

A Task Development Process: The Case of Fourth Grade Introduction to Matter Unit

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ABSTRACT

Learning is affected from individual characteristics, learning objectives, and appropriate construction of learning environments. Learning tasks that are designed in educational environments play influential roles on students' learning. The purpose of the current study was to develop fourth-grade science class tasks for Introduction to Matter Unit, using brain-based learning model and evaluate those tasks in the framework of brain-based learning principles. First, based on the learning objectives of the selected unit, several tasks were prepared. Then, those tasks were presented to the experts in the field of education to obtain information related to the utilities of each task in terms of learning objectives, developmental appropriateness, prior knowledge, time management efficiency, classroom organization, teacher-student roles, task difficulty, and material appropriateness. The procedural information provided by the experts was evaluated using Lawshe (1975) technique. The tasks were also implemented in a fourth-grade classroom. The results showed that the tasks are valid and compatible with the task design principles. The procedures used in this study are expected to contribute to the task development procedures in science lessons and other branches. It is also expected that the developed tasks will be in use of the researchers in the field of science education as well as the science and elementary school teachers.

Keywords: Task development, science lesson, Lawshe technique, brain-based learning, elementary school.

INTRODUCTION

The pace of technological and scientific developments in recent years has engendered a need of renewing the educational process. This need brought about many research being made on how to practice the learning. The main focus of those research is related to developing learning environment which will provide a permanent and high-level learning product over time (Yiğit & Akdeniz, 2003). Turning the learners from passive to interactive in learning environments increases the productivity of teaching. Hence, the reforms in the Turkish educational system are being founded on the individual-centered, constructivist approach. In 2005, the science education program relying on constructivist approach requiring the active participation of students in the learning process has been implemented (MEB, 2005). This reconstruction brought about many studies concerning this program (for example, Demircioğlu, Özmen & Demircioğlu, 2004; Gömleksiz & Bulut, 2007; Korkmaz & Konukaldı, 2015; Özmen & Yazıcı, 2015; Tekbiyık & Akdeniz, 2008; Uzal, Erdem, & Ersoy, 2015). The featured issues in these studies were the opinions of classroom and science teachers, the utility of the program and the utility of the tasks in the program.

Contrary to the studies related to the evaluation of the renewed program, the concept of task, one of the most important elements of the teaching-learning situations, has started to be emphasized in recent years. Although it is highly important, there is not enough detailed study about the concept of task. In related studies, description of tasks in science lessons and the examples of tasks are not explained in detail. Studies mainly focus on the ways teachers perceive the tasks and must-be features are defined as well (Gömleksiz & Bulut, 2007; Korkmaz & Konukaldı, 2015; Özmen & Yazıcı, 2015; Uzal, Erdem & Ersoy, 2015).

In the official website of Turkish Language Institution, task is described as "a learning situation that children are willingly participated because it suits their purposes and requirements." Considering this definition, it can be said that task is an act which is suitable for individual's learning purpose alongside with individual's willingness. This individual-centered definition is in line with the constructivist program. In the literature in general, tasks are described as the planned, organized and controlled tasks aiming that students achieve the program objectives (Fidan & Erden, 1993).

In international studies, educational tasks are defined as either task or activity. Ainley, Pratt and Hansen (2006) used "task" and "activity" as different meanings in their collective work. They claim that "task" displays the action prepared by teacher and "activity" displays the action which happens inside the class. In the science education program in Turkey, activity is not defined. Furthermore, the concept of activity which is the subject of this study is stated as "*in science class, while selecting teaching-learning and assessment tasks, it should be noted that individuals reach the behaviors which were stated in objectives using their skills such as query, observation, interpreting data and scientific process*" (MEB, 2015).

In the literature, the most emphasized issues are the qualifications of a task and the points to be considered while designing an activity. Uğurel and Bukova-Güzel (2010) defined the concept of activity in their collective work based on the sample tasks applied in math classes. Moreover, they drew a theoretical framework for points to be considered while designing an activity. Yazıcı and Özmen (2015) inquired opinions of teachers regarding the utility of the experiments and tasks those are in science education program. In their study, Korkmaz and Konukaldı (2015) emphasized the process of creating an activity in which they inquired the effect of the interdisciplinary thematic teaching approach for science and technology education on students' learning products. Waldrip, Prain and Carolan (2010) evaluated the effect of versatile presentations made by students during their learning process and stated that there is a strong correlation between science class tasks and students' conceptual development process.

In general, studies suggest that tasks have significant influences on learning. Given that, it is important to develop tasks suitable for adopted learning approach, model and objectives. However, it is difficult to determine always-valid principles for task development. In their collective work, Kerpiç and Bozkurt (2011, p. 305) summarized the principles to be considered in task-designing process as the followings: Purpose, duration, classroom organization, students' prior knowledge, multiple starting points, comprehensiveness, the suitability of used material, the role of teacher, the role of student, students' challenge and assessment and evaluation.

The purpose of the current study was to present the steps of task preparation process based on brain-based learning model. Hebb, one of the pioneers of the neurophysiological theory, emphasized that nature of learning cannot be comprehended without knowing the circuits in the brain operation (Özden, 2010). Brain-based learning is the organization of learning by considering brain functioning rules in purpose of meaningful learning (Duman, 2007). Brain-based education for learners requires the design of rich and appropriate experiences relevant to life those to be implemented as harmonious to ensure that students understand the essence of the experience which results in learning (Caine & Caine, 2002).

In the present study, first, based on the objectives of Introduction to Matter Unit and brain-based learning model, tasks were developed and, then, based on task designing principles, task validity was evaluated.

METHOD

In this study, a road map detailing the process of task development for science class was presented. Because the tasks were prepared based on brain-based learning principles, they were defined as "Brain-Based Science Class Tasks." This investigation was called as a case study (Yıldırım & Şimşek, 2011).

In the study, first, task designing principles and the definition of these principles were identified and presented. Afterwards, tasks were prepared based on brain-based learning model and course objectives. Then, a validity study was conducted to determine whether prepared tasks were suitable for designing principles and learning model. Based on experts' opinions, Lawshe's technique (1975) was applied. Finally, a pilot study was conducted to determine its utility and the potential presence of the problematic situations. Pilot study was carried out in a primary school in Beykoz district, in Istanbul with the participation of 38 fourth grade students aged between 9 and 10 ($n_{girls} = 17$, $n_{boys} = 21$).

2.2 Task Development Process

In this section, the process of task development was presented step by step. In the task development process, four phases were followed as presented below:

Phase one: The objectives of the selected unit, Introduction to Matter, was examined considering cognitive behavior levels to make certain that the purpose of task was compatible with the objectives. For that purpose, an objective indicator chart in relation to expected cognitive behavior levels and task components was created (see Appendix).

Phase two: In order to examine the coherence between brain-based learning model and tasks, the task drafts were prepared using brain-based learning principles defined by Caine & Caine (2002).

Phase three: The relevance of the prepared tasks and the appropriateness of the content were consulted to the experts for validity check. This step was described in detail in section 2.3.

Phase four: A pilot study was conducted with the prepared tasks. The tasks were revised based on the difficulties encountered in practice. Although this step was outside the scope of the present study, it was included as a stage because it was a part of the task development process.

2.2.1 Task Designing Principles

The adapted principles of task designing process (Kerpiç & Bozkurt, 2011) were presented in Table 1 along with descriptions. Because the notion of task is wide and every branch has different necessities, developing all-time valid principles is difficult. The definitions and criteria for tasks can be extensive (Uğurel & Bukova-Güzel, 2011). In the current study, during the process of task development the following six principles were taken into account: The purpose, students' prior knowledge, duration, classroom organization, teacher-student roles and the degree of difficulty of tasks.

Table 1. Task Designing and Application Principles

Principles	Criteria Being intended for a new objective
Purpose	Being intended for supporting learned concepts Being intended for students to overcome the difficulties and misconceptions Being intended for creating awareness for epistemological structure of the field
Duration	Making time management planning Determining how much time to spare for tasks
Classroom Organization	Determining how students will be organized during practice (individual, group, whole class etc.) Making clear how students will work and how teacher will end the task
Students' prior knowledge	Providing adequate content knowledge (prior knowledge about either subject or concept) (For instance, providing students information about how to work alone or with a group) Providing information about tools to be used during task (For example, if the students are asked to create a shape with the help of a program, they should have the adequate knowledge about using that program)
Multiple starting points	Giving students multiple starting points while starting to a task
Comprehensiveness	Making task that are available for all levels of students (Tasks should be organized for not only students who give correct answers but also all students)
Relevance of materials	Considering the supportive and facilitative dimensions of materials to be used during the task (Even though materials are often perceived as concrete, a problem, a formula or worksheets can also be evaluated as materials.) Paying attention to the reasons for using specific materials and how to use them, whether they have an alternative, are accessible, why and how they will be used and their limitations.
Role of teacher	Determining the role of teacher to apply the task as planned (These roles should be considered such as clarity of instructions, use of tools, organization of students, student difficulties, interventions, assessment and evaluation)
Students' challenge	Taking necessary measures to estimate that students may experience difficulties in the process (What is expected are that instructions to be understandable and instructions to be given considering materials, resources, duration and student's studying habits (individual-group-classroom) or lack of students' prior knowledge)
Assessment and Evaluation	Including assessment and evaluation in purpose of determining whether the tasks have accomplished their goal (According to students' studying habits (such as group work), process should be evaluated and practices after task should be discussed in the design)
Flexibility	Taking measures in case an unexpected situation happens during task (Circumstances such as whether the task will continue or not, adequacy of the determined time, organization of the class and use of the tools must be open to change)

Source: Kerpiç & Bozkurt, 2011, pp. 306-307.

2.2.2 Task Samples

2.2.2.1 Task Name: Look at my card: True or False?

Task Implementation Steps:

In this task, students are given three cards in different colors.

The cards hold three meanings: I agree, I disagree or I am uncertain (eg, orange card presents agreement, yellow card presents disagreement and blue card presents uncertainty)

The teacher reads the following sentences about the topic:

- Iron is attracted by the magnet.
- Sponge doesn't absorb water.
- The magnet pulls the metal material.
- Wood doesn't absorb water.
- Cloth absorbs water.
- Some objects float in the water, some objects sink in water.

Listening to these sentences, students put the cards in correct order (if they sit, they put them on the desk) and they explain to teacher why they chose that card. Scheduling and description of this activity are given in Table 2.

Table 2. Introduction to Matter Unit “Look at my card: True or False?” Task

Plan	Description
Purpose	Using the five senses, explains the basic features that characterize the substance A formative assessment task for objective
Task difficulty level	Beginner (every student can attend)
Duration	30'
Classroom organization	Nested-U Layout
Teacher-student role	Teacher-supporting and guiding; active student participation

2.2.2.2 Task Name: Let's Help Mete

Task Implementation Steps:

In this task, separating mixtures is presented with an interactive presentation (20'). Planning and description relating to the task is presented in Table 3.

Table 3. Introduction to Matter Unit “Let's help Mete” Task

Plan	Description
Purpose	Determines and tests the methods that s/he uses to separate mixtures in daily life
Task difficulty level	Intermediate
Duration	40'+ 40'
Classroom organization	Appropriate for group work, as clusters
Teacher-student role	Teacher as supporting and guiding, active student participation

In order to turn the task to an activity, the following problem is presented.

Case study: *Mete put iron powder, pepper, stone and sand in his school bag as all of which were in one plastic bag as a mixture intended for the next day's science class experiment. The next day, in the classroom, the teacher said “Kids, put your experiment materials on your desks.” Then, all students started to place the materials on their desks.*

Mete's deskmate, Zeynep, placed her materials on the desk in separate containers. Finally, she put the magnet next to them.

Having looked around, Mete got worried seeing that all his friends put the materials separately. Mete wondered if he had it all wrong. Their teacher asked them to just leave the iron powder alone. Mete started to worry more since he put his all materials together in just one bag. How could he separate them?

Case studies are presented and taught to classes as power point presentation. Plastic bags presented in the story are distributed to students' desks including the materials. Having received the tools which can be used for separation, students are expected to fulfill the duty as they put themselves in Mete's place. They are asked to save every separation operation to structured experiment record sheet.

The teacher walks around the groups and tries to guide students. The class separates the materials using the tools as many as they can. If a group fulfills the assignment correctly, the teacher asks that group repeat the experiment in front of the class. If the operation cannot be completed in time, the teacher evaluates all groups one by one and provides the separation operation to be completed by guiding them.

2.2.3 Expert Opinions: Validity Study for Tasks

In this section, with the purpose of validity, the descriptive features of experts, the collection and evaluation procedures of expert opinions were explained. Task evaluation criteria and Lawshe technique (1975) were

presented. Evaluations on the prepared tasks were collected based on the discussions made with the experts whom qualifications were stated in Table 4.

Table 4. Demographic Features of the Experts in the Study

Codes	Gender	Age	Professional title	Field of Education
1	F	32	Teacher	Primary Science Teaching
2	F	38	Teacher	Primary School Teaching
3	M	39	Teacher	Primary School Teaching
4	M	32	Ph.D.	Program Development
5	M	32	Ph.D.	Program Development
6	F	32	Ph.D.	Science Education
7	F	32	Ph.D.	Primary School Teaching
8	F	32	Ph.D.	Primary School Teaching

Note: M: Male, F: Female

The tasks were evaluated according to the criteria presented in Table 5. In order to demonstrate the quantitative results of this assessment, Lawshe (1975) technique was used and the content validity ratio was obtained for each item. Lawshe technique, converts qualitative data obtained from experts' opinions into quantitative data for content validity. In this technique, each test item is evaluated by experts using three measures, which are "the test item is sufficient to measure the targeted behavior", "the test item should be revised to measure the targeted behavior," and "the test item is insufficient to measure the targeted behavior."

Table 5. Task Assessment Criteria

Principle	Questions for Evaluation
Purpose	Is the task appropriate for the objective's purpose?
	Is the task appropriate for the objective's cognitive level?
	Is the task appropriate for brain-based learning principles?
Student prior knowledge	Does the task require student's prior knowledge?
Duration	Does the time adjusted for the task adequate?
Classroom Organization	Is it explained how to organize the class for task?
Teacher-student roles	Is it stated which roles teacher and students will have in the task?
Degree of task difficulty	Is the task appropriate for students' level?

Lawshe (1975) technique is performed in six stages. These are (1) The expert group is created, (2) the scale form is created, (3) expert opinions are taken, (4) the content validity ratio on items is calculated, (5) the content validity index is determined, and (6) based on content validity ratio criteria, items in the scale are determined (Yurdugül, 2005). Using experts' opinions and the formula below, the content validity ratio was calculated.

$$CVR = \frac{N_s}{N/2} - 1$$

N_s = Number of experts indicating that "item is necessary/suitable"

N = Total number of experts assessing the item

When the formula is applied, if all the experts indicate that the item is suitable, CVR equals to 1, if half of the experts indicate that the item is suitable CVR equals to 0, and if more than half experts indicate that the item is suitable CVR is higher than 0, and less than half indicate it is suitable, then CVR is lower than 0. CVR values used to evaluate the data were presented in Table 6.

Table 6. CVR Minium Ratios

Number of Experts	Minimum Value	Number of Experts	Minimum Value
5	0.99	13	0.54
6	0.99	14	0.51
7	0.99	15	0.49
8	0.78	20	0.42
9	0.75	25	0.37
10	0.62	30	0.33
11	0.59	35	0.31
12	0.56	40	0.29

Note: $p < 0.05$ (Venaziano & Hooper, 1997, as cited in Yurdugül, 2005, p. 2).

In the present study, because the expert group was consisted of eight individuals, the findings obtained by the formula were evaluated with the criterion of .78 at .05 significance level.

RESULTS

Based on the experts' opinions, the tasks were evaluated and the content validity ratio (CVR) for each task was calculated. The results were presented in Table 7.

Table 7. CVR Ratios of Tasks Based on Task Evaluation Criteria

Task number	Criteria					
	Purpose	Students' prior knowledge	Duration	Classroom Organization	Teacher-student roles	Degree of difficulty
1	1.00	1.00	0.75	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00	1.00	1.00
3	1.00	1.00	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00	1.00	1.00
5	0.50	1.00	0.50	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	0.75	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00	1.00
Total	0.96	1.00	0.92	1.00	1.00	1.00

The majority of the tasks submitted to the experts were found to be valid based on CVR ratios. For the fifth task, two experts reported negative comments in relation to purpose (e.g., appropriateness of content for brain-based learning model) and duration (e.g., appropriateness of the time set for this activity). Therefore, this task was omitted and its alternative fourth task was placed in the study. As seen in Table 7, the tasks, in general, were found appropriate by the experts. There were a few more negative opinions on the duration criteria. By looking at the content validity index, however, it can be said that in terms of given criteria, the prepared tasks are valid and applicable.

DISCUSSION

In this study, task development procedures for a science class unit, using brain-based learning model, was explained in detail. This research has questioned whether the tasks are appropriate for purpose and level of objective and used several presented stages for evaluation. Harris and Hofer (2009) state that the plan of a learning situation starts with determining the purpose of the learning. Making educational choices for this learning experience, choosing the appropriate type of task, identification of formative and summative assessment strategies, tools and resources that can be recommended for students are the following steps.

Emphasizing the duration in the task is also important. Taş (2010) states that lack of set time for the task and the fact that students are given much more time than they need lead to perception that students assume the task is unnecessary. The use of time criterion in tasks has an important role in the studies. Moreover, tasks which are thought not to be appropriate for this criterion are excluded from the extent of the study. If the time is not determined for the task, the tasks may not reach their goals (Özmantar & Bingölbali, 2009).

Henningsen and Stein (1997) emphasize that tasks, which transfer students' higher level thinking skills into action, are based on students' prior knowledge and they have a proper plan with the form of adequate time. Prepared tasks require proper class environment and teacher skills in order to let the students present their higher level cognitive skills during task (Stylianides & Stylianides, 2008). To determine the organization of class and the teacher-student roles are other required measures for tasks to be carried out in a healthy way (Swan, 2007). All these criteria were taken into account for the task development process in this study.

Considering the fact that learning environments, teachers and learners are not stable, it is hard to put always-valid principles. However, in order to present proper tasks, tasks must be prepared considering task design principles. Through this way, productivity taken from the tasks will increase and the problems which may arise during the practice of task will decrease to the minimum (Kerpiç & Bozkurt, 2011). In the current study, by explaining each step in task development, it is expected that the necessary attention has been drawn to the issues in task design. Using similar stages, teachers and researchers can develop new tasks in their disciplines.

Tasks play important roles in the learning practice. The stages presented in this study are thought to increase the quality of tasks prepared. During the task development process, taking as many experts' opinions as possible makes the results more reliable and valid. Also, because student group dynamics can change the way of learning and tasks, pilot studies are important to determine the organization of tasks. There might be some cases that may not require pilot study. For example, if the purpose is to conduct an action research, then pilot study can become unnecessary because it is the research itself. However, if the tasks are tools in an investigation, then pilot study becomes necessary. In the current study, a pilot study was conducted because the tasks were considered as tools. The findings of the pilot study were not reported in this paper.

This study showed that the Brain-Based Science Class Tasks, the subject of this study, are valid and applicable in science classes in fourth grade. It is expected that science teachers and researchers in the field of science will benefit from the developed tasks in their class and in future research.

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Appendix. Chart for “Introduction to Matter Unit” Objectives with the Levels of Cognitive Behaviors and Tasks

OBJECTIVES	COGNITIVE BEHAVIOR LEVELS AND THE TASKS						Task Name and Level
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	
4.3.1.1 Explains the fundamental features of matter by using five senses.		*					Task 1- I am solving a problem <i>Evaluation Level</i> Task 2- Look at my card: True or False? <i>Comprehension Level</i>
4.3.2.1 Knows the phases of matter and gives examples for different phases of the same substance.		*					Task 3- Try to know who I am? <i>Comprehension Level</i>
4.3.2.2 Compares the main features of the phases of matter.		*					Task 4- Together, hand by hand Our products are fabulous <i>Comprehension Level</i> <i>Synthesis Level</i>
4.3.3.1 Measures the mass and volume of different materials and compares them.			*				Task 5- I am measuring mass and volume <i>Application Level</i> Task 6- I am learning the units <i>Comprehension Level</i>
4.3.3.2 Identifies the matter using measurable properties.		*					Task 7- I am learning by relating <i>Comprehension Level</i>
4.3.4.1 Designs and makes experiment about cooling and heating of matter.			*		*		Task 8- I am vaporizing the water Task 9- I am observing freezing <i>Application Level- Evaluation Level</i>
4.3.4.2 Makes experiment and interprets the findings about the phase changes in matter due to the effect of heat.			*			*	
4.3.5. Defines and explains the difference between matter and object.	*	*					Task 10- Find, Select, Stick <i>Knowledge- Comprehension Level</i>
4.3.6.1 Classifies the matters that s/he uses often in daily life as pure matter or mixture and explains the differences between them.		*		*			Task 11- Pure or Mixture? <i>Comprehension Level</i>
4.3.7.1 Determines and tests the methods to separate the mixtures that s/he encounters in daily life.			*				Task 12- Let’s Help Mete <i>Application-Analysis Level</i>
4.3.8.1 Discusses separating the mixtures with relation to their contribution to a country’s economy and the effective use of resources.						*	Task 13- I am separating the mixtures and contributing to my country <i>Evaluation Level</i>