The effect of argumentation-based teaching performed for environment-energy issues on critical thinking of prospective classroom teachers

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Abstract. The aim of this research is to investigate the effect of argumentation-based teaching carried out for environment-energy subjects on critical thinking of prospective classroom teachers. The research was conducted in accordance with the quantitative research method and pre-post-test semi experimental design with experimental-control group was used. Environmental education lessons were taught for ten weeks in the experimental and control groups based on argumentation and traditional teaching, respectively. After the argumentation-based teaching process, when prospective classroom teachers pre-test scores obtained from the critical thinking skill test are statistically controlled a significant difference, was found in favor of the post-test critical thinking skill mean scores of the experimental group (p <0,05), and the effect of the application was "middle effect" (η²: 0,11). The critical thinking levels of the experimental group prospective classroom teachers were found to be higher than those of the control group.

Keywords: Argumentation-based teaching process, critical thinking skill, environment-energy subjects, prospective classroom teachers

INTRODUCTION

In today's science education, it is emphasized that it is important to abandon the understanding of equipping students with the information based on memorization, and instead, they should be enabled to research and question the information they have obtained and use this information in different situations and solving problems in a functional way (Aktaş, 2017). The Ministry of National Education (MEB) has defined the desired student profile through the science programs it has published and characterized them as the individuals who investigate the source of information, question and discuss events and situations (MEB, 2013; 2018). In order to educate this student profile, teachers should have the desire to discover the natural and physical world and should include the methods and strategies, through which they create the knowledge in their own minds by thinking just like a scientist and which enables them to investigate, question and discuss knowledge, into their learning-teaching processes (Babacan, 2017).

Another method that can be included in learning-teaching processes in science courses and that enables the discussion of events and situations scientifically is the argumentation process. Argument refers to the statements put forward in order to present the strengths of a situation or subject and to convince others to this idea (Güzel, Erduran & Ardaç, 2009). Arguments form the claims, data, reasons, and supporters that contribute to a discussion process (Erduran, Simon & Osborne, 2004). Argumentation is seen as a mental activity and is used to support mental activities, evidence and claims through verbal and written activities (McNeill & Pimentel, 2010). Argumentation is defined as a process that allows individuals to be curious and active, helps with meaningful and permanent learning, and provides students and teachers with the opportunity to reveal their own opinions (Aydın & Kaptan, 2014). In the
process of argumentation, students contribute to knowledge generation processes like a scientist as well as helping to develop high-level thinking skills (Namdar, 2017). In this process, an individual aims at convincing another individual by using verbal, social and logical propositions that will reveal, reject or prove the acceptability of an opinion and the proposition stated in the opinion (Van, Eemeren and Grootendorst, 2004). In this way, while certain claims or results of the argument intersect, its evidence and supporters are produced by the student (Zohar and Nemet, 2002).

In the discussions that are traditionally applied in science courses, an environment supporting the teacher-learner interaction can be prepared; the process starts when the teacher asks a question to the students and ends with the evaluation of the answers received from the students. On the other hand, in in-class discussions where argumentation is included in the learning process, an environment based on producing ideas is formed and the course process becomes more productive by evaluating different ideas in line with the evidence and by selecting the argumentation which reveals the best opinion (Aktaş, 2017). In the argumentation process, students aim at reaching a common opinion based on the data existing among different ideas (Furtak, 2006). Thus, a discussion environment based on establishing an argument is created in classrooms and students are allowed to ask questions to each other, reach a conclusion, evaluate the results, interpret the proposed ideas scientifically and analyze the interpretations (Çınar, 2016). The argumentation method enables the subjects to be taught in a more interesting way, allows students to remember the information learned, to learn information more permanently, to do analysis and synthesis, and it is an important teaching method for students in terms of improving reading, writing and speaking skills (Schmoker & Graff, 2011).

Halpern (2003) characterized critical thinking as purposeful, logical and goal-oriented and stated that it covered problem-solving, designing inferences, calculating possibilities and decision-making. Individuals who can think critically can actively use cognitive processes and interpret the results they reach by subjecting the information they obtain to an evaluation based on criteria (Yeşilpinar, 2011). They should be able to test the reliability of the claims, which have been put forward, through good observations and inferences from these observations and to determine the contradictions and inconsistencies (Deniz, 2009). Through the argumentation process, students can be critical thinkers who are interested in subjects, open-minded, attentive while researching the information regarding a subject, focused on questioning this information, honest in confronting their personal prejudices, meticulous in decision-making and willing to reconsider their decisions (Facione, 2011). When they are involved in the argumentation process and encounter different views, they can reflect their own ideas, become aware of the accuracy or inaccuracy of their ideas, recognize misconceptions, and eventually learn better (Cross, Taasoobshirazi, Hendricks & Hickey, 2008). Erduran and Jimenez-Aleixandre (2008) stated that argumentation process contributes to scientific literacy of students, encourages them to speak and write with the science language, activates critical thinking in addition to providing students with an epistemological belief and science culture, because argumentation-based learning environments require the collaboration of everyone in the classroom, and instead of accepting information as it is, they allow for questions, discussions, evaluations, criticisms and finding a middle ground (Angün & Atalay, 2016). In this way, the argumentation process becomes a structure where students can gain different perspectives and develop critical thinking by communicating with each other (Chen & She, 2012). Considering these important contributions, it is important to focus on not only the conceptual information but also the argumentation process during the science education since it will enable students to develop critical thinking skills and understand the scientific subjects (Driver, Newton & Osborne, 2000).

Zohar and Nemet (2002) argue that the most effective teaching of argumentation skills is enabled when students think over real-life problems and discuss them. By nature, socio-scientific subjects address real-life problems and direct students towards establishing a relationship between daily life and problems and discussing these issues (Lin & Mintzes, 2010). Socio-scientific issues are open-ended, unsolved and dilemma problems, and they can be evaluated in different and conflicting thinking patterns (Levinson, 2006). Accordingly, socio-
The effect of argumentation-based teaching performed ...
studies are examined, it is seen that when learning-teaching processes are designed based on argumentation, they enable permanence in learning (Şahin, 2016; Kuzzu, 2018; Acar, 2009), increase in academic achievement (Hasançebi, 2014; Deniz, 2014; Aktaş, 2017; Karaer, 2016), positive development in individual characteristics (Lin and Mintenz, 2010; Sampson et al., 2010) and increase in argument-construction skills (Keys, et al., 1999; Tal and Kedmi, 2006; Öztürk, 2013; Torun, 2015; Çiftçi, 2016; Sadler, 2006; Anagün and Atalay; 2016; Erenler, 2017).

It is seen that the sampling of the majority of the conducted studies consisted of secondary school students and science teachers/prospective teachers and the argumentation process was employed in laboratory activities. However, a study that used the argumentation-based teaching process as a tool for environment-energy issues, measured critical thinking skills in this way, and whose study group consisted of prospective classroom teachers, has not been encountered in the literature. With this research, socio-scientific situations in the environment-energy issues were examined in the argumentation process, and prospective teachers were placed in the center of learning. Moreover, it was thought to be important and would contribute to the literature that prospective classroom teachers were involved in a modern teaching process both for preparing themselves for the profession and educating the new generation.

In line with this purpose, the basic problem statement of the research was determined as follows: "Does argumentation-based teaching performed for environment-energy issues have an effect on critical thinking of prospective classroom teachers? " Sub-problems created in the context of the basic problem statement are listed below:

1. Is there a significant difference between pre-process and post-process critical thinking skills mean scores of prospective classroom teachers to whom the lessons were taught via traditional teaching and prospective classroom teachers to whom the lessons were taught via argumentation-based teaching?

1.1. Is there a significant difference between the critical thinking mean scores when the critical thinking skill pretest scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching and prospective classroom teachers to whom the lessons were taught via traditional teaching are controlled?

1.2. Is there a significant difference between pre-process and post-process critical thinking skill mean scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching?

1.3. Is there a significant difference between the pre-process and post-process critical thinking skill mean scores of the prospective classroom teachers to whom the lessons were taught via traditional teaching?

2. What is the level of pre-process and post-process critical thinking skills of prospective classroom teachers to whom the lessons were taught via argumentation-based teaching and to whom the lessons were taught via traditional teaching?

**METHODS**

**Research Model**

The research was conducted in accordance with the quantitative research method and quasi-experimental design with pretest-posttest experimental-control groups was used in the research. In this design, measurements related to the variable dependent on the experimental and control groups are obtained by using the same measurement tools as pretest and posttest, however, the experimental process is applied to the experimental group (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2012). The experimental process applied is presented in Table 1.

As shown in Table 1, the Critical Thinking Appraisal Scale was applied as pretest-posttest in order to measure the change in the critical thinking skills of the prospective classroom teachers before and after the argumentation-based teaching process. The procedural stage was applied in the environmental education courses and included ten-week argumentation-based teaching process conducted for environment-energy issues for prospective classroom teachers.
After the experimental process, pretest and posttest data were analyzed and the data were interpreted.

### Table 1. Quasi-experimental design with pretest-posttest experimental-control groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest</th>
<th>Process (10 Weeks)</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Prospective Classroom Teachers)</td>
<td>Critical Thinking Appraisal Scale</td>
<td>Teaching Lessons with Traditional Teaching</td>
<td>Critical Thinking Appraisal Scale</td>
</tr>
<tr>
<td><strong>Experimental Group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Prospective Classroom Teachers)</td>
<td>Critical Thinking Appraisal Scale</td>
<td>Teaching Lessons with Argumentation-Based Teaching Process</td>
<td>Critical Thinking Appraisal Scale</td>
</tr>
</tbody>
</table>

### Implementation Process

In terms of the environmental education course, the research was carried out by the researcher based on the traditional teaching methods with control group prospective classroom teachers and based on the argumentation-based teaching method with experimental group prospective classroom teachers. Teaching lessons with traditional teaching is defined as a form of implementation in which methods such as direct instruction, question-answer and discussion are used in the leadership of the teacher and the course process is guided by the teacher (Gürses, 2010). However, in recent years, especially with the fundamental changes made by the Ministry of National Education in the curricula in 2005, directing students towards research-questioning stands out as a method that teachers frequently benefit from. However, in the control group, the researcher structured the subjects of environmental education course with the traditional teaching specified by Gürses (2010), and frequently used the teaching methods of direct instruction, question-answer and large group discussion during the course and managed the course process in a teacher-centered way. In addition, the researcher tried to diversify the course process by supporting the subjects related to environmental education with visual and auditory tools.

In the experimental group, the researcher started the course by making a short reminding about the previous week’s environmental education course subjects, gave short information regarding the subjects to be taught in that week, diversified the subjects with visual and auditory tools and tried to receive feedback about the subject by using the question-answer method. After the completion of that week’s course subjects, the prospective classroom teachers were asked to construct an argument regarding environment-energy issues in the rest of the course. In this process, the scenario form reflecting the environment-energy relationship was firstly distributed and the prospective classroom teachers were asked to read this scenario, construct individual arguments and individual counterarguments according to the Toulmin Argument Model (1958), which is the most widely used in educational studies in the literature, and write these arguments on the form. At this point, the researcher played a role as a guide, answered the scientific questions about the scenarios by walking around the classroom and encouraged the prospective teachers to support their claims with valid evidence while constructing the argument and to create higher quality arguments by using the argument components (claim, data, ground, warrant, qualifier and rebuttal). This process lasted approximately 20 minutes. Afterwards, the group scenarios reflecting the environment-energy relationship in which the same scenario was included were distributed and it was asked to discuss individual and individual counterarguments in heterogeneous small groups that were formed. At the end of the discussion process, the groups were asked to construct the group argument and the group counterargument. In the meantime, the researcher acted as a guide and visited the groups. This process lasted approximately 20 minutes. The researcher ended the course by collecting the individual scenario forms of each prospective classroom teacher and group scenario forms of each group.

The scenarios designed for environment-energy issues were prepared by the researchers after taking three expert opinions in terms of conformity to the purpose, clarity of the statements, and validity of the scope. The pre-application of the scenarios was conducted with...
prospective classroom teachers who were not included in the sample group. The scenarios on which arguments were asked to be constructed were arranged by the researchers according to the widespread use of the energy resources in our country and their discussion status in the public opinion within the scope of environment-energy relationship. The names of the scenarios and the subjects they are related to are presented in Table 2.

**Table 2. Information related to the prepared scenarios**

<table>
<thead>
<tr>
<th>Week</th>
<th>Scenario Name</th>
<th>Scenario Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hydraulic Energy</td>
<td>Use of hydraulic power, hydroelectric power plants (HPP) and the use of wave power plants, their environmental impacts, economic reflections.</td>
</tr>
<tr>
<td>2</td>
<td>Electric Car</td>
<td>Comparison of electric and gasoline-powered vehicles in terms of operation principle, usage, performance, environmental impacts and economic reflections.</td>
</tr>
<tr>
<td>3</td>
<td>Paris Climate Change</td>
<td>Use of fossil fuels, increase in greenhouse gases, global warming, measures taken and environmental and economic reflections.</td>
</tr>
<tr>
<td>4</td>
<td>Bio-fuel Production</td>
<td>Bio-fuel production methods, usage, limitations and threats to the agricultural sector.</td>
</tr>
<tr>
<td>5</td>
<td>Nuclear Energy</td>
<td>Nuclear energy and production methods, nuclear power plants, wastes, environmental and economic reflections.</td>
</tr>
<tr>
<td>6</td>
<td>Wind Energy</td>
<td>Wind Power Plants (WPP), functionality, environmental and economic reflections.</td>
</tr>
<tr>
<td>7</td>
<td>Solar Energy</td>
<td>Solar Power Plants (SPP), functionality, environmental and economic reflections.</td>
</tr>
<tr>
<td>8</td>
<td>Sıcak Çermik</td>
<td>Geothermal energy, usage, comparison with tourism sector, environmental and economic reflections.</td>
</tr>
<tr>
<td>9</td>
<td>Hydrogen Energy</td>
<td>Hydrogen energy production methods, usage areas, limitations, environmental and economic reflections.</td>
</tr>
<tr>
<td>10</td>
<td>Future of the Energy</td>
<td>The diversity of energy resources and the reasons of the resources preferred by the prospective teachers.</td>
</tr>
</tbody>
</table>

The duration of the course, the content of the environmental education course subjects and the content of the scenario prepared for environment-energy issues were taken into consideration and the control group was tried to be equalized with the duration of the course by the researcher. This process continued for 10 weeks in the course process of an academic period.

**Sampling**

In this research, firstly the pilot study and then the actual study were performed in order to determine the reliability of the data collection tool and critical thinking skill levels of prospective classroom teachers. 385 prospective teachers, who were selected with convenient sampling method and receiving education in the 1st, 3rd and 4th grades of Department of Primary Education - Division of Classroom Education of a university in a province in the Central Anatolian Region, participated in the pilot study.

In the actual study, second-grade prospective teachers, who were selected with the criterion sampling method and studying in the Faculty of Education - Department of Primary Education - Division of Classroom Education of the related university in the fall semester of the 2017-2018 academic year, were included in the sample and the study was carried out in the Environmental Education course process. The criterion used in the determination of the study group of the research was that the prospective classroom teachers were taking the environmental education course. The reason why environmental education course was
determined as a criterion is that the content of the course would enable prospective teachers to be more aware of environment and energy-related issues and it was suitable for argumentation-based teaching. University placement scores of the prospective classroom teachers in the two branches of the second grades were compared with the independent groups t-test, and no significant difference was detected between the university placement scores of the groups (t(86) = 0.267; p=0.790). Accordingly, the branches were considered identical, and one of the branches was determined as the experimental group (N:44) and the other was determined as the control group (N:44). For the process of constructing the group argument, heterogeneous groups consisting of six prospective teachers were formed by considering the gender variable and pretest mean scores that the experimental group prospective classroom teachers obtained from the data collection tool, and the prospective teachers were enabled to discuss the scenarios and construct arguments in these groups.

**Data Collection Tool**

As the data collection tool, "*Critical Thinking Appraisal Scale*" developed by Watson and Glaser (1964) was used in the research. The scale consists of the dimensions that include some important skills for critical thinking and includes the problems, situations, discussions and comments that an individual may face in his/her daily life (Saçlı, 2008). The scale measures individuals’ ability to identify problems and evidence, to make inferences and to evaluate abstract concepts and generalizations, and it also measures the relationship among all sub-dimensions (Demiral, 2014). The scale is a paper-pencil test consisting of 100 items and five dimensions. For participants, each sub-section has an instruction regarding how to answer the questions, and the skill to be measured in that section is also explained. In the instruction section, a sample case is given, and how to answer the questions is explained on this sample. Following this sample case, the main text is given, and the participants are asked to make a choice. According to the results of the research conducted for these scale items, Houle, Morse and McCune stated that the total scores obtained from the test validly measured the competences of the individuals in terms of critical thinking (Çikriç, 1993). Participants receive a score of 1 for each correct answer and 0 for each incorrect answer. The total score obtained from the scale indicates the individual's critical thinking level. A high total score indicates a desired critical thinking and a low total score indicates a poor critical thinking. It was calculated that the mean scores of the students varied between 57.7 and 70.2, and the reliability value was between 0.85 and 0.87 (Saçlı, 2008).

The Critical Thinking Appraisal Scale (Form YM) was adapted into Turkish by Çikriç (1993). When the total scores of the students in the sample where the Critical Thinking Appraisal Scale was developed and the students included in the sample of the study adapted into Turkish are compared, it is seen that the scores of the students in Turkey are lower. In terms of this difference, Çikriç (1993) stated that some of the items in the scale were directly related to the United States, these items were out of context for the students in our country and we had a society that does not like reading as a country as well as the excessive number of items. Since the reliability value was calculated in the range of $0.60 < \text{KR-20} < 0.80$ in the adaptation studies applied to university students (Çikriç, 1996; Kaya, 1997; Özcan and Çelenk, 2007; Demiral, 2014), the scale was accepted as considerably reliable (Büyüköztürk et al., 2012) and the researchers decided to use the Critical Thinking Appraisal Scale in this study conducted with prospective classroom teachers.

In order to test the reliability of the data collection tool, a pilot study was conducted with 385 prospective classroom teachers apart from the study group, and the KR-20 reliability coefficient was calculated as 0.53 with the data obtained from the scale. This value was found to be lower in the studies conducted with prospective teachers in our country. This may have resulted from the low number of the sample in the pilot study. Another reason may be that this scale was not applied to the prospective classroom teachers of a single university or some items were not understood due to the length of some scale items. However, since the coefficient of 0.53 is considered to be reliable in the literature (Büyüköztürk et al., 2012; Yıldırım & Şimşek, 2011), it was interpreted that the Critical Thinking Appraisal Scale was reliable. In this context,
the scale was applied as pretest and posttest to the experimental and control groups prospective classroom teachers.

According to the mean scores obtained from the pilot study, prospective classroom teachers were divided into high, medium and low critical thinking levels. The formula determined by Sağdıç (2008) was used for the separation of these levels. As a result of the pilot study, when the three levels determined according to the critical thinking mean scores of the prospective classroom teachers were calculated and rounded to full scores; it was determined that 50-56 score range constituted the low critical thinking level, 57-69 the medium level and 70-76 the high level. These levels, which were determined based on the scores, were used as reference points in the pretest and posttest for the prospective classroom teachers in the control and experimental groups.

The actual study regarding the Critical Thinking Appraisal Scale was conducted as pretest and posttest with the prospective classroom teachers in the experimental and control groups and the KR-20 reliability coefficients were calculated with the data obtained from the scale (KR-20$_{pretest}$=0.52; KR-20$_{posttest}$=0.58). These values were interpreted as reliable since they were close to the reliability value calculated in the pilot study and in the range of $0.50 < KR-20 < 0.60$. Accordingly, the data obtained from the Critical Thinking Appraisal Scale for the pretests and posttests in the actual study were accepted as reliable.

Data Analysis

SPSS and Excel package programs were used in the analyses related to the Critical Thinking Appraisal Scale applied before and after the argumentation-based teaching. In the analyses of the data, Kolmogorov Smirnov and Shapiro Wilk tests were primarily carried out for the normality of the distribution. Frequency distribution was used to determine the critical thinking skill levels of the prospective classroom teachers in the control and experimental groups before and after the process. The covariance analysis (ANCOVA) was used to test the critical thinking skill posttest mean scores by controlling the critical thinking skill pretest scores of the prospective classroom teachers in the control and experimental groups. In ANCOVA, covariant is assigned in the comparison of the test scores of the groups and a variable (or variables) having a relationship with the dependent variable is controlled statistically. ANCOVA can be used when the following assumptions are provided: a linear relationship between the covariant and intra-groups dependent variable, equality of the regression slopes, a relationship between the samples whose mean scores will be compared, not having a very high level of relationship between covariant if there is more than one covariant ($|r|<0.30$) and measurement of the covariant with reliable and errorless measurement tools (Yıldırım and Şimşek, 2013).

The difference between the mean pretest-posttest scores of the prospective classroom teachers in the experimental and control groups was analyzed by using the dependent groups t-test, and the effect size (eta squared $[\eta^2]$) was calculated according to the variance between the scores. Effect size is defined as a standardized measurement of the difference between mean scores and reported as the standardized difference (Çapık, 2014). In the calculation of the effect size, the calculation (Cohen’s d formula) put forward by Cohen was taken into consideration. According to Cohen, if the value of $d$ is less than 0.2, the effect size is small; if it is 0.5, it is medium and if it is higher than 0.8, it indicates a large effect (Kılıç, 2014).

RESULTS

The aim of this study is to examine the effect of argumentation-based teaching performed for environment-energy issues on critical thinking of prospective classroom teachers. The data distribution normality of the pre-posttests was examined before addressing the sub-problems of the research. Kolmogorov-Smirnov and Shapiro Wilk tests were performed for the normality of the data set. In this study, the number of the data is 87 according to the Kolmogorov-Smirnov test results; when the size of this value is greater than 0.05 for both the pretest and posttest and the skewness and kurtosis coefficients are between +2 and -2, it is emphasized that the scores
show normal distribution. Table 3 shows the Normality Test results of the Critical Thinking Appraisal Scale applied to the experimental and control groups as pretest and posttest.

**Table 3. Critical thinking appraisal scale experimental and control groups normality distribution results**

<table>
<thead>
<tr>
<th></th>
<th>Kolmogorov-Smirnov*</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>df</td>
</tr>
<tr>
<td><strong>Pretest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>0.067</td>
<td>44</td>
</tr>
<tr>
<td>Control Group</td>
<td>0.124</td>
<td>44</td>
</tr>
<tr>
<td><strong>Posttest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>0.105</td>
<td>44</td>
</tr>
<tr>
<td>Control Group</td>
<td>0.112</td>
<td>44</td>
</tr>
</tbody>
</table>

*p>0.05

As seen in Table 3, in the Kolmogorov-Smirnov normality analysis, it was detected that both pretest and posttest data of the experimental and control groups showed normal distribution (p>0.05). Furthermore, the skewness and kurtosis coefficients of the data were checked and it was determined that the skewness (-0.140/0.357) and kurtosis (-0.680/0.702) coefficients of the pretest data of the experimental group and the skewness (-0.698/0.357) and kurtosis (0.273/0.702) coefficients of the pretest data of the control group were between +2 and -2. It was determined that the skewness (-0.299/0.357) and kurtosis (-0.207/0.702) coefficients of the posttest data of the experimental group and the skewness (-0.143/0.357) and kurtosis (-0.230/0.702) coefficients of the posttest data of the control group were also between +2 and -2. As a result of the analyses, it was decided to use parametric measurements in the pre-posttest data analyses of the experimental and control groups regarding the Critical Thinking Appraisal Scale. Findings related to the sub-problems examined in the research are respectively given below:

1. **Is There a Significant Difference Between Pre-Process and Post-Process Critical Thinking Skills Mean Scores of Prospective Classroom Teachers to Whom the Lessons Were Taught Via Traditional Teaching and Prospective Classroom Teachers to Whom the Lessons Were Taught Via Argumentation-Based Teaching?**

In order to determine whether the argumentation-based teaching process affected the prospective classroom teachers’ critical thinking skills, the mean scores that the teachers in the experimental and control groups received from the Critical Thinking Appraisal Scale were taken into consideration. Prospective classroom teachers can receive a score of 1 for each question and a maximum of 100 scores from this test. Findings related to the research problem and sub-problems are presented below with the help of tables:

1.1. **Is there a significant difference between the critical thinking mean scores when the critical thinking skill pretest scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching and prospective classroom teachers to whom the lessons were taught via traditional teaching are controlled?**

The covariance analysis (ANCOVA) was used to test the critical thinking skill posttest mean scores by controlling the critical thinking skill pretest scores of the prospective classroom teachers in the control and experimental groups. The main assumptions of ANCOVA were controlled before the comparisons of the groups. The relationship between the critical thinking pretest mean scores (the control variable) and the posttest mean scores (the dependent variable) was examined (r=0.302; p=0.002), and a linear relationship was determined. The group*pretest combined effect was not significant (F(1-84)=0.504; p=0.480), and the assumption that the regression slopes were equal was accepted. The assumption of the equality of the variances of the groups was performed with Levene test and the result of this test showed...
that the variance could be considered equal (p=0.169). The reliability of the measurement tool was tested in both pilot and actual studies and the measurement tool was accepted to be reliable and ANCOVA process was followed.

The results of ANCOVA conducted for the comparison of the posttest mean scores between the groups by examining the critical thinking skill pretest scores are given in Table 4.

Table 4. ANCOVA results regarding the comparison of the posttest mean scores between the groups when the critical thinking skill pretest scores are controlled

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>sd</th>
<th>Average of Squares</th>
<th>F</th>
<th>p</th>
<th>Effect Size ($\eta^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>325.687</td>
<td>1</td>
<td>325.687</td>
<td>10.282</td>
<td>0.002</td>
<td>0.111</td>
</tr>
<tr>
<td>Group</td>
<td>336.426</td>
<td>1</td>
<td>336.426</td>
<td>10.621</td>
<td>0.002*</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>2692.381</td>
<td>85</td>
<td>31.675</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>409063.000</td>
<td>88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.005

When Table 4 is examined, it is seen that F values calculated by ANCOVA are significant for both pretest (covariant) and posttest. The significance (F(1.85)=10.282; p<0.05) of the F value belonging to the pretest reveals that the pre-process critical thinking skills of the prospective classroom teachers explain a significant level of variance. When the critical thinking skill pretest mean scores were statistically controlled, it was determined that there was a significant difference between the critical thinking skill posttest mean scores of the prospective classroom teachers to whom the lessons were taught via the argumentation-based instruction and the critical thinking skill posttest mean scores of the teachers to whom the lessons were taught via traditional teaching method (F(1.85)=10.621; p<0.05). Eta squared ($\eta^2$) value was found to be 0.111 and 11% of the variance regarding the critical thinking posttest mean scores of the prospective classroom teachers resulted from the difference of the argumentation-based teaching process. According to Cohen, this value (0.06<$\eta^2$<0.14) is accepted to be at the medium level.

Bonferroni test was applied to determine the difference between the groups. It was detected that the critical thinking skill posttest corrected mean scores ($\bar{X}_{\text{experimental corrected}}=69.85$) of the prospective classroom teachers to whom the lessons were taught with argumentation-based teaching were higher than the critical thinking skill posttest corrected mean scores ($\bar{X}_{\text{control corrected}}=65.94$) of the prospective classroom teachers to whom the lessons were taught via traditional teaching and a significant difference was determined in terms of the mean scores (p<0.05). This result can be interpreted in a way that when the critical thinking skill pretest scores are controlled, the argumentation-based teaching process moderately increased the prospective classroom teachers’ critical thinking skills compared to the traditional teaching.

1.2. Is there a significant difference between pre-process and post-process critical thinking skill mean scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching?

Before and after the argumentation-based teaching process, the critical thinking skill mean scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching were calculated and compared with the dependent groups t-test and presented in Table 5.
As seen in Table 5, the critical thinking skill posttest mean scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching are higher than the pretest mean scores. It is seen that the difference between the critical thinking skill pre-posttest mean scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching is statistically significant ($p<0.05$). The effect size of the difference between the pre-posttest mean scores (Cohen’s $d$) was calculated as 0.64, and since this value is in the range of $0.2<d<0.8$, it has a moderate effect. This situation can be interpreted in a way that the argumentation-based teaching process increased the critical thinking skills of prospective classroom teachers.

**1.3. Is there a significant difference between the pre-process and post-process critical thinking skill mean scores of the prospective classroom teachers to whom the lessons were taught via traditional teaching?**

Before and after the argumentation-based teaching process, the critical thinking skill mean scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching were calculated and compared by using the dependent groups t-test and presented in Table 6.

As seen in Table 6, the critical thinking skill posttest mean scores and pretest mean scores of the prospective classroom teachers to whom the lessons were taught via traditional teaching are very close to each other. It is seen that the critical thinking skill pretest and posttest mean scores of the prospective classroom teachers to whom the lessons were taught via traditional teaching are not statistically significant ($p>0.05$). In this context, it can be interpreted in a way that a teacher-centered course process, that is, teaching of lessons with the traditional teaching method, could not improve the critical thinking skills of prospective classroom teachers.

**2. What Is the Level of Pre-Process and Post-Process Critical Thinking Skills of Prospective Classroom Teachers to Whom the Lessons Were Taught Via Argumentation-Based Teaching and Those to Whom the Lessons Were Taught Via Traditional Teaching?**

With the pilot study, the critical thinking skill levels of the prospective classroom teachers were determined as low, medium and high based on the critical thinking mean scores. Pretest and posttest critical thinking skill levels of the prospective classroom teacher candidates in the experimental and control groups were determined according to the scores they received from the scale and the frequency distributions related to the levels of the teachers were presented in Table 7.
Table 7. Pretest and posttest critical thinking skill levels

<table>
<thead>
<tr>
<th>Groups</th>
<th>Critical Thinking Level</th>
<th>Score Range</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental Group</td>
<td>Lower End Level</td>
<td>0 - 49</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>Low Level</td>
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<td>1</td>
</tr>
<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>Medium Level</td>
<td>57 - 69</td>
<td>30</td>
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<td></td>
<td></td>
<td>29</td>
<td>33</td>
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<tr>
<td>Experimental Group</td>
<td>High Level</td>
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<td>12</td>
<td>19</td>
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<td></td>
<td>11</td>
<td>10</td>
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<td>Experimental Group</td>
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<td>Control Group</td>
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<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>0 - 100</strong></td>
<td><strong>44</strong></td>
<td></td>
</tr>
</tbody>
</table>

The critical thinking levels of the prospective classroom teachers in the experimental and control groups in terms of pretest and posttest are given in Figure 1 and Figure 2 prepared based on the Table 6.

![Figure 1](image)

**FIGURE 1. Pretest and posttest critical thinking skill levels of the experimental group**

When Figure 1 is examined, considering the pretest scores of the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching, it is seen that they are concentrated at medium level of critical thinking skill (N:30). When the posttest scores were examined, it was detected that the number of prospective teachers with low level of critical thinking skill decreased by 1 (N:2 - N:1), the number of prospective teachers with medium level of critical thinking skill decreased by 13 (N:30 - N:17), the number of the prospective teachers...
The effect of argumentation-based teaching performed with high level of critical thinking skill increased by 7 (N:12 - N:19) and the number of prospective teachers with upper end level of critical thinking skill increased by 7 (N:0 - N:7).

**FIGURE 2. Pretest and posttest critical thinking skill levels of the control group**

When Figure 2 is examined, considering the pretest scores of the prospective classroom teachers to whom the lessons were taught via traditional teaching, it is seen that they are concentrated at the medium level of critical thinking skill (N:29). When the posttest scores were examined, it was observed that the teachers were again concentrated at the medium level of critical thinking skill (N:33), the number of prospective classroom teachers with high level of critical thinking skill (N:11 - N:10) and the number of prospective classroom teachers with high level of critical thinking skill decreased by 1 (N:1 - N:0).

When Figure 1 and Figure 2 are evaluated together, the critical thinking levels of the prospective classroom teachers are at the medium-level. However, after the process, the prospective classroom teachers to whom the lessons were taught via argumentation-based teaching had a higher level of critical thinking skill compared to the prospective classroom teachers to which the lessons were taught via traditional teaching. Based on this result, it can be interpreted that the argumentation-based teaching process increased the critical thinking skill levels of the prospective classroom teachers.

Within the framework of these findings, it was found that the argumentation-based teaching performed for environment-energy issues increased the mean scores and levels related to the critical thinking skills of prospective classroom teachers.

**DISCUSSION and CONCLUSIONS**

As a result of the research, the critical thinking skill mean scores of the prospective classroom teachers in experimental and control groups were calculated almost the same before the argumentation-based teaching process, and they had a medium level of critical thinking skills. When the studies conducted on the critical thinking skill for teachers and prospective teachers were reviewed, the critical thinking tendencies of teachers and prospective teachers were found at the low level (Türkmen, 2014; Yüksel, Uzun & Dost, 2013, Akgün and Duruk, 2016), below the medium level (Akdere, 2012) or at the medium level (Polat, 2014; Serin, 2013). The result obtained in this study is similar to that of the other studies conducted with prospective teachers. Özelçi (2012) emphasizes that implementations strengthening the critical thinking skills are not carried out in the faculties of education. In a study, Yeşilpinar (2011) states that the courses taken by the prospective classroom teachers during their bachelor studies are insufficient in terms of critical thinking, and this results from the theoretical aspect of the courses. In this study, the medium level of critical thinking skills of the prospective classroom teachers increased by 7 (N:12 - N:19) and the number of prospective teachers with upper end level of critical thinking skill increased by 7 (N:0 - N:7).
classroom teachers may arise from the fact that participants were in the second grade and they had not encountered any courses strengthening their critical thinking skills before. When different studies were reviewed, findings indicated that different implementations developed the critical thinking skills within the educational process. In their study, where they aimed at developing the critical thinking skills through group activities, Fung and Howe (2012) detected a significant difference in the critical thinking posttest results in favor of the experimental group at the end of the group activities. In a quasi-experimental study with a pretest-posttest control group including prospective teachers, Schreglmann (2011), who designed a subject-based critical thinking program, discovered a significant difference in the critical thinking posttest scores in favor of the experimental group. In a study conducted with prospective science teachers, Yıldırım (2009) revealed that science education based on critical thinking was more effective in directing towards critical thinking compared to traditional teaching methods, and this can be explained with the fact that prospective teachers are placed in the center of the learning process. In a study, Arsal (2017) reported that prospective teachers obtained scientific results when they established hypotheses, collected data to test these hypotheses, analyzed and interpreted these data, and a significant increase was observed in the critical thinking tendencies of the prospective teachers at the end of this process. Consequently, it is recommended to different researchers to employ different implementations for critical thinking and its teaching in faculties of education. When viewed from this perspective, it is believed that this study, which was conducted with the sampling of classroom teaching, contributes to both the literature and prospective teachers. In the study, an attempt was made to enhance the critical thinking skills of the prospective teachers by providing the course of environmental education via the argumentation-based teaching process.

When the pretest critical thinking skill mean scores of the prospective classroom teachers in experimental and control groups were controlled after the argumentation-based teaching process, the difference between the posttest critical thinking skill mean scores were observed statistically significant in favor of the experimental group. Moreover, it was also discovered that the difference between the pretest-posttest mean scores of the prospective classroom teachers in the experimental group was statistically significant and the effect size was medium. Besides, it was concluded following the implementation that the prospective classroom teachers in the experimental group had a higher level of critical thinking skill than those in the control group. This leads to the conclusion that the argumentation-based teaching enhanced the critical thinking skills and critical thinking levels of the prospective classroom teachers. Similar to the findings of this study, augmented reality implementations supported by the argumentation method, which were executed by Demiral (2017), increased the critical thinking skills of the secondary school students in the experimental group. Babacan (2017) wanted secondary school students to produce arguments on socio-scientific topics and observed improvements in the critical thinking qualities of the students as a result of the activities. In another study related to nuclear energy, which is a socio-scientific topic, the judgment levels of the prospective teachers who produced arguments were observed to have increased (Demircioğlu & Uçar, 2014). In a study where the astronomy-integrated chemical experiments were enriched with the argumentation-based teaching approach, a positive contribution was observed in the development of the critical thinking skills of the students with special talents. As interpreted, this was because students followed and criticized the thinking strategies of each other in small group discussions and then restructured them as arguments (Tüysüz & Tüzün, 2018). In the research designed for prospective mathematics teachers, where Çelik, Gökçe, Yenmez and Özpınar (2017) examined the critical reading levels via the online argumentation method, it was determined that the online argumentation environment increased the critical thinking skill scores of the students statistically and significantly at the end of the eight-week implementation. According to Göbel (2013), critical thinking skills of the individuals are not inherited; these skills can be learnt, taught and developed. When viewed from this perspective, the designed process contributed to the development of the prospective teachers’ critical thinking skills and supported the results of other researches. Kishife (2012) states that students who have prior knowledge about a subject participate in the argumentation process more actively and structure
their arguments in a correct way. Due to the nature of the socio-scientific scenarios prepared, information provided to students, inclusion of dilemmas and individual and group discussions within the argumentation-based teaching process enabled the prospective classroom teachers to handle the subject more holistically, to think multi-directionally, to approach the scenarios with a different perspective by exchanging ideas and to develop their critical thinking skills in this process. In a study, Açışlı (2016) found that the prospective classroom teachers’ critical thinking mean scores, which is a sub-scale of critical thinking tendencies, were high, and the prospective teachers could reason and use objective evidence, and they were cautious against the potential problems that might emerge. Consequently, prospective classroom teachers could interpret the socio-scientific scenarios by using the analytic thinking skills and had a critical approach in this study.

Throughout the argumentation-based teaching process, researchers went beyond the traditional teaching, which is directed by the teacher as Gürses (2010) stated, during the lesson, and gave the prospective classroom teachers an opportunity to think, discuss and socialize through interaction by enabling their active participation. Accordingly, the activities of establishing individual arguments, group arguments, individual counterarguments and group counterarguments applied in this process can be included in the courses of environmental education for making a positive contribution to the critical thinking skill. Thus, the argumentation-based teaching will help prospective teachers in terms of being sensitive to the environmental problems and producing solutions for the problems. Arguments, counterarguments and confutations of the prospective teachers can develop their tendencies of empathizing and enable them to approach their own ideas in a critical way. With this effect, prospective teachers can acquire the cognitive flexibility skill, which was put forward by Kuhn (1991). In addition, the application of this process on other prospective teachers (Preschool Teaching, Social Studies Teaching, Science Teaching etc.), who receive the course “Environmental Education” compulsorily or electively, can be considered important to prepare them for their professional lives and to develop their pedagogical skills. In this research, for the identification of the prospective teachers’ critical thinking skills and their change after the process, “Watson - Glaser Critical-Thinking Appraisal Scale” and scenarios reflecting the environment-energy relationship were used. While the process is designed by different researchers, they can be recommended to structure the process with different data collection tools and different socio-scientific subjects (cloning, GMO, gene therapy etc.) and to compare the results.

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The effect of argumentation-based teaching performed ...


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