European Journal of Educational Research
Volume 6, Issue 3, 367 - 384
ISSN: 2165-8714
http://www.eu-jer.com/

The Effects of Learning Activities Based on Argumentation on Conceptual Understanding of 7th Graders about "Force and Motion" Unit and Establishing Thinking Friendly Classroom Environment

Ayse Buber*
Dokuz Eylul University, TURKEY

Gul Unal Coban
Dokuz Eylul University, TURKEY

Received: April8, 2017 ▪ Revised: July19, 2017 ▪ Accepted: July 19, 2017

Abstract: The purpose of this study was to investigate the effects of learning activities based on argumentation about "Force and Motion" unit on conceptual understanding and views about establishing thinking friendly classroom environment of 7th graders. The study was conducted with total 39 students (20 students in experimental group and 19 students in control group) in a secondary school. The experimental group received learning activities based on argumentation while the control group received regular science learning depending on the current science curriculum for over five week period. Both groups were given Force and Motion Concept Test and Thinking Friendly Classroom Scale before and after the instruction. Besides, six students from the experimental group were interviewed after the instruction about conceptual understanding and thinking friendly classroom features by a form developed by the researchers. The results showed that there isn't a significant difference between conceptual understandings of experimental and control group students. Besides, it was found that there is a significant difference between thinking friendly classroom scale of experimental and control group students in favor of experimental group. Moreover, the results of the interviews conducted with six of experimental group indicated that they feel themselves in thinking friendly classrooms and with a fine conceptual understandings are fine although they have some misconceptions.

Keywords: *Argumentation, conceptual understanding, thinking friendly classroom features, force and motion unit.*

To cite this article: Buber, A., & Coban Unal, G. (2017). The effects of learning activities based on argumentation on conceptual understanding of 7th graders about "force and motion" unit and establishing thinking friendly classroom environment. *European Journal of Educational Research*, *6*(3), 367-384.doi: 10.12973/eu-jer.6.3.367

Introduction

The studies about how science concepts can be learned better showed that students had difficulties about learning science concepts, so many misconceptions in science subjects and problems in connecting their science knowledge to their daily lives (Akkus and et al., 2003; Aydin, 2008; Bar & Travis, 1991; Baser &Cataloglu, 2005; Seloni, 2005; Baskan, 2006; Baysari, 2007; Chen, Hand &Mcdowell, 2013; Costu and et al., 2007; ErduranAvci, Kara & Karaca, 2012; Tao & Gunstone, 1999; Yagbasan & Gulcicek, 2003). These results were supported by internationally comparative exams such as PISA and TIMSS which aim to determine about how students solve problems in their daily lives upon science courses (PISA, 2012 National Preliminary Report 2013; TIMSS, 2011 National Preliminary Report 2014). The reasons of students' low success in researches and the misconceptions they had were that the science concepts were abstract and the teaching methods and techniques weren't enough to teach these abstract concepts (Demirci, 2008; Duit & Treagust, 2003; Okumus, 2012; Uzun, Gelbal & Ogretmen, 2010; Yildiz, 2008;).

Turkish Science Curriculum has a variety of teaching methods and techniques in consistent with its context. The basic philosophy of Turkish Science Curricula since 2005 is constructivism. However, inquiry and argumentation is emphasized more specifically in 2013 Turkish Science Curriculum. According to this recent 2013 curriculum's new approach, the inquiry process in courses tackles not only "discovery and experiment" but also "explain and create argument" process (Turkish Ministry of National Education Board of Education and Discipline Primary Science Curriculum [MEB], 2013). Students should know how to argue in order to explain natural world around them with strong warrants, attend to decision-making process in scientific and socio-scientific subjects actively and make the

*Corresponding author:
Ayse Buber, Department of Science Education, Dokuz Eylul University, Izmir / Turkey
Email: buberayse@gmail.com

right decisions in these subjects (Kutluca, 2012; MEB, 2013; Temizyurek, 2003). Argumentation provides students to think like a scientists and it is a method which finds out student's thinking process and develop reasoning mechanisms (Kelly & Takao, 2002; Osborne and et al., 2004). On the contrary many researches emphasize its important role in developing qualified conceptual understanding and scientific thinking on students, it is seen that argumentation is not widely and frequently used in science courses (Driver and et al., 2000; Karisan, 2011; Suzuk, 2011; Zohar & Nemet, 2002). It is reported in many studies that argumentation couldn't be practiced in science courses effectively because teachers are inadequate in starting and continuing argumentation process, they are lack of knowledge about argumentation, there are problems about creating active arguing environments and as a result students aren't used to argue with others (Driver and et al., 2002; Driver and et al., 2000, Okumus, 2012; Ulucinar Sagir, 2008). From this point, it is thought that the learning activities in this research are useful for teachers who meet with argumentation first time to teach how to start and continue argumentation process in science courses.

In the argumentation process students not only learn the science concepts and identify the knowledge, but also construct old knowledge and scientific rules to new conditions by asking questions, make contact between own knowledge and environmental phenomenon, create arguments and claims and also use reasoning skills (Deveci, 2009; Dori and et al., 2000; Kutluca, 2012). When the argumentation is examined as a part of thinking process, it can be seen that it takes an active role in construction of knowledge (Kuhn, 1993; Lawson, 2003; Tumay, 2008). Because argumentation includes process of rebutting opposite opinions and making run the opinions in the practice stage, it is related to conceptual change and higher order thinking skills closely (Arli, 2014; Dole &Sinitra, 1998; Gultepe, 2011). In this respect it is believed that the activities for this research contribute students' conceptual understandings and teachers and student's behaviors which are indicative of thinking.

There are so many researches about 'Force and Motion' unit in use of a variety of methodological approach. In the exploration and inquiry process, not only students learn science concepts through experimentation and discovery, but also they should learn through create an argument in which they explain their observations with strong warrants. It is believed that the learning activities based on argumentation in this unit will be reference to show how the argumentation model can be used in science courses. Therefore, this study aims to answer following research questions:

1. Is the learning activities based on argumentation in seventh grade "Force and Motion" unit effective on students' conceptual understandings?
2. Is the learning activities based on argumentation in seventh grade "Force and Motion" unit effective on establishing thinking friendly classroom environment?

Argumentation

Argument is a combination of theories and evidences which come up with an explanatory result or support or rebut a claim or a model (Toulmin, 1958). Duschl & Osborne (2002) define argument as a mortar which keeps together evidences and theories in environments in which constructions of scientific explanations are actualized. Additionally Kuhn (1991) and Means & Voss (1996) define argument as assertion, claim or thesis which warrants accompany to support, verify or corroborate.

While Sampson & Clark (2008) define argument as a structure which is constructed to indicate and justify claims and explanations, they define argumentation as all of the complex processes of formation of the structures used by individuals. Therefore argument and argumentation concepts differ from each other. In the same way Yerrick (2000) and Solomon (1991) define argumentation as a configuration process of argument and they define argument as a part of this process.

Argumentation is a process in which different opinions are evaluated by individuals (in same or different viewpoints) to solve a problem, understand a phenomenon, decide on an issue or put forward opinions, criticize and evaluate these opinions and it is also all of the operations in this process and cognitive products as a result of evaluation of the process (Kuhn, 1993, 1992, 1991; Simon, Erduran & Osborne, 2006; van Eemeren, 1996; van Eemeren, 1995). Jimenez-Aleixandre & Erduran (2007) define argumentation as an experimental and theoretical model which emerges as a result of defending main claim with evidence and justification in accordance with data in scientific issues.

In light of all these definitions and explanations, argumentation is line of conversations in which individuals try to prove their opinions' accuracies and validities with evidences and warrants in environment open to social interaction.

Toulmin's Argumentation Pattern

Toulmin defines argumentation as an activity in which individuals put forward claims, support their claims with warrants in related to data, specify the claim's validity in different conditions and support their warrants (Osborne, 2005).

The starting point of an argumentation is putting forward an opinion (viewpoint, assertion, thought) against to a phenomenon or a situation. In other words, an individual tries to prove the opinion about a situation. This component is specified as "claim" in Toulmin Argumentation Pattern (TAP). The conditions like statistics information and evidences which the claim is based on, is evaluated as "data" component in TAP. When there is an uncertainty about data's accuracy, using additional data or different evidences to verify the available data is "warrant" in the model. Warrants explain how the individuals evaluate the data after reasoning process between data and claim and how the claim is formed. The "backings" is one of the components which intensifies the warrant for acceptance, provides understanding the causes of argumentation and provides the reliability of claim in the model. Individuals question warrant's reliability with backings and if there are unreliable or incorrect backings, these backings enable individuals to exclude the claims. In an argumentation "qualifier" component states the situations in which warrants are not valid. The circumstances in which the claims are incorrect and invalid states "rebuttal" component (Driver and et al., 2000; Scheweizer, 2002; Simon, Erduran& Osborne, 2006; Toulmin, 2003).

Six components in Toulmin Argumentation Pattern and their relationships between each other are given in Figure 1.

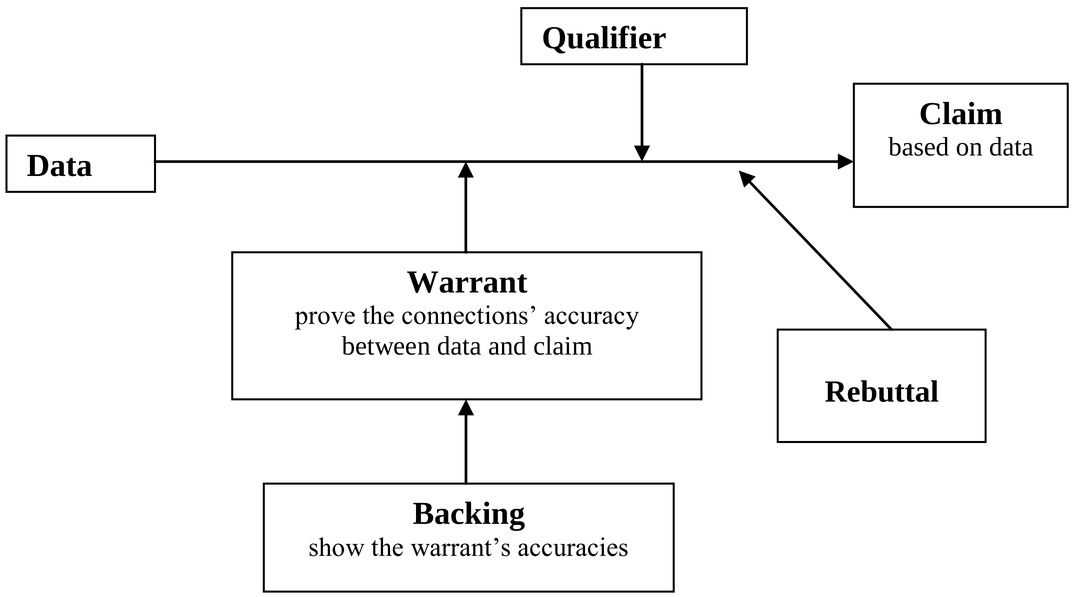

Figure 1.Toulmin Argumentation Pattern (Toulmin, 1958)

While claim, data, warrants and backings are the main components of Toulmin model; qualifiers and rebuttals components usually have been using in the complex arguments (Driver and et al., 2000).

When Toulmin examines argumentations in different fields, he states that some components of the model can be variable and others can be stable (Toulmin, 2003). If the components demonstrate change depending on fields (medicine, law, science), these components are designated "field-dependent" or "field-variant". If the components don't show change depending on field, these components are designated "field-invariant". While backing, warrant and data can be field-variant or field-invariant, claim, rebuttal and qualifier are field-invariant (van Eemeren, 1996; Jimenez-Aleixandre & Erduran, 2007).

Thinking and Argumentation

In recent years, there is a growing number of studies focus on argumentation discourse in science context (Driver, Newton & Osborne, 2000; Duschl & Osborne, 2002; Erduran & Jimenez-Aleixandre, 2008; Erduran, Simon & Osborne, 2004; Kuhn & Udell, 2007; Lawson, 2003). These works are related to two frameworks. One of them is related to science studies highlighting the importance of discourse in the construction of scientific knowledge and consequences for education, the other one is related to socio cultural perspective which notices the role of social interaction in learning and thinking processes (Jimenez-Aleixandre & Erduran, 2007). So science education can be conceivable as promoting a way of thinking and not as a body of knowledge and fixed facts (Driver & Newton, 1997; Zohar & Nemet, 2002). Driver, Newton & Osborne (1998) and Kuhn (1992) state that courses involving argument will require students to externalize their thinking because argument involves the exercise of reasoning. Educators seek to develop thinking skills in order to make students become proficient in advancing, critiquing and defending claims in reasoned discussions with each other (Kuhn & Udell, 2003).

Constructing an argument involves considering alternative positions. Even arguments constructed by a student are put together by thinking of cases that the arguments have to contest (Driver and et al., 1998). When children engage in such a process and support each other in high quality argument, the interaction between students does not only promote reflexivity, appropriation and the development of scientific knowledge, but also students try to grasp the connection between evidence and claim is to understand the relationship between claims and warrants by using thinking (Quinn, 1997). Therefore students need opportunities not just to hear explanations given to them by experts (teachers, books, computer programs), but they also need to practice using ideas themselves to gain confidence in their use and through this process develop ways of thinking (Driver and et al., 1998). In the light of these explanations it can be stated that, argumentation is a powerful vehicle for developing the higher order thinking (Jimenez-Aleixandre & Erduran, 2007).

Perkins (1992) emphasized that 'learning is a consequence of thinking' which can be interpreted as learners are active thinkers about what they are learning and when it is thought that argumentation process consisted of different thinking ways, argumentation is one of key to learn scientific concepts by using thinking.

Methodology

Research Goal

This study is based on pretest-posttest control group quasi-experimental research design in which the researcher seeks out effects of treatment on the independent groups which are assigned as experimental and control groups (Cothari, 2004). This research is structured to see the effects of the learning activities based on argumentation on 7th graders' conceptual understandings and perception about establishing thinking friendly classroom environment. The control and experimental groups are assigned randomly. The experimental design of study is presented in Table 1.

Table 1. Experimental Design of the Research

Groups	***Pre-tests***	***Treatment***	***Post-tests***
Experimental Group *(N=19)*	*T1, T2*	Learning Activities Based on Argumentation	*T1, T2, T3*
Control Group *(N=20)*	*T1, T2*	Regular Science Education depending on Turkish Science and Technology Curriculum (2005)	*T1, T2*
T1: Force and Motion Concept Test, T2:Thinking Friendly Classroom Scale, T3: Semi-Structured Interview			

Sample

The participants of this research are 7th graders of a secondary school in one of the cities located on the north west of Turkey. A total of thirty nine 7th grade students (N=20 in experimental and N=19 in control groups) took place in the research. Before the research, experimental group students had argumentation preparation courses about how to conduct practices in the activities and also how to use components of argumentation process.

Data Collection Tools

Force and Motion Concept Test, Thinking Friendly Classroom Scale and semi-structured interviews were used for collecting data in this research. The instruments were given to students at the beginning and at the end of the "Force and Motion" unit.

Force and Motion Concept Test: In order to determine students' conceptual understanding levels before and after the treatment, 7th Grade Force and Motion Unit Concept Test (FMCT) which was developed by Yildiz (2008) was used in the research. FMCT has 18 two-tier item with KR-20 reliability coefficient of 0.77. The first part of FMCT has multiple choice items which include answer of the question and distractors. The aim of this part is to decide student's factual knowledge. The second part of FMCT includes reasons of the student's answers were given in the first part. These reasons were formed of true response and identified misconceptions. So the second part shows student's mental models about concept and explanatory knowledge. In this part, in addition the multiple choices, there is also facility for students to express different opinions as "In my opinion…" as the last choice of this part. The student's answers of first and second part were considered in scoring of the test items. According to this, if the chosen choice shows misconception in both parts, this answer is scored as 1 point. If student answers first part as correct but second part as false, this answer is scored as 0 point. Lastly, if student chose correct choices in both parts, this answer is coded as 0 point. In this case, the highest score of this test is 18 point and the lowest score is 0 point. While the higher score shows that student has high misconceptions, the lower score shows that student has low misconceptions.

Thinking Friendly Classroom Scale: In this research, the purpose of using 'Thinking Friendly Classroom Scale (TFCS)' is to figure out student's behaviors about learning thinking and how teaching strategies, methods and techniques support thinking in their science courses. TFCS has 3 sections as "Teacher Behaviors of Developing Thinking", "Student Behaviors of Developing Thinking" and "Thinking Disruptive Behaviors" which was developed Doganay & Sari (2012) and internal consistency for each section is 0.89, 0.82 and 0.69 and 0.89 for whole scale. TFCS is likert-type rating scale (1.Never, 2.Sometimes, 3.Usually, 4.Always) and has 30 items (six of items are negative and twenty four of items are positive). When the 6 items of "Thinking Disruptive Behaviors" section reverse about scoring, the highest score of test is 120 and the least score of test is 30. The higher score of scale shows that the classroom environment has positive features about student's thinking.

Semi-Structured Interviews: In order to support quantitative data of students' conceptual changes and thoughts about thinking friendly classroom environment more detailed data were collected and analyzed through qualitative ways. Semi-structured views developed by the researcher had been actualized with six students from experiment group. Interview questions are formed in 2 different sections (1.Thinking Friendly Classroom Environment and 2.Force and Motion Unit). There were five questions in the interview totally. These questions were reorganized in accordance with opinions of three science teachers and two masters from science education field. Lastly, the researcher conducted pilot interview with three students who had already given regular instruction about 7th Force and Motion Unit in order to overcome problems about understanding questions.

Procedure

During the instruction, while the experimental group received argumentation based learning activities, the control group received teaching activities in Turkish Science and Technology Curriculum by the same instructor (the science teacher) for five weeks. Before the instruction, researcher gave some information to the teacher about what the argumentation is, how the process of argumentation progresses, what the importance of this research is and how the teacher should guide to the students in argumentation process for three times. In addition to this training, "Teacher Guidance Material" was prepared to help instructor about activities and how the activities could be applied in experimental group.

Treatment in Experimental and Control Groups

Before the instruction, FMCT and TFCS were applied to experimental and control groups. There was an activity about what argumentation is, how the process of argumentation is, argumentation model and argumentation components in experimental group. The instructor used activity papers which were prepared for the students and activity paper were collected end of the course in the experimental group. The researcher had kept in touch with the instructor about lessons and had given information about following lessons for the experimental group. The instructor carried out lessons with the teaching activities in Turkish Science and Technology Curriculum. After the instruction, FMCT and TFCS were applied to experimental and control groups. According to results of FMCT, the semi-structured interviews carried out with six students having a variety of conceptual understanding (low, medium and high) from experimental group.

Analyzing of Data

Two kinds of data were analyzed in different ways. Firstly the analysis of data collected through each quantitative data collection tool was analyzed by Shapiro-Wilk Test in order to test whether the data display normal probability plots (Buyukozturk, 2011; George & Mallery 2010; Tabachnick & Fidell, 2013). Therefore Independent Samples T-Test was used comparing experimental and control groups' pre and posttests and Paired Samples T-Test was used comparing experimental group's pre and posttests and control group's pre and posttests.

For the analysis of data from interviews coding categories were developed. Therefore primarily coding categories and definitions of these categories in literature were examined. The categories for the Thinking Friendly Classroom Features were formed by the researcher. In order to reach concepts and relationships which explain collected data, content analysis was used (Yildirim & Simsek, 2013). To this end, firstly collected data was conceptualized and afterwards organized. According to new concepts and the themes which explained the data.

The interview questions belong to thinking friendly classroom features are placed in 3 categories. These are *Teacher Behaviors Develop Thinking, Student Behaviors Develop Thinking* and *Behaviors Affect Thinking*. After content analyses had done with available data, significant parts in data were express with a word or sentence. In 'Teacher Behaviors Develop Thinking' category, get opinion, use evidence, let student interaction, provide to use scientific process skills, respect and show tolerance and give example codes were constituted. In 'Student Behaviors Develop Thinking' category, attend and express himself in activities and argumentation easily in the course, justify answers with experiments, justify answers with using daily observations and examples justify answers with the knowledge has been learnt in books and journals, justify answers with knowledge they have learnt from other codes were constituted. In 'Behaviors Affect Thinking' category, refrain from classmates while expressing thoughts, use experiments and formulas to solve difficult questions, ask help from teachers or experts to solve difficult questions or subjects they wonder about, use argumentation to take information for difficult questions or curious things, search difficult questions or curious things on the web, teacher care student's thoughts, teacher care thoughts which are memorized from books, express homework nettably codes were constituted. Subsequently, one of the researchers described data in different parts of interview in same category and code and presented this information which is associated with each other according to emerging concept or category. The other researcher also conducted the data analysis apart from the first researcher. They both typed the codes separately for all of the 6 students interviewed. For the reliability of the procedure the level of agreement between the coding of the two researchers. The calculation results about thinking friendly classroom environment features for each student indicated [S1 (93%), S2 (87%), S3 (81%), S4 (91%), S5 (88%), S6 (81%)] quite reliable according to Ryan and Bernard (2000) who claim the criterion of correspondence percentage must be higher than .70. In this instance, it can be said that the data of interviews is coded reliably.

In order to analyze the data, the rubric developed by Yildiz (2008) was used after revision. The original rubric has 5 categories for classifying students conceptual understanding as Table 2. In addition to these categories "no idea" category was added by the researchers for addressing the "empty" response.

Table 2. The Categories for Questions in Force and Motion Unit

Categories	Explanations
Complete Scientific Understanding (CSU)	The response of student corresponds to an opinion which is scientifically accurate and all descriptions of this opinion must reflect the right response's all components.
Partial Scientific Understanding (PSU)	The response is accurate scientifically however descriptions don't reflect some components of right response.
Two-Way Understanding (TWU)	The response of student includes scientific truths as well as there are components which show that student has got misunderstanding.
Misunderstanding (M)	The response shows that the student constructs inaccurate descriptions scientifically to explain phenomenon about force and motion unit.
Non-Question Descriptions (NQD)	The response is scientific but there isn't any description about the question.
No Idea (NI)	There aren't any responses for the phenomenon about force and motion unit.

In order to provide reliability of data analysis of students' conceptual understanding, two researchers' separate classifying process was compared through the level of agreement. The level of agreement percentages between two researchers were S1 (93%), S2 (91%), S3 (87%), S4 (90%), S5 (91%), S6 (91%). Miles & Huberman (1994) states that it is enough for the reliability of data to find correspondence percentage higher than 0.70.

Findings / Results

The results of descriptive statistics conducted at the beginning of analysis is given in Table 3. Some students' responses to instruments were missing so these responses were not evaluated.

Table 3. Descriptive Statistics Related to FMCT and TFCS scores

	Experimental Group		Control Group	
	Pre	**Post**	**Pre**	**Post**
Scores on FMCT				
N	16	16	15	15
Mean	8.56	8.00	9.33	9.00
SD	2.22	1.96	2.35	1.36
Skewness	0.43	-0.66	-0.729	-0.78
Kurtosis	-1.09	-0.68	0.381	0.19
Scores on TFCS				
N	20	20	18	18
Mean	95.95	99.15	87.39	86.44
SD	1.58	1.35	1.14	1.56
Skewness	-0.95	-0.72	0.63	0.19
Kurtosis	1.09	0.09	-0.01	-1.25

Table 3 indicates basic descriptive statistics related to the pre and post FMCT and TFCS scores. The highest score that might be obtained from FMCT is 18. As mentioned in the methods part, the higher score shows that the student has more misconceptions. The mean FMCT score of experimental group was smaller than that of the control group in the pretest as well as in the posttest. The mean scores of both groups were decreased to some degree from the pretest to posttest. The mean score decrease for the experimental group (8.56-8.00) was 0.56 and the mean decrease for the control group (9.33-9.00) was 0.33. The highest score that might be obtained from TFCS would be 120. This high score shows that the features of classroom environment are positive in terms of thinking. The mean TFCS score of the experimental group was higher than that of the control group both in the pretest and the posttest. The mean increase for the experimental group (99.15-95.95) was 3.2 and the mean increase for the control group (86.44-87.39) was -0.95. These results showed that experimental group increased the TFCS score whereas control group decreased. All skewness and kurtosis values were in the acceptable range known as the skewness and kurtosis values are expected as near -1.5 and 1.5 respectively for a normal distribution (Tabachnick & Fidell 2013). In order to determine if there were significant differences between experimental and control groups in pre and posttests of FMCT and TFCS, 'Independent Samples T-Test' was used to compare the groups. The results are given in Table 4.

Table 4. Independent Samples T-Test's Results for FMCT and TFCS

	Pretest		Posttest	
Groups	**Experimental**	**Control**	**Experimental**	**Control**
FMCT Results				
N	16	15	16	15
Mean	8.56	9.33	8.00	9.00
S	2.22	2.35	1.97	1.36
sd	29		29	
t	.94		1.64	
p	.36		.11	
TFCS Results				
N	20	18	20	18
Mean	95.95	87.38	99.15	86.44
S	15.82	11.44	13.52	15.62
sd	36		36	
t	1.89		2.69	
p	0.07		0.01*	

Table 4 shows that there isn't significant difference between experimental and control groups in FMCT pretests ($t(29)=0.94$, $p>.05$). This situation shows that prior to instruction both groups had similar misconceptions. According to posttest results of FMCT, there isn't significant difference statistically although both groups (progress of the experiment group is better than that of the control group according to decreases of means) advanced and decreased misconceptions. TFCS pretest results show that there isn't significant difference between the groups so in the beginning of the instruction experiment and control groups had similar views about thinking friendly classroom features. There is a significant difference between experiment and control groups in TFCS posttest results (t(36)=2.69, p<.05). After instruction, experiment group's evaluation scores ($\overline{X}$ =99.15) advanced more than that of control group ($\overline{X}$ =86.44). The effect size is calculated by using t-test results and found .167 and so 17% (large effect size) of the variance which is found in TFCS is bound up with learning activities based on argumentation approximately. And Cohen d is .87 and this shows that the difference between TFCS means scores of experimental and control groups is .87 standard deviation.

The results of t-test for controlling if there is a significant difference between pre and posttest of FMCT and TFCS is given Table 5.

Table 5. Paired Samples T-Test's Results for FMCT and TFCS

Groups	**Experimental**		**Control**	
	Pre	**Post**	**Pre**	**Post**
FMCT Results				
N	16	16	15	15
Mean	8.56	8.00	9.33	9.00
S	2.22	197	2.35	1.36
sd	15		14	
t	.84		.46	
p	.41		.65	
TFCS Results				
N	20	20	18	18
Mean	95.95	99.15	87.39	86.44
S	15.82	13.51	13.52	15.62
sd	19		17	
t	-0.832		0.182	
p	.41		.90	

In Table 5, it is found that there isn't any significant difference between pre and posttest results of experimental group's scores in FMCT (t(15)=0.84, p>.05). Whereas the mean score of experimental group before the instruction ($\overline{X}$ = 8.56), it decreased to $\overline{X}$ =8.00 end of the instruction. According to FMCT results of control group, there isn't significant difference between pre and posttests of the group, either (t(14)=0.46, p>.05). In the beginning of the instruction, the mean of experiment group was $\overline{X}$ =9.33 while it was $\overline{X}$ =9.00 end of the instruction. In TFCS results, there isn't significant difference between pre and posttests of experiment group (t(19)=-0.832, p>.05). There isn't significant difference between pre and posttests of control group, either (t(17)=0.182, p>.05). Whereas the mean of experiment group was $\overline{X}$ =95.95 before the instruction, it was $\overline{X}$ =99.15 end of the instruction. Although there isn't a significant difference, posttest scores of experiment group were increased as compared to pretest so it can be said that the views of experiment group about thinking friendly classroom features were developed positively. However TFCS posttest results were less than that of pretest and this means that control group's views were developed negatively.

In order to examine effects of learning activities based on argumentation on students' conceptual understandings and views about thinking friendly classroom features more detailed, six students from experimental group were interviewed. Responses of students about thinking friendly classroom features and result of analyses were given in Table 6. Categories which were used in the examination of interviews and creation stages were explained in the method part of the research.

Table 6. Codes, Frequencies and Student's Views for Thinking Friendly Classroom Features Part of the Interview

CATEGORIES		CODES	f	%	Student Views
Teacher Behaviors Develop Thinking		- Respect and show tolerance	10	31	S1:..explained us the subject what we didn't understand with the example… S3:…he respects and tolerance… S4:… while we argue, everybody says each other, take help… S2: ...He usually asked our opinions. He said to us you could say everything…
		- Let student interaction	9	28	
		- Get opinion	7	22	
		-Provide to use scientific process skills	4	13	
		- Use evidence	1	3	
		-Give Examples	1	3	
		Total	**39**	**100**	
Student Behaviors Develop Thinking		- Attend and express himself in activities and argumentation easily in the course	7	32	S1:… For example he makes us do experiment…. S2:.. If someone doesn't know something, I can prove it by doing experiment or if I have knowledge about that subject, I tell… S3: … By telling to him. If there are pictures, I use these pictures by proving… S4: … I prove with my observations on the subject…. S6: … for example if I read something from a book or a journal, I show this as a proof. I can say I read this in this book or this journal…
		- Justify answers with experiments	6	27	
		- Justify answers with using daily observations and examples	6	27	
		- Justify answers with the knowledge has been learnt in books and journals	2	9	
		- Justify answers with the knowledge they have learnt from other	1	5	
		Total	**22**	**100**	
Behaviors Affecting Thinking	Student Behaviors	- Ask help from teachers or experts to solve difficult questions or subjects they wonder (+)	9	21	S4:… We take help from friends because we do activities with group… S3:…We have a group. We think together with friends and try to explain problem… S4:… I ask to teacher. I search on the web. Another… I use our course book… S1:… For example our teacher says us to take notes, he says the pages, he asks us to explore that subject, we explore… S2:… First of all he wants us to state what we understood. For example he ask someone firstly, he explains later… S6:… because even if my every words are wrong or right, he answer and also he cares our thoughts not memorizing knowledge from books… (*(+)=Codes state positive behaviors, (-)=Codes state negative behaviors.)
		- Use argumentation to take information for difficult questions or curious things (+)	7	16	
		- Search difficult questions or curious things on the web (+)	4	9	
		- Refrain from classmates while expressing thoughts (-)	4	9	
		- Use experiments and formulas to solve difficult questions (+)	2	5	
	Teacher Behaviors	- Express homework nettably (+)	10	23	
		- Care student's thoughts (+)	7	16	
		Total	**43**	**100**	

Table 6 shows that in teacher behaviors develop thinking category students stated that their teacher show 'respect and show tolerance (31%), let student interaction (28%) and get opinion' behaviors mostly. Student's statements devoted to these behaviors are like these: *"S1: He is never angry. But he cares our thoughts…; S2: He usually shows tolerance to us. He never gets angry with us. More precisely he behaves caressingly…; S3: He respect and show tolerance our different thoughts…".* Students expressions about how their teacher provides opportunities to their cooperation are like these: *"S5: we have a group in which we are 5 persons…; S3: He sometimes helps our group. He tells what we don't understand. Firstly he shows the experiment how it would be done, later we try to do experiment…".* Besides the responses of the students about how the teacher asks student's thoughts are like these: *"S2: He helps so much about my thinking. He has usually asked our thoughts. He said us to say what we think about. I improved my thinking in this way…".* However 'use evidence (3%)', 'give example (3%) and 'provide to use scientific process skills (13%) behaviors which play a part in instruction based on argumentation which is come to the fore in MEB (2013) curriculum are not used sufficiently by teacher according to student's expressions. Student's statements for these behaviors which were used insufficiently by teacher are like these: *"S1: ...For example we pushed two balls from different heights. First of all I thought which one* *would come first, later I tried…; S3: …For instance he explained a subject which we didn't understand by exemplifying…; S4: …For example, when I solved the problems, he asked me to use evidences and so I solve problems by using evidence…".*

In students behaviors develop thinking category, students state that they attend and express themselves in activities and argumentation easily in the course (32%); they justify answers with experiments (27%) and they justify answers with using daily observations and examples (27%). Expressions of students who state that they attend and express themselves in activities and argumentation easily in the course are like these: *"S1: …For example my thought is different and that of my friend is different, either. It is same for our group, too. So I am trying to prove that my idea is right…; S2: Yes I express my thoughts easily. Our teacher gives opportunities every time to us…; S3: …For instance, he said that we would do exercises about argumentation. Everyone asked what it is. He asked us to search about it. We searched and explained in the course. Then, he explained and exemplified argumentation. He wanted us to say a claim later he said his own claim. We found evidences of his claim. Ever group said different opinions. We could talk easily…".* Statements of students who express that they justify with experiments and also daily observations and examples are like these: *"S2: I am not good at explaining my evidences but I could guess end of the experiment. For example, if someone doesn't know the subject, I could prove by doing experiment or if I have enough knowledge about the subject I can share this…; S4:… firstly I suggest a claim later I predict on the subject and I prove with my old observations…".*

In student behaviors affecting thinking category, most of students stated that they ask help from teachers or experts to solve difficult questions or subjects they wonder (21%), they use argumentation to take information for difficult questions or curious things (16%) and they refrain from classmates while expressing thoughts (9%). It show parallelism with the aim of the research that the students use argumentation to take information for difficult questions or curious things. It has an important role for student's thinking that students bandy out a claim in activities based on argumentation, justify their claims, produce more claims, use rebuttals. The students stated their thoughts about these behaviors affecting their thinking like these: *"S4: …One of my group friends suggests a claim then everyone tell their own evidences and make co-decision…; S3: …We had a group and we were trying to explain the subject by putting head together, we eliminate wrong claims…".* The causes of refraining from classmates while expressing thoughts can be lack of self-confidence, thinking classmates ridicule with himself or having difficulties while expressing what he knows. Students state their thought on this subject like these: *"S5: …For example I couldn't ask because my friends would say why I ask this question or they would say that it is easy question when I ask…; S6:..I cannot ask because there are more clever students than us. They always know the right answers so I don't want to say my own opinion because they would underestimate my intelligence…".* When the codes were analyzed in teacher behaviors affecting thinking, students stated that the teacher cares student's thoughts (23%) and express homework nettably (14%). Student's thoughts belong these responses are like these: *"S1:…Firstly he waits us to tell what we understand. For example he asks someone then he tell the subject…; S2:…He sometime gives a schedule for homework and sometimes explain by writing on the board or talking. When I don't understand, he explains gently…; S5:…even if my every word is wrong or right, he explains properly and he has explained that we should talk with our own thoughts not with the memorizing knowledge…".*

The categories which are given in Table 7 were used while analyzing responses of students to questions devoted to Force and Motion Unit. The distributions of student's responses were given in Table 7 after review.

Table 7. Codes and Frequencies for 'Conceptual Understanding' Part of the Interview

	CSU	PSU	TWU	M	NQD	NI	Total
SUBJECTS	**f / %**	**f / %**	**f / %**	**f / %**	**f / %**	**f / %**	**f / %**
Impact-Reaction Force at Springs	f:16	f:0	f: 2	f: 0	f: 0	f: 0	**f: 18**
	% 89	% 0	% 11	% 0	% 0	% 0	**% 100**
Work	f:8	f:0	f:4	f:5	f: 0	f: 0	**f:18**
	%44	%0	% 28	% 28	% 0	% 0	**% 100**
Gravity Potential Energy, Kinetic Energy, Conversion of Energy	f: 14	f: 6	f: 3	f: 0	f: 1	f: 0	**f: 24**
	% 58	% 25	% 12	% 0	% 4	% 0	**% 100**

Table 7: Continued

SUBJECTS	CSU f / %	PSU f / %	TWU f / %	M f / %	NQD f / %	NI f / %	Total f / %
Elasticity Potential Energy	f: 3	f: 0	f: 2	f: 0	f: 1	f: 0	**f: 6**
	% 50	% 0	% 34	% 0	% 16	% 0	**% 100**
Simple Machines	f:43	f:3	f:0	f: 18	f: 0	f: 2	**f: 66**
	% 65	% 5	% 0	% 27	% 0	% 3	**% 100**
Frictional Force Cause Energy Loss	f: 13	f: 4	f: 3	f: 3	f: 0	f: 1	**f: 24**
	% 54	% 17	% 13	% 13	% 0	% 3	**% 100**

CSU: Complete Scientific Understanding, PSU: Partial Scientific Understanding, TWU: Two Way Understanding, M: Misconception, NQD: Non-Question Description, NI: No Idea

The questions for conceptual understanding part were categorized according to the titles of subjects and three questions were asked to students about 'Impact-Reaction Force at Springs' subject. The responses of students were analyzed almost as scientifically accurate (89%). Some student's responses in CSU category are like these: *"S1: …It is opposite. Orhan applies the force leftward and the spring apply force rightward. Both forces are equal. The spring is strained much more. It stores more energy and it apply more force…; S5: …The force which Orhan applies to the spring and the force which the spring applies to Orhan are equal. Because we compress more to the string, it applies more force…".* In the same subject, 11 percent of student's responses include scientific truths as well as there are statements which show that student has got misunderstanding. The responses in TWU category are like these: *"S2:…Size of forces is equal. Because how he compresses the spring strongly, the spring respond with the same force. But when we think the spring's thickness and kind, the spring's force can be different…; S3:…The forces are same. Because Orhan apply the force to spring, his force passes to spring and spring response to him with the same strength."*

When the responses of students to three questions about 'Work' subject were analyzed, 44 percent of students took place in CSU category. The statements of students in this category are like these: *"S5: …to do work physically, force and direction of movement must be in the same direction. The vase moves from up to down and it does work because force and movement are in the same direction…; S4: …It doesn't do work because there isn't movement in the force direction…".* 28 percent of students took place in TWU category in which the student's response can be accepted scientifically accurate but there some expressions which show student have got misconception. Some statements of this category are like these: *"S4: …It doesn't because there isn't movement in the direction of force. It means that movement isn't in the direction of force…; S2: …While she lifts up the vase, she does work but while she winds down, direction of force is up but direction of movement is down so there isn't any work…; S1: Does she hold the vase up, right? She makes the vase to move to down so she doesn't do work. For example, if we go up with our bag, we do work because we carry the bag, our burden goes up, too. The directions of force and motion should be same in order to do work. I think in this way…".* There are student's expressions in which the students construct inaccurate descriptions scientifically to explain the questions 'Work' subject. 28 percent of student's responses are in M category: *"S3:…There was an example which was given by the teacher. I compare with that situation. 'Walk with the bag on your hand', it is same with this. She takes then puts, I don't think she does work. Because the condition of doing work is that object must move…"*

In 'Gravity Potential Energy, Kinetic Energy, Conversion of Energy' subject, 58 percent of student's responses are scientifically accurate so they are in CSU category; 25 percent of student's responses are scientifically accurate but there are some deficiencies so they are in PSU category; 12 percent of student's responses include scientific truths as well as some statements show misunderstanding so they are in TWU category and lastly 4 percent of student's responses are scientifically accurate but they aren't related to question so these responses are in NQD category. Some responses of students for this subject are like these: *"S3:…While the athlete goes up, his kinetic energy converse to gravity potential energy. Gravity potential energy is about height. Kinetic energy is about motion…While he is going up, his kinetic energy decrease but his potential energy increase (PSU)…; S1: While the athlete was running leftward, he had kinetic energy because he has got force and burden (TWU)…; S5:…In the first part of picture, I don't think athlete has any energy because he doesn't do work. The ability to do work is energy (NQD)…"*

In 'Elasticity Potential Energy' subject, 50 percent of the responses of students is in CSU category, 34 percent of responses is in TWU category and 16 percent of responses is in NQD category: *"S1:...The ball which is 20 kilogram goes higher. Because the ball is heavy and it applies more force so it goes higher than the other ball which is 10 kilogram (TBA)...; S2:...Now their masses are different but the ball 20 kilogram push the string much more and goes faster but the other ball is lighter so I think this ball can go to the same height, either. I think both of them go to the same height because the heavier one push the spring more strongly but the other is lighter and so it can reach the other one (TWU)...; S3:...The ball 10 kilogram goes higher than other one because it is lighter than other one. When spring is compressed, the ball goes higher (NQD)..."*

In 'Simple Machine' subject, 65 percent of student's responses is in CSU category, 5 percent of responses is in PSU category, 27 percent of responses is scientifically unacceptable so it is M category and 3 percent of student's responses is in NI category because they don't have any idea about question. Some statements of students are like these: *"S1:...If we put the support bar the side of elephant, the height which elephant goes would be less because the burden bar gets smaller (CSU)...; S5:...The simple machine we used provides convenience on work subject. For example if there isn't lever, the mouse wouldn't raise the elephant because of its weight. The mouse applies less force with this machine (PSU)...; S2: ...The simple machine we used provides energy economy. The mouse has to apply more force in order to raise elephant. Because the support part is getting smaller, it uses less force (M)..."*

In 'Frictional Force Cause Energy Loss' subject, the student's responses to four questions were analyzed and 54 percent of responses is scientifically accurate so it is in CSU category, 17 percent of responses in PSU category, 13 percent of responses include scientific truths as well as misunderstandings so it is in TWU category,13 percent of responses is in M category in which there are scientifically inaccurate descriptions and lastly 3 percent of responses is in NI category because students didn't state any opinion. Student's statements are like these: *"S4: ...The cause of wheel's warming after Burak drove the car is frictional force. Because the wheel rubs the road, kinetic energy converses heat energy (CSU)...; S1: ...After the car has gone for a while, the cause of car's stoppage is frictional force. I think that frictional force affect object's mass so objects stop (PSU)...; S3: ...The cause of car's stoppage is that car's energy can be over or it goes very slowly (TWU)...; S1: ...When the car stopped after it has gone for a while, its energy has lost, not converse (M)..."*

In the above, when the student's responses were analyzed, students generally learnt the Force and Motion Unit however there are some indicators which show some of students have different misconceptions.

Discussion and Conclusion

The current study investigated the effectiveness of learning activities based on argumentation on students' conceptual understanding and establishing thinking friendly classroom environment. The descriptive statistics results showed that the learning activities based on argumentation improved the mean FMCT scores of experiment group more than control group as both groups were increased their scores to some degree from the pretest to posttest and the mean increase was higher for the experimental group (Table 3). And also the mean TFCS scores of experiment group is developed more than control group however, while experiment group increase their score to some degree from the pretest to posttest, control group decreased their score to some degree from pretest to posttest. It may be claimed that, learning activities based on argumentation made increase experiment group's FMCT and TFCS scores.

Following the descriptive statistics, when the comparison for scores of FMCT and TFCS are examined for statistical significance (Table 4), it is seen that learning activities based on argumentation made significant effect on establishing thinking friendly classroom environment but no significant effect on students' conceptual understandings. The effect size is .167 and so 17% (large effect size) of the variance which is found in TFCS is bound up with learning activities based on argumentation approximately. And Cohen d is .87 and this shows that the difference between TFCS means scores of experimental and control groups is .87 standard deviation. In other words, learning activities based on argumentation significantly affected the experimental group's TFCS scores by comparison with control group.

The result of this study regarding the conceptual understanding has similarities with the previous researches. For example, Cinar (2013), studying with 5th graders about effects of argumentation to students' learning products, found that there isn't significant difference regarding conceptual understanding between experimental and control groups end of the research. Kaya (2009), in her study she researched scientific argumentation based teaching on primary school students' conceptual understandings and found that there isn't significant difference between three teaching methods 'Traditional Teaching', 'Inquiry-Based Teaching' and 'Scientific Argumentation-Based Teaching' learning acids and bases subject. However there are studies which show that argumentation applications help students to improve their conceptual understandings (Chen & She, 2012; Kaya, 2013; Sekerci, 2013; Tekeli, 2009). Okumus (2012) and Kucuk (2012) who searched learning method based on argumentation on students' conceptual understandings in States of Matter and Heat Unit, found out that students in experimental group improve that much more than students in control group. Moreover Chen & She (2012) studied effects of argumentation applications on students' conceptual understandings and arguments of experimental group and they found that experiment group's conceptual understandings and arguments better than that of control group.

The interview's results with 6 students from experimental group regarding conceptual understandings were investigated and when students' responses were analyzed, 63 percent of them was in CSU, 9 percent of them was in PSU, 9 percent of them was in TWU, 16 percent of them is was in M, 1 percent of them was in NQD and 2 percent of them was in NI categories. In the light of these findings, students mostly have misconceptions in 'Work, Simple Machines and Frictional Force Cause Energy Loss' subjects. For example, Yilmaz (2001) investigated students' misconceptions in mechanic subjects and found out that students mostly had misconceptions in frictional force. Besides, ErduranAvci and et al. (2012) studied with pre service science teachers to determine misconceptions in 'Work' subject and they found some misconceptions like 'simple machines provide savings in work, if the force is more, work is more, either, if the spent energy is more, work is more, either…' which are similar misconceptions found in this research. Most researches emphasize that many different methods can eliminate misconceptions but misconception can never be resolved (Aydin, 2008; Genc, 2008; Gunaydin, 2010; Keles, 2007; Secer, 2008; Sahin, 2010; Ozsevgec, 2007; Tokiz, 2013).

The results related to thinking friendly classroom features are in conflict with Doganay & Yuce's (2010) research result in which he searched that how the verbal expressions and questions used by an instructor in the courses effect students' thinking skills and it concluded that instructors are disqualified for making students to gain thinking skills because they don't ask questions improving thinking. Besides Gelen (1999) evaluated instructors' sufficiencies on bringing students thinking skills and their application levels of solving problem, decision process, asking questions, critical and creative thinking in courses and although instructors thought that they were qualified bringing students these skills, they were unsuccessful in application in courses.

The results of interviews with 6 students regarding opinions about thinking friendly classroom features were stated in different categories. In 'Teaching Behaviors Develop Thinking' category, while teacher mostly shows give examples (26%) behavior, he rarely shows use evidence (2%) behavior which is important for argumentation activities. In 'Student Behaviors Develop Thinking' category, whereas students state that they mostly show attend and express themselves in activities and argumentation easily in the course (32%), justify answers with using daily observations and examples (27%) or with experiments (27%), they rarely show justify answers with the knowledge they have learnt from other (5%). This result is important in terms of purpose of science education because explain the responses with strong justifications (MEB, 2013). In 'Behaviors Affecting Thinking' category, students state that they usually refrain from their classmates while expressing their thoughts (9%) which affect their thinking mostly. These results are supported many researches from literature. For example Bell (1997), searched how argument representations can make student thinking visible, found out that the software based on argumentation promote individual-focused learning by thinking about the topic in general terms, students learnt how to construct their argument in specific terms and also it promoted expressing their own ideas.

The study may be concluded that learning activities based on argumentation are useful for students to gain thinking behaviors and also revealed those students' opinions and encountered obstacles and external behaviors affecting their thinking in science courses. In this study, students' conceptual understanding didn't improve significantly in terms of statistic. But when the Table 2 is checked, it is seen that students reduce their misconceptions according to descriptive analysis results. Therefore, it may take some more time for students to reconceptualize or lose their misconceptions through argumentation learning. As a method of teaching, learning activities based on argumentation not only make gain student thinking skills and improve conceptual understand, it also helps students how to conduct a discuss, how to justify their opinions, how to talk confidently which they will use in their future lives.

References

Akkaya, M. M. (2006). Ortaogretim 10.Sinif Ogrencilerinin Moment Konusundaki Kavramsal Anlama Duzeylerinin Belirlenmesi [Determination of Grade 10 Students' Conceptual Understanding Levels on the Topic of Moments]. MA diss., Balikesir University

Akkus H., Kadayifci, H., Atasoy, B. & Geban, O. (2003).Effectiveness of Instruction Based on Constructivist Approach on Understanding of on Chemicial Equilibrium Concept. *Research in Science and Technological Education,*21(2): 209-227.

Arli, E. E. (2014). Argumantasyon Tabanli Bilim Ogrenme Yaklasiminin (ATBO) Mevsimlik Tarim Iscisi Konumundaki Dezavantajli Ogrencilerin Akademik Basarilari ve Dusunme Becerilerine Etkisi [The Impacts of Argumentation Based Science Inquiry Approach on Seasonal Agricultural Worker Students' Academic Achievement and Thinking Skills]. MA diss., Ataturk University

Aydin, S. (2008). Ilkogretim 6.Sinif Fen ve Teknoloji Dersi Kuvvet ve Hareket Unitesinin Sosyal Yapilandirmaci Ogrenme Yaklasimi Cercevesinde Ogretimi [Teaching of Force and Motion Unit of Grade 6 Science and Technology Lesson Under Social Constructivism Perspective].MA diss., Balikesir University.

Bar, V. & Travis, A. S. (1991). Children's Views Concerning Phase Changes. *Journal of Research in Science Teaching* 28(4): 363- 382. Doi: 10.1002/tea.3660280409

Baser, M. & Cataloglu, E. (2005). Kavram degisimi yontemine dayali ogretimin ogrencilerin isi ve sicaklik konusundaki yanlis kavramlarinin giderilmesindeki etkisi [Effect of conceptual change oriented instruction on remediation of students' misconceptions related to heat and temperature concepts]. *Hacettepe University Journal of Education* 29(2005):43- 52.

Baskan, H. (2006). Fen ve Teknoloji Ogretiminde Drama Yonteminin Kavram Yanilgilarinin Giderilmesive Ogrenci Motivasyonu Uzerine Etkisi [The Effect of Using Drama Method on Determining the Misconceptions and Motivation in Science and Technology Teaching].MA diss., Karadeniz Technical University.

Baysari, E. (2007). Ilkogretim Duzeyinde 5. Sinif Fen ve Teknoloji Dersi Canlilar ve Hayat Unitesi Ogretiminde Kavram Karikaturu Kullaniminin Ogrenci Basarisina, Fen Tutumuna ve KavramYanilgilarinin Giderilmesine Olan Etkisi [The Effect of the Concept Cartoon Usage on Achievement, Science Attitute and Elemination of Misconcepts on 5th Grade Science on Living Things and Life Theme].MA diss., Dokuz Eylul University.

Bell, P. (1997). *Using Argument Representations to Make Thinking Visible for Individuals and Groups*. Paper presented at the Proceedings of the 2nd International Conference on Computer Support for Collaborative Learning, Canada, 10-19.

Buyukozturk, S., Cakan, M., Tan, S. & Atar, H. K. (2014). *TIMSS 2011 National Preliminary Report.* Ankara: MEB.

Buyukozturk, S. (2011).Sosyal Bilimler IcinVeri Analizi El Kitabi [Handbook of Data Analysis for Social Sciences]. Ankara: Pegem.

Chen, C. H., & She, H. C. (2012).The Impact of Recurrent On-line Synchronous Scientific Argumentation on Students' Argumentation and Conceptual Change. *Educational Technology & Society* 15(1): 197-210.

Chen, Y. C., Hand, B., & McDowell, L. E. A. H. (2013). The Effects of Writing-to-Learn Activities on Elementary Students' Conceptual Understanding: Learning About Force and Motion Through Writing to Older Peers. *Science Education* 97(5): 745-771. doi: 10.1002/sce.21067

Costu, B., Ayas, A. &Unal, S. (2007). KavramYanilgilariVeOlasiNedenleri: KaynamaKavrami [Misconceptions About Boiling and Their Possible Reasons]. *Kastamonu Education Journal* 15(1): 123-136.

Cothari, C. R. (2004). Research Methodology Methods and Techniques (2nd press) Jaipur:New Age International Limited Publishers

Cinar, D. (2013). ArgumantasyonTemelli Fen Ogretiminin 5.SinifOgrencilerininOgrenmeUrunlerineEtkisi [The Effect of Argumentation Based Science Instruction on 5th Grade Students' Learning Outcomes]. PhD diss., Necmettin Erbakan University.

Demirci, N. (2008). Toulmin'in Bilimsel Tartisma Modeli Odakli Egitimin Kimya Ogretmen Adaylarinin TemelKimyaKonulariniAnlamaveTartismaSeviyeleriUzerineEtkisi [The Effect of the Teaching Focused on Toulmin's Scientific Argumentation Model upon the Chemistry Teacher Candidates on General Chemistry Topics and Levels of Argumentation]. MA diss., Gazi University.

Deveci, A. (2009). Ilkogretim 7.SinifOgrencilerinin 'MaddeninYapisi' KonusundaSosyobilimselArgumantasyon, BilgiSeviyeleri ve Bilimsel Dusunme Becerilerini Gelistirmek [Developing Seventh Grade Middle School Students' Socioscientific Argumentation, Level of Knowledge and Cognitive Thinking Skills in the Structure of Matter Subject].MA diss., Marmara University.

Doganay, A. & Sari, M. (2012). Dusunme dostu sinif olcegi (DDSO) gelistirme calismasi [A Study of Developing the Thinking-Friendly Classroom Scale (TFCS)]. *Elementary Education Online,11*(1), 214-229.

Doganay, A. & Guzel Yuce, S. (2010). Ogrencilerin Dusunme Becerilerinin Gelistirilmesinde Rehberlik Yardim: Bir Ogretmenin Sozel Notlari Analizine Iliskin Durum Calismasi [Scaffolding in Improving Students' Thinking Skills: A Case Study of the Analysis of a Teacher's Verbal Expression]. *Educational Administration: Theory and Practice 16*(2),185-214.

Dole, J. A., & Sinatra, G. M. (1998). Re-conceptualizing Change in The Cognitive Construction of Knowledge. *Educational Psychologist, 33*(2/3), 109-128

Dori, J.Y., Tal, T. R. &Tsaushu, M. (2003). "Teaching Biotechnology Through Case Studies-Can We Improve Higher Order Thinking Skills of Nonscience Majors?" *Science Education,87*(6): 767-793. doi: 10.1002/sce.10081

Driver, R., Newton, P. & Osborne, J. (2000). Establishing The norms of scientific -argumentation in classroom. *Science Education, 84*(3), 287-312. Doi:10.1002/(SICI)1098-237X(200005)84:3<287::AID-SCE1>3.0.CO;2-A

Driver, R. & Newton, P. (1997).Establishing the Norms of Scientific Argumentation in Classrooms. Paper presented at the European Science Education Research Conference, Rome, September.

Duit, R., & Treagust, D. F. (2003).Conceptual Change: A Powerful Framework For Improving Science Teaching and Learning. *International Journal of Science Education,25*(6), 671-688

Duschl, R. A. & Osborne, J. (2002).Supporting and Promoting Argumentation Discourse in Science Education. *Studies in Science Education, 38*(1), 39-72.

ErduranAvci, D., Kara, I., &Karaca, D. (2012). Fen bilgisi ogretmen adaylarinin is konusundaki kavram yanilgilari [Misconceptions of science teacher candidates about work]. *Pamukkale University Journal of Education, 31*(2012/1), 27-39

Erduran, S., & Jiménez-Aleixandre, M. P. (2007).*Argumentation in ScienceEducation: Perspectives from Classroom-Based Research.* Springer Science and Business Media B. V.

Erduran S., S. Simon & 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. doi: 10.1002/sce.20012

Gelen, I. (1999). Ilkogretim Okullari 4. Sinif Ogretmenlerinin Sosyal Bilgiler Dersinde Dusunme Becerilerini Kazandirma Yeterliklerinin Degerlendirilmesi [The Evaluation of 4th Grade Elementary School Teachers Competences about Teaching Thinking Skills in Social Studies Course].MA diss., Cukurova University.

Genc, G. (2008). Ilkogretim 6.SinifOgrencilerininKuvvetveHareketKonusunuAnlamaDuzeyleriveKavramYanilgilari [6th Grade Primary School Students'Understanding Level and Misconception in the Subject of Force and Motion].MA diss., Ataturk University.

George, D. and M. Mallery. (2010). *SPSS for Windows Step by Step: A Simple Guide and Reference*. Boston: Pearson

Gultepe, N. (2011). Bilimsel Tartisma Odakli Ogretimin Lise Ogrencilerinin Bilimsel Surecve Elestirel Dusunme Becerilerinin Gelistirilmesine Etkisi [Effect of Argumentation Based Instruction on Improvement of High School Students' Science Process Skills and Critical Thinking Ability].PhD diss., Gazi University.

Gunaydin, G. (2010). 6. SinifOgrencilerininKuvvetveHareketKonusundakiKavramYanilgilarininIncelenmesi [6th Grade Student's Misconceptions about Force and Motion Analysis].MA diss., Sakarya University.

Jiménez-Aleixandre, M. P. and Erduran, S. (2007). "Argumentation in Science Education: an Overview" *In Argumentation in Science Education: Perspectives from Classroom-Based Research, edited by* S. Erduran & M. P. Jiménez-Aleixandre, 3-27, Dordrecht: Springer.

Karisan, D. (2011). Fen Bilgisi Ogretmen Adaylarinin Iklim Degisiminin Dunyamiza Etkileri Konusundaki Yazili Argumantasyon Yeteneklerinin Incelenmesi [An Explororation of Preservice Science Teachers' Written Argumentatin Skills Regarding the Global Climate Change Issue]. MA diss., YuzuncuYil University.

Kaya, E. (2013). Argumentation Practices in Classroom: Pre-Service Teachers' Conceptual Understanding of Chemical Equilibrium. *International Journal of Science Education, 35*(7):1139-1158

Kaya, B. (2009). Arastirma Temelli Ogretim ve Bilimsel Tartisma Yonteminin Ilkogretim Ogrencilerinin Asitler ve Bazlar Konusunu Ogrenmesi Uzerine Etkilerinin Karsilastirilmasi [Comparison of Research Based Instruction and Scientific Discussion Method on Primary School Students' Learnings about Acids and Bases Subject]. MA diss., Marmara University.

Keles, E. (2007). *Altinci Sinif Kuvvet ve Hareket Unitesine Yonelik Beyin Temelli Ogrenmeye Dayali Web Destekli Ogretim Materyalinin Gelistirilmesi ve Etkililiginin Degerlendirilmesi* [Developing and Assessing Effectiveness of Web Supported Instructional Material Based on Brain Based Learning for 6th Grade Force and Motion Unit]. PhD diss., Karadeniz Technical University.

Kelly, G. & Takao, A. (2002). Epistemic Levels in Argument an Analysis of University Oceanography Students' Use of Evidence in Writing. *International Science Education, 86*(3), 314-342. doi: 10.1002/sce.10024

Kuhn, D. & Udell, W. (2007).Coordinating own and other perspectives in argument. *Thinking and Reasoning,13*(2), 90-104.

Kuhn, D. & Udell, W. (2003).The development of argument skills. *Child Development,74*(5), 1245-1260

Kuhn, D. (1991). *The Skills of Argument.* Cambridge: Cambridge University Press.

Kuhn, D. (1992). Thinking as argument. *Harvard Educational Review,62*(2):155-178.

Kuhn, D. (1993). Science as Argument: Implications for Teaching and Learning Scientific Learning. *Science Education,77*(3): 319-337. doi: 10.1002/sce.3730770306

Kutluca, A. Y. (2012). Fen ve Teknoloji Ogretmen Adaylarinin KlonlamayaI liskin Bilimsel ve Sosyobilimsel Argumantasyon Kalitelerinin Alan Bilgisi YonundenIncelenmesi [Investigating of Pre-Service Science Teachers'Socio-Scientific and Scientific Argumentation Quality in Terms of Content Knowledge Level]. MA Diss., AbantIzzetBaysal University.

Kucuk, H. (2012). *Ilkogretimde Bilimsel Tartisma Destekli Sinif Ici Etkinliklerin Kullanilmasinin Ogrencilerin Kavramsal Anlamalarina, Sorgulayici Ogrenme Beceriler iAlgilarina ve Fen ve Teknoloji'ye Yonelik Tutumlarina Etkisi* [The Effect of Using Argumentation Supported Classroom Activities in Elementary Education on Students' Conceptual Understandings, Inquiry Learning Skill Perceptions and Attitudes towards Science and Technology]. MA diss., Mugla Sitki Kocman University.

Lawson, A. E. (2003). The Nature and Development of Hypothetico- Predictive Argumentation with Implications for Science Teaching. *International Journal of Science Education, 25*(11), 1387-1408. doi: 10.1080/0950069032000052117

Means, L. M. & Voss, J. F. (1996).Who reasons well? Two studies of informal reasoningamong children of different grade, ability, and knowledge levels. *Cognition and Instruction,14*(2):139-178.

MEB.(2013). *Turkish Ministry of National Education Board of Education and Discipline Primary Science and Technology Curriculum* [In Turkish]. Ankara: MEB Publications.

Miles, M. B. & Huberman, A. M. (1994).*Qualitative Data Analysis: An Expanded Sourcebook.* USA.

Okumus, S. (2012). *Maddenin Hallerive Isi Unitesinin Bilimsel Tartisma (Argumantasyon) Modeli Ile Ogretiminin Ogrenci Basarisina ve Anlama Duzeylerine Etkisi* [The Effects of Argumentation Model on Students'Achievement and Understanding Level on the Unit of "States of Matter and Heat"]. MA Diss., Karadeniz Technical University.

Osborne, J. (2005). The Role of Argumentation in Science Education. In *Research and the Quality of Science Education*, edited by K. Boersma, M. Goedhart, O. de Jong, H. Eijkelhof, sayfa, Netherlands: Springer.

Osborne, J., Erduran, S. & Simon, S. (2004). *Ideas, Evidence and Argument in Science. Video. In-service Training Manual and Resource Pack.* London: King's College London.

Ozsevgec, T. (2007). Ilkogretim 5.Sinif Kuvvet ve Hareket Unitesine Yonelik 5E Modeline Gore Gelistirilen Rehber Materyallerinin Etkinliklerinin Belirlenmesi [Determining Effectiveness of Guided Materials About Force and Motion Unit Based on the 5E Model for Elementary Students]. PhD Diss., Karadeniz Technical University.

Perkins, D. N. (1992).Person-Plus: A Distributed view of Thinking and Learning. In *Distributed Cognitions: Psychological and Educational Considerations*, edited by Gavriel Salomon, 88-110. USA: Cambridge University Press.

Quinn, V. (1997).*Critical thinking in young minds*. London: David Fulton.

Sampson, V. & Clark, D. (2008).The Impact of Collaboration on the Outcomes of Scientific Argumentation. *Science Education,93*(3), 448-484. doi: 10.1002/sce.20306

Scheweizer, D. M. (2002).Heating up the Science Classroom through Global Warming: An Investigation of the Use of Argument in Earth System Science Education. PhD diss., Universty of California.

Secer, S. (2008).6. Sinif Ogrencilerinin Kuvvet ve Hareket Konusundaki Alternatif Kavramlarinin Belirlenmesi ve Kavramsal Gelisimin Incelenmesi [Determining 6th Grade Students' Alternative Conceptions about Force and Motion Unit and Investigating Conceptual Development].MA diss., Balikesir University.

Seloni, S. R. (2005). Fen bilgisi ogretiminde olusan kavram yanilgilarinin proje tabanli ogrenme ile giderilmesi [Resolving the misconceptions in science education by project based learning approach]. MA. Diss., Marmara University.

Simon, S., Erduran, S. & Osborne. J. (2006).Learning to Teach Argumentation: Research and Development in the Science Classroom. *International Journal of Science Education,28*(2), 235-260. doi:10.1080/09500690500336957

Simon, S., Osborne, J. & Erduran.S. (2003).Systemic teacher development to enhance the use of argumentation in school science activities. (pp:198-217) in *Leadership and professional development in science education: New possibilities for enhancing teacher learning.* London & New York: RoutledgeFalmer.

Solomon, J. (1991). *Exploring the Nature of Science: Key Stage 3*.UK:Glasgow.

Suzuk, E. (2011). Model Roketcilik Arastirmaci-Sorgulama Ortaminda Ogrenciler Tarafindan Olusturulan Argumanlarin Kalitesinin ve Bilimsel Kredibilitesinin Arastirilmasi [Exploring the Quality and Scientific Credibility of Students'Argumentation in Model Rocketry Community of Inquiry].MA diss., Marmara University.

Sahin, C. (2010). Ilkogretim 8.Sinif "Kuvvet ve Hareket" Unitesinde "Zenginlestirilmis 5E OgretimModeli"ne Gore Rehber Materyaller Tasarlanmasi, Uygulanmasi ve Degerlendirilmesi [Design, Implementation and Evaluation of the Guided Materials Based on the "Enriched 5E Instructional Model" for the Elementary 8thGrade "Force and Motion" Unit].PhD diss., Karadeniz Technical University.

Sekerci, A. R. (2013). Kimya Laboratuvarinda Argumantasyon Odakli Ogretim Yaklasiminin Ogrencilerin Argumantasyon Becerilerine ve Kavramsal Anlayislarina Etkisi [The Effect of Argumentation Based Instruction on Studenst' Argumentation Skills and Conceptual Understanding in Chemistry Laboratory].PhD diss., Ataturk University.

Tabachnick, B. G. & Fidell, L. S. (2013). *Using Multivariate Statistics*. Boston: Pearson.

Tao, P. K., & Gunstone, R. F. (1999). The Process of Conceptual Change in Force And Motion During Computer-Supported Physics Instruction.*Journal of Research in Science Teaching* 36(7): 859-882. doi: 10.1002/(SICI)1098-2736(199909)36:7<859::AID-TEA7>3.0.CO;2-J

Tekeli, A. (2009). Argumantasyon Odakli Sinif Ortaminin Ogrencilerin Asit-Baz Konusundaki Kavramsal Degisimlerin eve Bilimin Dogasini Kavramalarina Etkisi [The Effect of An Argumentation-Centered Class Environment on the Conceptual Change about Acid-Base and the Understanding Nature of Science].MA diss., Gazi University.

Temizyurek, K. (2003). *Fen Ogretimi ve Uygulamalari* [Instruction and Applications of Science]. Ankara: Nobel.

Tokiz, A. (2013). Ilkogretim6., 7. ve 8. Sinif Ogrencilerinin Kuvvet ve Hareket Konusundaki Kavramsal Anlama Duzeylerinin Kavram Karikaturleri, Kavram Haritasi, Cizimler ve Gorusmeler Kullanilarak Degerlendirilmesi

[Evaluating the Conceptual Understanding Level of Primary School 6th, 7th and 8th Graders on the Issue of Force and Motion by Using Concept Cartoons, Concept Map, Drawings and Interviews]."MA diss., Celal Bayar University.

Toulmin, S. (2003).*The Uses of Argument*. Cambridge-UK: Cambridge University Press (Updated Edition)

Toulmin, S. (1958).*The Uses of Argument.* New York: Cambridge University Press.

Tumay, H. (2008). Argumantasyon Odakli Kimya Ogretimi [Argumentation Focused Chemistry Teaching]. PhD diss., Gazi University.

Ulucinar Sagir, S. (2008). Fen Bilgisi Dersinde Bilimsel Tartisma Odakli Ogretimin Etkililiginin Incelenmesi [Investigation of Effectiveness of Argumentation Theory Based Teaching in Science Courses].PhD diss., Gazi University.

Uzun, N. B., Gelbal, S. &Ogretmen, T. (2010). Modeling the Relationship Between TIMSS-R Science Achievement and Affective Characteristics and Comparing the Model According to Gender. *Kastamonu Education Journal, 18*(2), 531-544.

Van Eemeren, F. H., Grootendorst, R., Henkemans, F. S., Blair, J. A., Johnson, R. H., Krabbe, E. C. W., Plantin, C., Walton, D. N., Willard, C. A., Woods J. & Zarefsky, D. (1996). *Fundamentals of Argumentation Theory: A Handbook of Historical Backgrounds and Contemporary Developments*. Mahwah: Lawrence Erlbaum Associates.

Van Eemeren, F. H. (1995). A World of Difference: The Rich State of Argumentation Theory. *Informal Logic,17*(2): 144-158.

Yagbasan, R. & Gulcicek, C. (2003). Fen Ogretiminde Kavram Yanilgilarinin Karakteristiklerinin Tanimlanmasi [Describing the Characteristics of Misconceptions in Science Teaching]. *Pamukkale University Journal of Education,1*(13), 102-120.

Yerrick, R. K. (2000). Lower track science students' rgumentation and open inquiry instruction. *Journal of Research in Science Teaching, 37*(8), 807-838.

Yildirim, H. H., Yildirim S., Yetisir, M. I. &Ceylan, E. (2013).*PISA 2012 National Preliminary Report.* Ankara: MEB Publications.

Yildirim, A. &Simsek, H. (2013).*Nitel Arastirma Yontemleri* [Qualitative Research Methods]. Ankara: Seckin.

Yildiz, E. (2008). 5E Modelinin Kullanildigi Kavramsal Degisime dayali Ogretimde Ust Bilisin Etkileri: 7. Sinif Kuvvet ve Hareket Unitesine Yonelik Bir Uygulama [The Effects of Metacognition during the Instruction Based on Conceptual Change Used with 5E Model: An Application Regarding the Force and Motion Subject in the 7th Grade]. PhD diss., Dokuz Eylul University.

Yilmaz, S. (2001). *The Effects of Bridging Analogies on High School Students' Misconceptions in Mechanics*.MA diss., Middle East Technical University.

Zohar, A. & Nemet, F. (2002).Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching,39*(1), 35-62. doi:10.1002/tea.10008.