulating the influence of instructional outcomes. This type consists of studies that: describe and document a particular design, development, and/or evaluation project; emphasize entire models or specific development tasks and/or processes; determine the effectiveness of instructional product or procedure (Richey & Nelson, 1996). Type 2 developmental researches, in contrast, usually present the format, development, and assessment periods rather than a show of these processes. The

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key difference is that the target point of Type 2 studies tend to be more generalized, being aimed at enhancing the ultimate models employed in these procedures.

2. Developmental Research

The current development research generally followed the type one developmental research approach. According to van den Akker and Plomp (1993), development research is characterized by: Development of versions products (curriculum documents and materials), including empirical evidence of their quality, and generating methodological directions for the design and evaluation of such products.

This study includes the main phases as suggested by Plomp et al. (2007). Specifically the developmental research has three phases as given in Figure 1: Needs and content analysis, Versioning phase (iterative cycles of design and formative evaluation), and Assessment phase (semi-summative evaluation) (Plomp et al., 2007, p. 22).

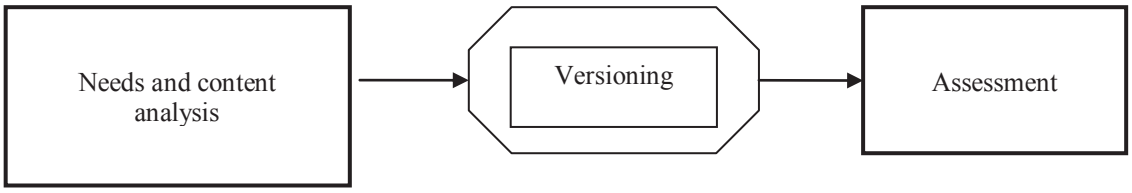

Figure 1. Phases of developmental research

3. Phases of developmental research in this study

In the present developmental research, the three phases for the development of the STS teaching and learning materials were carried out as follows:

3.1. First phase: Needs and Content Analysis

This phase consisted of four steps as shown in Figure 2.

3.1.1. Developing science, technology and society (STS) elements inventory checklist for Palestinian society for analyzing the science textbooks (Abualrob, 2011a).

In this section the development of a science, technology and society (STS) elements inventory for Palestinian society (checklist) was necessary for analyzing the ninth grade science textbooks. The objective of the content analysis was to discover whether these textbooks contain STS elements that encourage an interaction between science, technology and society, or provide mere descriptions of science. Moreover, the benefits of science to society were further evaluated in the content analysis. A list of science, technology and society elements meaningful to Palestinian society was essential for analyzing the textbooks. Therefore, it was necessary to determine initially which STS elements should be chosen to conduct the content analysis.

3.1.2. Analyzing STS elements in ninth grade science textbooks in Palestine (Analysis of the textbooks based on the checklist)

Content analysis involves the description and analysis of text in order to represent its content. The focus is on description of the contents of the text. Content analysis establishes “meaning” only in the sense of what is explicit in the words used in the text and what is implicated by their use from the range of alternatives that could have been employed. There is however, no suggestion that the text has an essential meaning. Content analysis is a simple affair of describing the actual content of a text (Ahuvia, 2001; Budd, Thorp, & Donohew, 1967; Holsti, 1969). The three components of content analysis as defined by Holsti (1969) are (a) objectivity, (b) systematic, and (c) generality.

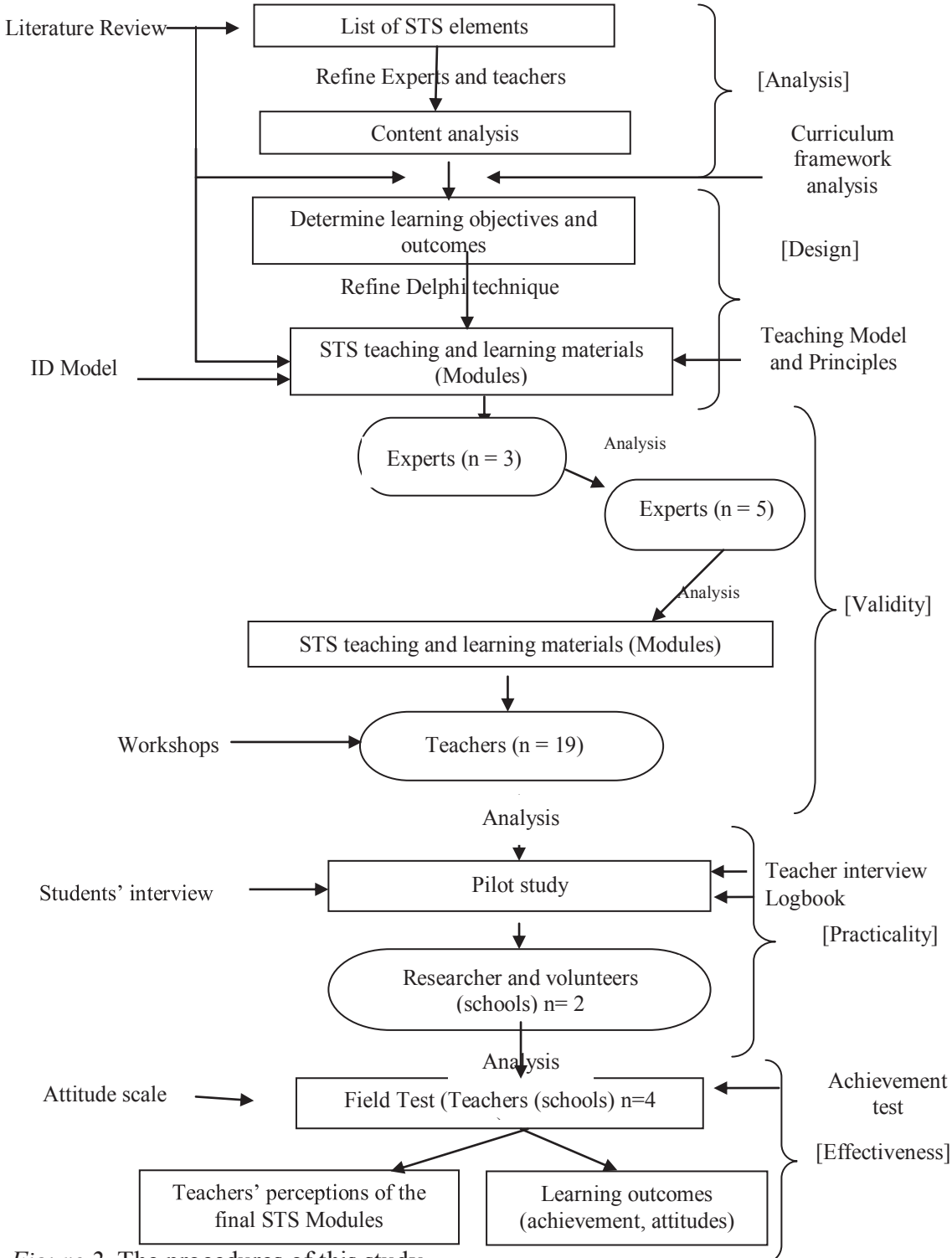

Figure 2. The procedures of this study.

Content analysis offers many advantages for use in educational fields. It can provide with the same quantity of data in a number of items or different ways. Data collector bias is reduced by using this method (Ahuvia, 2001). It is a suitable method for making wise decisions when selecting textbook content or selecting textbooks for classroom use (Anderson, 2000). Due to the above mentioned advantages, the current study used content analysis to analyze STS elements in the contents of ninth grade higher elementary Palestinian science textbooks. To carry out the content analysis, three main procedures were performed: preparing the tool for content analysis, coding, and analyzing the content of the textbooks.

3.1.3. Analyzing the Palestinian Curriculum Framework

The researcher analyzed the Palestinian curriculum framework to identify the characteristics of the existing curriculum, and to determine the extent to which there was a need to adjust the STS teaching and learning objectives to suit the STS approach.

3.1.4. Reviewing the Literature on Science Education in Palestine

The researcher analyzed the situation of science education in Palestine by reviewing the literature on science education in Palestine. The review covered the studies in all of science education domains such as curriculum studies, pedagogy, learning activities, and students' academic achievement.

3.2. Second phase: Versioning phase (iterative cycles of design and formative evaluation)

This phase consisted of four steps as shown in Figure 2.

3.2.1. Determining the possible learning objectives and learning outcomes for STS elements in ninth grade science in Palestine

After developing the STS elements list and analyzing the ninth grade science textbooks, the researcher determined the STS teaching and learning objectives (Abualrob & Daniel, 2011), based on the following criteria: (a) that both the learning objectives and learning outcomes must be related to an identified set of problems and needs assessment, (b) must contain clear statements of both the learning objectives and learning outcomes, and (c) that both the learning objectives and learning outcomes are achievable through instruction rather than some more efficient means such as enhancing motivation (Dick & Carey, 1996). In addition, they must be closely related to the Palestinian science curriculum.

3.2.2. Utilizing the design principles and teaching model identified as a guide in developing STS teaching and learning materials (modules)

Designing and developing STS teaching and learning materials (modules) require principles as a guideline to structure and support the design and development activities (Plomp et al., 2007). Design principles provide insights into the purpose, main characteristics of the STS teaching and learning materials, guidelines for designing the STS teaching and learning materials and implementation conditions (Dick & Carey, 2001; Plomp et al., 2007). In addition, STS teaching and learning materials (modules) should reflect a model for teaching these modules.

3.2.3. Determining the validity of the STS teaching and learning materials (modules)

Validity refers to answering specific questions: Do the components of the materials reflect the very latest knowledge? Are all components connected to each other consistently? Are the materials consistently linked to the STS approach? The experts and teachers' appraisal activities were conducted to gain insight into the validity aspects of the modules. Figure 2 shows the stages involved in the process of creating versions of the STS teaching and learning materials.

3.2.4. Determining the practicality of the STS teaching and learning materials (modules)

As shown in Figure 2, the experts' and teachers' appraisal was used in improving the validity of the materials by generating valuable suggestions. For the most part, many of the suggestions were incorporated into the third draft and a few (e.g., time estimations) were considered during the pilot study. The aim of the tryouts was to identify any problems as to the practicality of the materials before applying them in a regular classroom setting (Fauzan, 2002). Thus tryouts were carried out in similar settings as in the classrooms. Investigation of the module's practicality was focused on some issues, for example: Are the modules easy to use? Do students learn as intended? Is the time mentioned in each lesson enough? Are the modules related with STS? The issues were evaluated by conducting the interviews and analyzing teachers' logbooks.

3.3. Third phase: Assessment phase

This phase consisted of the following steps as shown in Figure 2.

Assessment phase represents the last phase in the current developmental research. Also, this is the last phase according to Plomp et al. (2007) (Assessment phase: semi-summative evaluation). The purpose of this phase in the current developmental research was to determine the effectiveness of the STS teaching and learning materials (modules). The effectiveness of the STS teaching and learning materials (modules) was based on the perceptions of teachers about the STS modules (Tecle, 2006) and the student learning outcomes (Fauzan, 2002; Plomp et al., 2007; Tecle, 2006).

3.3.1. The teachers' perceptions about the final STS teaching and learning materials (modules)

The aim of this phase was to determine the effectiveness of the developed modules. Accordingly, after developing the modules, it was important to ensure that the developed modules reflect the Palestinian situation and the goals of the STS approach. Furthermore, the aim of this phase was to elicit teachers' perceptions about infusing the developed modules instead of the existing textbooks. In addition to the teachers' interviews, the researcher developed an instrument for evaluating the STS teaching and learning materials (Abualrob, 2011b).

3.3.2. The student learning outcomes

The investigation was focused on the impact of STS modules on students' understanding and their performance. The students' understanding mainly refers to the students' achievement conducted through the post-test while they were in the treatment and control groups respectively. The students' performance included students' attitudes towards STS. A quasi-experimental procedure was used to study whether STS modules affect science achievement and attitudes towards science among students in terms of gender and location compared to the use of the traditional textbooks (Abualrob, 2011c). Tecle (2006) also used this procedure for investigating the impact of the professional development scenario.

4. Conclusion

This study contributes the ways of developing STS modules for teaching and learning science. It is concluded that the process of developing science materials should be based on science technology and society (STS) development process to ensure that students benefit from improved scientific content. However, STS teaching and learning materials development must involve science teachers, experts in the Ministry of Education and professors teaching science subjects in Palestinian universities, which was one of the limitations of this study. This study has contributed to the existing body of literature by generating methodological directions for designing and evaluating STS teaching and learning materials (STS modules).

In closing, the processes and procedures used in developing the current intervention can be used as a framework for similar studies in other parts of the world.

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