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Exploring Secondary Students' Conceptions about Fire Using a Two-Tier, True/False, Easy-to-Use Diagnostic Test

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Abstract

This article describes the design of a misconception diagnostic test about fire-related phenomena. It proposes a new test format in which a certainty-measuring tier has been integrated into each of the true/false response choices. This format is argued to be easier for teachers to use than the increasingly popular three-tier format. First, we review the available literature about misconception diagnostic tests and then literature about fire-related misconceptions. We then describe the design process of the test, which was preceded by an interview phase. We then describe its administration to 221 secondary school students. We finally present, in an explorative and accessible manner, the results that were obtained. These results support the existence of previously recorded misconceptions, but also bring certain nuances to some of their previous interpretations. They also support the hypothesis according to which some misconceptions are presumed to be more widespread than they truly are. Conclusive remarks are formulated about the benefits of the use of our—and other—misconception diagnostic tests.

Keywords: Misconceptions, Diagnostic test, Fire, Certainty.

Introduction

The Use of Misconception Diagnostic Tests

Successfully teaching for conceptual change in science first requires that teachers know about the existence and nature of possible "misconceptions" (DiSessa, 2006; Duit & Treagust, 2003; von Aufschnaiter & Rogge, 2010; Vosniadou, 1994) that could potentially interfere with learning. Misconceptions are ideas about how the world works that do not conform to scientific knowledge and are therefore considered by specialists as pedagogical obstacles. "The origin of these alternative conceptions may be grounded in traditional culture, knowledge, environment, economy, medicine, and personal thinking" (Chang, Lee, & Yen, 2010, p. 911). Thus, "identifying misconceptions and their causes prior to teaching becomes important in developing lessons that ultimately result in the reconceptualization of learning […]" (Arslan, Cigdemoglu, & Modeley, 2012, p. 1668). To do so, teachers can get informed through science education literature or, if they have good reasons to believe that their particular students are not representative of previously studied learners (Chang et al., 2010; Stavy, Tsamir, Tirosh, Lin, & McRobbie, 2006), they can also use available diagnostic tests (Treagust, 1988). When these teachers become certain enough about the conceptual state of their students, they can begin preparing lessons that will challenge their misconceptions (Posner, Strike, Hewson, & Gertzog, 1982) or make more scientific conceptions prevail (Potvin, 2013) over the more naive ones. Thus, "assessment of misconceptions is very important for effective science instruction" (Pesman & Eryilmaz, 2010, p. 208).

According to Caleon and Subramanian (2010), "the identification and investigation of alternative conceptions is one of the most important tasks in educational research" (p. 940). Therefore, it is not surprising that "over the past three decades, diagnostics tests have become a relatively prominent assessment tool in science education for data collection concerning the misconceptions on domain-specific knowledge" (Arslan et al., 2012, p. 1670).

The most common type of test for this purpose is the multiple-choice (MC) test. This type of test is very interesting for diagnosing misconceptions because of the presence of distractors (incorrect yet tempting choices of answers) that correspond to frequent misconceptions. MC tests therefore allow for the assessment of not only assimilations (monotonic learning), but also accommodations, because when learners can not only produce a correct answer but furthermore resist attractive yet false ones, then we can suggest that their learning has gone beyond simple assimilation, or rote learning. Such well-designed tests sometimes allow researchers to see if

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pedagogical treatments are enough to produce fundamental changes or not. In such an experiment, Gabel *et al*. used a multiple-choice test which allowed her to understand the strong persistence of misconceptions about burning though students were adequately exposed to scientific knowledge. The multiple-choice test, which was based on misconceptions reported in the literature, and the pre- and post-instruction interviews, indicated that "many misconceptions were persistent." (Gabel, Monaghan, & MaKinster, 2001, p. 447)

What Have We Learned From Recent Diagnostic Test Developments?

In recent years, a number of new tests have been designed and proposed to researchers and teachers, and a new kind of format, the three-tier MC test, has progressively emerged. First, it is important to define what a second tier is: the most commonly used diagnostic test in science education is by far the classic *Force Concept Inventory*, which allows for the assessment of frequent misconceptions about simple mechanics. In 1995, the designers suggested that in order to improve its effectiveness, the test might benefit from a "second tier" that would ask students to *justify* their choice of answer in an open format. When justifying the use of such a second tier in their own test, Arslan et al. explained the following:

> Hestenes and Halloun (1995) recommended that a correct answer along with a wrong reason (false positive) and a wrong answer followed by a correct reason (false negative) be used to provide evidence for content validity […]. Minimization of the probability of false negatives and false positives provides higher validity in multiple-choice tests. (Arslan et al., 2012, p. 1676)

Pesman and Eryilmaz (2010) also reported the risk of false positives and false negatives in the design of their diagnostic test about electrical circuits. However, another risk was also reported, more inherent to the function of a diagnostic test.

> Although two-tier tests provide more information than other commonly applied methods for efficiently collecting data from large populations, some limitations have been identified. The presence of guessing may result due to overestimating the participants' levels of knowledge as well as misconceptions as these tests do not discriminate lack of knowledge from misconceptions (Caleon & Subramanian, 2010; Pesman & Eryilmaz, 2010). An additional tier, which contains a certainty of response index, has been proposed to compensate for the likely weakness of the diagnostic tests (Hasan, Bagayoko, & Kelley, 1990; Pesman & Eryilmaz, 2010). (Arslan et al., 2012, p. 1670)

The *Certainty of Response Index* (CRI) is a confidence rating. This type of rating can "be regarded as an individual's 'internal, estimated belief' in his or her own accuracy" (Renner & Renner, 2001, p. 23). Cordova *et al.* are also cautious in their description of the construct and add that "confidence in prior knowledge should not be confused with self-efficacy. Whereas self-efficacy in this context refers to a prospective judgment of one's capabilities to learn about a specific topic, confidence in prior knowledge refers to a retrospective judgment of whether one's current understanding of the topic is correct" (2014, p. 165). According to Pesman and Eryilmaz (2010, p. 209), Caleon and Subramanian (2010, p. 941), and Odom and Barrow (2007, p. 100), all of whom refer to Hasan et al. (1990), when confidence in prior knowledge is combined with an incorrect answer, this answer can be thought of as a strong clue to the presence of a misconception. Conversely, weak confidence expressed about a wrong answer can be considered as a mere lack of knowledge. "Distinguishing a lack of knowledge from a misconception is crucial because remediation of a lack of knowledge or a misconception may entail different instructional methods" (Pesman & Eryilmaz, 2010, p. 209).

Although crucial, the pedagogical effects of high confidence in prior but false knowledge are unclear. Cordova reports cases in which it is presumed to strengthen prior knowledge and make change more difficult. But based on the available literature on feedback, she also reports cases in which certainty facilitates change. Her own results also point in this direction. She hypothesizes the following:

> It may be that when prior knowledge conflicts with the scientific information being presented, learners who are more confident in their prior knowledge may be more likely to pay attention to the alternative conception and overcome the barrier of inaccurate prior knowledge when specially designed conceptual-change based interventions, […] are used. (Cordova et al., 2014, p. 172)

According to Caleon and Subramanian (2010), "only a few researchers […] have included confidence ratings in developing tests" (p. 941). Nevertheless, we believe it is very interesting because, if the "confidence" variable can be integrated into research design, it could allow teachers to better design or choose the pedagogical treatments for certain profiles of certainty. In a recent research study, for example, we showed that traditional teaching settings might better benefit students in cases where they have doubts about their answers, and problem-based learning settings might better benefit students in cases where they feel more confident about their answers (Potvin, Riopel, Masson, & Fournier, 2010).

However, to researchers' despair, many of these tests, especially three-tier tests, though sometimes used by researchers, are very seldom used by teachers. These frequently overworked teaching professionals still appear to not be wholly convinced of the importance of diagnostics prior to teaching. Furthermore, the enormous task of administrating and analyzing these tests might be their *coup de grâce*. We therefore believe that with the need for diagnostic, also comes the need for diagnostic tests that are easier to use.

Students' Conceptions about Fire

Fire is one of the most common and familiar chemical reactions that students can witness (Chang et al., 2010; Driver, Guesne, & Tiberghien, 1985). Burning is often used as an introductory example (yet often treated superficially) in chemistry textbook chapters (Boujaoude, 1991; Gabel et al., 2001) at the secondary level. Nevertheless, it is subject to many misconceptions (Boo, 1995; Boujaoude, 1991), "making the study […] of students' understandings about this concept important for effective instruction" (Boujaoude, 1991, p. 691). Studies about fire have mostly used interviews, often supported by the observation of objects burning (wax, paper, alcohol, wood, etc.), as in studies by Bouajoude (1991) and Rahayu (1999). Some researchers have also used questionnaires, such as Watson (whose questionnaire, which is available, inspired us) or Prieto and Dillon (1995), and some have combined both (Gabel et al., 2001).

Recorded conceptions have been judged by researchers as being essentially "cued by visible aspects of events" (Boujaoude, 1991, p. 701). Rahayu (1999, p. 297) hypothesized that "combustion is a particularly difficult example of chemical change since it involves the gaseous state in both reactants and products, and decomposition as well as synthesis." Finally, students' conceptions are also presented as fragmented, inconsistent, and task specific. For example, "[…] most students described the burning of a candle as melting, the burning of alcohol as evaporation, and the burning of bread as changing color" (Boujaoude, 1991, p. 699).

Inspired by Driver (1985), Boo reports a prototypical and rather simplistic idea of fire that many students seem to acknowledge as true:

> […] burning involves a flame; products are smoke and an incombustible material known as the ash; the change is irreversible; and oxygen/air is needed, but its role is unclear or unknown. After specific instruction which includes the concept of interaction between oxygen and the combustible material, both studies reported that students are still unable to grasp the role of oxygen in combining chemically with the combustible material. Instead, they still show evidence of the use of perceptual thinking instead of conceptual thinking. (Boo, 1995, p. 52)

Many other important invariants in students' answers were recorded frequently enough to be considered as noteworthy conceptions by researchers and reviewers. Many of the most important ones are synthesized in Table 1.

Table 1. Some reported misconceptions about fire, combustion, or burning

Misconception	Author(s)
• "The sole products of fire are smoke and an incombustible material known as the ash."	(Driver & Easley, 1985)
• "Burning objects decrease in mass." • "Metals are thought to melt or oxidise, but not burn." • "Only carbon-containing compounds are thought to be capable of burning." • "The candle wax in a burning candle is not burning, but only melting."	(Boo, 1995, pp. 53-54)
• "Air is not actively involved in burning." • "A substance is not used up, nor new substances formed in the burning process." • "Heat is thought of as a substance that is formed in the burning process." • "Particles can be destroyed in a flame."	(Schollum & Happs, 1982)
• "Some combustibles are believed to be unable to burn, but only to melt or evaporate. For instance, combustion of a candle is interpreted as the wax melting, iron is said to melt, and the combustion of alcohol in an alcohol lamp is explained as alcohol turning into vapour." • "Air is undergoing a transformation independent of the combustible material."	(Meheut, Saltiel, & Thibergien, 1985)
• "Oxygen or air is not involved in the change that is burning." • "The flame or fire is an active agent of change." • "Matter may be transmuted into heat." • "One substance changes to a different form of the same substance." • "Burning involves things going red and a flame appearing." • "Solid residues or ash are the incombustible bits left behind."	(Watson et al., 1995, pp. 489-494)
• "Alcohol and oxygen are not actively involved in burning." • "Substances undergo no chemical reaction during burning." • "Terms such as *evaporation* and *burning* can be used interchangeably when describing burning alcohol." • "Phrases such as *chemical change* and *physical change* can be used interchangeably when describing burning things."	(Boujaoude, 1991, p. 700)
• "The wick was the candle fuel."	(Gabel et al., 2001, p. 447)

However, the set of misconceptions described in Table 1 does not seem to be internally consistent as a whole. Indeed, these misconceptions are not necessarily shared by the majority of students, or by students of the same age; some misconceptions seem to partially contradict others. Also, some of the statements hardly describe misconceptions, but rather conceptual errors (though they could serve as indirect clues to the presence of misconceptions). Nevertheless, they form a rather solid basis on which we decided to develop our own test (see below).

We have also noticed in research that leads to the identification of misconceptions that the consideration of fire is often made under certain sets of curricular constraints. Sometimes, fire is seen as a *security* matter, or as a *culturally* interpreted phenomenon (Chang et al., 2010), but perhaps even more often as an essentially (almost exclusively) *chemical* phenomenon (Gabel et al., 2001). Indeed, subsections of studies include, for example, definitions, combustion, burning, products or conservation of matter—all chemically relevant angles that might not necessarily seem as central to young students as the colour of the flame, combustible (or not) materials, smoke, the necessary conditions to light a fire, or violent fires (explosions), etc. We will therefore choose not to limit ourselves to school-oriented perspectives on fire, but instead begin our investigation in a more open-ended mode, while still being attentive to what the research tradition has already identified.

Research Objectives

Considering the elements presented above and the synthetic critique elements that emerged, we will focus on achieving two main goals:

1) To develop through the knowledge of well-documented conceptions and open interviews an easy-to-use multiple-choice test that will allow teachers to diagnose the presence of misconceptions about fire.
2) To conduct (with the developed test) an exploration of secondary students' conceptions about fire.

Method

Design of the Instrument

According to Pesman and Eryilmaz (2010, p. 208), "combining interviews and multiple-choice tests seems to be the best way for making sense of students' understanding when taking the pros and cons of them into account." We will therefore heed this advice by integrating both ways of gathering data. Also, according to Morales (2012, pp. 26-27), "high quality conceptual multiple-choice tests greatly differ from the traditional MC tests in the process of development […]. The whole process involve[s] three major phases: (i) *Preparation* (in which reviews, observations and literature are considered); (ii) *Development* of the conceptual test […]; and (iii) *Validation*." The best three-tier tests were recently developed according to this process, with very few adaptations. Caleon and Subramanian (misconceptions about waves), for example, as well as Arslan (misconceptions about global warming, greenhouse effect, ozone layer depletion, and acid rain), were inspired by David Treagust's (1988) recommendations, which suggested beginning with the identification (within an expert team) of concept boundaries; then questions "were written based on the concept boundaries and in accordance with the extensive related literature" (Arslan et al., 2012, p. 1671-72); and finally the questions were piloted to an important number of subjects. Pesman and Eryilmaz (2010, p. 210) (misconceptions about simple electric circuits) also followed very similar phases. We therefore propose to rigorously follow this kind of three-step development process: *Preparation*, *Development*, and *Testing*.

Preparation

The authors (who all have science teaching experience as well as research experience) of this study piloted the preparation phase. For purposes of ease, it was decided from the beginning that we would renounce the use of the usual *justification* tier. We were aware that this might be at the expense of completely controlling the false negative and positive answers. But ease of use and the possibility of convincing teachers to use the test were judged to be sufficiently beneficial. However, it was decided that preserving the third tier (certainty in prior knowledge) could also contribute to reducing false negatives and positives, thus reducing the consequences of rejecting the second tier.

Following this, and inspired by previously recorded misconceptions about fire (see Table 1), an interview grid was created in order to assist the interviewers in collecting coherent data as well as encouraging fruitful interviews. This guide was given to 24 interviewers (who all have bachelor degrees in science), divided into teams of 2 to 4 interviewers, with the mandate to to ask open-questions to 7 secondary school students (per team). In this exploratory phase, we used the services of many interviewers in order to favor the emergence of a fair variety of misconceptions. A total of 42 voluntary secondary-school students with no special training about fire (except ordinary school curricula) were interviewed for durations of half an hour to an hour and voice-recorded. Interviewers received prior training on the importance of providing a good interview climate, of welcoming verbalizations without judgement or feedback (except encouragement to talk), of avoiding questions that begin with the word "why" (judged as too school-like and typically used for testing conceptions instead of exploring them), of favouring Ericksonian reflection (repeating the subjects' last words to encourage them to deepen their explanations), of occasionally asking students (in an optional fashion) about their level of certainty (1 to 5), and of thanking them for their participation (at the end), etc. The interview guide they used proposed the following start-up questions:

- **What is fire?** (with the possible use of a photo of a wooden "camp-style" fire [see Figure 1]) Other possible "start-up" words: *flame*, *ember*, *ash*, *smoke*, *crackling*, *burning brand*.

- **How does it work?** Other possible supporting questions: *Where does the heat come from? Where does the wood go? Why do the flames go up? What's left of the wood after it burns? What do you need to light a fire? What can extinguish a fire? How can fire be extinguished?*
- **To conclude**: *What else do you know about fire that you would like to explain to me?*

Figure 1. Image of a wood fire

Interviewers were also told to ask more precise questions if they had time or to fully pursue interesting lines of thought, when applicable.

After the interviews, the interviewers submitted multi-page written reports synthetically describing the recorded verbalizations. The interviewers and the three experts also held a two-hour workshop together to share the interesting conceptions that they had inferred and recorded in their reports.

Development

Based on the above-mentioned preparation phase and on the collected data (literature and interviews), the development of the questionnaire began. It immediately appeared to the expert team that many of the potentially interesting ideas could hardly be gathered into four or five choices of questions. Instead, it was suggested and decided that every "misconceptual" response could easily be translated into a true/false format. Many of these questions could, however, be gathered into sections of a questionnaire (for example, a section about "What can burn?"). In retrospect, this choice was also interesting for another reason: MC always suggests that there is only one correct answer. However, it is not implausible that a subject would adhere to more than one distractor. Thus, our decomposition of each possible MC question into multiple true/false questions would allow for a subject to fall for more than one distractor, in turn allowing the recording of multiple misconceptions. Indeed, distractors, unlike correct answers, are not necessarily mutually exclusive.

With this decision, it appeared that it would also be possible to integrate the third tier (certainty) with the first one, providing a very simple-to-handle (and simple-to-analyze) format. For example, every question had the same format as the example in Table 2:

Table 2. An example of a question and the possible choices of answers given to students

Question (statement)	Choices				
Plants can burn.	I'm *certain* it is true.	I *suspect* it is true.	I *do not* know.	I *suspect* it is false.	I'm *certain* it is false.

The team included questions that tested all the misconceptions they suspected to be frequent. They were suspected to be frequent when more than one interviewer team recorded similar incorrect answers from different students. At that point, the questionnaire went into a two-week iterative development phase, during which time discussions based on reports were conducted among the experts on a daily basis. At the end, a 79-question document (divided into 13 theme-based sections) was proposed for testing. A discussion was held about the correct answer to attribute to each question, and research of scientific documents was carried out when an agreement could not be reached. When an agreement still could not be reached about the correct answer even though research of scientific documents had been conducted, the question was reformulated until the team was satisfied, or else it was deleted.

Testing the Instrument: Exploring Conceptions and Misconceptions

Sample and Procedure

The subjects were 212 French-speaking students from secondary schools in the greater Montreal area, Canada. They were recruited by their teachers, who were asked to cooperate with the project by the researchers. There were 134 girls and 78 boys (the majority of girls is due to recruitment at a few girls-only schools). The vast majority were in grades 9 (n=94) and 10 (n=94), with very few from grades 8 (n=9) and 11 (n=8). The mean age was 15 years and 8 months with a standard deviation (SD) of 1 year (363 days). The portrait is therefore rather representative of students from the middle of secondary school (although a bit more of girls than boys).

Students were read the instructions by the teacher and were invited to complete the questionnaire by answering to the best of their ability. They had half an hour to do so. They responded to three socio-contextual questions (girl/boy, birthdate, school level) and then to 79 conceptual questions. They were told that even though the statements were in groups, they had to choose one of the five choices (I'm sure it is true; I suspect it is true; I don't know; I suspect it is false; I'm sure it is false) for each of the statements.

Afterward, we first checked for cases who selected the same answer for all questions, marked the answer in any order like Z shape or any repeated orders (lack of honesty) were dropped from the study, and then proceeded to input and analyze the data. We wanted this analysis to be as simple as possible in order to convince teachers that they did not need advanced knowledge in statistics to use the test and be able to interpret the data. Other classic validations of tests use factor analysis, internal consistency indexes (*Cronbach* alphas) and other means, but we chose to work essentially on descriptive statistics. This way of working was also better suited to an exploratory study and furthermore while using a questionnaire containing strictly ordinal data.

Results and Discussion

The results were presented under three categories: the first is about potential "misconceptual" answers, which will include answers that reached a threshold of (arbitrarily decided) 33% general inaccuracy (initially regardless of expressed certainty); the second is about potential "lack of knowledge" answers (at least 33% of "do not know" or missing answers); and the third is about potential "accurate" answers (at least 33% general accuracy), which will be presented as perhaps too easy to be included in future versions of our diagnostic questionnaire.

Potential "Misconceptual" Answers

For purposes of uniformity and to facilitate the interpretation of tables 3, 4, and 5, we have corrected the answers and presented them in "accurate/inaccurate" instead of true/false format, which would necessitate repeatedly going back and forth to see the correct answer every time. Therefore, for the following tables, the coloured columns show a left→right "inaccurate to accurate" continuum, with the most certain answers at the ends.

Table 3 gives the percentages of answers for the 20 most "inaccurate but certain" statements among the ones which got at least 33% total inaccuracy. Statements are presented in decreasing order of "inaccurate but certain" percentages of answers. For an equal number of these answers, a decreasing order of "inaccurate but uncertain" answers prevails. Missing answers are not included in the percentages.

Table 3. Distribution percentage of potential "misconceptual" answers for each statement

Question number	Statement	Correct response	Inaccurate but certain	Inaccurate and uncertain	Does not know	Accurate but uncertain	Accurate and certain	Missing (N)
12	The Sun is a true fire.	F	60	20	5	8	6	4
3	Diamonds can burn.	T	50	22	16	7	4	4
20	Flames go up because they search for oxygen, which is in the air and not in the soil.	F	48	33	8	5	6	5
45	Fire is a gas.	F	45	35	9	3	9	6
11	Lava is a true fire.	F	40	23	6	12	19	5
57	Lighting a match is absolutely necessary to start a wood fire.	F	39	15	1	3	41	6
13	Fireworks are a true fire.	T	38	25	10	18	10	5
77	The tip of the flame is hotter than the base.	T	38	22	20	11	9	7
74	A bigger fire is always hotter.	F	36	25	6	14	19	6
71	Water can extinguish a fire because it neutralizes the flames.	F	35	36	11	7	10	7
48	Friction (like rubbing two rocks together) is absolutely necessary to start a wood fire.	F	32	22	5	12	29	7
23	At its origin, light from fire came from energy that came from the Sun.	T	30	26	28	10	5	7
62	Smoke is a part of the cycle of fire.	F	28	32	21	9	9	8
39	Fire is made of matter.	F	26	34	18	10	12	6
60	Black smoke (instead of whiter smoke) indicates that the fire is more intense.	F	26	29	18	12	14	8
76	The ember is hotter than the flame.	F	26	22	30	14	8	7
72	Water can extinguish a fire because it transforms fire into smoke.	F	24	27	10	14	25	6
2	Metals can burn.	T	24	25	12	23	17	5
65	Smoke contains oxygen.	F	24	21	23	16	16	8
53	Carbon dioxide (CO_2) is absolutely necessary to start a wood fire.	F	21	19	18	13	29	7
59	Smoke is partially made of steam.	T	19	17	19	25	19	7

We believe that the first 10 questions provide valuable hints that possibly betray the presence of misconceptions. Not only do they have a lot more "inaccurate but certain" answers than all the other types of answers, but they also show more "inaccurate but certain" answers than "inaccurate and uncertain" answers, indicating that many students probably hold deeply rooted misconceptions on which they base their answers. Indeed, "by definition, misconceptions are *strongly held* cognitive structures that are not consistent with scientific concepts (Hammer, 1996). This definition can be restated as follows: for a conception held by a student to be a misconception, it requires not only being inconsistent with scientific concepts but also being strongly advocated by the student" (Pesman & Eryilmaz, 2010, p. 209).

Some of the misconceptions are rather surprising. Of course, we already knew that most students have difficulty recognizing that metals or wax can burn (see question 2, hereafter designated [like all other questions] as *Q2: 24%* [*all percentages presented in this section are for "inaccurate but certain" responses*]), but the scores for diamonds (Q3: 50%) are much stronger. It might be that students confuse the well-known mechanical strength associated with diamonds with other "durability" properties. Students also seem to have significant difficulty determining what fire truly is. We already knew that students had trouble recognizing fire as an event (a chemical reaction), but they also seem to agree that it is made of matter (Q39: 26%), more precisely a gas (Q45). This impressive score (45%) could, however, be an effect of the structure of the questionnaire because it asked in a sequence if fire was a liquid, a solid, or a gas (Q43–Q45). Perhaps students felt the need to choose between at least one of these three possibilities. However, the association of fire with the idea of gas has already been recorded.

Apparently students do not feel strong discomfort identifying the Sun (Q12: a strong 60%) and lava (Q11: 40%) as true fires (even though there is obviously no air in space and lava does not produce flames [it is, however, incandescent]). It might be that very high temperatures that produce incandescence are hard to accept as not being fires. We could also report that common socially shared expressions such as "solar fire" can interfere with school messages. However, fireworks seem to be more difficult to qualify, as they should be. We could hypothesize that the brevity of the fire phenomenon does not contribute to its qualification. The temperature of fire also seems to be problematic. Students seem to adhere to the idea that the centre (or base) of a fire is hotter than the rest, even hotter than the tip of the flame (which is not the case, however, with Q77: 38%); likewise, an ember is considered to be hotter than the flame (Q76: 26%), which (surprisingly for some of us) it is not. Bigger fires are also considered to be necessarily hotter than smaller ones (Q74: 36%) and to produce darker smoke (Q60: 26%), which is not necessarily the case. It also seems to be difficult for students to see the flame as a product of fire. Instead, they seem to attribute an active role to the flame: the statement that "flames go up because they search for oxygen, which is in the air and not in the soil" got an impressive 48% approval (+ certainty). In Q71 (35%), students agree that "water can extinguish a fire because it neutralizes the flames." These last observations are in line, we believe, with Watson's observation that the flame is an active agent of fire (Watson et al., 1995, pp. 489-494). However, we should note that it is true that when flames are absent, the fire should be considered as extinguished, by definition.

However, we believe that the rather strong score of 39% obtained for Q57, "lighting a match is absolutely necessary to start a wood fire," should not be considered as strong as the other "misconceptual" answers. Indeed, it also got a strong 41% of "accurate and certain" answers. We therefore believe that different students might have understood the question differently. Thus, we do not recommend including it in future versions of the questionnaire. We also noted similar though weaker effects for Q48 and Q53, which are similarly constructed. It is, however, a little surprising for the latter that some students would strongly see carbon dioxide as necessary to start a wood fire. It is not impossible that students know it is involved in the process, but are confused about its role. This has also been recorded in the past for oxygen (Schollum & Happs, 1982; Watson et al., 1995).

Another rather strong result is that students do not seem to acknowledge that "at its origin, light from fire came from energy that came from the Sun" (through photosynthesis) (Q23: 30%). However, it is not easy to determine which misconception could be at the origin of this wrong answer. It is possible that the question simply appeared odd (and therefore difficult to agree with) because of a lack of knowledge about the origin of the energy that is released through, for instance, a wood or gasoline fire.

Other strong results for "inaccurate but certain" answers could reveal misconceptions, but since "inaccurate but uncertain" answers become more popular as we descend the list (even becoming stronger than "inaccurate but certain" ones), we believe it is not safe to think of them as revealing strong misconceptions and fulfilling Hammer's strict criteria. However, we believe that for the "misconceptual" answers discussed above, teaching might benefit more from accommodation initiatives than from regular teaching methods.

"Do Not Know" or Missing Answers

Table 4 provides the distribution percentages of answers for statements that got at least 33% total "does not know" or missing. It is a little hazardous to associate missing answers to "lack of knowledge"; therefore, statements are presented only in decreasing order of "do not know" number of answers. For an equal number of these answers, a decreasing order of "missing" answers prevails.

Table 4. Distribution percentage of potential "lack of knowledge" answers for each statement

Question number	Statement	**Correct response**	**Inaccurate but certain**	**Inaccurate and uncertain**	**Does not know**	**Accurate but uncertain**	**Accurate and certain**	**Missing (N)**
6	Asbestos can burn.	F	15	23	45	8	9	5
34	The colour of a flame depends on magnetic fields.	F	7	10	32	25	27	7
70	Water can extinguish a fire because it changes the nature of the combustible.	F	11	23	32	10	24	5
76	The ember is hotter than the flame.	F	26	22	30	14	8	7

Few questions (only four) qualify for this category. This interesting result, especially considering the fact that so many answers in the test were inaccurate, could be considered as a result in and of itself. Indeed, Cordova has already argued that "students still generally tend to be overconfident" (Cordova et al., 2014, p. 165). The small size of Table 4 (in comparison with tables 3 and 5 [see below]), we believe, supports this claim. Students often do not dare to reveal their lack of knowledge. They clearly preferred to provide positive or negative answers, even if they were uncertain.

We believe the most surprising result is Q6 about asbestos. Living in the province where the most asbestos in the world is produced, the students still did not seem to know (45%) or were wrong about (38%) its flameproof properties. Clearly, Quebec schools should do more to teach students about asbestos and its history.

Results for Q34 are not surprising, since it is plausible that most students never had the opportunity to establish links between fire and magnetic fields. We could, in fact, consider the 53% score of students who got the answer right as encouraging. The same could be said about question Q70, that "water can extinguish a fire because it changes the nature of the combustible." We already discussed Q76, that "the ember is hotter than the flame," because it also got rather high inaccuracy scores. This rather puzzling result might suggest that for this question, students are generally either deceived, or not informed.

"Accurate" Answers

Table 5 provides the percentages of answers for the 20 most "accurate and certain" statements among the ones which got at least 33% total accuracy. The statements are presented in decreasing order of "accurate and certain" percentages of answers. For an equal number of these answers, a decreasing order of "accurate but uncertain" answers prevails. Missing answers are not included in the percentages.

Table 5. Distribution percentages of answers for statements that are potentially too easy

Question number	Statement	**Correct response**	**Inaccurate but certain**	**Inaccurate and uncertain**	**Does not know**	**Accurate but uncertain**	**Accurate and certain**	**Missing (N)**
47	A combustible (e.g., wood) is absolutely necessary to start a wood fire.	T	2	0	1	13	84	5
55	The colour red is absolutely necessary to start a wood fire.	F	1	1	6	8	83	7
52	The presence of the Moon is absolutely necessary to start a wood fire.	F	0	1	4	13	82	7
15	A lit candle is a true fire.	T	1	4	1	13	80	4
50	A combustive (e.g., oxygen) is absolutely necessary to start a wood fire.	T	3	2	4	13	78	5
43	Fire is a liquid.	F	1	2	10	13	74	6
46	Air is absolutely necessary to start a wood fire.	T	7	4	3	15	70	8
51	The presence of the Sun is absolutely necessary to start a wood fire.	F	6	9	4	12	68	6
44	Fire is a solid.	F	1	5	11	16	67	6
27	Ash is a product of the combustion of wood.	T	1	2	9	23	66	6
1	Plants can burn.	T	2	5	6	21	66	5
9	Certain gases can burn.	T	5	6	6	23	61	3
18	Flames go up because they are attracted by the Sun's gravity.	F	3	5	14	16	61	5
40	Fire is a chemical reaction.	T	4	6	5	25	59	5
56	Wind is absolutely necessary to start a wood fire.	F	9	13	4	15	59	6
7	Certain solids can burn.	T	2	4	9	28	56	5
10	The flame of a barbecue is a true fire.	T	9	8	5	23	56	5
49	A magnifying glass is absolutely necessary to start a wood fire.	F	14	14	7	13	53	7
63	Smoke contains carbon dioxide (CO_2).	T	0	4	15	29	52	7
41	Fire is a mechanical reaction.	F	2	10	15	26	48	8

Of course, these last items that did not allow us to record any misconceptions. The reader might be a little puzzled as to why some of these questions were included in the questionnaire. The reason is that we systematically chose to include questions that appeared at least more than once in the interviews in order to encourage the possibility of identifying new and unexpected misconceptions. Obviously, certain results show that some of them were anecdotal.

Since some accuracy rates are so high, it is difficult to consider that they should be given more attention in class. However, sometimes, an imperfect accuracy rate could suggest that more assimilation efforts could be made. But, for a diagnostic test like the one we are developing (with a rather strict set of criterion for identifying misconceptions), they are not the most useful. However, rejecting them all is not necessarily advisable, because if every question left creates tension within the subjects, it could alter their perception of the exercise and unduly increase their vigilance, causing their answers to be less spontaneous.

However, we noticed that some of these high-scoring questions are somewhat surprising. For example, the statements of Q26, Q40, Q50, and Q63 appear, despite their technical character, to be widely accepted. This should be credited to the schools. Students seem to easily acknowledge that fire is a chemical reaction that needs a combustible material and which produces carbon dioxide. We can also say the same about the answers to Q68, Q69, and Q73 (which are about the mechanisms by which one can extinguish a fire and which all got above 52% accuracy, despite the fact that they can be judged as rather misleading). Q38 ("The colour of the flame depends of the quality of the blend with oxygen") and Q17 ("Flames go up because the air that's heated by the fire is lighter than the surrounding air [for comparable volumes]"), which are quite technical, still got a positive 62% for general accuracy.

Other Interesting Percentage Distributions

The three preceding tables (3, 4, and 5) show the answer distributions that are interesting in light of misconceptions, lack of knowledge, and (excessive) easiness. But there are also other distributions of certain questions that are interesting for our discussion. Most of them occur in the continuity of Table 5 (which was limited to the 20 highest accuracy scores). They show high accuracy scores, even though theses scores might be somewhat surprising in light of the available literature or the interview phase of our research. Indeed, some have been discussed at length by the authors or have appeared repeatedly in the interviews. We therefore could have formulated positive hypotheses about their frequent inaccuracy. But even though accuracy/inaccuracy does not have absolute thresholds, our team was nonetheless surprised to see them get such high accuracy scores.

- Q4: "Certain minerals can burn" (true) got 54% accuracy, despite the fact that literature shows that students often view minerals as incombustible (Boo, 1995; Meheut et al., 1985).
- Q28: "Ash is made only of wood bark, which does not burn" (false) got 61% accuracy, despite the fact that a certain number of students said in the interviews that bark does not burn.
- Q67: "Water can extinguish a fire because it is stronger than fire" (false) got 51% accuracy, even though it came up frequently in the interviews.
- Q66: "Smoke is a part of the clouds" (false) shows that there is a rather good distinction made between clouds and smoke, despite the fact that it has been presented as a teaching difficulty (Potvin, 2011).
- Q42: "Fire is a phase change" (false) got 42% accuracy, even though literature shows that students often see combustion as such (Boo, 1995; Meheut et al., 1985). In the same line of thought, Q31 ("Ash is chemically different from wood" [true]) got an encouraging 58% accuracy, with as much as 32% of "accurate and certain" answers).
- We also already knew from Gabel's work that students often think that certain liquids cannot burn (Gabel et al., 2001). It is therefore a little surprising to see that Q8 ("Certain liquids can burn") got 45% "accurate and certain" answers.

We believe these interpretations are interesting because they challenge the idea that such conceptions are widely spread. In every single case described above (except the first one), the "accurate and certain" scores were even stronger than the "accurate but uncertain" ones, which seems to strengthen the claim that students did not adhere strongly to the associated misconceptions.

Indeed, during teaching, it is not possible to focus on all possible conceptions. Therefore, only the most frequent misconceptions should be addressed systematically, whereas others may be treated on a more individual basis.

Toward a New Version of the Test

In light of the precedent analysis of the data, we suggest that further development of our diagnostic test should reject or reformulate certain questions for clarity and economy. Such development should, in our opinion, take into account the detailed and coded suggestions that appear in Appendix 1. However, it might be inadvisable to reject all “too easy” questions, because it could probably cause “whole test effect” differences, changing the attitude of the students toward the test. Also, some too easy questions could allow teachers to better understand that certain misconceptions might not be as widespread as anticipated (as discussed above).

We hope that teachers will be inclined to use the test or certain questions in order to design their own. We hope that some will choose to strategically administer the test to their students and use the results to monitor their progress. We also hope that they share their results with us for comparison.

Conclusion and Recommendations

In this article, we described the development and the first actual test of a conceptual diagnostic instrument about fire. We did not proceed with a typical validation of the test, but instead concentrated our efforts on creating an instrument that would be easy to use and analyze. Therefore, a true/false format was proposed, with a certainty tier integrated in the answer choice. The test was inspired by the available literature about conceptions concerning fire, combustion, and burning, but also by an initial open-ended interview phase. It allowed the researchers to confirm the presence of answers that could suggest the presence of certain classic misconceptions about fire, some of which had already been recorded in literature, such as the conception that hard solids, like metals or diamonds, cannot burn, and difficulties qualifying fire as such. Indeed, according to our results, 60% of all subjects, for example, believed that the Sun is a true fire. Our results also seem to confirm an “active” role of the flames, which are not conceived as an emanation. We believe that the “certainty” tier of our test allowed us to confirm the solidity of certain misconceptions and also allowed us to—at least partially—reduce interpretations that could have been the product of guessing or “on the spot” context-based intuitions. Indeed, we chose to qualify as misconceptions only those responses with a strong “inaccurate but certain” distribution. Regarding identified misconceptions, we would like to warn teachers that it is more than possible that they will encounter them while teaching and we suggest that accommodation teaching initiatives be undertaken instead of mere assimilation methods.

We also believe that our results show that students are often overconfident about their spontaneous reasoning. Indeed, many answers showed high inaccuracy levels even though the possibility of answering “I do not know” without any consequence was given. We believe that teachers should be made aware of this and that students are often not humble enough when it comes to a familiar phenomenon like fire. We therefore believe that “transmissive” teaching models that presume such modesty might not be appropriate as often as thought. It is also possible, however, that students do not develop enough of a humble attitude because school usually does not encourage it. Instead, answers, good or bad, are always required in order to test accurately, and uncertainty is not an encouraged attitude. Most of the time, we believe that it is seen as a weakness. Students might have transferred such a “misconception” about uncertainty while answering our test questions.

Finally, we believe that our instrument provided the opportunity to test the presumed widespread character of some previously recorded misconceptions. For example, the statement “certain minerals can burn” surprisingly recorded a rather fair accuracy score (“metals” did not fare so well and “diamonds” were second worst). Q42 (“Fire is a phase change”) also got more accuracy than inaccuracy, which challenges the importance given to a confusion between physical/chemical changes by previous literature (Boujaoude, 1991).

We believe that our questionnaire could allow teachers to do the same: not only test for the presence of misconceptions, but also “put to the test” how solid they are. We think these two last ambitions are possibly as legitimate as the first one. We also believe the contribution of our research might lead in this direction: to raise awareness among teachers about misconceptions but, furthermore (and perhaps more importantly), to help them get in line with the conceptual state of their class (without overdoing it) and plan effective and economical ways to promote scientific accommodations as well as assimilations.

Our test unfortunately might not have the robustness of other well-designed diagnostic tests that were previously proposed and validated by strong research designs (Arslan et al., 2012; Caleon & Subramanian, 2010; Morales, 2012; Pesman & Eryilmaz, 2010; Treagust, 1988). For example, for now it remains at an exploratory phase and it also rejected the second tier of investigation, which was strongly argued as important in previous literature. It is therefore possible that our test recorded false negatives and false positives in more than tolerable quantities. We are fully aware of this possibility, but we also believe that to be useful, tests must first be used. This is why we proposed a format that avoids heaviness in management. Thus, we invite all possible users of the test to contact us and tell us what they think of it and its shortcomings. We will be more than happy to propose improved versions based on such exchanges.

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Appendix A

The 79 statements of the questionnaire and the proposed recommendation for each for future versions of the test are presented below in Table 6. Legend: For rejection → (E) means *too easy*; (S) means *potential structural problem* (identified in retrospect), (NR) means *not necessarily relevant for a diagnostic test* considering the final answers.

Table 6. Question number, associated statements, correct responses, and recommendations

Question number	Statement	Correct response	Recommendation after analysis
1	Plants can burn.	T	Reject (E)
2	Metals can burn.	T	Retain
3	Diamonds can burn.	T	Retain
4	Certain minerals can burn.	T	Reject (E)
5	Concrete can burn.	F	Reject (E)
6	Asbestos can burn.	F	Retain
7	Certain solids can burn.	T	Reject (E)
8	Certain liquids can burn.	F	Retain
9	Certain gases can burn.	T	Reject (E)
10	The flame of a barbecue is a true fire.	T	Reject (E)
11	Lava is a true fire.	F	Retain
12	The Sun is a true fire.	F	Retain
13	Fireworks are a true fire.	T	Retain
14	The filament of a light bulb is a true fire.	F	Reject (E)
15	A lit candle is a true fire.	T	Reject (E)
16	Flames go up to flee the heat that is at the base of the fire.	F	Reject (E)
17	Flames go up because the air that's heated by the fire is lighter than the surrounding air (for comparable volumes).	T	Reject (E)
18	Flames go up because they are attracted by the Sun's gravity.	F	Reject (E)
19	Flames go up because they follow electric charges in the air.	F	Reject (NR)
20	Flames go up because they search for oxygen, which is in the air and not in the soil.	F	Retain
21	Light comes from the heat of the fire.	T	Reject (S)
22	The burning wood transforms directly into light.	F	Reject (E)
23	At its origin, light from fire came from energy that came from the Sun.	T	Retain
24	Fire does not emit light; it absorbs light from its surroundings.	F	Reject (E)
25	Fire is not made of matter, thus it absorbs light.	F	Reject (E)
26	Light comes from the transformation of chemical energy into light energy.	T	Reject (E)
27	Ash is a product of the combustion of wood.	T	Reject (E)
28	Ash is made only of wood bark, which does not burn.	F	Reject (E)
29	Ash is made only of incompletely burnt wood.	F	Reject (E)
30	Ash has the same mass as burnt wood (1,000 g of wood will produce 1,000 g of ash).	F	Reject (E)
31	Ash is chemically different from wood.	T	Reject (E)
32	Ash comes from something other than wood, since it has completely burned.	F	Reject (E)
33	Ash is a part of smoke.	T	Reject (E)
34	The colour of a flame depends on magnetic fields.	F	Reject (NR)
35	The colour of a flame depends on the presence of certain combustibles.	T	Reject (E)
36	The colour of a flame depends on the altitude of the fire.	F	Reject (E)
37	The colour of a flame depends on the temperature of the surroundings.	F	Reject (E)
38	The colour of a flame depends on the quality of the blend with oxygen.	T	Reject (E)

39	Fire is made of matter.	F	Retain
40	Fire is a chemical reaction.	T	Reject (E)
41	Fire is a mechanical reaction.	F	Reject (E)
42	Fire is a phase change.	F	Reject (E)
43	Fire is a liquid.	F	Reject (E)
44	Fire is a solid.	F	Reject (E)
45	Fire is a gas.	F	Retain
46	Air is absolutely necessary to start a wood fire.	T	Reject (E)
47	A combustible (e.g., wood) is absolutely necessary to start a wood fire.	T	Reject (E)
48	Friction (like rubbing two rocks together) is absolutely necessary to start a wood fire.	F	Reject (S)
49	A magnifying glass is absolutely necessary to start a wood fire.	F	Reject (E)
50	A combustive (e.g., oxygen) is absolutely necessary to start a wood fire.	T	Reject (E)
51	The presence of the Sun is absolutely necessary to start a wood fire.	F	Reject (E)
52	The presence of the Moon is absolutely necessary to start a wood fire.	F	Reject (E)
53	Carbon dioxide (CO_2) is absolutely necessary to start a wood fire.	F	Reject (S)
54	A sufficient quantity of heat is absolutely necessary to start a wood fire.	T	Reject (E)
55	The colour red is absolutely necessary to start a wood fire.	F	Reject (E)
56	Wind is absolutely necessary to start a wood fire.	F	Reject (E)
57	Lighting a match is absolutely necessary to start a wood fire.	F	Reject (S)
58	Smoke is created by the wind.	F	Reject (E)
59	Smoke is partially made of steam.	T	Reject (E)
60	Black smoke (instead of whiter smoke) indicates that the fire is more intense.	F	Retain
61	Smoke contains ash.	T	Reject (E)
62	Smoke is a part of the cycle of fire.	F	Retain
63	Smoke contains carbon dioxide (CO_2).	T	Reject (E)
64	Smoke can change colour depending on what is burnt.	T	Reject (E)
65	Smoke contains oxygen.	F	Retain
66	Smoke is a part of the clouds.	F	Reject (E)
67	Water can extinguish a fire because it is stronger than fire.	F	Reject (E)
68	Water can extinguish a fire because it prevents photosynthesis in the wood.	F	Reject (E)
69	Water can extinguish a fire because it prevents oxygen from reaching the fire.	T	Reject (E)
70	Water can extinguish a fire because it changes the nature of the combustible	F	Reject (NR)
71	Water can extinguish a fire because it neutralizes the flames.	F	Retain
72	Water can extinguish a fire because it transforms fire into smoke.	F	Possibly retain
73	Water can extinguish a fire because it cools fire.	T	Reject (E)
74	A bigger fire is always hotter.	F	Retain
75	When a fire gets hotter, it changes colour.	T	Possibly retain
76	The ember is hotter than the flame.	F	Retain
77	The tip of the flame is hotter than the base.	T	Retain
78	The heat of fire is generated by its light.	F	Reject (E)
79	The heat of fire depends on the combustible material.	T	Reject (E)

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Turkish Chemistry Teachers' Views about Secondary School Chemistry Curriculum: A Perspective from Environmental Education

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Abstract

Teachers' views about environmental education (EE) have been regarded as one of the most important concerns in education for sustainability. In secondary school chemistry curriculum, there are several subjects about EE embedded in the chemistry subjects in Turkey. This study explores three chemistry teachers' views about to what extent the subjects related with EE should be integrated into secondary school chemistry curriculum at an individual level of analysis. The findings of the study indicate that there is a consensus among teachers on the inadequacy of secondary school chemistry curriculum for providing students an effective EE. However, there is an inconsiderable divergence among the teachers' views about the placement of subjects about EE in chemistry curriculum and the integration of subjects about EE into the curriculum. Through the results of the study, policy makers and curriculum developers would gain a comprehensive insight about deficiencies in chemistry curriculum for EE from the point of view of chemistry teachers and they would have opportunity to realize the ways for the remedy of this deficiency.

Key words: Environmental education, chemistry curriculum.

Introduction

It is clear for all mankind that the decline in the vitality of the planet is almost everywhere, which mainly results from population growth, industrial discharges, consumption patterns, solid wastes disposal, and domestic wastewater discharges, etc. However, we still have the chance to recover this tendency in declining through taking the necessary precautions before it is too late. Therefore, EE takes its place as one of the key means of reacting in the face of environmental threats (Teksoz, Sahin, & Ertepinar, 2010).

Environmental education can be defined in a general view as the education process dealing with humankind's relationship with the natural and human-made surroundings, and includes the relation of population, pollution, resource allocation and depletion, conservation, transportation, technology, economic impact and urban and rural planning to the total human environment (Peterson, 2007). Thus, the concept EE involves knowledge and comprehension about ecological, social and political processes and their influences (Bartuseviča, Cēdere, & Andersone, 2004). In Tbilisi Declaration which was created in the first Intergovernmental Conference on Environmental Education, the goals of EE stated as (1) to foster clear awareness of, and concern about, economic, social, political, and ecological, interdependence in urban and rural areas; (2) to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment; (3) to create new patterns of behavior of individuals, groups, and society as a whole towards the environment (UNESCO, 1977). The Tbilisi Declaration has been used as a grounding document to outline what EE is and how it should be taught in various contexts.

There are many advantageous aspects of EE. The teachers perceived that EE was not only a way to teach about the environment, but also an innovative way to achieve basic educational goals like reading and student skills Besides becoming more aware of the environment and environmental issues, students would learn to care about the environment and appreciate nature, students would learn of their impact on the environment, and students would realize their responsibility for the earth (Middlestadt, Ledsky, & Sanchack, 1999).

Environmental education has a wide extent ranging from environmental pollution (water pollution, air pollution, soil pollution, noise pollution, solid wastes, and hazardous wastes), global warming (climate

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change), environmental cycles (C, H_2O and N_2 cycles), biodiversity, energy usage, health education, to resolution of environmental problems (recycling, renewable energy sources, population and environment)

(Teksoz, Sahin, & Ertepinar, 2010). EE subjects are interdisciplinary in nature, thus the extent to which discipline-oriented teachers are able to deal with interdisciplinary subjects is the limiting factor for introducing environmental issues as an integral part of the science curriculum (Gough, 2002).The issues within the scope of EE should be integrated into the curriculum of all the natural sciences because the environmental issues are not separate from problems of chemistry, physics and biology (Bartuseviča, Cēdere, & Andersone, 2004). In addition, the issues related to EE should be in the core of science curriculum. According to Edelson (2007), the reasons why the issues related to EE should be included in the core of secondary school science curriculum are (i) they are important for students and society; (ii) they are representative of contemporary science in ways that the disciplinary courses that currently comprise the core curriculum are not; (iii) they create an opportunity for students to experience an applied science; (iv) they are particularly engaging context for learning fundamental science. Implementation of EE in secondary school depends on both school curricula and teachers` environmental competencies.

Integrating the issues related EE into secondary school chemistry curriculum would be an effective means in order to come over the problem of discrepancy between the chemistry curriculum and the information necessary for life in modern society and to gain students a meaningful mode of chemical thinking and understanding attitude towards environmental processes and skills which are useful for practical life (Feierabend, Jokmin, & Eilks, 2011). Therefore, in secondary school chemistry curriculum, an approach that establishes a joint between chemistry and environmental issues should be adopted by curriculum designers. Moreover, many researchers have suggested that teaching chemistry in the context of real-world issues as a way that motivates and interests students (Hofstein, Eilks, & Bybee, 2011; Holbrook & Rannikmae, 2007, 2009; Marks & Eilks, 2009, 2010). Thus, integrating more environmental issues in chemistry curriculum would provide students a better understanding about the relation of chemistry with daily-life. According to the findings of the study of Mandler, Mamlok-Naaman, Blonder, Yayon, and Hofstein, (2012) using more environmental examples in teaching chemistry increase students' awareness towards environmental issues, especially issues that are connected to their everyday lives and students see chemistry as a way of better understanding and as a better way of solving environmental problems. Moreover, a five-year evaluation report on Chemistry in the Community (ChemCom) which was published in 1992 concluded that students wanted to learn chemistry through environmental contexts (Sutman & Bruce, 1992).

According to the literature, there is a clear consensus among researchers about integrating environmental issues in science curriculum in general and in chemistry curriculum in particular (Edelson, 2007; Ernst, 2007; Hofstein, Eilks, & Bybee, 2011; Holbrook & Rannikmae, 2007, 2009; Lieberman & Hoody, 1998; Marks & Eilks, 2009, 2010; Sutman & Bruce, 1992). In the last decade many studies have been conducted about the integration of EE in science education and implementation of EE in secondary schools (American Chemical Society, 2006; Benett & Lubben, 2006; Hofstein & Kesner, 2006). However, in science education literature there has not been any study that directly studies on the extent to which subjects related with EE should be integrated into science or chemistry curriculum. This study aims to fill this gap in the literature. The purpose of this study is to explore Turkish chemistry teachers' views about to what extent the subjects related with EE should be integrated into secondary school chemistry curriculum at an individual level of analysis. The findings of this study would be mainly important for curriculum designers and policy makers on the account of the fact that it reflects chemistry teachers'-as implementers of curriculum- views about how and to what extent EE can be embedded into chemistry curriculum. Through the findings of this study, policy makers and curriculum developers would have opportunity to comprehend and realize what the deficiencies are in chemistry curriculum and problems in implication of the curriculum for conveying EE in chemistry. The research question of this study is "To what extent the subjects related with EE should be integrated into secondary school chemistry curriculum according to Turkish chemistry teachers?" and the sub research questions used in this study are as follows:

(1) To what extent, do chemistry teachers regard the chemistry curriculum including subjects for environmental education?
(2) According to the chemistry teachers, which subjects about EE should be added on or removed from the secondary school chemistry curriculum and what are the reasons for those additions or removals?
(3) According to the chemistry teachers, what should be the placements of the subjects about EE in chemistry subjects in secondary school chemistry curriculum and what are the reasons for those placements?

The Study

The case-study approach was chosen as a research method in the study due to its robust grounding in reality, accessibility to teachers and its ability to generate a detailed and rich narrative. Generalization takes the form of 'theoretical inference' in which the conclusions move beyond the individual cases to a more general and a theoretical level (Hammersley, 1998).

Participants

The findings presented in this paper are based on detailed interviews undertaken with three experienced chemistry teachers, Sevil, Enis and Ersin in three secondary schools located in different cities in Turkey as a part of research. Table 1 provides some brief biographical details about the participants involved. Each participant has been working in different cities in Turkey. All of the participants have never before taken any courses on EE in their undergraduate education and they also have not attended any in-service training about environmental education.

Table 1. Details of research participants

	Teacher 1: Sevil	Teacher 2: Enis	Teacher 3: Ersin
Years teaching	8	11	12
Gender	Female	Male	Male
School type	Public	Private	Public
School size	1000	500	1200
School situation	Urban	Urban	Urban
Age	33	35	37

Data collection

The researcher conducted semi-structured interviews with experienced chemistry teachers for the purpose of gathering information directly from participants' mind. One-on-one interviews were conducted by telephone by using open-ended interview questions in Table 2. Therefore, the response modes used in the interview was unstructured. Each interview lasted for about 30 minutes and interview protocols were used during the interviews.

Table 2. Interview questions in relation to the research questions

Interview Questions	Relation to the Research Question
To what extent is chemistry curriculum related to environmental education?	1st research question
In chemistry curriculum which subjects include topics related to environmental education?	1st research question
Are they adequate for an effective environmental education?	1st research question
Do you emphasize sufficiently on those subjects?	1st research question
Which of the following environmental issues should be in the chemistry curriculum? Why? a. Water pollution b. Solid wastes c. Hazardous wastes d. Global warming e. Air pollution f. Loss of biological diversity g. Consumption patterns	2nd research question

h. Deforestation i. Noise pollution j. Soil pollution k. Population and environment l. Environmental cycles (C, H_2O and N_2 cycles) m. Energy usage *In which chemistry subjects should those be integrated?*	 2nd research question
Beyond the scope of current chemistry curriculum, are there any environmental issues which are discussed in the class? *If yes, in which chemistry subjects should those subjects be taught? Why?*	2nd research question 3rd research question
Do you think that environmental education should be a separate must course rather than being in chemistry curriculum? Why?	3rd research question

Analysis of Data

The Turkish secondary school chemistry curriculum was investigated in detail and related to EE the aims and the subject matters were listed in order to validate what the interviewees stated about the curriculum and the curriculum itself. During the interviews, I checked whether interviewees' statements matched up with the curriculum or not and the issues which were not overlapped were questioned to clarify whether the interviewees omitted those issues in the lessons or forgot to state to the interviewer. Moreover, in order to validate the accuracy of findings, I got feedback from participants about the final reports about the interviews. All participants affirmed the reports without a disagreement. Furthermore, an expert scholar in the field reviewed and asked questions about the study from beginning to the end.

Findings

The study revealed a remarkable degree of similarity among the views of the three chemistry teachers on the inadequacy of chemistry curriculum for providing students an effective EE. Moreover, data from all chemistry teachers suggest that subjects related to EE were not taught appropriately in the lessons. However, despite their apparent agreement about inadequacy of chemistry curriculum, the picture which emerged from detailed analysis of the interview data showed that there is a disagreement about the integration of EE subjects into the chemistry curriculum and proper placements of those subjects in the chemistry curriculum.

To what extent, do chemistry teachers regard the chemistry curriculum including subjects for environmental education?

All of the teachers agreed that the chemistry curriculum was inadequate for providing students an effective EE and the chemistry curriculum did no treat environmental subjects in a wide coverage:

> I think our curriculum doesn't include subjects related with environmental issues, its relation to EE is superficial and narrow-scoped, and also it's not sufficient to develop students an understanding about environmental issues. (Sevil)
>
> The chemistry curriculum doesn't mention a lot about the importance of environment and the effects of people's behaviours on environment ... and although chemistry is very closely related to environment, the curriculum doesn't give chance for an effective environmental education. (Ersin)

Moreover, all teachers similarly stated that existing subjects related to EE were not taught appropriately due to several reasons which were the time allocated for those subjects, the placement of those subjects in the curriculum and technical reasons in that teachers could not test some subjects as they were taught after the final examination of the semester:

> There are only two subjects related with environmental education that I focus in lessons. One of them is a separate unit titled as 'Chemistry in Life'. It's the last unit of ninth grade chemistry course … I can't teach the unit in detail as it's taught after the final exam of the semester. The other one is taught as a short part in the 'Radioactivity' unit. Here, the only focus is on the effect of radioactivity on living things … These two subjects aren't adequate of course for a good environmental education. (Enis)

> The specified lesson hours in the curriculum for subjects related with EE are so few that it's impossible to provide students an understanding about environment and to gain them an environmental perspective… (Ersin)

> The only unit that wholly allocated to environmental issues is "Chemistry in Life". This is the last unit of the ninth graders and because students become tired and remain indifferent toward all lessons, they can't learn it efficiently. If this unit hadn't been at the end of the second semester of the year, it'd probably have been more effective in terms of EE. (Sevil)

According to the chemistry teachers, which subjects about EE should be added on or removed from the secondary school chemistry curriculum and what are the reasons for those additions or removals?

There was a disagreement among teachers' views on inclusion of subjects which were related to EE in chemistry curriculum. One of the teachers (Sevil) proposed that all the subjects within the scope of EE should be in the chemistry curriculum and a comprehensive integration of EE and chemistry should be established in order to provide an effective EE claiming that chemistry is the most suitable branch of science for realization of that purpose:

> Because EE subjects are more relevant to chemistry rather than other branches of science, it should be the main platform to teach environmental issues. Moreover, all of the other branches of science should include subjects related EE as well as chemistry. … As all of the subjects of EE are closely related to chemistry, they can be taught in chemistry lessons except a few such as biological diversity and noise pollution. (Sevil)

On the contrary, the other two teachers (Ersin and Enis) suggested that some subjects related to EE should be immersed in chemistry curriculum to a certain extent. Water, soil and air pollution, consumption patterns energy usage, and climate change should be involved in the chemistry curriculum. However, they opposed EE subjects to be included in the core of chemistry curriculum due to the fact that chemistry subjects may face the danger of being undervalued and omitted in the curriculum:

> It's not possible for chemistry curriculum to cover all the environmental issues but environmental pollution and consumption patterns may be involved in the curriculum due to their importance for our life. We use up our water resources by using chemicals such as detergents and fertilizers. … Beyond the scope of curriculum, in lessons, sometimes students ask about consumption patterns and their effects on environment, and we talk over the issue. … I want my students be more aware students of environmental issues and I want to teach them some subjects about environmental issues but I'm a chemistry teacher in the first place. (Enis)

> Some subjects about EE should be taught by immersing in chemistry subjects such as water pollution, solid wastes and global warming … If the curriculum included all the subjects in the scope of environmental education, how we would achieve to teach chemistry in detail. … Will it be a chemistry lesson or an environmental chemistry lesson? (Ersin)

According to the chemistry teachers, what should be the placements of the subjects about EE in chemistry subjects in secondary school chemistry curriculum and what are the reasons for those placements?

There was not an agreement among teachers' views on both placement of the subjects related EE in the chemistry curriculum and how to teach EE subjects; through integrating chemistry course or as a separate course on EE. On the one hand, Ersin and Enis had the idea of teaching EE subjects as a separate course; on the other hand Sevil suggested that the EE subjects should be integrated into chemistry curriculum rather than being taught as a separate course for a better understanding:

> EE subjects should be taught together with chemistry subjects, in this way students will understand the scientific background of the issues and chemistry will be a more enjoyable lesson for the students. (Sevil)

The ideas of teachers about the placements of subjects in the scope of EE into chemistry subjects are shown in Table 3.

Table 3. Placement of subjects of EE into chemistry subjects

Subjects related to EE	Chemistry Subjects according to Teachers		
	Teacher 1: Sevil	Teacher 2: Ersin	Teacher 3: Enis
Water pollution	Compounds & Solutions	Solutions	Compounds & Solutions
Solid wastes	Chemical Reactions	Chemical Reactions	-
Hazardous wastes	Compounds/ & Radioactivity	Compounds/ Electrochemistry	-
Global warming	Gaseous State	-	-
Air pollution	Gaseous State	Gaseous State	Gaseous State
Loss of biological diversity	-	-	-
Consumption patterns	Organic Chemistry	-	Compounds & Chemical Reactions
Deforestation	Organic Chemistry	-	-
Noise pollution	-	-	-
Soil pollution	Solutions	Compounds & Periodic Table	Compounds & Solutions
Population and environment	-	-	-
Environmental cycles	Gaseous State	-	-
Energy usage	Energy in Chemical Reactions	Energy in Chemical Reactions	-

Discussion and Conclusion

This study confines itself to interviewing three chemistry teachers working in high schools. The scope of the study is narrowed by secondary school chemistry curriculum and its approach to environmental education. Furthermore, affective domains such as chemistry teachers' attitudes, self-efficacy beliefs, or motivations toward environmental issues are beyond the scope of this study. On the other hand, the limited number of participants can be seen as a potential weakness for the study. However, due to the fact that participants are quite experienced and they have been in the field as the implementers of the curriculum, the findings of the study can be regarded as quite valuable and significant.

In Turkey EE is still not a part of the core secondary school chemistry curriculum and adopted curriculum does not provide a means for an effective EE and what is worse, it includes only a few subjects related with environmental education. Generally these subjects even were not taught appropriately by chemistry teachers due to some reasons such as insufficiency of amount of time allocated for those subjects and the placements of those subjects in the curriculum. Although there is not a consensus about teachers on the integration of EE subjects into chemistry curriculum, previous researches indicate that through integrating EE in chemistry, students may gain a meaningful mode of chemical thinking and understanding attitude towards environmental processes and skills (Feierabend, Jokmin, & Eilks, 2011; Hofstein, Eilks, & Bybee, 2011). Thus, curriculum designers and policy makers should take necessary measures according to the findings of the study owing to the importance of environmental education; the subjects for EE should be immersed and integrated in secondary school chemistry curriculum urgently. In order to realize this, in-service teachers should be trained on EE by Ministry of Education, and in chemistry departments of education faculties, there should be at least one undergraduate must course about environmental education.

For further researches, quantitative studies can be conducted to reveal the deficiency and the needs in chemistry curriculum from EE perspective and to assess the competence of chemistry teachers in EE. Further analysis may also reveal the differences between the Turkish curriculum and those of other countries' from the point of chemistry teachers' views through an environmental perspective.

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Appendix

INTERVIEW PROTOCOL

Date:
Gender:
Age:
Experience:
Duration:

Questions	**Interviewer Notes**	**Reflective Notes**
To what extent are chemistry curriculum related to environmental education?		
In chemistry curriculum which subjects include topic related to environmental education?		
Are they adequate for an effective environmental education?		
Do you emphasize sufficiently on those subjects?		
Which of the following environmental issues should be in the chemistry curriculum? Why? a. Water pollution b. Solid wastes c. Hazardous wastes d. Global warming e. Air pollution f. Loss of biological diversity g. Consumption patterns h. Deforestation i. Noise pollution j. Soil pollution k. Population and environment l. Environmental cycles (C, H_2O, and N_2 cycles) m. Energy usage		
In which chemistry subjects should those be integrated?		
Beyond the scope of current chemistry curriculum, are there any environmental issues which are discussed in the class?		
In which chemistry subjects should those subjects be taught? Why?		
Do you think that environmental education should be a separate must course rather than being in chemistry curriculum?		
Do you think that environmental education should be a separate must course rather than being in chemistry curriculum? Why?		
Do you think that environmental education should be a separate must course rather than being in chemistry curriculum? Why?		
Is there anything that you want to add?		

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Which one is better? Jigsaw II versus Jigsaw IV on the Subject of the Building Blocks of Matter and Atom

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Abstract

In this study, the effect of using Jigsaw II and Jigsaw IV techniques on the subject of "Atoms-The Basic Unit of Matter" in science course of 6th grade on academic achievement was examined. Pre-test post-test control group research was used in the study. Study population is all secondary schools in Turgutlu district of Manisa province and the sample group was determined from "Samiye Nuri Sevil Secondary School" among 20 secondary schools in Turgutlu district through cluster sampling method. The experiment and control groups of the research were constituted from two branches based on the results of pre-test and there are 48 persons in total of which 24 are in experiment and 24 are in control group. In the study, the subject of "Atoms- the Basic Unit of Matter" was taught to the experiment group by using Jigsaw IV technique and it was taught to the control group by using Jigsaw II technique. In this research, Science achievement test consisting of 12 multiple-choice items which were developed by the researcher was used. T-test was used for the analysis of data obtained as a result of achievement test. In paired samples t-test (dependent group) conducted for achievement pre-tests and post-tests of the control and experiment group a significant difference was found, while no significant difference in terms of statistics in favor of the experiment group was found in independent samples t-test (independent group) conducted for post-tests of the control and experiment groups. At the end of the research, although the effect of Jigsaw II and Jigsaw IV techniques on the achievement in Science course was found to be positive on students learning, no statistical differences were found in these two techniques.

Key words: Cooperative learning, Jigsaw II technique, Jigsaw IV technique.

Introduction

In today's information age, the primary goal in our education system should be gaining the skills to the students to reach knowledge rather than transferring. This is possible with high-level thinking process skills. In other words, it requires meaningful learning, rather than memorizing, and problem solving and scientific process skills. Science course is the leading course to gain such abilities (Buzludağ, 2010; Kaptan and Korkmaz, 2001). Science can be defined as to examine the observed nature and natural phenomena in a systematic manner and efforts to estimate the unobserved phenomena. As it is understood from this definition, science is the product of the efforts of humankind to understand the nature (and oneself) (Ayna 2009; Turgut et al., 1997). Science was born due to the desire of humans to explain the natural phenomena. Science education began with the observations of the ancient people and to transfer their knowledge and observations to others (Gürdal et al., 1998).

Primary education has a special place and importance in our education system because primary education is an education phase preparing students for life, informing them on natural and social environment and providing guidance (Gürdal and Yavru, 1998). Science has a significant place due to this characteristic of the primary school. Along with latest developments in education, one of the methods and techniques which are primarily used in science education is cooperative learning method. According to Açıkgöz (2008), cooperative learning method can be simply described as the learning process that students study in small groups and help each other (etc. Doğru, 2012). In this context, cooperative learning method is a group study. However, constitution and implementation of cooperative learning groups differ from group studies (Bozdoğan et al., 2006, p.26). A group study only becomes a cooperative learning when the students in the group make effort to bring the learning of them and other students in the group to the top level. In order to perform cooperative learning, the students in a group should help each other by interaction and should produce a joint study rather than working on a particular part of the work independently. Thus, "educational activity, in which the students participate personally, helps them to understand the subject better and not to forget it easily" (Küçükahmet, 1997, p.59). "Students in the

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class in which cooperative learning environment is obtained, study within positive cooperation; each member has a particular and explicit role; joint study process is important and the group members analyze and discuss their work" (Lee et al., 1997, p.3). "Achievement of the group depends on the performance of the group members. For this reason, individuals have to help each other in order to achieve their individual goals" (Slavin, 1980, p.21; Lejik and Wyvill, 1996, p.270). "Group of members aware of the requirement of the group achievement in order to achieve their individual goals helps other members. More importantly group members encourage each other" (Johnson and Johnson, 1989, p.7). In cooperative learning approach, each student takes on several duties.

There are 8 sub-techniques commonly used in cooperative learning method so far. One of them is jigsaw technique. This method was developed by E. Aranson (1978). These procedures are followed in Jigsaw technique. First of all, students are divided into 3-7 person jigsaw groups and the subject is divided into segments. Then, the students are divided into individual groups and constitute the expert groups with other students who assigned to the same segment. Students in expert groups work by helping each other to develop strategies to learn and teach their segments to other group members. Such expert groups return to their jigsaw groups after they complete their studies and become ready for the segment. They give lecture to the group members on what they have learned about their segment. Following the presentation of the chapter or the subject by the group members in this way, the whole class is given an individual quiz on relevant material. The results of the quiz are evaluated individually (Yılayaz, 2012; Açıkgöz, 1992). After Aronson, educational researchers studying on Jigsaw technique made new arrangements and developments in Jigsaw technique starting from the flexible applications of this technique. In Table 1 below, Jigsaw techniques developed by several researchers are compared:

Table1.Comparison of jigsaw techniques*

Step	Jigsaw II	Jigsaw III	Jigsaw IV
1.			Introduction
2.	Experts sheet assigned to expert groups	Same as Jigsaw II	Same as Jigsaw II
3.	Group answers expert questions prior to returning to home teams	Same as Jigsaw II	Same as Jigsaw II
4.			Quiz on material in the expert groups checking for accuracy
5.	Students return to home teams sharing their information with team mates	Same as Jigsaw II	Same as Jigsaw II
6.			Quiz on material shared checking for accuracy groups
7.		Review process whole group by Jeopardy, or Quiz Bowl etc.	Same as Jigsaw III
8.	individual assignment and grade	Same as Jigsaw II	Same as Jigsaw II
9.			Re-teach any material missed on assessment as needed.

* Adapted from Holliday (2002, p. 4).

When Table 1 is examined; It is seen that Jigsaw II and Jigsaw IV techniques diverse in 1st, 4th, 6th, 7th and 9th steps. Accordingly;

In first step; the first difference is seen in Jigsaw IV. In this technique, as different from Jigsaw II, the teachers conducts activities such as movie screening, discussion platform, brainstorming, problem solving, lecturing to all groups, and presentation of the lesson plan or using other methods for the introduction of the lecture regarding the chapter or material to be studied by the class (Holliday, 2000). This implementation is an activity conducted to catch the students' attention on the chapter before the study when they are in their jigsaw groups.

In fourth step; unlike Jigsaw II, in Jigsaw IV, a test is applied in order to check whether the students studying in expert groups have learned the information in relevant chapters. Correct answers and the level of understanding are checked with this test application. With the assistance of the instructor and facilitation of the studies, agreement between the students in expert groups on the answers is provided. Then, students in expert groups return back their jigsaw groups (Holliday, 2002).

In sixth step; there is difference between Jigsaw applications. In this step, unlike Jigsaw II, a second test is applied in order to check whether the students in jigsaw groups learn the whole chapter or material in Jigsaw IV (Holliday, 2002,).

In seventh step; unlike Jigsaw II, in Jigsaw IV technique, several tests, activities and forms are used to reexamine the study processes of all groups. In this process, before passing to individual evaluations, the state of learning the course, chapter or relevant material is submitted for the examination of whole class. This examination period is very important in terms of forming a basis for students to study the relevant chapters for the second or third time (Holliday, 2000).

In ninth step; unlike Jigsaw II, in Jigsaw IV, the instructor completes the study by summarizing and teaching the unanswered questions or unlearned parts of the chapters as a result of evaluations. However, this practice is optional. In the case of students gain required behaviors, practices in this step are not necessary. The practices in this step are very important especially for students with low level of achievement before passing to the next chapter (Holliday, 2002).

The positive effect of using cooperative learning method -Jigsaw techniques on academic achievement is supported by several researches. As a result of the study titled "The Effect of Education with Cooperative Learning (Jigsaw Technique) on student achievement for the Chapter of 'Reproduction Growth and Development in Living Beings' of 6th Grade Science and Technology Course" and conducted by Buzludağ (2010), it was found that cooperative learning-Jigsaw technique positively affect the achievement in Science and Technology course. In the study carried out by Doğru (2012) named "The Effect of Jigsaw Technique on Self-efficacy, Anxiety and Memorability Levels of Students in Mathematics Education", it is determined that Jigsaw technique has more beneficial effects on self-efficacy, anxiety and memorability levels when compared with the traditional education method. In another study titled "The Effects of Group Study with Cooperative Learning Methods on Achievements, Attitudes for the Course and Memorability of the Learned Subjects" and conducted by Oral (2000), it was found that cooperative learning (Jigsaw II) activities has more beneficial effects on achievement levels at the end of the course, memorability of the learned subjects and attitudes of the students for study period when compared with group studies. Slavin and Karveit (1979) revealed that cooperative learning (Jigsaw II) activities improve achievement compared to the traditional education method in their study in which they examine the academic achievements, affective behaviors like attitude, anxiety and self-respect of primary school students. Shafiuddin (2010) revealed that Jigsaw technique improves achievement more efficiently when compared with the traditional education method in his study with experimental design.

In this study, an answer was sought for the question "Is there any effect of Cooperative learning method-Jigsaw II and Jigsaw IV techniques on the education of 'Atoms- the basic unit of matter' subject of primary school 6th grade Science and Technology course?". Three questions were determined for the solution and answers were sought. These questions are: "Is there any significant difference between pre-test and post-test scores of the experiment group?", "Is there any significant difference between pre-test and post-test scores of the control group?" and "Is there any significant difference between post-test scores of the experiment and control groups?"

Method

Research Model

In the research, pre-test – post-test control group research design was applied. One of two equivalent branches was designated as experiment group and control group randomly and, pre-test and post-test measurements were carried out on both groups and shown in the Table 2 as follows.

Table 2. Pre-test post-test experiment design with control group

Group	**Pre-test**	**Experimental Process**	**Post-test**
G1	T1	Cooperative Learning Method (Jigsaw IV)	T2
G2	T2	Cooperative Learning Method (Jigsaw II)	T2

G1: The experimental control group to which Jigsaw IV method is applied

G2: The experimental control group to which Jigsaw II method is applied

T1 and T2: Achievement tests on "Atoms- the basic units of matter"

Population and Sampling

Study population is all secondary schools in Turgutlu district of Manisa province and the sample group was determined from "Samiye Nuri Sevil Secondary School" among 20 secondary schools in Turgutlu district through cluster sample selection. Pre-test was conducted on all branches of 6th grade in order to determine the experiment and control groups of the research. The experiment groups (24) and control groups (24) which are constituted from two equivalent branches according to pre-test results of the students are composed of 48 students. The t-test was used to determine whether there is a significant difference between the groups. Results of the analysis are given in the Table 3.

Table 3.The average pre-test scores for group accreditation, results of the t-test

Group	**N**	$\bar{X}$	**Ss**	**t**	**P**
Experiment	24	5,45	2,39	-1,142	0.259
Control	24	6,20	2,14		

$p > 0.05$

According to Table 3, mean and standard deviation scores of the experiment group were determined as 5.45 and 2.39 respectively in the achievement pre-test conducted before intervention. The mean and standard deviation scores were determined as 6.20 and 2.14 respectively. No statistically significant difference ($p>0.05$) was observed in the independent-samples t-test conducted for achievement pre-tests of the control and experiment group. According to this result, the pre-test success of the experiment group is within the same standard deviation range as the pre-test success of the control group. This indicates that both the experiment and control groups are equivalent.

Data Collection Instruments

In the research, the following assessment instrument was used to determine achievements of the students on "Atoms- the basic units of matter" which is a 6^{th} grade science course.

Achievement Test of Science Course: The achievement test used in the research was prepared by the researcher. In order to develop this test, all acquisitions on the subject of "Atoms- the basic units of matter", 6^{th} grade were determined based on primary science education program (MoNE, 2010), some of the questions were selected from among the assessment questions of the textbooks used in the schools currently and the questions within the open education lecture notes, whereas some of the questions were prepared by the researcher so that there will be a question on each acquisition. The 17-questions test was checked by experts (from university) and 5 questions were excluded. Pilot execution of the test was performed on the 7^{th} grade students in the school where the research is conducted (because the students have already learned the subject) and reliability of the test was measured. So, reliability of the test was found 0.66. Than the test was conducted as pre-test and post-test.

Application

Two equivalent branches (6A= experiment, 6D=control) were selected with respect to the results of pre-test. The lesson was provided to the experiment group by means of the education program prepared in accordance with the Jigsaw IV technique of the cooperative learning method whereas in the control group Jigsaw II technique of the cooperative learning method was applied to teach subject. In both experiment and control groups, teaching activities were conducted by the researcher.

Applications in the Experiment Group

The researcher informed the students in the experiment group that the subject of "Atoms- the basic unit of matter" will be taught by the Jigsaw IV technique of the cooperative learning method. Then information on the approach was provided. Heterogeneous groups of 6 students were created by the researcher by taking into consideration interest, ability and achievement levels of the students in the classroom before the intervention. The classroom was organized to allow the group work to be performed. Before the intervention, the science achievement test was implemented as a pre-test in order to assess prior knowledge of the students in the experiment and control groups. After the students understood the studies to be performed, the intervention was initiated and the Jigsaw IV technique of the cooperative learning method was implemented. The students in groups completed their studies. The researcher provided guidance during the intervention and ensured the study to be performed in accordance with its purpose.

Applications in the Control Group

The subject of "Atoms- the basic unit of matter" was taught by means of the Jigsaw II technique of the cooperative learning method. The students were informed about the approach and heterogeneous groups of 6 students were created by the teacher. The science achievement test was also implemented as a pre-test in the control group. At the end of the study, the science achievement test was implemented as post-test in both experiment and control groups. Such applications performed with control and experiment groups last for 2 weeks.

Analysis of Data

Comparisons were made on data from the Science Achievement Test on the subject of “Atoms- the basic units of matter” between experiment and control groups by means of SPSS software package. For pre-test and post-test comparisons of experiment and control groups, the independent samples t-test was used. The pair samples t-test was used for pre-test post-test comparison of the experiment group and pre-test post comparisons of the control group. Significance level was accepted as at least 0.05. The results of analysis were interpreted individually by tabulating.

Findings

The Table 4 includes the reliability coefficients for the Science Achievement Test performed in the control and experiment groups. Cronbach's alpha coefficient for reliability was found as 0.66. Such results obtained show that the reliability of the test is 66% and this result is reliable statistically.

Table 4. Reliability coefficient for science achievement test

Reliability Coeff.	N	R
Cronbach Alfa	24	0,66

Findings for the First Sub-Problem: The first sub-problem was “Is there any significant difference between pre-test and post-test scores of the experiment group?” Mean scores of pre-test and post-test and standard deviations of the experiment group were calculated. The t-test was used on dependent groups in the SPSS statistic software package in order to determine significance of the difference between averages of the pre-test and post-test scores in the experiment group. Results are shown in the Table 5.

Table 5. Result of the dependent group t-test performed for achievement pre-test and post-tests of the experiment group

Experiment Group	**N**	$\bar{X}$	**Ss**	**t**	**P**
Pre-test	24	5,45	2,39	-3,646	0.001
Post-test	24	7,12	2,36		

$p<0.05$

According to Table 5, the mean score of the achievement pre-test of the experiment group and standard deviation was found as 5.45 and 2.39 respectively. The mean score of the post-test of the experiment group and standard deviation was found as 7.12 and 2.36 respectively. A statistically significance difference at level of 0.05 was found in the dependent group t-test carried out for achievement pre-test and post-test of the experiment group. This difference occurred in favor of the post-test. As it is understood from this result, implementation of the Jigsaw IV technique of the cooperative learning method enhanced the student achievement.

Findings for the Second Sub-Problem: The second sub-problem was “Is there any significant difference between pre-test and post-test scores of the control group?” Mean score of pre-test and post-test and standard deviations of the control group were calculated. The t-test was used on dependent groups in the SPSS statistic software package in order to determine significance of the difference between averages of the pre-test and post-test scores in the control group. Data are shown in the Table 6.

Table 6. Result of the dependent group t-test performed for achievement pre-test and post-tests of the control group

Control Group	**N**	$\bar{X}$	**Ss**	**t**	**P**
Pre-test	24	6,20	2,14	-3,095	0.005
Post-test	24	7,95	1,92		

$p<0.05$

According to Table 6, the mean score of the achievement pre-test of the control group and its standard deviation was found as 6.20 and 2.14 respectively and, the mean score of the post-test of the control group and its standard deviation was found as 7.95 and 1.92 respectively. A statistically significance level of 0.05 was found in the dependent group t-test carried out for achievement pre-test and post-test of the control group. This difference occurred in favor of the post-test. As it is understood from this result, implementation of the Jigsaw II technique of the cooperative learning method enhanced the student achievement.

Findings for the Third Sub-Problem: The third sub-problem was "Is there any significant difference between post-test scores of the experiment and control groups?" Mean score of total post-test scores of both the experiment and control groups and standard deviations were calculated. The t-test was used on independent groups in the SPSS statistic software package in order to determine significance of the difference between averages of the post-test scores of the groups. Data are shown in the Table 7.

Table 7. Results of the independent group t-test performed for achievement post-tests of the control and experiment group

Groups	**N**	$\bar{X}$	**Ss**	**t**	**P**
Experiment	24	7,12	2,36	-1,340	0.187
Control	24	7,95	1,92		

$p>0.05$

According to Table 7, the mean score of the achievement post-test of the experiment group and its standard deviation was found as 7.12 and 2.36 respectively. The mean score of the post-test of the control group and its standard deviation was found as 7.95 and 1.92 respectively. A statistically significant difference at level of 0.05 was not obtained in the independent group t-test performed for the achievement post-tests of the control and experiment groups. Accordingly, post-test achievement of the experiment group is in the range of the same statistically significant standard deviation as post-test achievement of the control group. The Jigsaw IV technique and Jigsaw II technique of the cooperative learning methods have shown equally success on the science achievement post-test. This represents same impact of the Jigsaw IV and Jigsaw II techniques of the cooperative learning method on the student achievement.

Conclusion

In this study, it was aimed to show the effects of the Jigsaw IV and Jigsaw II techniques of the cooperative learning method on teaching of the subject "Atoms- the basic units of matter" in the Science Class of primary 6^{th} Grade. The results showed that both these techniques increase the academic success of students. The results of the research, which was made by means of the Jigsaw techniques at different fields and different class levels, show parallelism with the results of this study (Buzludağ, 2010, Doğru, 2012, Oral, 2000, Slavin and Karveit, 1979, Shafiuddin, 2010). The cooperative learning method ensures active participation of the students to learning process. The students interact with class mates, thus efficiency in learning and students' interests in the course increase. Therefore, employment of the cooperative learning techniques in the Science subjects should be expanded at all levels of education in our country. The classrooms in the schools should be organized in compliance with cooperative method and provided with necessary facilities for this method.

The following suggestions were made by taking into account the findings form the research and the results obtained.
1. The research is restricted with the use of the Jigsaw technique (Jigsaw IV and Jigsaw II) of cooperative learning method. Otherwise, researches which compare other cooperative learning techniques or cooperative learning and other modern learning methods may be conducted.
2. This research is restricted with a Science course provided to 48 students from 6^{th} grade for two course hours per week, a similar research may be conducted on larger groups at different class levels within different courses for a longer time.
3. Variables taken under the research are restricted with the achievement level. Besides, affective variables may be researched.
4. If the cooperative learning method and its techniques are introduced to pre/in-service teachers practically by in-service training activities, this may make such method and techniques applicable by teachers in other classes as such in the Science class.
5. The researchers or teachers who desire to use the Jigsaw IV and Jigsaw II technique should make some preparatory works by taking into account the students who are not familiar to such techniques and have no

information on the steps of such techniques before such techniques are implemented. Such works may include the introduction of the techniques to students, providing information on differences of this technique from other Jigsaw techniques, implementation steps of the techniques, assessment process, and time proposed for the technique.

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Family Background and School Achievement of Children with Motoric Disorders

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Abstract

There is no pedagogical literature about school achievement that does not include the family as a very important factor. Family and family relationships of children with motoric disorders are determined by the ability of parents and other family members to build an objective attitude toward the child with disability. That includes the construction priority in the development of the child. The main aim of this paper is to provide information about possible correlation between various family backgrounds of children with motoric disorders and their school achievement. The family background is defined by several general and specific pedagogical aspects. General aspects of the family background are related to the socio – economic status. Special pedagogical characteristics are related to parents interest in school achievements of their children, parens' help with the child learning (defined through the school curriculum), parent's involving in forcing studying habits and their support in exploring children social surrounding. Participants in this research were 75 parents all with children with motoric disorders in one school for education of children with different forms of disability. The survey used in this study was designed by the researchers. The results show that there is no correlation between economic conditions of family and school achievement of children with motoric disorders. There is a correlation between school achievement and educational status of parents, marital status of parents, parental assistance in homework, encouraging child to learn when child is coping with some difficulties at school, ensuring consistency in learning and conversation between parents and child on various topics.

Key words: Family background, Children with motoric disorders, School achievement.

Introduction

The interests of modern science in special education and rehabilitation is turning to schools more and more with the goal of determining whether the schools are living up to the expectations set before them and their work. The importance of dealing with this segment of the educational process, and therefore the bigger need for feedback as well, is derived from the complexity of the general motoric, cognitive, linguistic, social and emotional functioning of this group of students and the enormous influence it has on structuring of the activities, grouping of success and the entire teaching plan and its effect, in general.

The family – school relationship and its influence on the school achievement of the children with motoric disorders is one of the least examined problems in the area of special education and rehabilitation of persons with motoric disorders. This is, by all means, unjustified, considering that "the elementary school is the closest to the family and should perform its tasks in cooperation with the family. The school's openness towards the family and vice versa is unique in many ways and is unlike any other on any other stage of schooling. The elementary school has the interest and the obligation for establishing the initial cooperation with the family and helping to establish the family's trust toward the school and towards the education in general" (Nikolić, 1998:4). Harčev (1982) considers the family the basic component of the personality development throughout the entire life. Family, in Harčev's opinion isn't just a social microenvironment but a micro cosmos in its own right because the structure of the family is a model of the social structure. Many socio-psychological personality components are accomplished inside family circles. A child is taught not only the obligations of family life, but is also prepared for a life in the community and society. Life styles, authority of the members of the family, the size of the family as well as the social changes which greatly influence the dynamic of family relations (nowadays, a large number of divorced marriages in urban and economically developed environments, changes

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in relationship between genders and upraising styles in the family) present important factors in understanding the family environment and the children development on one side. On the other side is the family that is deeply grounded in the system of child's needs.

Divorces are more frequent for families with children with motoric disorders than for the families whose children don't have that type of problem. When the family remains whole, the father is often absent, and when he is present he rarely and inadequately communicates with his child. Children with motoric disorders lose faith in their own abilities, a sense of low self-esteem appears comparing to other students and peers, they tend to become introvert, anti-social, and tend to drift into daydreaming that compensates for their failure, negative attitudes begin to form towards the environment, the teacher and the subject as well as a misunderstanding on the relation student-school, student-parent, due to constantly experiencing failure and due to the inability to affirm themselves in socially acceptable forms of behavior, children with motoric disorders compensate for all of that with aggression, evasion, regression to primitive forms of behavior and alike (Hrnjica, 2007). Including these students in regular schools is essentially changing the school in its whole, affecting the atmosphere in the class, influencing the methodical approaches in presenting the teaching units, changing the evaluation standards. The school can significantly stabilize the feeling of security in the child when the child is successful and accepted by the teachers and peers, but a good cooperation between the family and school also plays an important role.

The forms and contents of cooperation with parents are far more diverse in elementary schools, starting from different types of mutual informing, through educating parents in pedagogical functions, up to including them in the realization of the parts of the programmed contents. Because of the importance of the cooperation between the family and the school in educating the young generations, and having their comprehensiveness in mind, the family and the school is often attributed the role of the "usual suspect" for all the mishaps and unwanted occurrences"(Nikolić, 1998:4). The subject of this research is the connection between different aspects of family environment with children with motoric disorders and their school achievements.

Method

The research method is descriptive, and the research, in its essence, provides a description of the characteristics of the family environment of the children with motoric disorders and their connection with school achievements. A surveying technique was used. For the needs of this research a *Survey for the evaluation of the pedagogical aspects of the family environment of the children with motoric disorders* was created. A large number of questions in the inquiry have the elements of the evaluation scale. The survey is comprised of several parts: a) socio-economic status of the family (four items); b) parents' interest in the school achievements of their children with motoric disorders (seven items); c) parental assistance with the child schoolwork; d) parental engagement in forming of the studying habits of the children with motoric disorders (six items); e) parental support of the children with motoric disorders with getting to know the larger environment (seven items). The survey consisted of 24 questions.

With the goal of acquiring data on the intellectual status, on the type and degree of the motoric disorder, data on the teaching program by which the student is learning, as well as the data on the school achievements, both the scholarly and the medical documentation of the students were used. The same documentation was used in acquiring the socio-economic and educational status of the family. The independent variable in this research is related to the characteristics of the family environment. It is operationalized through the following dimensions: socio-economic status of the family and specifically pedagogical characteristics (parents' interest in the school achievements of their child with motoric disorder, the parents' help with studying, parents' engagement in forming the child's studying habits and parental support in helping the child get to know the larger environment). The dependent variable in a more free sense is related to the school achievement of the child with motoric disorder, which is determined through school's documentation, as well as the type and the degree of the motoric disorder which is determined based on the available medical documentation. The data was gathered in an elementary school for the education of the children who are receiving hospital treatment "Dr Dragan Hercog" in Belgrade, Serbia. The research sample consisted of 75 parents with children with motoric disorders. The parents of children whose intellectual functioning was average and who had been, in the moment of the conducting of the research, attending classes regularly were surveyed. Besides these parameters, we made sure that the children were classified, by the act of categorization, in a group of children with motoric disorders and that they come to the classes from a family atmosphere or that they are hospitalized with one parent. Mothers were more present in the sample (44 or 58,7%) as compared to the fathers (31 - 41,3%), but without a statistically significant difference ($p = 0,784$). The children of the surveyed parents, a majority anyway (32 or

71,1%), have accomplished excellent grades in school, then very good grades (10 or 22,2%), and good grades (3 or 6,7%). There were no students who failed the class or achieved low grades.

Results and Discussion

Socio-economic Status and the School Achievement of the Students

The distribution of the surveyed participants by marital status shows that the majority of them were married (64 or 85,5%), then divorced (5 or 6,7%), as well as single parents (6 or 5,3%). The statistical analysis of the connection between the marital status and the student's school achievement shows that there is a statistically significant connection on a p = 0,001 level. This means that we can claim, with a 99% statistical certainty, that there is a connection between the marital status of the parents and the student's school achievement. In other words, we can say that our research has shown that students with motoric disorders show better school achievement if the parents are married, in a marital union, that is. In situations where the child grows up with both parents a high, statistically significant, difference in noted – as compared to the situations where the child grows up with a single parent – concerning the connection between the availability of internet and school achievement. An interesting fact is that in cases where a child grows up with both parents, where the family unit is complete, there is a larger amount of books in the home library than in the cases where that is not the case (p = 0,041).

Table 1. The connection of school achievement and specifically-pedagogical characteristics of the family

Parents' interest in their children's school achievements	p	Parent's help to children in schoolwork	p	Parents engagement in forming of the child's studying habits	p	Parental support to children with motoric disorders in getting to know the larger environment	p
Interest in homework	**0,010**	The subject which the children need the most help with	0,460	Persistent learning only in one and the same place	0,429	Children involvement in everyday activities	0,107
Providing assistance for completing homework	**0,002**	Consistency in providing the help for with studying	0,081	Who develops working habits Mother Father Brother or sister teachers friends	0,189 0,704 0,599 0,852 0,105	Taking children to various sport and cultural events Children participation in workshops Do parents inform the children about the happenings	0,419 0,322 0,692
Which grade was the hardest for the child	0,852	Encouraging the child	0,028				
Which grade the child is now	0,105						
Are the parents cooperating with the teachers	0,669						

According to a research within the project called "Phenomenology of the disabilities and development disorders" (Golubovic and Assoc., 2005) 87,8 per cent of the children from Belgrade, of a younger school age, is living in a complete family, around 11,5 % is living with a single parent. By comparing this to the results of our research we can see the difference in the family structure, almost as much as 10% in favor of the children with typical development, according to the completeness of the family. As for the family difficulties, which influence the student success in school and school behavior, the parents and the teachers within the "Education for the society of knowledge" research (MNTP 49001, 2006 – 2010) have singled out turbulent family relations and out-of-order living circumstances as: divorce, child birth, serious illness or death of the family members, bad quality of the child – parent relationship, socio-economic problems in the family and lower educational level of the parents.

In our research we have found a high connection between the academic status of the parents and the school achievement of the students (p = 0,003). This fact shows us that the students whose parents have a higher academic status show better school achievement. The importance of the differences between successes in learning, considering the degree of education in parents, Stanojlovic (1992) confirms as well in his research conducted on a sample of students and parents in Belgrade, in the municipality of Palilula. He determined that the children who are getting better results come from the families where parents have a higher educational level. The TIMSS study in 2003 conducted with standardized international instruments in Serbia on a representative sample of eighth grade students, shows that, as far as the parents academic level is concerned, the most surveyed participants come from families where parents have a secondary school degree or college degree 67%, which was also shown by our research, while there is a significantly smaller percentage where the parents have a university degree (21%). A small percentage of the surveyed students' parents have only 4 or 8 grades of elementary school finished (12%), and only 1% of the parents didn't finish even 4grades of elementary school. The international average of parents with a faculty degree is 28%, and the among countries with the highest level of academically educated parents we have Norway 66%, USA 56%, Armenia 51% and Sweden with 48%. A correlation between school achievement and the parents' employment status wasn't found (p = 0,920), as well as the one between the student's school achievement and the housing status of the family. The connection between the employment status of the participants and their children school achievements wasn't statistically important (p = 0,220).

The Relationship between Parents' Interest and School Achievement of Children with Motoric Disorders

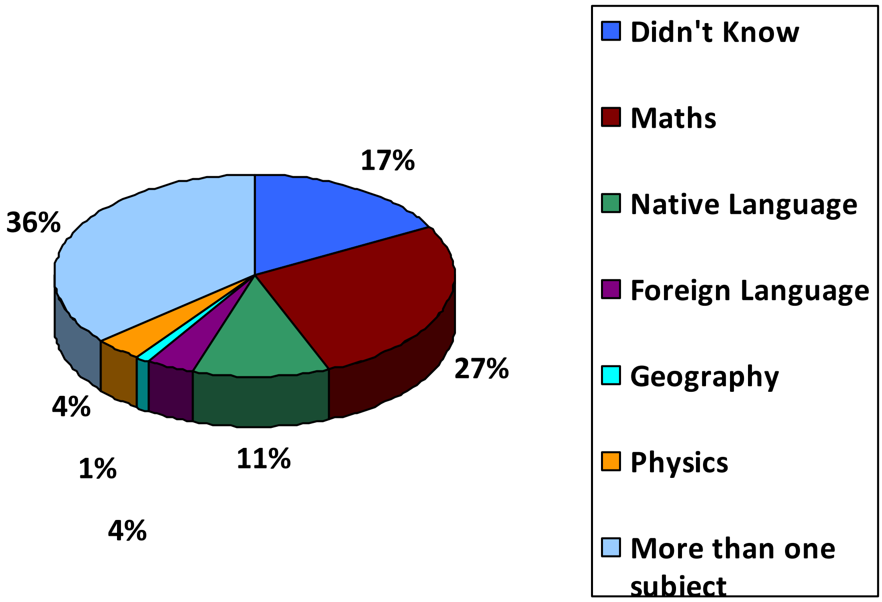
Parents' interest in providing assistance in doing homework has a statistically significant impact on the school achievement of the students (p = 0,010). Namely, more the parents are interested in child homework, more the child shows better school achievements. Furthermore, a very high and statistically significant connection between providing assistance in doing homework and child's school achievements was discovered (p = 0,002). In other words, we can say that more the parents are providing the necessary assistance to the children with their homework, better the school achievement of the children is.

A statistically significant correlation between the school achievements of the children with motoric disorders and: 1) if the parents know which of the grades was hardest for the child (p = 0,852); 2) if the parents know which grade their child attends (p=0,105); 3) if the parents cooperate with teachers (p=0,669); wasn't found. Studies about parents' engagement in educating their child in American state schools (Chen and Chandler 2001) point to the act that the children whose parents were actively engaged and cooperative with the school, have a better chance to accomplish higher educational achievements, are more frequent in attending classes and have a higher level of aspirations, better attention and are more frequent at doing their homework assignments.

Parents' Assistance to Children with Studying

Studying the connection between the subjects which require the most help in doing homework and school achievements of the students we didn't discover a statistically significant connection between these two variables (p=0,460). Nevertheless, important information is that it is Mathematics, an isolated subject, that the largest number of our sample's surveyed participants 21 or 27% is providing their children help with (see Graph 1).

The largest number of surveyed participants of the sample is just guiding their child while doing homework (41,3%), checking the already done homework (34,7%) or explaining what is unclear in schoolwork (28%). 22 participants (or 29,3%) do not provide any sort of assistance with homework, which is in discrepancy with the answers on the question about the subjects which the children require help with. We notice that there is a large number of parents who notice that their child needs help with homework (64 or 85,3%), but that only 53 (or 70,6%) of our surveyed participants are actually providing assistance. The reasons for this discrepancy will be the subject of future research. The distribution of the participants according to whether they encourage their child when it is having a hard time with schoolwork shows us that 60 of the surveyed participants (or 80%) always encourage their child when it is having troubles. The research has shown that the more the parents encourage their child the more achievement in schoolwork the child has (p=0,28).



Graph 1. Which subject does your child need the most help with

The largest number of the surveyed participants is providing their children with constant help in studying (30 or 41%), while the same number provides usually constant help and irregular help with studying (each 14 or 18,7%). The constancy in proving help to their children with studying doesn't significantly influence the school achievement of the students (p=0,081).

There is no statistically significant connection between the accomplished school achievements and the type of help provided, as follow: explaining what was unclear in schoolwork (p=0,518); I read the lesson to him/her and then we go through it together again (p=0,234); I check what he/she has learnt after studying alone (p=0,178); I don't help my child with studying (p=0,720); other help with studying (p=0,441).

There is no statistically significant connection between the source of the help provided to children in studying and the accomplished school achievement: 1) between the mother who helps her child the most and its school achievement (p=0,185); a teacher as the one who provides help and school achievement (p=0,570); the father as the one who provides help and school achievement (p=0,454); a sibling as the one who provides assistance and school achievement (p=0,665).

Parents' Engagement in the Forming of Working and Studying Habits in the Children with Motoric Disorders

While evaluating the parents' engagement in forming the studying habits of children with motoric disorders we examined whether the parents insist that the child always studies in the same place; who develops studying habits in children; which working habits are considered important; as well as ways of developing working habits. The majority of the surveyed participants (29 or 38,7%) always insist that their child studies in the same spot, 17 of them (22,7%) usually insists this, and 14 (or 18,7%) never insists, while 6 (or 8%) of the surveyed participants usually doesn't insist that their child studies in the same place. Seven or 9,3% wasn't sure whether they should do that. The working habits are developed by the mother in the opinion of 58 surveyed participants (77,3%), then the teacher (13 or 17,3%) and then the fathers (11 or 14,9%), the siblings (10 or 13,3%), and friends (6 participants or 8%) were identified as the people who help the students with motoric disorder form working and studying habits in a smaller degree.

The distribution of the surveyed participants according to the habits they deem important shows that 68% of the surveyed participants consider that all studying habits are important. Relearning the lessons is important to 33,3% of the surveyed participants, and doing homework regularly is a habit 32% surveyed participants considered important. Practicing parts of the school material is a studying habit which 15 of the surveyed participants (or 20% of the sample) considered important.

The distribution of the surveyed participants according to the way the working habits are developed in their child showed that the most of the participants do this by consistency to a schedule (37 or 49,3%), then by reward (22 or 29,3%), while 6 of the participant or 8% use punishment or other methods to develop these habits. 11 participants or 14,7% don't develop the studying habits of their children. Connecting the school achievement of the students and consistency to a schedule a statistically significant connection between these two variables was established (p-0.030). A correlation between school achievement of the students with motoric disorders and the rest of the variables which were used to follow the parents' engagement in forming the habits wasn't found ($p>0,005$).

Parental Support to the Children with Motoric Disorders in Getting to Know the Larger Environment

The largest number of the surveyed participants of our sample (40 or 53,3%) completely agreed with the claim that they should inform their child about what happens in their surroundings, while 30,7% of the parents mostly agreed. The smallest number of the participants (1 or 1,3%) does not inform their child about what happens in their surroundings. Twenty two or 29,3% of the participants regularly includes their child in everyday activities, while 21 or 28% usually does this. In these activities, 12 participants or 16% doesn't include their children in these activities and 10,7% is not entirely sure whether to do it or not. Twenty four participants or 32%of our sample usually visit sport and cultural events with their children, while 21,3% usually doesn't do so. A large part of the negative distribution is noticed here, comparing to the previous results, which can be interpreted thought problems in transport and architectural barriers which prevent the access of the persons with motoric disorders.

Analyzing the responses of the surveyed participants of our sample we notice a dominance of answers in which the activity of involving the children with motoric disorders in workshops outside the school premises is negated (45,3% of the parents never involve their children in this activity, while 17,3% mostly don't do this which makes 62,6% of the total sample). The activity which is the most dominant in their free time is walking or recreation (46 or 61,3%), followed by discussion on various topics (33 or 44%) and watching television (30 or 40%). Fifteen participants or 20% read in their free time or go to sport or cultural events (14, or 18,7%).

Forty eight per cent of the participants try to bring closer events which are unavailable to the child, while 28% usually does this. Ten participants (13,3%) are undecided, while only 6,7% of the participants never do this. The answers to this question speak in favor of the fact that the parents are investing an effort and that they are aware of the importance of involving their child in everyday life, even to the events which are inaccessible to the child. The distribution of the surveyed participants according to the way they are trying to involve the child in the events which are unavailable for him/her shows that the parents for the most part, do this by reading magazines and newspaper together (34,7%), watching movies (32%), by using internet (21,3%), while around 4% of the parents aren't trying to involve their child at all.

Analyzing the connection between school achievement and the variable concerning the way the parents are trying to bring a child closer to an activity which is unavailable for him/her, we have found a statistically significant connection ($p=0,039$) between school achievement and discussions about different topics, which means that the results were better with those students whose parents used this way of involving the child in the events which are unavailable for him/her. There is no correlation between school achievement of the students with motoric disorders and other variables which were used to follow the parental support to children in getting to know the larger environment.

Conclusion

The family engagement, in certain measured variables, has the role of helping children with motoric disorders with school achievements, but we notice that a different factor is prevailing in creating the school achievement of these children. The fact that the received results in the area of specific aspects of the family environment do not correlate with available results of similar researches conducted on the children of the typical population speaks in favor of this, although a variation of the results and an existence of a statistical connection between specific pedagogical aspects of the family environment and school achievement of the children is noticed in these researches. We can find the reasons for these results in the following: 1) the research was dealing with examining the connection between school achievements of the students with motoric disorders and specific aspects of family background, that is, with variables which are difficult to control, because the results are based on responses of the parents, and, therefore, subjective and not objective; 2) the students included in the research have a school achievement in the diapason of 2 grades (from 3 – good to 5 – excellent) which can be characterized as a very good average achievement, and because of this, the possibility of getting a difference in measurable variables and checking the significance of the correlation of the variables ensued and school achievement was greatly decreased; 3) apart from this, the researches which have been dealing with school achievement of the students with motoric disorders (Ilic-Stosovic, 2005) point out that a numerical grade isn't an objective indicator of the school achievements of the student, because in the forming of such numerous other factors are presents, so it is possible that a high average such as this one has no objective value. This research has once again confirmed that the population of the children with motoric disorders, because of their specific family, personal and general functioning, requires a special methodological and researching approach.

Recommendations

Future research in this field should concentrate on examining to what degree do motoric disorders (type and degree), beside parents' engagement, influence the appearance of failure in school, and school achievement should be checked by standardized tests of knowledge. Also, teachers should be introduced as a control group which would state their attitude about the parents' engagement. Furthermore, it would be interesting to examine the influence of the family background and environment on the appearance of the failure in school of the students with motoric disorders by comparing the group of children who come to school from a family environment with the ones who are in hospitals without any parents present.

Acknowledgements or Notes

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Nature of Science Lessons, Argumentation and Scientific Discussions among Students in Science Classes- A Case Study in a Successful School

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Abstract

Argumentation is highlighted as one of the most important activities of science education by many researchers. The main aim of this research is to examine primary school students' nature of science classes and argumentation skills in terms of their academic success in primary science classes. Thus, the main interest of the study is centered on the nature of science lessons, the structure of the argument and an effort to scaffold students' understanding concerning the argument's structure. As this was considered the initial, but students have to acquire fundamental skills before dealing with the inner validity of an argument. Moreover, successful and chosen students for this study were studied carefully dense by the researchers. In that scope, the study was designed on ***qualitative*** research techniques which are detailed as explorative and fundamentally interpretation for the related topic. Since a particular school's successful students are considered in the research, it could be viewed and designed as a case study. The study is conducted with 8th graders with the age of 12-13 in a private elementary school. Focus group interviews and classroom observations during science lessons were the basic tools to obtain data. The results were grouped under the following aspects: objectives of science education, science teaching methods of teachers, teaching materials and teacher's attitudes towards his/her students during the class. Two science teachers in this school both give importance inquiry based teaching science. This research has demonstrated that even the most successful 8th graders in science classes do not necessarily understand fundamental concepts about nature and science. The science teachers in this research also mentioned that the interactive nature of information technologies can support students in carrying out inquiry-based activities, using problems, questions, and even theories that they themselves define and develop argumentation.

Keywords: Science education, Elementary science, Argumentation, Scientific discussion.

Introduction

A central idea of research in the field of science learning and instruction, with particular reference to Vygotsky and the sociocultural perspective, is that communication is the central element in linking students' views to science's way of modeling the world. From a socio-cultural point of view, communication is understood as a tool, not only as a means to delivering formation, but rather to engage students in 'talking their way' into the world of science. Furthermore, instead of evaluating the individual ability of students and teachers, educational success may be explained first by the quality of classroom dialogue (Mercer, 2007). In line with the sociocultural approach, researchers have developed the concept of 'dialogic teaching' (Alexander, 2004; Nystrand, Gamoran, Kachur, & Prendergast, 1997), understood not only as the interaction between participants in the classroom, but, especially in science, with teachers orchestrating the dialogue between daily thoughts and the view of science (Mortimer & Scott, 2003). Moreover, one of the systematic tools for enhancing scientific view among students can be called argumentation.

Argumentation is highlighted by various researchers as one of the most important activities in science education (Newton, Driver, & Osborne, 1999). Main reasons for this do not refer just to the educational value of argumentation as a skill but also to its value as a social skill (Erduran, Simon, & Osborne 2004). Despite its noted importance and the assertion that it is a skill that needs to be explicitly taught (Kuhn &Udell, 2003), argumentation is not adequately practiced in primary science education (Tytler& Peterson, 2003).

The main objective of this research is to examine primary school students' nature of science classes and their argumentation skills in terms of their academic success in primary school science lessons. Thus, the specific interest of the study is centered on the nature of science lessons, the structure of the argument and an effort to

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scaffold students' understanding concerning the argument's structure. As this was considered the initial, but students have to acquire fundamental skills before dealing with the inner validity of an argument. Moreover, a successful and chosen school's students for this study were studied carefully dense by authors. The purposes of the study in detail and research questions are presented in the following.

Purpose of the Study

The purpose of this study is to examine the nature of science lessons, argumentation and usage of scientific discussions of the 8^{th} graders who are successful at science courses and Turkey's National High School Placement Test(TEOG). Moreover, the aim of the study is to explore whether there is a correlation between academic success at science classes and argumentation skills of the students. Moreover, one dimension of the research consist "Teacher's Behaviors and Student-Teacher Interaction in Science Classes"**.** It is expected that the results will highlight the importance of argumentation during scientific discussions in science classes.

In order to conduct a study about the nature of argumentation and usage of scientific discussions of the focused group in this research, the following research questions were asked:

a. How the nature of science is lessons organized in an academically successful elementary school's science class?
b. How are the teacher behaviors and student-teacher interactions in science classes?
c. Do the 8^{th} graders who are successful in science classes and at TEOG argumentation in science lessons?
d. What is the nature of argumentation and scientific discussions in this science class?

Significance of the Study

Since the mid-90sresearch has increasingly focused on students' argumentation skills (Erduran& Jiménez-Aleixandre, 2008). Science educators not only argue that argumentation is an important aspect of science education in general; but they also assume that argumentation enhances the learning of the science content (Zohar &Nemet, 2002). On the contrary, research indicates that students' ability to argue is limited by their content specific knowledge (Means & Voss, 1996; Sadler, 2004). Even though these two arguments are present, research rarely explicitly addresses the interrelationship between argumentation (learning about science), conceptual understanding (learning of science) and academic success.

Research on argumentation often addresses the processes of students' activities (that is, their discourse about a topic or a task). Research on students' conceptual learning typically focuses on the outcomes of such processes (that is, students' conceptions at a specific point in time). Only rarely does research on students' conceptions focus on how students utilize their conceptual understanding while acting in "normal" learning settings. As a consequence, research aiming to relate argumentation and learning outcomes-academic success typically address students' conception prior and/or post to instruction which focuses on argumentation but not during this instruction (Zohar &Nemet, 2002).

Another methodological limitation in current projects is the idea of "quality" as a means to distinguish "good" from "poor" argumentation. Studies in science education typically offer at least two different approaches with either a content-oriented or a more structure-oriented focus (or a mixture of both). On the one hand, students' argumentation skills are assumed high quality when students' argumentation shows high relevance between data and claim (Means & Voss, 1996). On the other hand, the quality of an argumentation is assumed to increase when it consists of more justifications, which also rebut alternative arguments (Jiménez et al., 2005; Osborne et al., 2004; Zohar &Nemet, 2002). However, the quality of an argumentation might also differ in terms of the quality of conceptual understanding incorporated (Aufschnaiter et al., 2008). This situation should lead students' good scientific understanding and learning outcomes, so academic success.

This study is important because it aims at revealing the relation between academic success in science and nature of an argumentation and scientific discussions among elementary students. Also, it aims at helping to gain insights to readers about the issue. Academic success in this study is the achievement in science course which are measured by exam scores.

Method

The aim of this study is to examine the nature of argumentation and usages of scientific discussions of the 8^{th} graders who are very successful at science classes and Turkey's National High School Placement Test (TEOG) in the research progress. In that scope, the study is designed on qualitative research techniques which are detailed explorative and fundamentally interpretive for the related issue. Since a particular school's successful students are focused in the research, it can be viewed and designed as a case study. *A case study* is a detailed examination of one setting, or a single subject, a single depository of documents or one particular event (Bogdan &Biklen, 2006, p. 59). According to this definition, it can be mentioned that a qualitative research design are meaningful for the explanation of a case in a private elementary school are conducted in this study.

Sample Group

The study will be conducted with 8^{th} graders with the age of 12-13 in a private elementary school. This school is chosen as its students achieved successful results in National High School Placement Test. In year 2009, 2010, 2011 and 2012, students in the chosen school achieved the best scores in TEOG and ranked first among all primary schools in Ankara. When examined in detail, in terms of each section, the students' ranked first also in science section of the exam. Bearing these achievements in mind, 8^{th} graders in this school aroused interest of the researchers and became main focus of this study. Since this study has a qualitative research design and in depth analysis of the case, maximum variation in terms of sampling will be done for the said group.

Data Collection

By this research we aim at obtaining detailed information in order to explain the correlation between argumentation skills and scientific discussion properties of successful students. Since this is a complex procedure, different types of data collection techniques were applied in the study. Q**ualitative** research methods used in order to obtain data. Focus group interviews and in-class observations during science lessons were the basic tools in order to obtain data. In that context, face to face interviews with participants are done and also data about students' argumentations were collected in a natural atmosphere. However, additional data collection tools were used when necessary such as videotaping during procedure of the study. Interviews were taped for transcription and analysis. Interview questions coincided with the answer of the research questions. After the tapes were transcribed, they were analyzed to identify prevailing themes by coding and categorizing the essential meanings of the responses. Same coding procedure was used during the observation process. Where notes were taken also on interactions in classroom by researchers in order to enrich and strengthen the obtained data.

Validity and Reliability of the Study

The major sources of data for the study were face-to-face interviews and classroom observations as mentioned above. In addition, researchers took notes during classroom interactions among students and between students and teacher. Each document underwent a qualitative analysis for identifying patterns and themes. In order to increase the reliability of the study, researchers applied peer debriefing on analysis and use data triangulation since they are important factors in ensuring the quality of a qualitative inquiry (Bogdan &Biklen, 2007). Moreover, direct quotes from teachers enhanced the credibility of the findings and conclusions. Researchers' notes on observations and the transcriptions of the science teachers' interviews are shared and discussed with the participants in order to discuss the accuracy of the records. Likewise, the content of the class notes, the transcriptions of the class discussions and the observation of the interaction among teachers' and their students were used to support the accuracy of the patterns and themes.

Results and Discussion

The main purpose of this study was to examine the nature of science lessons, argumentation and usage of scientific discussions of the 8^{th}graderswho achieved high success at science courses and TEOG. The main aim of the study is to explore whether there is a relation between academic success at science classes and argumentation skills of the students. At this point, elementary science teachers' supportive approach and in-class behaviors could lead students attaining higher scientific discussion skill and so forth. So, the results and findings of this research were presented in the following sections.

Teacher Behaviors and Student-Teacher Interaction in Science Classes

This part of the study aimed at determining science teacher's behaviors and student- teacher interaction in science classes. In order to conduct the research, observations were made in the data collection process. Transcripts of the lessons were made collected and analyzed, with particular attention paid to interactions that involved questions. Many different aspects were observed and observation results were presented. The natural atmosphere of the observed class was examined and reported.

Natural Setting of the Class

There were 22 students in the class. In terms of classroom layout, there was a teacher table, a blackboard in the right hand side, and student chairs at the left side. Students were sitting two by two pupils and their faces were looking at the blackboard. There was an electronic board (smart board) next to the blackboard. Boys and girls were sitting in a mixed order. There was a classroom bookshelf behind teacher's table. Also a notice board was on the wall behind the students. Some posters and illustrations on the board were about English course. The class was enough illuminated, so it was radiant in the class.

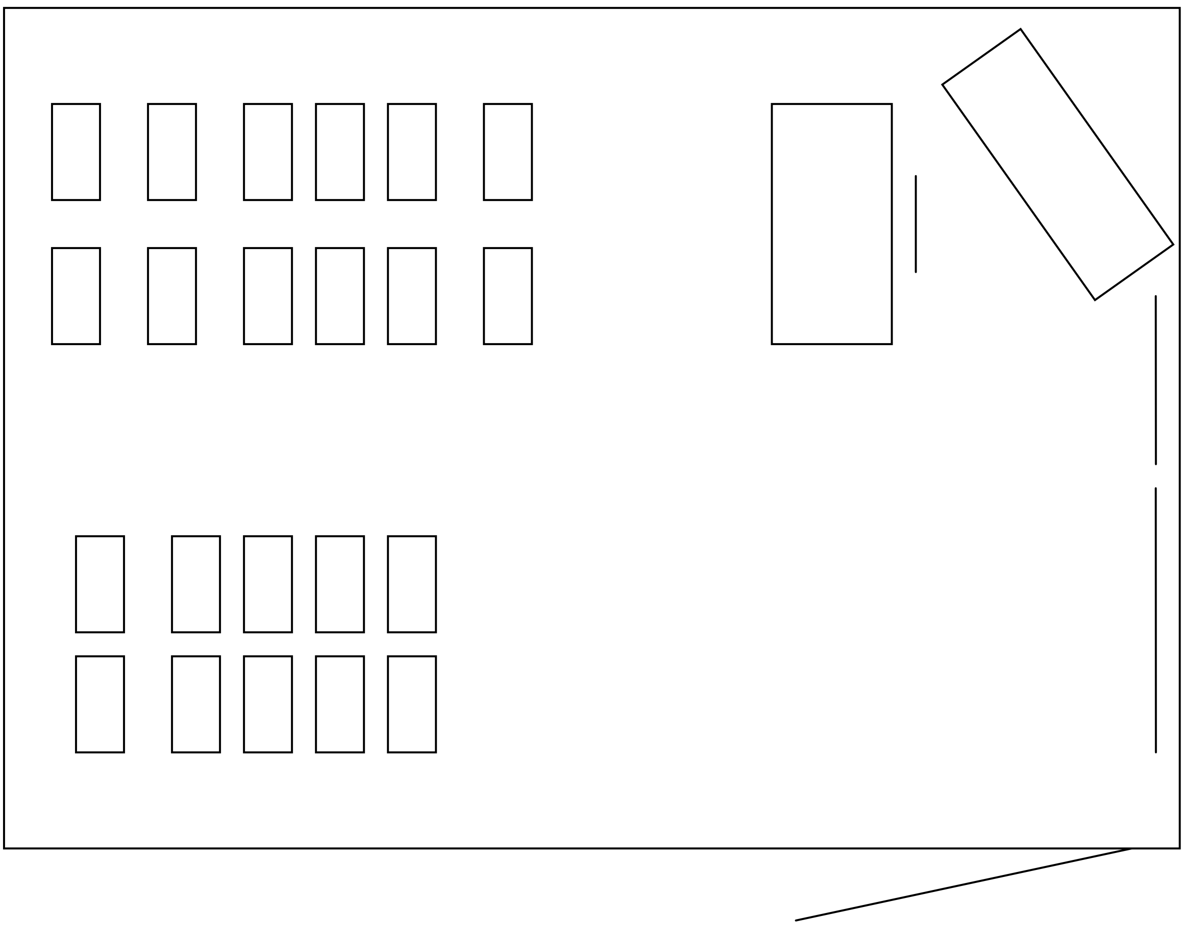

Figure 1: Natural setting of the science class

Evaluation of Teacher Behaviors and Interaction in the Class

The results of the observations were included the relationship between teacher's classroom management behaviors, student engagement and achievement of elementary science students. It was found that particular management behaviors and class norms which were correlated with achievement and engagement by science teacher are:

- ✓ Identify students who do not understand directives and helps them individually,
- ✓ Maintain learner involvement in lessons,
- ✓ Reinforce and encourage the efforts of learners to maintain involvement,
- ✓ Attend to routine tasks,
- ✓ Use instructional time efficiently,
- ✓ Provide feedback to learners about their behavior,
- ✓ Manage disruptive behavior among students.

Another focus of the observations was the interrelationships among three major components of classroom teaching: subject matter's content knowledge, classroom management and instructional practices. The study involved elementary school science classes of different achievement levels taught by the same female teacher. Findings indicated that teacher's limited approach on student-centered teaching of science content.

Teacher's strict classroom order resulted in heavy dependence on the textbook and teacher's individual activities and avoidance of whole-class activities (e.g., discussion).

Additionally, one purpose of this study was to develop an analytical framework that represents in-class discussion and questioning in science, find out how teacher use questioning to engage their students in thinking about conceptual content. Enabling the construction of knowledge and identify the various forms of feedback were provided by teachers in the follow-up move of the initiation-response-follow-up format of teaching exchange. As Mercer (2007) highlights, instead of evaluating the individual ability of students and teachers, educational success may be explained first by the quality of classroom dialogue. Thus, lessons were observed across a variety of lesson structures such as expository teaching, whole-class discussions, and hands-on practical work. Unfortunately, there were any hands on practice in the lesson. Interactional issues related to ways of speaking and questioning that encourage student responses and thinking were addressed during the observation.

Classes were mostly thought with a teacher-centered method since the teacher preferred to instruct and explain the subject generally by herself. However, she used different types of questioning in the lesson. She asked open and close ended questions frequently. Sometimes she directed the question at a specific student or sometimes answered her own question by herself. She also used a known-answer question and controlled the dialogue. Teacher's feedback in the questioning process is crucial. Four different types of feedback were identified. They were; approving and disapproving, repeating students' responses with no feedback and providing manipulative feedback. Many times teacher told the students what to do.

The Nature of Science Lessons and Teacher Views in an Academically Successful School- Interview Results

An exploratory study was implemented about science teaching in a school which has high academic performance. One of the groups that are focused was science teachers of the school. Interviews were conducted with the teachers and obtained data were analyzed. Many aspects of science teaching in classroom were examined according to the results. Then results were grouped according to the following aspects: aim and objects of science education, science teaching methods of these teachers in their science class, materials used while teaching and teachers' approaches for being successful in science classes. Below the data analysis results and discussions for them are presented by teachers' views. The common framework of science learning outcomes described the goals of science education that these teachers mentioned are: A scientifically literate individual needs; to acquire certain knowledge, skills, and attitudes; to develop inquiry, problem-solving and decision-making abilities; to become a lifelong learner; and to maintain a sense of curiosity about the world.

Memorization of information emphasizes teaching the conclusions of others: "schools are reinforcing the message that science education is about remembering the results of other's research 'facts' rather than developing the ability to conduct one's own". Teaching of science as a body of irrefutable knowledge does not provide students with knowledge and understanding that will be useful for them in their lives; in fact, this erroneous perception simply reinforces a trend of either blind acceptance or mistrust of scientific research. Furthermore, a typical feature of science education has been that teachers rarely or never go beyond science content in their instruction, and do not relate content to other domains of scientific literacy to provide a larger context (Lederman, 1992). As pointed out by Lederman, "the most sophisticated view of knowledge available to us today says that it is a falsification of the NOS to teach concepts outside of their social, economic, historical, and technological contexts".

Teachers in this school were both giving importance to inquiry for teaching science. They mentioned that developing inquiry skills should be one the most important aims of science teaching. The teaching of science in the K-12 (the sum of primary and secondary education) classroom has been less than successful. Students typically do not develop science literacy and do not understand the role and relevance of science in society. As one of the science teacher said:

"I think inquiry-based learning promises to improve science teaching by engaging students in real exploration, thereby achieving a more realistic conception of scientific endeavor as well as providing a more learner-centered and motivating environment. It can also be used to support teaching the nature of science. The inquiry approach is still not prevalent in the classroom, and is often misused. This may be the result of multiple factors, such as the duration of class hours, lack of effective means for students to conduct independent research, the difficulty of incorporating abstract concepts with inquiry, and lack of teacher expertise and experience. But in our school we are trying to do in this way."

Teachers argued that in support of the conclusion that students at the elementary, middle and high school levels do not develop a sound understanding of science that is useful for their everyday lives. Teachers have suggested that students do not see how science applies to everyday life, and thus there is very little integration of science with everyday thinking among students. This research has shown that according to teachers' views; even students with a higher success in science classes do not necessarily grasp fundamental concepts about nature and science.

"In a society increasingly permeated with developments in science and technology, an understanding of the nature of science enables students to be more informed consumers of scientific information. The majority of students do not, however, possess adequate conceptions of the science. Not surprisingly, then, science is said to be poorly taught in schools. Several aspects of traditional school science teaching may be responsible for this. Schools have typically employed a didactic approach, with an emphasis on transmitting the content of scientific theories to students: teachers dispense knowledge to passive student audiences, with textbooks alone constituting the science curricula; students are rarely involved in direct experiences with scientific phenomena. This approach does little to motivate real learning, and reflects the antiquated notion that students learn by being asked to memorize information.

These teachers argue that the learning environment created by science teachers play an important role in shaping students' perceptions of the way science is practiced and how new knowledge is created: *"Many teachers are exploring a constructivist approach to teaching which recognizes that each individual's existing knowledge and attitudes affect their learning.* This suggests that a constructivist approach to learning science may also make it easier to get students to learn how to "think scientifically". Inquiry-based learning, when authentic, complements the constructivist learning environment because (as) it allows the student to tailor his own learning process.

They also mention that the interactive nature of information technologies can support students in carrying out inquiry-based activities, using topics, questions, and even theories that they themselves define and develop. Thus, teachers have to become better equipped to act as a guide and facilitator, allowing student to engage in a more realistic scientific inquiry experience. In addition, they said that; computer-supported learning environments make it easier for students to propose their own research focus, produce their own data, and continue their inquiry as new questions arise, thus replicating scientific inquiry more realistically.

"It can support the teacher in focusing more on supporting and sustaining the teaching process."
"Furthermore, students who are permitted to use their own resources in developing, implementing and evaluating projects are likely to find, with little doubt, need for considerable revision."

By enabling, facilitating and supporting inquiry-based learning in the classroom, computer technology can also improve the teaching of science. It may be unrealistic to strive for a complete and thorough understanding and discussion of science in the elementary classroom, but teaching towards a basic understanding on science is possible. So, teachers can use computer technology in different ways to support their representation of elements of science.

Unlike the impression created by textbook learning, which is that science consists of fixed, unchanging facts, internet can much more effectively represent the fluid character of knowledge by its ability to revise information continuously and to provide access to various sources. Computer technology and media can also facilitate the manipulation of variables in experiments and models. Students can thus predict, observe, and explore the effects of experimental parameters on dependent variables in more complex experiments than it could ordinarily be replicated in the classroom.

“I like using simulations in my lessons very much. Simulations can also be used to further an understanding of the nature of science by facilitating the use of different methods to investigate the same issue.”

The use of simulations can also assist teachers in shifting the emphasis to thinking, conjecture and talk about scientific method, about the reasons, limitations and benefits of carrying out controlled experimentation, and about qualitative interpretation of evidence. According to teachers; models are another important tool used in science investigations, and are valuable means of expressing an understanding of a process and of constructing knowledge. Research suggests that when using computer simulations and modeling, students tend to develop new strategies for solving problems and they complete tasks of greater cognitive complexity, test personal hypotheses by making predictions, develop higher-order thinking skills, and engage in complex causal reasoning. It is important to note that the use of simulations has certain potential drawbacks as well, and must be incorporated into the classroom with care.

However, one of the teachers warns that computer simulations should not be used to replace real experiences, but rather to support them. The limitations of virtual representations should be pointed out by the teacher, and an appropriate context should be provided to students. Lastly, the success in science lessons is discussed. Both of the teachers focused on motivation and told that it is a “necessity”. They argue that teachers should obtain a positive feedbacks in-class atmosphere and should motivate students. When you talk about success in science: *“a successful student in science makes arguments and can discuss…”*

*“A successful student should be a good problem solver, makes inquiry and transfers the knowledge to his/her daily life and real life situations…”.*One teacher described the successful student also reach the success in The National Exam. She told that the students who got high grades in TEOG can also be counted as a successful student.

Conclusion

The purpose of this study is to examine the nature of science lessons, argumentation and usage of scientific discussions of the 8th grade elementary students who have high academic success at science courses and TEOG. Meantime, the aim of the study is to explore whether there is a relationship between academic success at science and argumentation skills of students. Our results demonstrate that, firstly the natural environment of the science classes is accentuated. Then, results of the observations were included in the relationship among teacher classroom management behavior, student engagement, and student achievement of elementary science students. It was found that there are particular management behaviors and class norms which were correlated with achievement and engagement by science teacher. These are mostly identifying students who do not understand directives and helps them individually, reinforcing and encouraging the efforts of learners to maintain involvement in lessons, providing feedback to learners about their behavior and managing disruptive behavior among students.

Findings indicated that the teacher's limited approach on student-centered teaching of science content and her strict classroom order resulted in heavy dependence on the textbook and teacher centered activity and avoidance of whole-class activities (e.g., discussion) similarly. Lessons were observed across a variety of lesson structures such as expository teaching, whole-class discussions, and hands-on practical work. Unfortunately, there weren’t so many hands on practice in the lesson. Interactional issues related to the ways of speaking and questioning that encourage student responses and thinking were addressed during the observation.

Teacher’s feedback in the questioning process is crucial. Four different types of feedback were identified. They were; approving and disapproving, repeating students’ responses with no feedback and providing manipulative feedback. Many times teacher told the students what to do. The results were grouped according to following aspects: aim and objectives of science education, science teaching methods of these teachers in their science class, materials used while teaching and teachers’ approaches for being successful in science. The common framework of science learning outcomes described the goals of science education that these teachers mentioned are: A scientifically literate individual needs to acquire certain knowledge, skills, and attitudes; to develop inquiry, problem-solving and decision-making abilities; to become a lifelong learner; and to maintain a sense of wonder about the world.

Secondly; teachers in this school are both give importance to inquiry for teaching science. They mentioned that developing the inquiry skills should be one the most important aims of science teaching and enriching argumentation skills. Students typically do not develop science literacy and do not understand its role and relevance of science in society. Teachers argued that in support of the conclusion that students at the elementary, middle and high school levels do not develop an understanding of science that is useful for their everyday lives. Teachers have suggested that students do not see how science is applied to the everyday life, and that there is very little integration of science within everyday thinking among students.

This research has shown that according to teachers' views; even students with the most 8th grade success in science do not necessarily grasp fundamental concepts about nature and science. This result suggests that a constructivist approach to learning science may also make it easier to get students to learn how to "think scientifically". Inquiry-based learning, when authentic, complements the constructivist learning environment because it allows the individual student to tailor their own learning process. Science teachers in this research also mentioned that the interactive nature of computer technology can support students in carrying out inquiry-based activities, using topics, questions, and even theories that they themselves define and develop argumentation. By facilitating and supporting true inquiry in the classroom, computer technology can also improve the teaching of science. It may be unrealistic to strive for a complete and thorough understanding and discussion of science in the elementary classroom, but teaching towards a basic understanding is possible. Thus, as a result, we believe that teachers can use computer technology in different ways to support their representation of elements of science. The use of simulations can also assist teachers in shifting the emphasis to thinking, conjecture and talk about scientific method, about the reasons, limitations and benefits of carrying out controlled experimentation, and about qualitative interpretation of evidence. According to teachers; models are another important tools used in scientific studies, and are a valuable means of expressing an understanding of a process and of constructing knowledge. So usage of modeling for science concepts can develop students' scientific discussion and argumentation kills.

Recommendations

Recommendations for educators and researchers according to this research results are given below:

Development of scientific discussion and argumentation skills of elementary students requires a complex approach and education program. It can show a yearly progress for a student. A constructivist approach to learning sciences may also make it easier to get students to learn how to "think scientifically". Inquiry-based learning, when authentic, complements the constructivist learning environment because it allows the individual student to tailor their own learning process.

Teachers should illustrate a comprehensive approach on student-centered teaching of science content and also give importance to inquiry for teaching science. Improvement of the inquiry skills should be one the most important objective of science teaching and gathering argumentation skills.

The use of simulations and IT can also assist the teacher in shifting the emphasis to thinking, assuming and talk about the scientific method, about the reasons, limitations and benefits of carrying out controlled experiments , and about qualitative interpretation of evidence. Also usage of modeling for science concepts can develop students' scientific discussion and argumentation kills.

The results of this study are focused in-class-environment and activities of a specific school. Similar researches can be done within different stages of education via studying different type and level.

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A Historical Perspective of Medical Education

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Abstract

Even though there are significant developments in recent years in medical education, physicians are still needed reform and innovation in order to prepare the information society. The spots in the forefront of medical education in recent years; holistic approach in all processes, including health education, evidence-based medicine and professionalism. Medical education; undergraduate, postgraduate and continuing medical education covering the period varies from country to country for the duration of this period. Increasing day pursuing the importance of medical education and student-centered education and is spread across the country as well as in blended learning model that includes educational centered education. Medical faculty, students and teaching staff should be informed about innovations and developments should offer opportunities for that matter, should support administrative and economic necessarily.

Key words: Medical education, Blended learning model, Holistic approach.

Introduction

There have been efforts to improve the quality of medical education since the early 1980s. In this process, the Edinburgh Declaration (1988) and Recommendations of World Summit on Medical Education (1993) have constituted a milestone (Global Standards). In the Edinburgh Declaration, the purpose of medical education is defined as training physicians that work for the improvement of health of all individuals. It is expected that physicians are trained as careful listeners and observers, sensitive communication experts and effective clinicians. The faculties of medicine have been increasing in number; however, some of these faculties lack a clear mission statement, sufficient funding and sufficient clinical education and research opportunities. Although significant progress has been achieved in medical education in recent years, there is still room for reforms and innovations to prepare physicians for the information society. (*Türk Tabipleri Birliği Mezuniyet Öncesi Tıp Eğitimi Raporu – 2010).*

A Short History of Medical Education

Medical education is roughly divided into three periods:
1) Period before Flexner (until 1910), which was based on master-apprentice model,
2) Flexner period (1910-1970), during which biomedical approaches prevailed in education,
3) Society-centered medical education.

Flexner argued that the master-apprentice model failed to train qualified physicians and that there was a need for greater emphasis on science in medical education (Flexner, A,2002; Aytekin NT, 2002) For him, discipline-based approach was more appropriate given that increasing information load and health problems were increasing; and all stages of education should be offered in classes, laboratories and faculty of medicine hospitals, i.e. institutions of tertiary healthcare services (Magzoub M, *2000;* Schmidt H, *2000).* In society-based education, students have the chance to encounter cases of health problems from the first year of education, which enable them to handle the problems they will encounter more comfortably owing to past experience (Schmidt H, 2000; *Maastricht: Network Publications; 2000)*

The Aim of Pre-Graduation Medical Education

In recent years, the highlights in medical education are holistic approach, evidence-based medicine and professionalism in all stages of healthcare including education. In this respect, during six years of medical education, the aim is to train physicians that:

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- adopt "***a holistic (bio, psycho, social and cultural) approach***" in all procedures related to healthcare,
- have developed identity and awareness of the profession of medicine from the perspective of medical history; perform the profession of medicine based not only on techniques and scientific foundations and evidence but also on evidence in line with "**humanistic and professional values** (professionalism)",
- have developed competency of "**reflective thinking and practice**", and hence are open to "**continuous professional and personal development**", being aware of their individual and professional roles, qualifications, potentials, restrictions, responsibilities and rights,
- prioritize "**individual and social benefit**" with the aim of "**protecting and improving the health of individuals and the society**" in line with national and international health systems and policies and all organizational and administrative processes related to health.

In other words, the aim of medical programs is to train physicians equipped with the competencies listed under three categories in the National Competencies Framework, i.e. medical practices, critical and scientific thinking and approaches, and professionalism (*Mezuniyet Öncesi Tıp Eğitimi ULUSAL ÇEP(Çekirdek Eğitim Programı), 2014).*

Period of Medical Education

In the faculty of medicine, the period of education is six years, each of which covers an academic year (Ege Üniversitesi Tıp Fakültesi Entegre Eğitim-Öğretim Yönergesi,2013). Although the period of medical education varies from one country to another, it covers three stages in all countries, i.e. pre-graduation, post-graduation and lifelong medical education. The internship period is included in regular period of education in some countries and requires extra one year or eighteen months in some other countries. In Belgium, one of the European Union countries, the period of medical education is seven and a half years: three and a half years for medical sciences, two years for pre-clinical studies and final two years for clinical sciences. In Germany, medical education is completed in six years: three years for basic sciences, two years for clinical sciences and one year for medical practice. In the Netherlands, medical education requires six years, i.e. four years for pre-clinical studies and two years for clinical studies (Leinster S, 2003; Özdemir ST, 2005).

Content of Medical Education

Three Main Categories of Content in Pre-graduation Medical Education:
Faculties should design the content of pre-graduation medical education in a way to cover and integrate the following three fields:

a) **Educational content related to medical practices and professional skills:** The faculties offer the relevant educational content in consideration of basic medical practices and level of learning they determine in the framework of Core Educational Program.
b) **Educational content related to information on medicine as a science:** The scientific basis and information content fall under the following three categories in the field of medicine. The medical education programs developed by faculties are required to cover these three categories:
    - **Basic sciences:** Basic sciences on which medical education is grounded (*genetics, anatomy, embryology, physiology, biochemistry, etc.*) and medicine-related content of these sciences,
    - **Clinical sciences:** Clinical sciences covered in medical education (*pathology, clinical pharmacology, public health, epidemiology, clinical microbiology/infection control, immunology, internal and surgical sciences, etc.)* and the content of these sciences,
    - **Behavioral sciences and social sciences:** Content of research planning and biostatistics, psychology, sociology, anthropology, health management, etc. related to healthcare.
c) **Educational content related to professional codes, values and professionalism:** The third main component of a qualified medical education is professionalism (*humanist, social and professional values*). The faculties of medicine are first required to define the competencies and then design the educational content according to particularly professional competencies. There is a need to integrate the relevant content to the whole education process. Some of the components of educational content related to professionalism are as follows:
    - Communication skills, interpersonal relations and teamwork,
    - Ethical and professional values and responsibilities,
    - Humanist, social and cultural values and responsibilities,
    - Reflective practices and continuous development,

- Health systems and policies, management and society-centered medicine,
- Education and counseling **(***Mezuniyet Öncesi Tıp Eğitimi Ulusal Çekirdek Eğitim Programı (ÇEP)***,***2014*) .

Educational Models in Faculties of Medicine

In Turkey, out of 54 faculties of medicine, 34 (60.7%) adopt the mixed model, 18 (32.1%) adopt teacher-centered education model and 4 (7.1%) adopt student-centered education model. With regard to curriculum, 47 (83.9%) faculties use a system-based (integrated), 5 (8.9%) discipline-based (classical), 3 (5.3%) problem-based and 1 (1.7%) integrated and classical curriculum models. Problem-based education constitutes less than 10% of curricular activities in 30 faculties and 10% to 25% of curricular activities in 8 faculties (*Türk Tabipleri Birliği Mezuniyet Öncesi Tıp eğitimi Raporu, 2010)*. There is a program in medical education in 33 faculties, and it is planned to establish a program in medical education in 15 faculties (*Türk Tabipleri Birliği Mezuniyet Öncesi Tıp eğitimi Raporu, 2010*).

Conclusion

The faculties of education are expected to define and update their institutional objectives and targets related to education, research and service in consideration of changes in diagnosis and treatment methods as well as in the provision of healthcare services (*Mezuniyet Öncesi Tıp Eğitimi Ulusal Standartları,2014)*. Teaching and assessment methods used in medical education should be planned in a way to support learning skills and lifelong learning motivation of students. There is a need for activities where student can use the skills they acquire, evaluation of performances and provision of feedback (*Mezuniyet Öncesi Tıp Eğitimi ULUSAL ÇEP(Çekirdek Eğitim Programı, 2014).* The faculties of medicine should inform their students and teaching staff about national and international mobility programs, enable them to take part in such programs and provide administrative and financial support for participation in mobility programs (*Mezuniyet Öncesi Tıp Eğitimi Ulusal Standartları, 2014*).

One of the recent issues is the place of social media in medical education. Social media potentially allows active learning with the content designed by educators and encourages interaction. The flexibility of online instruments enables the customization of content according to personal needs of students (Geyer EM, 2008) *Isolated to integrated:An evolving medical informatics curriculum. Med Ref Serv Q. 2008;27:451–461).* The use of social media in education is a developing field about which further studies are required. Teachers have difficulty in getting adapted to the use of social media in education; however, it is clear that social media has positive effects on education (17). (Cheston, CC*, 2013).*

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