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Analysing the Elementary Science and Technology Coursebook and Student Workbook in Terms of Constructivism

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Abstract**—**The curriculum of the primary school science course was redesigned on the basis of constructivism in 2005-2006 academic years, in Turkey. In this context, the name of this course has been changed as "Science and Technology"; and both content and course books, students workbooks for this course have been redesigned in light of constructivism. The aim of this study is to determine whether the Science and Technology course books and student work books for primary school 5th grade are appropriate for the constructivism by evaluating them in terms of the fundamental principles of constructivism. In this study, out of qualitative research methods, documentation technique (i.e. document analysis) is applied; while selecting samples, criterion-sampling is used out of purposeful sampling techniques. When the Science and Technology course book and workbook for the 5th grade in primary education are examined, it is seen that both books complete each other in certain areas. Consequently, it can be claimed that in spite of some inadequate and missing points in the course book and workbook of the primary school Science and Technology course for the 5th grade students, these books are attempted to be designed in terms of the principles of constructivism. To overcome the inadequacies in the books, it can be suggested to redesign them. In addition to them, not to ignore the technology dimension of the course, the activities that encourage the students to prepare projects using technology cycle should be included.

Keywords**—**Constructivism, Coursebooks, Science and Technology Education.

I. Introduction

IN primary education, Science Course is one of the courses that play a significant role in improving students' creativity through synthesizing, interpreting, scientific thinking. In this context, both Science Courses and course books as resources for course content are quite important for students to gain skills, values and knowledge for life and education because course books are the primary means that students encounter scientific facts. A good Science course book should encourage students to make experiments, to engage in individual and group projects, to join in field trips, to read extra Science books and to carry out various activities [4]. It cannot be expected that to have effective and efficient Science courses with a course book that are not related to practical applications and students' daily lives, personal interests.

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The course books, which will be used in the activities developed in light of new teaching-learning theories, should also reflect the developments and change of these theories. Thus, in Turkey, the curriculum of the primary school science course was redesigned on the basis of constructivism in 2005-2006 academic years. In this context, the name of this course has been changed as "Science and Technology"; and both content and course books, students workbooks for this course have been redesigned in light of constructivism.

Different from traditional course book, the essential characteristics of a constructivist Science course book, which can be used to encourage students to attain new information and to provide conceptual change, can be listed as follows [1], [3], [5], [8], [9], [10], [11]:

- Books should pay attention to students' prior knowledge and help to change the prior knowledge. Therefore, books should contain conceptual change texts. In these texts, through questions students' prior knowledge should be activated.
- Students are aware of the relationship between ideas in course book and real life in order to realize meaningful learning and to bring forth concept change. Then, students begin to use concepts denoting real life events. Thus, by presenting examples from real life, students can be encouraged to think on them. In this way, students can internalize scientific information and turn it into their own knowledge.
- To provide students' conceptual change, texts with analogies should be used because analogy based thinking consists of definition and transfer of constructive information from the known system to new and relative system
- Open-ended questions should be included either at the end of subject explanation or at the proper places in between texts in order to prompt students to discover, to learn through trial and error and to make them more active.
- To eliminate misconceptions originated form daily spoken language, the differences between concepts and relations should be defined well to students and these differences and relations should be often mentioned within the texts.
- For comprehension, the questions of "why" should be answered. If these questions are answered, it means that

learning at the level of comprehension is achieved. Thus, in the course books the question of "why" should be used very often.

- The course books should address to students with different intelligences (memory areas) in accordance with the multiple intelligence theory. Thus, Science course books should contain various components such as stories, experiments, problems, pictures, maps etc.
- The arranged laboratory activities should entail students to inquiry, to engage in group work and experimental design, to collect and analyze data, to discuss, interpret and report findings.
- In the course books, visual components should be often used. In a good Science course book not only writing and formulas but also many visual components such as pictures, figures, graphics should take place.
- Learning develops through individuals' interaction with others; as individuals share their perspectives, exchange information and solve problems on the basis of collaboration. Therefore, in the Science course books; there should be activities that will encourage students to work in collaboration by doing group works with their peers.
- In the course books, alternative measurement and evaluation methods and techniques should be used.
- The subjects should be explained including as many different perspectives as possible. Thus, various resources through which students can attain information should be recommended.

It is inevitable to obtain successful results and to have effective and efficient Science courses with the course books which are designed according to constructivism in relation to students' daily lives, personal interests and practical applications.

Thus, the aim of this study is to determine whether the Science and Technology course books and student work books for primary school 5th grade are appropriate for the constructivism by evaluating them in terms of the fundamental principles of constructivism.

II. Method

In this study, out of qualitative research methods, documentation technique (i.e. document analysis) is applied. In the literature, it is emphasized that for a research related to education, course books, curriculum instructions, in-school correspondences, student registrations, meeting records, student guidance records and files, student and teacher handbooks, student course assignments and exams, course and unit plans, teacher files, documents related to education and so forth can be used as data source [2], [6]. In this study, the Science and Technology course book and student workbook are used as the documents to be investigated.

Furthermore, in this study, while selecting samples, criterion-sampling is used out of purposeful sampling techniques. While selecting the Science and Technology course book and workbook for the 5th grade, used in this study, the main criterion is to select the ones which are the publications of State Books of Ministry of Education. The examined units are selected as one physics, biology and chemistry unit.

In this study, literature is reviewed to put forth the theoretical grounds of the topic. The researcher developed "The List of Criteria for Analyzing of Course Book" by determining criteria that should take place essentially in a Science course book and student workbook on the basis of the principles of constructivism. Moreover, while developing these criteria, the researcher made use of literature review and expert opinions (from five different area experts). Each item in this list of criteria constitutes the themes used for document examination. Data is analyzed according to these themes. During data analysis, each procedure is carried out by the researcher and another expert independently, and then the findings are compared and reliability is estimated. The analysis is continued until the researcher and the expert have consensus in their evaluations. For the reliability of the study, using Miles and Huberman's [7] formula, it was calculated as % 97,61. The findings are interpreted with quotations from the course books.

III. Findings

In this section, findings obtained as a result of document examination and their interpretations will be presented. Within the context of the List of Criteria for analyzing of Course Book, the distributions of themes in the units of "Let's Solve Our Body Puzzle", "Recognition of Substance and Its Change", "Electricity in our Life" are presented in Tables.

A. Findings Related to the Unit of "Let's Solve Our Body Puzzle"

As seen in Table I, when the unit of "Let's Solve Our Body Puzzle" is analyzed in terms of constructivist criteria, it is observed that the Science and Technology course book is not appropriate for four criteria out of 14 predetermined criteria. As a result of examination, it is obtained that the course book does not include project and research topics, and there is no laboratory activities. Besides, it is seen that alternative measurement and evaluation methods and techniques are not used so much; also students are not directed to different information resources such as books, journals, encyclopedias, web sites etc.

TABLE I
THE DISTRIBUTIONS OF THEMES ACCORDING TO UNIT

Themes	***Unit***	
	"Let's Solve Our Body Puzzle"	
	Course Book	***Work book***
1. Examining students' prior knowledge	+	-
2. Encouraging students to think on daily life samples	+	+
3. Including visual components such as pictures, figures, graphics.	+	+
4. Including analogies	+	-
5. Including projects and research topics that students will conduct	-	+
6. Revealing the differences between concepts and relationships in between concepts	+	-
7. Including open-ended questions	+	+
8. Providing different perspectives to students	+	-

through case study, various scenarios or different problem situations		
9. Addressing to the students with different intelligences through stories, questions, experiments, pictures, charts and concept maps etc.	+	+
10. Using "Why" questions that provide meaningful learning	+	-
11. Including group work activities	+	+
12. Arranging laboratory activities that entail students to inquiry and work in group, collect, record, interpret data, discuss and report	-	-
13. Using alternative measurement-evaluation method and techniques	-	+
14. Directing students to different resources such as cooks, journals, encyclopedias, Internet etc.	-	-

Both students' prior knowledge is examined, also activated and students are encouraged to think on the daily life examples through open-ended questions on the entry page of the unit and the sections called "I wonder…" at the beginning of each activity, and with examples mentioned within the unit. Furthermore, it is observed that visual components such as pictures, photographs, figures, graphics and so forth are included throughout the unit, however, it should be emphasized that due to some unclear, out of focus visuals, students can have difficulty in perceiving them. Furthermore, in different places of the unit, analogies are used. For instance; *the operation of digestion system is resembled to operation of a machine*. Moreover, to reveal and emphasize the differences between concepts or the relationships between concepts, either verbal expressions are used or through tables, differences and similarities of concepts are presented. For instance; *types of food and their functions are classified by means of a table*. Additionally, it is seen that there are open-ended questions throughout the unit. The question of *How does food we eat interfuse into blood?* can be given as an example of the open-ended questions in the unit. However, it should be underlined that the unit is quite inadequate in terms of providing students different perspectives through case studies, various scenarios, and problem situations. In the unit, there is only one problem situation; in the created scenario *two friends' nutrition styles are explained and which of these friends' diet is correct and what to do to help the one who has a wrong nutrition style have a well-balanced diet* is converted into a problem situation for the students. Moreover, the unit is also inadequate to address the students with different intelligences. Throughout the unit, only with the activity of *doing tooth model with dough* different intelligences are taken into consideration. Besides, the question of "why" which is considered to provide meaningful learning is used adequately and effectively. For instance; *Why are there waste materials in our blood?* is asked. Finally, only one activity that encourages group work is observed. This activity *recommends students to work in groups of five to determine the nutrition ingredients.*

In the student workbook, it is seen that the unit of "Let's solve our Body Puzzle" contains activities in accordance with the alternative measurement and evaluation methods and techniques. Out of these methods and techniques; concept maps, project works, 'structured grid', self-assessment forms and puzzles are used. Likewise, there are some activities addressing to the students with different intelligences. These are the activities for multiple intelligence such as reading passages and comprehension questions, story completion, creating model (digestion model), preparing poster and advertisement.

B. Findings Related to the Unit of "Recognition of Substance and its Change"

As observed in Table II, when the unit of "Recognition of Substance and Its Change" is analyzed in terms of principles of constructivist approach in terms of 14 predetermined criteria, it is seen that this unit is not appropriate for 5 criteria. During the examination of the course book, it is obtained that there are no analogies, and no activities that can provide students different perspectives through case study or problem situations. Furthermore, it is observed that project and research topics as well as alternative measurement and evaluation methods and techniques are not included; lastly, it is revealed that students are not directed to different resources such as books, journals, encyclopedias and web sites etc.

TABLE II
THE DISTRIBUTIONS OF THEMES ACCORDING TO UNIT

Themes	***Unit***	
	"Recognition of Substance and Its Change"	
	Course Book	***Work book***
1. Examining students' prior knowledge	+	-
2. Encouraging students to think on daily life samples	+	+
3. Including visual components such as pictures, figures, graphics.	+	+
4. Including analogies	-	-
5. Including projects and research topics that students will conduct	-	+
6. Revealing the differences between concepts and relationships in between concepts	+	-
7. Including open-ended questions	+	+
8. Providing different perspectives to students through case study, various scenarios or different problem situations	-	-
9. Addressing to the students with different intelligences through stories, questions, experiments, pictures, charts and concept maps etc.	+	+
10. Using "Why" questions that provide meaningful learning	+	-
11. Including group work activities	+	-
12. Arranging laboratory activities that entail students to inquiry and work in group, collect, record, interpret data, discuss and report	+	-
13. Using alternative measurement-evaluation method and techniques	-	+
14. Directing students to different resources such as cooks, journals, encyclopedias, Internet etc.	-	-

Similar to biology unit, with the open-ended questions on the entry page of this unit and the sections of "I wonder…" at the beginning of each activity, and sometimes with samples within the unit, it is aimed to examine and activate students' prior knowledge and to enable them to think on the daily life samples. Throughout the unit, visual components such as picture, photograph, figure, graphic etc are often included.

Moreover, in the unit, the differences and relationships between the concepts are clearly mentioned. For instance; it is noted that *the concept of heat is usually confused with the concept of temperature and the differences between these concepts* are explained.

As a result of examination, it is seen that open-ended questions are used throughout the unit. For example; with the question of *Scientists invented balloons that can carry people benefiting from the theory of gas expansion. So how do these balloons fly?* it is aimed to provide opportunities for students both to follow the technological developments and to explain the gas expansion scientifically. However, the unit can be defined as inadequate to address the students with different intelligences since throughout the unit, there is only one activity that asks *two sample problems and give solutions referring to nutrition amounts and energy values given in a table*. On the other hand, in the unit, the question of "why" for meaningful learning is adequately asked. For example; *Why do we wear clothes with light colors while we prefer to wear clothes with dark colors?* is asked in the unit. Regarding group work activities, in the unit there is no expression such as working in groups or dividing in groups, however, in the activities there are pictures that show that activity is performed in a group. Moreover, in the examined unit, it is seen that there are many laboratory activities. However, it is observed that few of these activities entail students to predict, then to collect and record data, then interpret the results and discuss, finally, report the findings.

In the student workbook, it is observed that the unit of "Recognition of Substance and Its Change" is prepared according to the alternative measurement and evaluation methods and techniques. Out of these methods and techniques; concept maps, 'structured grids', performance assignments, research homework, experiment, project work, V diagram and puzzles are used. Furthermore, to address to the students with different intelligences, reading passages, using concepts derived from puzzle in a sentence, examining pictures or photos and writing explanations about them. Additionally, in the workbook, as a result of feature of the unit, there are some activities oriented to students' scientific process skills such as recording and interpreting data, constructing tables and forming graphics.

C. Findings Related to the Unit of "Electricity in our Life"

As indicated in Table III, when the unit of "Electricity in Our Life" is examined in terms of the principles of constructivist approach, according to 14 criteria, it is seen that the Science and Technology course book is not appropriate for four of these criteria. As a result of examination, neither analogies nor project and research topics are included and alternative measurement-evaluation methods and techniques are not used. Besides, it is revealed that students are not directed to different information sources (e.g. books, journals, encyclopedias, web sites etc.).

TABLE III
THE DISTRIBUTIONS OF THEMES ACCORDING TO UNIT

Themes	***Units***	
	"Electricity in Our Life"	
	Course Book	***Work book***
1. Examining students' prior knowledge	+	-
2. Encouraging students to think on daily life samples	+	+
3. Including visual components such as pictures, figures, graphics.	+	+
4. Including analogies	-	+
5. Including projects and research topics that students will conduct	-	+
6. Revealing the differences between concepts and relationships in between concepts	+	-
7. Including open-ended questions	+	+
8. Providing different perspectives to students through case study, various scenarios or different problem situations	+	-
9. Addressing to the students with different intelligences through stories, questions, experiments, pictures, charts and concept maps etc.	+	+
10. Using "Why" questions that provide meaningful learning	+	-
11. Including group work activities	+	+
12. Arranging laboratory activities that entail students to inquiry and work in group, collect, record, interpret data, discuss and report	+	+
13. Using alternative measurement-evaluation method and techniques	-	+
14. Directing students to different resources such as cooks, journals, encyclopedias, Internet etc.	-	-

Similar to other examined units, in this unit, it is attempted to encourage students to think on the daily life samples through open-ended question on the entry page of the unit and the sections of "I wonder…" at the beginning of each activity, and some examples mentioned within the unit. Moreover, it is seen that throughout the unit, visual components such as pictures, photos, graphics, and figures are often used. The unit specifies the differences and relationships between the concepts clearly. For example; the differences and relationships of the *independent, dependent and constant variables* are explained in the unit. Additionally, as a result of examination, it is seen that open-ended questions are included within the unit. For instance; the question of *what are the differences between old washing machines and new washing machines that are developed as a result of new technology?* is asked to encourage students both to follow new technological developments and to explain the issue from a scientific perspective. However, it should be mentioned that the unit has some inadequacies in terms of providing students different perspectives through various scenarios or problem situations. In the unit, there is only one problem situation; *the problem that a robot called Fentero encounter* is explained and *what to do to increase the amount of light Fentero throws out* is asked. Moreover, the unit is not adequate to address to the students with different intelligences either. Throughout the unit, only once an activity that can address different intelligence, *a drama activity,* is given. On the other hand, in the unit, the question of "Why?" that can provide meaningful learning is effectively and efficiently used. For instance; "*How*

does the brightness of the lamp of toy car change when the number of batteries is increased? Why?" is asked in the unit. Moreover, throughout the unit, the activity that can encourage the students' group work can be suggested only once as a drama activity. Regarding the laboratories activities in this unit, it is observed that experiment activities are not designed in a way that can encourage students to predict then to collect and record data, then discuss and interpret the findings and record the results.

When the workbook is analyzed, it is observed that the unit of "Electricity in Our Life" is prepared in accordance with alternative measurement-evaluation methods and techniques. Among these methods and techniques, concept maps, project works, group-assessment forms and puzzles are used. However, as a result of examination it is observed that these activities are inadequate and it is suggested that many other alternative measurement-evaluation techniques and methods can be used for this unit. While in one activity the students are asked to draw the symbols of elements in electrical circuit, in another activity asking to find the mistakes in the picture of electrical circuit, it is aimed to address to the students with different intelligence.

IV. Discussion and Conclusion

When the Science and Technology course book and workbook for the 5th grade in primary education are examined, it is seen that both books complete each other in certain areas. Particularly, the inadequacies of the course book in terms of directing students to project and research work, the use of alternative measurement-evaluation methods and techniques and including activities addressing to the students with different intelligences are compensated with the activities in the workbook. In this context, as a result of analyzing in this study, it is observed that the workbook is designed with the aim to strengthen learning and evaluation.

As a result of analyzing of the books in this study, it is seen that while there are some points completely in accordance with the principles of constructivism, there are also some insufficient and inadequate points. For instance; in the course book, using daily life examples can help students both to internalize information easily and to integrate information related to tools used in daily life and their operation systems with technology more effectively. Moreover, it is observed that the course books are adequate to include open-ended questions and "why?" questions. However, the workbook activities are considered to have a better design to address to the students with different intelligences, in comparison with the activities in the course book. Furthermore, it is found that the workbook is especially better in terms of using alternative measurement-evaluation techniques and methods.

Additionally, some insufficient points in the course book and workbook are revealed as a result of analyzing. As an example of fundamental inadequacies in the books, it can be mentioned that analogies are used very rarely. Although in the course book it is attempted to specify the differences and relationships between the concepts, it is seen that the conceptual change texts are not included so much. Moreover, in the course book and workbook, it is observed that case studies and scenarios presenting various problem situations are insufficient. Furthermore, in the course book, almost no project and research topics are included, and the project and research topics in the workbook are inadequate. Another inadequacy in the books is the fact that the steps in the laboratory activities are explained in a much simpler way than the ones in the scientific research process. Finally, it is seen that the books are inadequate to direct the students to the different sources.

Consequently, it can be claimed that in spite of some inadequate and missing points in the course book and workbook of the primary school Science and Technology course for the 5th grade students, these books are attempted to be designed in terms of the principles of constructivism. To overcome the inadequacies in the books, it can be suggested to redesign them. For instance; to correct the students' misconception and to provide conceptual change, analogy texts and conceptual change texts can be used. In addition to them, not to ignore the technology dimension of the course, the activities that encourage the students to prepare projects using technology cycle should be included. Moreover, the students can be directed to other researches and other resources different from the course books such as journal, encyclopedia, web sites etc. that enable them to use information technologies in order to enable them to benefit from constantly changing and developing technology and to make them as science and technology literate.

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