Eurasian Journal of Educational Research 69 (2017) 1-19

Eurasian Journal of Educational Research
www.ejer.com.tr

Eliminate with Created Argument Environment after Evaluated and Categorized Misconceptions in an Ontological Sense*

Aysegul KINIK TOPALSAN[1] Hale BAYRAM[2]

ARTICLE INFO

Article History:

Received: 13 October 2016

Received in revised form: 12 February 2017

Accepted: 19 April 2017

DOI: http://dx.doi.org/10.14689/ejer.2017.69.1

Keywords

ontological categories, argumentation, force and motion, misconceptions

ABSTRACT

Purpose: This study aimed to ascertain misconceptions of students about basic physical concepts in the "Force and Motion" unit of secondary school seventh class curriculum, to eliminate the misconceptions with created argument environment and traditional approaches after evaluated, and categorize these misconceptions in an ontological sense. **Research Methods:** Considered fundamental problems and sub-problems for which answers are sought. A semi-experimental model with pre-test and post-test control groups was utilized. Detected ontological categories were analyzed and discussed for each question located in the "Force and Motion" concept test.

Findings: Before and after applications after physical concepts about the Force and Motion unit were examined and categorized ontologically. 301 examined misconceptions from students in the experimental group arose from placement in the higher category. 150 misconceptions that arose from the placement in the lateral category were identified before application. 252 misconceptions of the 301 misconceptions (83.72%) that arose from placement in the higher category were corrected due to argumentation works that were executed. 128 misconceptions out of 150 (85.33%) misconceptions that were placed in the lateral category were corrected after an argumentation analysis. **Implications for Research and Practice**: Studies such as determination, evaluation, and correction of misconceptions should be performed by using ontological categories. This study shows that the implementation of argumentation works is more successful in the elimination of misconceptions placed in constraint-based interaction-natural, random-event, and matter categories. In this way, learning environments can be designed to be more efficient and infallible.

© 2017 Ani Publishing Ltd. All rights reserved

* This article was presented at the Third International Eurasian Educational Research Congress (EJER, 31-3 June 2016).

[1] Corresponding author: Dr. Istanbul Aydin University, Faculty of Education, e-mail: aysegulkinik@aydin.edu.tr

[2] Prof.Dr. Marmara University, Faculty of Education, e-mail: haleb@marmara.edu.tr

Introduction

Misconceptions are generally defined as concepts structured inadequately or incorrectly by students, apart from concepts scientifically accepted as true, and that were acquired by students by the end of the educational process (Nakhleh, 1992). In the 2000s, misconceptions were treated in philosophical terms, as philosophically-based definitions were being introduced into the literature. Chi and Roscoe (2002) treated misconceptions on an ontological basis, arguing that all concepts and ideas belong to certain ontological categories.

As a term, ontology is defined as the "science of being." One of the simplest definitions of a possible ontology may be "a controllable lexicon." Ontology is concerned with beings and the basic categories to which beings belong (Chi, 2001). An ontological property is one that a being potentially possesses due to the ontological category to which it belongs (Chi, 1997). Concepts are placed in ontological categories according to the ontological properties they possess. The three primarily utilized ontological categories are matter, process, and mental states. Students produce misconceptions when they, for example, place a concept that belongs to the process category into the matter category. Therefore, one should determine the categories in which to place concepts, and, in the case of misplacements, ensure that the concepts in question are re-located to the correct categories by using various educational methods and techniques. This is crucial in order to identify the roots of misconceptions and, thus, eliminate them.

An individual may sometimes perceive concepts differently, apart from scientific situations, and may place them in different categories. Usually, when students do not understand a basic physical concept and place it in the categories that already exist in their mind, they struggle to understand higher level and more complex concepts and learn permanently. Therefore, students should establish bridges in a meaningful way between their intuitive thoughts regarding the events they witness in their lives and the physical topics and concepts (Ayvacı and Devecioğlu, 2002). To meaningfully establish such bridges, students' misconceptions should first be determined, and then eliminated (Ayvacı and Devecioğlu, 2002; Yağbasan and Gülçiçek, 2003; Turgut et al. 2011).

The first stage in eliminating and correcting misconceptions, as well as in planning the relevant teaching process, is to determine conceptual misplacements, assist students to test their own conceptualizations and gain awareness of the possible misconceptions, and enable the learners to acquire the ability of higher level reasoning. The second step is to use, in the teaching process, methods and techniques that would enable students to place concepts in the right categories. In this regard, it is suggested that integrating argumentation, a reasoning activity, into the class environment may be an effective strategy to direct students to conceptual changes (Niaz, Aguilera, Maza and Liendo, 2002; Nussbaum and Sinatra, 2003).

Toulmin's argumentation model is composed of an assertion, the proofs to support the assertion, the reasons that indicate the relationship between the proofs and the assertion, the supportive pre-information that strengthens the reasons, the qualifiers (restrictions), and finally, the refutations that indicate the situations in which the assertion is invalid (Erduran, Simon and Osborne, 2004). Driver, Newton, and Osborne (2000) suggested that the argumentation-based teaching activities in science classes possess three significant effects: improving conceptual comprehension, research skills, and questioning the validity of scientific knowledge. It is observed that argumentation is quite effective in solving problems in science education. Thus, this study tried to realize conceptual changes with the help of argumentative contexts that included pre-determined misconceptions.

Relevant studies are limited to the identification of misconceptions or the effects of various methods in eliminating misconceptions. It has been observed that the national and international literature include only a few studies that treat misconceptions in ontological terms (Soman, 2000; Özalp, 2008; Özalp and Kahveci, 2011; Şen and Yılmaz, 2012; Sanmarti, Izquierdo and Watson, 1995; Watson, Prieto and Dillon, 1997). These studies only treat misconceptions in ontological terms, but do not propose active methods to eliminate the misconceptions of the identified categories. This study is quite significant in that it ontologically evaluates the concepts regarding the subject of "Force and Motion" and determines the effects of employed argumentations in eliminating misconceptions caused by types of ontological categorizations. As the first study in this capacity, this paper will guide researchers in the subject of eliminating misconceptions that are ontologically determined. This study has treated, in ontological terms, students' misconceptions regarding basic physical concepts that are within the subject of "Force and Motion," such as force, frictional force, work, conservation of energy, mechanical energy, kinetical energy, potential energy, and energy stored in springs. After students' misconceptions in identified subjects were ontologically evaluated and categorized, contexts of argumentations were formed to eliminate the identified misconceptions. Argumentation activities were formulated and implemented based on students' existing misconceptions. This forms the basic stage of this study. Additionally, the extent to which the employed argumentation settings affect the levels of students' use of scientific process skills and increase their achievements at the levels of knowledge and comprehension was revealed.

Method

Research Design

Considering the study's aim, main problem, and sub-questions, it can be said that I used a semi-experimental method with a pre-test and post-test control group design. Dependent variables of the implemented experimental pattern were academic achievement, scientific process skills, and learning concepts. The following pre-tests and post-tests were administered to all participant students in order to determine the effects of two different teaching methods: the Force and Motion Subject Academic Achievement Test (FMAAT) to determine the effect on students' academic achievements, the Force and Motion Subject Concept Test (FMCT) to determine the effect on students' learning concepts, and the Scientific Process Skills

Test (SPST) to determine the effect on students' scientific process skills. The research pattern is indicated in Table 1.

Table 1

Research Design

Group	*Teaching Method Used*	*Pre-tests*	*Post-tests*
Control Group	Traditional Method	SPST, FMAAT, FMCT (n=35)	SPST, FMAAT, FMCT (n=35)
Experimental Group	Argumentation	SPST, FMAAT, FMCT (n=35)	SPST, FMAAT, FMCT (n=35)

Research Sample

The working group of this study was composed of students who attended a foundation university in Istanbul, in the 2012-2013 academic year, in two distinct groups. The working group consisted of 70 teacher candidates (2nd grade, primary school teaching) as 60 female and 10 male students. Working groups were determined based on the results of the pre-tests, and they were placed in two equal size groups with 35 students.

Research Instruments and Procedures

Force and Motion Subject Academic Achievement Test. The Force and Motion Subject Academic Achievement Test was composed of 25 questions to reliably determine whether there were any differences in students' learning levels regarding the Force and Motion subject. In preparing the test, six questions that exhibited a least distinguishing index were determined. These questions were later excluded from the Force and Motion Subject Academic Achievement Test and the investigation continued with the remaining 19 questions. Distinguishing indexes of these 19 questions differed from 0.30 to 0.50. Subsequently, in order to determine the reliability of the Force and Motion Subject Academic Achievement Test that consisted of 25 questions, the Cronbach's Alpha coefficient was calculated, which was found as 0.680. The KR-20 coefficient was also found as 0.833.

Force and Motion Subject Concept Test. The Force and Motion Subject had 17 questions in its finalized version, and seven of the test articles were adopted from the test developed by Ulu (2011) while the researcher formulized the remaining 10 questions by literature survey. To formulize the questions, research was first executed on both domestic and foreign studies on the misconceptions about the concepts of force, frictional force, work, conservation of energy, mechanical energy, kinetical energy, potential energy, and energy stored in springs. The questions were formulized to reveal the cited misconceptions and the further misconceptions based on them. The ontological categories were held as the basis of the question design. The

Cronbach's Alpha value was found as 0.710 and the KR-20 coefficient as 0.704 for the Force and Motion Subject Concept Test.

Scientific Process Skills Test. The Scientific Process Skills Test was applied to the experimental and control groups. The Turkish translation and adaptation of the test was executed by Geban, Aşkar, and Özkan (1992). The multiple-choice test, consisting of 36 questions, measures the following skills: defining variables, formulating hypotheses, operational defining, research design, and data analyses. In his research with 7th grades, Aydoğdu (2006) examined the Scientific Process Skills Test developed by Geban, Aşkar, and Özkan (1992) and excluded some of the articles as they were not compatible with the 8th grade cognitive development level, reducing the number of the articles to 28. For a pilot study, the test with 28 questions was administered to 336 randomly selected students attending nine different primary schools. After the application, the distinguishing indices, difficulties of the articles, and the reliability coefficient of the test were calculated. After the calculation, the questions with a distinguishing index below 0.30 were excluded from the test. Thus, a test with 25 multiple-choice questions and with a reliability of 0.81 was acquired to measure scientific process skills.

Data Analysis

Kolmogorov-Smirnov goodness-of-fit test was used to determine whether the points of the Force and Motion Subject Academic Achievement Test, the Force and Motion Subject Concept Test, and the Scientific Process Skills Test demonstrated normal distribution.

To determine whether there were any differences in subject-related learning levels and concept learning levels in the experimental and control groups before and after the Force and Motion Subject, FMAAT was applied to both groups as a pre-test, and independent group t-test was used to analyze the data obtained.

The answers given to FMCT were qualitatively analyzed. In this analysis, the misconceptions determined in each question of the test were ontologically categorized. Then, ontological category maps were formed, in which the right and wrong ontological categorizations were analyzed, after the pre-test and post-test, by providing frequencies and percentages.

To determine whether there were any differences among the pre-study scientific process skills on the part of the experimental and control groups, SPST was applied to both groups as a pre-test and post-test, and the independent group t-test was used to analyze the total points obtained. To determine whether there were statistically significant differences between the points that the students of both groups obtained in the sub-dimensions of SPST before and after the study, the independent group T-test was applied to the points obtained from the dimensions of defining variables, operational defining, and formulating hypotheses. The Mann-Whitney U Test was applied to the points obtained from the dimensions of research design, and data analyses.

Results

In this part, the findings are examined in two sections. First, the findings will address determining the misconceptions of Force and Motion and the efficiency of argumentations and traditional methods used to eliminate these misconceptions. Then, the findings about argumentations, traditional settings, and the teaching process are treated in terms of their efficiency to eliminate misconceptions that resulted from certain misplacements of concepts in ontological categories.

Having compared the points that the students of the control and experimental groups obtained from the FMAAT pre-test and post-test with the independent t-test, the p value of the pre-test was found as 0.876 ($p>0.05$), and the p value of the post-test as 0.012 ($p<0.05$).

Having compared the points that the students of the control and experimental groups obtained from the SPS pre-test and post-test with the independent t-test, the p value of the posttest was found as 0.000 whereas it was 0.890 for the pre-test. A significant difference was found in favor of the experimental group.

No statistically significant differences were found between the points that the students of the experiment and control groups obtained from the sub-dimensions of the SPST ($p>0.05$). Therefore, there were no differences observed between the scientific process skills that the experimental and control groups had at the beginning of the study. A significant difference was found in the SPST sub-dimensions for the experiment group in the results of the post-test.

No statistically significant differences were found between the points that the control and experimental groups obtained from the FMCT pre-test ($p=0.51$). However, a statistically significant difference was found between the points that the control and experiment groups obtained from the FMCT post-test ($p=0.00$). This result was interpreted as that the applied use of argumentation settings in the lab environment more greatly improved the students' level of learning concepts compared to the traditional understanding in which students carry out the instructions given to them during the lab practices.

Ontological Examination of the Force and Motion Subject Concept Test Misconceptions. The percentages of the students' answers to each question of the FMCT distributed by ontological categories were determined and presented in tables. In addition, toward the aim of the study, the students' misconceptions were examined by dividing them into categories. This process was applied elaborately to the 17 questions of the test. In this section, only the analysis of the first test question is included as an example.


Figure 1

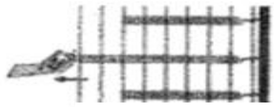
Figure 2

Figure 1. Force and Motion subject concept test, question one.

Question 1. A student compresses a spring in Figure 1 by 10 cm and releases it after a while. Then the student stretches the same spring by 10 cm, as in Figure 2, and releases it after a while. Which of the following judgments is correct?

A) The amount of energy stored in the spring is the same in both cases.

B) No energy is stored in the spring in both cases.

C) More energy is stored in the case given in Figure 1.

D) More energy is stored in the case given in Figure 2.

Which of the following is the reason of your answer in this question?

A) If a spring is compressed or stretched by the same amount, it will have the same amount of energy in both cases.

B) Work is required to store potential energy in the spring. Thus, no energy is stored in the spring in either case.

C) When a spring is compressed and stretched by the same length, it does not retain the same amount of energy. More energy is stored in the compressed spring.

D) When a spring is compressed and stretched by the same length, it does not retain the same amount of energy. More energy is stored in the stretched spring.

E) In my opinion, ……….

This question aims to draw attention to the topic of springs and their resilience in the subject of Force and Motion. It facilitated the questioning of the amount of energy stored in springs when compressed or stretched. The students' levels of comprehension regarding the energy stored in springs were evaluated by the evaluation criteria. Their misconceptions regarding the concept were examined in ontological terms, and the sources of misconceptions were determined on an ontological basis. Based on the obtained data, the levels of comprehension on the part of the students of the experimental and control groups in the pre-test and post-test are presented in Table 2 and Table 3, respectively.

Table 2

Students' Levels of Comprehension Regarding the First Question of the Force and Motion Subject Concept Pre-test

Comprehension Level	Experimental group		Control group	
	f	%	f	%
Thorough Comprehension	10	28.57	12	34.29
Misconception	20	57.14	22	62.88
Lack of Comprehension	5	14.29	1	2.86

Table 3

Students' Levels of Comprehension regarding the First Question of the Force and Motion Subject Concept Pre-test

Comprehension Level	Experimental group		Control group	
	F	%	f	%
Thorough Comprehension	27	77.14	24	68.57
Misconception	6	17.14	11	31.43
Lack of Comprehension	2	5.71	0	0

Table 2 indicates that, in the pre-test held before the application, 28.57% of the experimental group and 34.29% of the control group thoroughly comprehended the given concept about the amount of energy stored in springs. It also shows that 57.14% of the experimental group and 62.88% of the control group had a misconception about the given concept, and that 14.29% of the experimental group and 2.86% of the control group did not comprehend the concept investigated in the first question. When we examined the comprehension levels of the students in the same groups regarding the amount of energy stored in springs, we saw that the rate of students with thorough comprehension raised to 77.14% in the experimental group and to 68.57% in the control group, while the percentage of students with misconceptions dropped in a general sense. The table shows that the percentage of the students who could not comprehend the question in the experimental group dropped to 5.71%, while there were no such students in the control group. Another operation performed in the analysis of the first question of the FMCT was to determine the students' misconceptions. Table 4 indicates the misconceptions that the students exhibited in the first question of the FMCT pre-test, and Table 5 indicates the misconceptions that the students exhibited in the first question of the FMCT post-test.

Table 4

Misconceptions in the Answers that the Students Provided for the First Question of the Force and Motion Subject Concept Pre-test

Misconception	Experimental group		Control group	
	f	%	f	%
When a spring is compressed and stretched by the same length, it does not retain the same amount of energy. More energy is stored in the stretched spring.	10	28.57	11	31.43
When a spring is compressed and stretched by the same length, it does not retain the same amount of energy. More energy is stored in the compressed spring.	8	22.88	5	14.29
Work is required to store potential energy in the spring. Thus, no energy is stored in the spring in either case.	2	5.71	6	17.14

Table 5

Misconceptions in the Answers that the Students Provided for the First Question of the Force and Motion Subject Concept Post-test

Misconception	Experimental group		Control group	
	f	%	f	%
When a spring is compressed and stretched by the same length, it does not retain the same amount of energy. More energy is stored in the stretched spring.	2	5.71	3	8.57
When a spring is compressed and stretched by the same length, it does not retain the same amount of energy. More energy is stored in the compressed spring.	3	8.57	6	17.14
Work is required to store potential energy in the spring. Thus, no energy is stored in the spring in either case.	1	2.86	2	5.71

The last operation performed in the analysis of the first question of the FMCT based on the examination of the data given in Table 4 and Table 5 was to examine, in ontological terms, the misconceptions determined in the pre-tests and post-tests. Figure 2 indicates the ontological examination of the misconceptions of the students of the experimental group in the FMCT pre-test and post-test, while Figure 3 displays those of the control group.

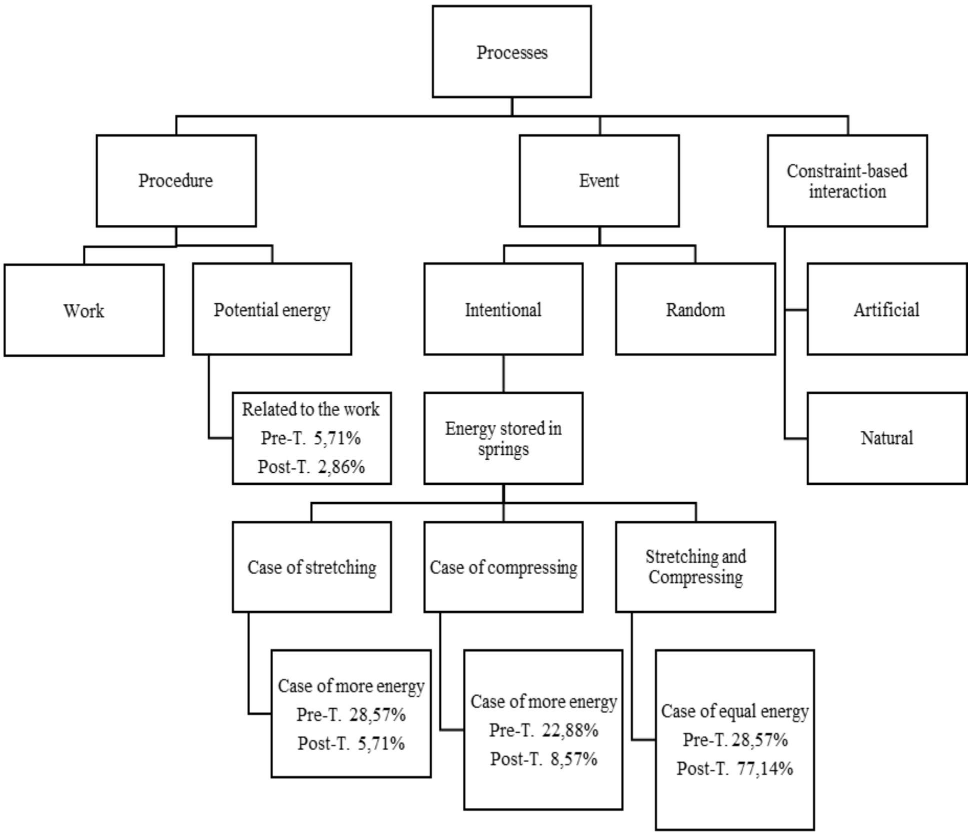

Figure 2. Ontological examination of the misconceptions of the students in the experimental group for the first question of the force and motion subject concept test

Figure 2 shows that the students who correctly answered the first question of the FMCT were those who placed the concept of the amount of energy stored in springs in the category of intentional event, a sub-category of the process category. The rate of these students was 28.57% in the pre-test, while it raised to 77.14% in the post-test.

In this study, we found two different sources, on an ontological basis, for the misconceptions about the energy stored in springs. One concerned the misconceptions that resulted from placing the concept about the amount of energy stored in springs in the categories of "case of compressing" and "case of stretching" that are among the side categories of the mentioned concept. The other concerned the misconceptions that resulted from placing the same concept in the operation category, one of the sub-categories of the process category.

In the misconception that resulted from placing the process category in the operation category, one of the sub-categories of the former, the students stated that it was required to execute a numerical calculatation on the spring for any potential energy to be stored in the stretched or compressed spring.

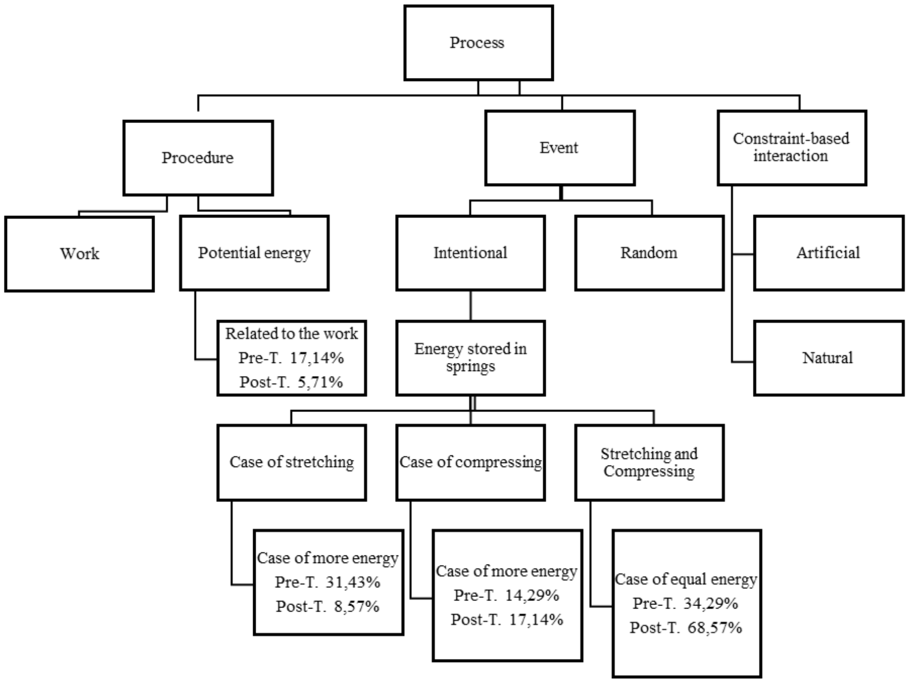

Figure 3. Ontological examination of the misconceptions of the students in the control group for the first question of the force and motion subject concept test

Figure 3 shows that the students who correctly answered the first question of the FMCT were those who placed the concept of the energy stored in springs in the category of intentional event, a sub-category of the process category. The rate of these the students of the control group was 34.29% in the pre-test, while it raised to 68.57% in the post-test. In this study, we found two different sources, on an ontological basis, for the misconceptions about the energy stored in springs. One concerned the misconceptions that resulted from placing the concept about the amount of energy stored in springs in the categories of "case of compressing" and "case of stretching," which are among the side categories of the mentioned concept.

The other concerned the misconceptions that resulted from placing the same concept in the operation category, a sub-category of the process category. In the misconception that resulted from placing the process category in the operation category, a sub-category of the former, the students stated that it was required to execute a numerical calculation on the spring for any potential energy to be stored in the stretched or compressed spring.

Discussion and Conclusion

After comparing the results of the scientific process skills test administered to the control group and the experimental group, a significant difference was found, in terms of the total points, in favor of the experimental group. After examining the results in terms of the sub-dimensions in the scientific process skills, a significant difference was found in all dimensions in favor of the experimental group. We may conclude, in the light of these findings, that the argumentations developed for the questioned concepts are more effective, compared to the activities performed in traditional ways, to enable students to improve the scientific process skills of defining variables, formulating hypotheses, operational defining, research design, data analyses. This conclusion supports the argument that, if students have experiences about scientific processes, these skills will be improved (NRC, 2000).

After comparing the results of the FMAAT post-test administered to the control group and the experimental group, a statistically significant difference was found in favor of the experimental group. Based on this finding, we may conclude that the argumentations developed for questioned concepts are more effective, compared to the activities performed in traditional ways, to increase students' academic achievements. Argumentations, which may easily be incorporated in activities performed in a lab setting, assist students in all areas and create different points of view. In this study, argumentations were used as course material, and, as they enabled the students to take all responsibility for learning, they increased the students' will to learn, allowing them to better internalize the concepts in question. This study indicates the impact of the class for which the number and content of the argumentation were arranged in line with the course of teaching. Studies on argumentations show that students' achievements increase in time (Akkuş et al., 2007). This situation is comparable with the data in the literature.

After comparing the results of the FMCT post-test administered to the control group and the experimental group, a significant difference was found in favor of the experimental group. Based on this finding, we may conclude that the argumentations developed for basic physical concepts are more effective, compared to the activities and experiments performed in traditional ways, to increase students' levels of learning concepts. This conclusion complies with the findings of Kaya (2005); Clark and Sampson (2007); De Vries, Lund, and Baker (2002); Driver et al. (2000); Duschl and Osborne (2002); Niaz et al. (2002); Uluçınar Sağır (2008); Zohar and Nemet (2002); Demirci (2008); Dole and Sinatra (1998); and Nussbaum and Sinatra (2003). Conducted at different levels of primary, secondary, and higher education, these studies show that course content developed with argumentations increase students' levels of learning concepts more than traditional methods. The most significant suggestion of these studies seems to be that, for conceptual change to be ensured, a convenient learning setting should be prepared in which new concepts can be compared with students' existing concepts, including the formation of deep reflections, relevant argumentations, and counter-argumentations.

In this study, before the application, the students of the experimental group had 301 misconceptions resulting from placement in an upper category and 150 misconceptions resulting from placement in a side category. Out of the 301 misconceptions resulting from placement in an upper category, 252 (83.72%) were eliminated. In addition, out of 150 misconceptions resulting from placing in a side category, 128 (85.33%) were eliminated. This situation reveals the impact of argumentation settings used in the teaching process. The misconceptions that appeared in the upper and side categories were largely eliminated. After examining the upper ontological and side categories, it was observed that the misconceptions placed in the side categories were more frequently eliminated. It was also found that the students acquired new misconceptions because of the argumentation settings and lectures. In this study, three new misconceptions were detected. Even though this kind of study might have been conducted carefully, it may not prevent students from creating new misconceptions. In his doctoral dissertation, Çelik (2010) argued that argumentations may result in similar cases of misconceptions. For conceptual change to be ensured, a convenient learning setting should be prepared in which new concepts can be compared with students' existing concepts, along with the formation of deep reflection, relevant argumentations and counter-argumentations (Dole and Sinatra, 1998; Nussbaum and Sinatra, 2003). The approach based on scientific argumentation may provide a teaching setting convenient for conceptual comprehension and conceptual change, but conceptual confusion may take place during the process, as well.

This study indicates that most of the misconceptions that resulted from the misplacement of the concepts of the sub-categories of the process ontological category, namely those of procedure, intentional event, constraint-based natural interaction, constraint-based artificial interaction, and random event. The misconceptions with the highest rate of occurrence are those that resulted from placement in the categories of procedure and intentional event, which are among the sub-categories of the process category. Slotta and Chi (2006) mentioned how physicists might eliminate strong and stable misconceptions by ontological training and instruct about the categories in which basic physical topics might emerge more intensely. It is seen, in the cited study, that the detected misconceptions, especially regarding the topic of electricity, were concentrated under the process category, and that the concepts were placed in the sub-categories of the process category in several ways due to the concrete examples given by teachers. Similarly, this study has shown that, before the argumentations, the students generally placed the basic physical concepts in question in the sub-categories of the process category, according to their levels of readiness.

It can be said that many of the misconceptions in the control group result from the misplacement of the concepts of the ontological category of the process in its sub-categories, namely those of procedure, intentional event, constraint-based natural interaction, constraint-based artificial interaction, and random event. Of the students in the control group, we determined 318 misconceptions resulted from placement in an upper category, and 131 misconceptions resulted from placement in a side category, all before the application. Out of the 318 misconceptions that resulted from placement in an upper category, 122 (38.36%) were eliminated, and out of the 131 misconceptions that resulted from placement in a side category, 59 (45.03%) were eliminated. This shows that traditional activities performed in lab settings are more effective in eliminating misconceptions that resulted from placement in a side category than from placement in an upper category. In addition, it is observed in the results that traditional activities might cause new misconceptions to be formulated by the students. At the end of the study, 31 new misconceptions were detected**.**

References

Akkus, R., Gunel, M. & Hand, B. (2007). Comparing an inquiry based approach known as the science writing heuristic to traditional science teaching practices: Are there differences?. *International Journal of Science Education,* 29 (14), 1745-1765.

Aydogdu, B. (2006). *Ilkogretim fen ve teknoloji dersinde bilimsel surec becerilerini etkileyen degiskenlerin incelenmesi* [Investigation of variables affecting scientific surrogacy skills in primary science and technology course]. Yuksek Lisans Tezi, Dokuz Eylul Universitesi Egitim Bilimleri Enstitusu, Izmir.

Ayvacı, H.S & Devecioglu, Y. (2002). Kavram haritasinin fen bilgisi basarısina etkisi [The Impact of the concept map on scientific success]. V. Ulusal Fen Bilimleri ve Matematik Egitimi Kongresi, Ankara

Chi, M.T.H. (1997). Creativity: Shifting across ontological categories flexibly. Ward,T. B., Smith, S. M & Vaid, J. (Eds.), *Conceptual structures and processes: Emergence, discovery and change*, 209-234. American Psychological Association, Washington.

Chi, Y. (2001). Ontology-based curriculum content sequencing system with semantic rules. *Expert Systems with Applications*, 36(4), 7838–7847.

Chi, M. T. H. & Roscoe, R. D. (2002). The processes and challenges of conceptual change. Limon, M. & Mason, L. (Eds), *Reconsidering conceptual change: Issues in theory and practice,* 3-27. Kluwer Academic Publishers.

Clark, D. B. & Sampson, V. (2007). Personally-seeded discussions to scaffold online argumentation. *International Journal of Science Education*, 29 (3), 253-277.

Celik, A.Y. (2010). *Bilimsel tartisma (argumantasyon) esasli ogretim yaklasiminin lise ogrencilerinin kavramsal anlamalari, kimya dersine karsı tutumlari, tartısma isteklilikleri ve kalitesi uzerine etkisinin incelenmesi* [Investigation of effect on Conceptual meanings, attitudes towards chemistry lessons, willingness to discuss and quality with scientific discussion-based approach to teaching].

Doktora Tezi, Gazi Universitesi Egitim Bilimleri Enstitusu Ortaogretim Fen ve Matematik Alanlar Egitimi Anabilim Dali, 122-140

De Vries, E., Lund, K.& Baker, M.J. (2002). Computer-mediated epistemic dialogue: Explanation and argumentation as vehicles for understanding scientific notions. *The Journal of the Learning Sciences*, 11(1), 63-103.

Demirci, N. (2008). *Toulmin'in bilimsel tartisma modeli odakli egitimin kimya ogretmen adaylarinin temel kimya konularini anlama ve tartısma seviyeleri uzerine etkisi* [The impact of Toulmin's focus on the scientific debate model of chemistry teacher candidates on understanding and discussing basic chemistry subjects]. Yuksek Lisans Tezi, Gazi Universitesi, Egitim Bilimleri Enstitusu, Ankara.

Dole, J. A. & Sinatra, G. M. (1998). Reconceptualizing change in the cognitive construction of knowledge. *Educational Psychologist*, 33, 109–128

Driver, R., Newton, P. & Osborne J. (2000). Establishing the norms of scientific argumentation in classrooms. *Inc. Sci. Ed*, 84, 287-312.

Duschl, R. A. & Osborne, J. (2002). Supporting and promoting argumentation discourse in science education. *Studies in Science Education*, 38, 39-72.

Erduran, E., Simon, S. & Osborne, J. (2004). Tapping into argumentation: developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education*, 88 (6), 915-933.

Geban, O., Askar, P. & Ozkan, I. (1992). Effects of computer simulated experiments and problem solving approaches on high school students. *Journal of Educational Research,* 86, 5 - 10.

Nakhleh, M. (1992). Why some students don't learn Chemistry: Chemical misconceptions. *Journal of Chemical Education*, 69(3), 191-196.

National Research Council (NRC). (2000). *Inquiry and the National Science Education Standards.* National Academy Press, Washington, DC

Niaz, M., Aguilera, D., Maza, A. & Liendo, G. (2002). Arguments, contradictions, resistances, and conceptual change in students' understanding of atomic structure. *Science Education*, 86, 505-525.

Nussbaum, E.M. & Sinatra, G. M. (2003). Argument and conceptual engagement. *Contemporary Educational Psychology*, 28, 384-395.

Özalp, D. (2008). *Ilkogretim ve ortaogretim ogrencilerinin maddenin tanecikli yapisi konusundaki kavram yanilgilarinin ontoloji temelinde belirlenmesi* [Diagnostic Assessment of Student Misconceptions about the Particulate Nature of Matter from Ontological Perspective].Yuksek Lisans Tezi, Marmara Universitesi, Istanbul

Özalp, D. & Kahveci, A. (2011). Maddenin tanecikli yapisi ile ilgili iki asamalı taniliyici sorularin ontoloji temelinde gelistirilmesi [Development of two-tier diagnostic items based on ontology in the topic of the particulate nature of matter]. *Milli Egitim Dergisi*, 191, 135–156.

Sanmarti, N., Izquierdo, M. & Watson, J.R. (1995). The substantialisation of properties in pupils' thinking and in the history of science. *Science and Education*, 4, 349-369.

Slotta, J.D. & Chi, M.T.H. (2006). Helping students understand challenging topics in science through ontology training. *Cognition and Instruction*, 24 (2), 261–289.

Soman, S. A. (2000). *Ontological caterization in chemistry: A basis for conceptualchange in chemistry.* Doctorate Thesis, Purdue University, West Lafayette, USA.

Turgut, Ü., Gürbüz, F., Turgut, G. & Açışlı, S. (2011). *Lise 2. sinif fen subesi ogrencilerinin "Kuvvet ve Hareket" konusundaki kavram yanılgılari* [Second-year science sub-school students in high school's misconceptions about force and movement.]. Trakya Universitesi Egitim Fakultesi Dergisi, 1(1), 71-85.

Uluçınar Sağır, Ş. (2008). *Fen bilgisi dersinde bilimsel tartisma odakli ogretimin etkililiginin incelenmesi* [Investigation of the effectiveness of scientific discussion-oriented teaching in science education]. Doktora Tezi, Gazi Universitesi Egitim Bilimleri Enstitusu, Ankara.

Ulu, C. (2011). *Argumantasyon tabanli bilim ogrenme yaklasimina dayali laboratuvar etkinliklerinin 7. sınıf ögrencilerinin kavram ogrenmelerine etkisi: yasamımızdaki elektrik unitesi* [Effects of laboratory activities through the argumentation based inquiry approach on 7th grade students' conceptual learning: electricity in our daily life unit]. Doktora Tezi, Marmara Universitesi Egitim Bilimleri Enstitusu, İstanbul

Yagbasan, R. & Gülcicek, C. (2003). Fen ogretiminde kavram yanilgilarinin karakteristiklerinin tanimlanmasi [Defining the characteristics of conceptual aspects in science teaching]. *Pamukkale Universitesi Egitim Fakultesi Dergisi*, 1 (13), 102-119.

Yılmaz, A.& Sen S. (2012). Erime ve cozunmeyle ilgili kavram yanilgilarinin ontoloji temelinde incelenmesi [Investigation of misconceptions about melting and coaling in ontology basis]. *Amasya Universitesi Egitim Fakultesi Dergisi*, 1(1), 54-72.

Zohar, A. & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching*, 39(1), 35-6.

Watson, J. R., Prieto, T., & Dillon, J. S. (1997). Consistency in students' explanations aboutcombustion. *Science Education*, 81, 425-444.

Kavram Yanılgılarının Ontolojik Açıdan İncelenmesi ve Bulunan Yanılgıların Oluşturulan Argüman Ortamları ile Giderilmesi

Atıf:

Topalsan-Kınık, A. & Bayram, H. (2017). Eliminating with created argument environment after evaluated and categorized misconceptions in an ontological sense. *Eurasian Journal of Educational Research,* 69, 1-19, DOI: http://dx.doi.org/10.14689/ejer.2017.69.1

Özet

Problem Durumu: Önemli fizik kavramlarını içeren kuvvet ve hareket konusu ile hemen hemen her düzeydeki öğrencide oldukça yüksek oranda kavram yanılgısı olduğu yürütülen araştırmalarla ortaya konulmuştur. Fakat benzer olarak yapılan bu çalışmalarda sadece kavram yanılgıları ortaya çıkarılmış ve yanılgıların nedenleri araştırılmadan farklı yöntem ve tekniklerle giderilmeye çalışılmıştır. Ontolojik kategorilere göre, yanılgıların nedenlerinin ortaya konulduğu değerlendirmenin yapıldığı araştırmalar sınırlı sayıdadır. Bu nedenle yapılan çalışmanın problem cümlesi, yanılgıların nedenlerini tespit etmek ve etkili bir yöntem önermek amacı ile "Kuvvet ve Hareket konusu ile ilgili geliştirilen argüman ortamlarının ve geleneksel olarak yürütülen öğretim sürecinin, Kuvvet ve Hareket konusu ile ilgili tespit edilmiş, ontolojik kategorileştirmeden kaynaklanan kavram yanılgılarını gidermede etkisi nasıldır?" olarak saptanmıştır.

Araştırmanın Amacı: Bu araştırmada, "Kuvvet ve Hareket" konusunda yer alan kuvvet, sürtünme kuvveti, iş, enerjinin korunumu, mekanik enerji, kinetik enerji, potansiyel enerji, yayların depoladığı enerji gibi temel Fizik kavramları ilgili öğrencilerde bulunan kavram yanılgılarını ortaya çıkarmak ve bulunan yanılgıları ontolojik açıdan değerlendirilip, kategorileştirildikten sonra oluşturulan argüman ortamları ve geleneksel olarak uygulanan öğretim süreci ile gidermek amaçlanmıştır.

Araştırmanın Yöntemi: Araştırmanın deseni, temel problemi ve cevap aranan alt problemler dikkate alındığında ön test-son test kontrol gruplu yarı deneysel modeldir. Çalışmada uygulanan deneysel desende, bağımlı değişkenler akademik başarı, bilimsel süreç becerileri ve kavram öğrenme olarak belirlenmiştir. Bu bağımlı değişkenler üzerinde etkisi incelenen bağımsız değişken ise uygulanan öğrenme-öğretme yaklaşımıdır. Ayrıca Kuvvet ve Hareket Konusu Kavram testinde yer alan her bir soru için tespit edilen ontolojik kategoriler derinlemesine analiz edilip tartışılmıştır.

Araştırmanın Bulguları: Uygulamanın ardından deney grubu ile kontrol grubu arasında, bilimsel süreç becerilerinden değişkenleri tanımlama, işlemsel açıklamalar yapma, araştırma tasarlama ile grafiği ve verileri yorumlama boyutlarında deney grubu lehine anlamlı bir fark oluşmuştur.

Yine gerçekleştirilen uygulamanın ardından deney grubu ile kontrol grubu arasında, akademik başarı ve kavram öğrenme düzeyleri açısından deney grubu lehine anlamlı bir fark oluşmuştur.

Yapılan uygulamaların öncesi ve sonrasında Kuvvet ve Hareket Ünitesi ile ilgili belirlenmiş temel Fizik kavramları ontolojik olarak incelenip kategorileştirdikten sonra, deney grubundaki öğrencilerin, uygulamadan önce üst kategoriye yerleştirmeden kaynaklanan 301 kavram yanılgısı, yanal kategoriye yerleştirmeden kaynaklanan 150 kavram yanılgısı tespit edilmiştir. Üst kategoriye yerleştirmeden kaynaklanan bu 301 kavram yanılgısının 252'si yapılan argüman çalışmaları sayesinde giderilmiştir. Üst kategoride giderilen kavram yanılgısının oranına bakıldığında %83,72 olduğu bulunmuştur. Yanal kategoriye yerleştirilen 150 kavram yanılgısının 128'unun da yapılan argüman çalışmaları sonrası giderilmiştir. Yanal kategoride giderilen kavram yanılgısının oranına bakıldığında %85,33 olduğu bulunmuştur. Bu durum öğretim süreci boyunca kullanılan argüman çalışmalarının olumlu etkisini ortaya çıkarmıştır. Üst ve yanal kategoride ortaya çıkan kavram yanılgıları büyük bir oranda ortadan kaldırılmıştır. Üst ontolojik ve yanal kategoriler kendi içerisinde incelendiğinde, özellikle yanal kategoriler içerisine yerleştirilmiş kavram yanılgılarının, yapılan argüman çalışmaları sonrası daha fazla giderildiği görülmüştür. Kontrol grubundaki öğrencilerin, uygulamadan önce üst kategoriye yerleştirmeden kaynaklanan 318 kavram yanılgısı, yanal kategoriye yerleştirmeden kaynaklanan 131 kavram yanılgısı tespit edilmiştir. Üst kategoriye yerleştirmeden kaynaklanan bu 318 kavram yanılgısının 122'si giderilmiştir. Üst kategoride giderilen kavram yanılgısının oranına bakıldığında %38,36 olduğu bulunmuştur. Yanal kategoriye yerleştirilen 131 kavram yanılgısının 59'ü giderilmiştir. Yanal kategoride giderilen kavram yanılgısının oranına bakıldığında %45,03 olduğu bulunmuştur. Bu durum labaratuar ortamında yapılan geleneksel çalışmaların, yanal kategoriye yerleştirilmiş kavram yanılgılarını gidermede, üst kategoriye yerleştirilmiş yanılgılara göre daha başarılı olduğunu göstermektedir. Bunun yanı sıra geleneksel olarak uygulanan çalışmaların öğrencilerde yeni kavram yanılgıları da çıkan sonuçlardan görülmektedir. Yapılan çalışmalar sonrasında 31 yeni kavram yanılgısı ortaya çıkmıştır.

Araştırmanın Sonuçları ve Önerileri: Araştırmada kavram yanılgılarının ontolojik kategorilere göre değerlendirilmesi bu yanılgıların ontolojiye göre hangi nedenlerden dolayı oluştuğunun anlaşılmasını sağlamıştır ayrıca argüman ortamlarının ontolojik olarak tespit edilmiş kavram yanılgılarından sınırlı etkileşim-doğal, rastgele olay ve madde kategorilerindeki yanılgıları gidermediki etkililiği sayısal verilerle ortaya konulmuştur. Bu nedenle aktarılacak konuların bu tür yanılgıları içermesi halinde, argüman ortamları yaratılıp öğrenme ortamı daha etkin ve yanılgısız hale getirilebilir. Yanılgıların nedenlerinin bilinmesi bu ve buna benzer araştırmalar için oldukça önemlidir. Kavram yanılgılarının giderilmesi ancak nedenleri üzerine yoğunlaşıp bunların oluşmalarını engelleyen çalışmaların, öğretim yöntemlerinin, vb. hazırlanmasıyla gerçekleştirilebilir. Bu nedenle ontolojik kategoriler yanılgıların nedenlerinin açığa çıkarılmasını sağladığından çok önemlidir. Kavram yanılgılarının belirlenmesi, değerlendirilmesi ve giderilmesi gibi araştırmalar ontolojik kategorilerden yararlanılarak gerçekleştirilmelidir.

Bunun yanı sıra öğretmenler farklı konularda, farklı argüman teknikleri ile geliştirecekleri çalışmalarla ders içeriklerinin kalitesini daha rahat arttırabilir. Bu nedenle yurt dışında birçok çalışma ile etkililiği belirlenen bilimsel tartışma modeli öğretmen adaylarına öğretilmeli ve öğretmen adaylarının tartışma becerileri geliştirilmeye çalışılmalıdır. Öğretmenlerin bilimsel tartışma sürecini öğrenmeleri, etkili tartışma yönetebilmeleri için bilimsel tartışma modeli öğretmenlere uygulamalı olarak anlatılmalı ve öğretmenlere bilimsel tartışma etkinlikleri yaptırılmalıdır. Farklı ders içerik ve kazanımlarında geliştirilen argüman çalışmaları bir kitap haline getirilebilirse, öğretmenler süreç içerisinde zorlanmadan argüman çalışmalarını uygulayabilir ve kendilerine uygun çalışmaları, yapılan bu kitapı kaynak alarak daha rahat oluşturabilir. Ayrıca argümanların bilimin doğasının anlaşılmasında, bilimin gelişmesinde, öğrenciler tarafından bilgilerin sorgulanmasında, bilgilerin kalıcı olmasında vb. olumlu etkileri düşünüldüğünde ders kitaplarında argümanlara yer verilmesinin öğrencilere önemli katkılar sağlayacağına inanılmaktadır.

Anahtar Kelimeler: Ontolojik kategoriler, argümantasyon, kuvvet ve hareket, kavram yanılgıları.