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Effect of cooperative learning and traditional methods on students’ achievements and identifications of laboratory equipments in science-technology laboratory course

Süleyman Aydin

Elementary Education Department, Education Faculty, Ağrı İbrahim Çeçen University, Ağrı, Turkey.
E-mail: saydin@agri.edu.tr. Tel: +905458779878.

Science lessons taught via experiments motivate the students, and make them more insistent on learning science. This study aims to examine the effects of cooperative learning on students’ academic achievements and their skills in identifying laboratory equipments. The sample for the study consisted of a total of 43 sophomore students in primary school education and who took a science technology laboratory applications course in the 2010 to 2011 academic year. Students took the course in two groups, one of which was selected, via cluster sampling, as the control group in which the traditional learning method was used, and the other as the experimental group, in which the cooperative learning method was used. The data were gathered using four measurement tools: The preliminary knowledge test (PKT), the science-technology laboratory achievement test (STLAT), the identification of experimental equipment test (IEET), and the science-technology course attitude scale (STCAS). Results of the study showed that the experimental group, compared to the control group, scored higher in academic achievement, in the identification of laboratory equipment, and in the attitudes towards science, and that the differences were statistically significant.

Key words: Cooperative learning, science-technology laboratory achievement, traditional learning.

INTRODUCTION

The knowledge accumulation we have today increases exponentially as science and technology continue to develop ever faster, which also represents a transition from industrial society to information society. Within this diverse body of knowledge, science related knowledge has a most important place, for science is the process of examining the nature and the totality of organized knowledge that arises out of this examination.

Scientific knowledge is knowledge that has been filtered from among all the knowledge that mankind has accumulated from the first ages onwards, knowledge that has been gathered in human beings’ interaction with the nature, collected, organized and passed down from one generation to another for centuries, and proven to be correct (Demirbaş and Bozdoğan, 2005). In this sense, science is the main source of technology, and thus plays a very important role in the development and economic growth of individual countries. Thus, states place a special emphasis on science education so that individuals who can generate new knowledge and technologies can be brought up, and that they do not get left behind in the race for scientific and technological development and to ensure they keep improving (Coştu et al., 2005).

Laboratory activities have been playing a special and central role in science education for a long time now, and science educators think that engaging students in science laboratory activities has many benefits (Garnet et al., 1995; Lunetta, 1998; Tobin, 1990; Hofstein and Lunetta, 2003). Laboratory experiments used in science education provide concrete experiences for students, which help them learn both the scientific concepts and
the scientific method. The literature on science education suggests that through experiments, students develop their skills and knowledge in hand skills, research, communication, concepts, hypothesis construction, variable identification, problem solving, running experiments, making observations and inferences, critical thinking, application, analysis and synthesis, scientific interpretation, how scientists work, different types of scientific method, the relationship between science and technology, curiosity, interest, risk-taking, cooperation, and fairness (Shulman and Tamir, 1973; Hodson, 1990; Tamir, 1991; Lunetta, 1998; Yıldız et al., 2006).

In addition, laboratory experiments in science education are made so that the students discover what they do not know yet, and confirm the truth of knowledge acquired from various sources in person. Science lessons learnt through experiments motivate students for more learning, and make them insist on science education (Kaptan, 1999). The science laboratory, which plays such an important role in science education, presents the students with a vast amount of special equipment. Making use of all this equipment requires a high level of preparedness on the part of the students. At this point, it is crucial that teachers select the right method in teaching, and the right approach to support students’ achievements.

Hofstein and Lunetta (2003) discuss the adequacy of some of the practices adopted in recent years, and make suggestions on what needs to be done in the 21st century. Some studies on the subject find that students face a lot of hurdles in laboratory work, that many students fail to grasp the connection between laboratory observation and theoretical knowledge, and that as a result, laboratories do not provide meaningful learning environments (Friedler and Tamir, 1990; Nakhle and Krajčík, 1993). It has been argued that laboratories do indeed provide meaningful learning environments, but that laboratory applications are usually not structured in an efficient manner to support learning (Doymuş et al., 2007). Hence, the need for the development of new approaches in laboratory work has drawn a lot of attention from researchers lately, paralleling a similar surge of interest concerning new approaches in theoretical classes.

Contemporary education approaches are based upon active (that is, problem-based, inquiry-based, project-based, and cooperative) learning methods. One of the active learning methods is cooperative learning. The concept of cooperative learning is still quite popular with teachers, school administrators, and education scholars (Slavin, 1990). It is also a commonly held approach in theory, research, and education applications (Graham, 2005; Maloof and White, 2005; Johnson and Johnson, 1999). Recently, there has been a significant increase in the use of cooperative learning, which is more efficient than other learning methods (Slavin et al., 1995; Siegel, 2005; Webb et al., 2002).

Cooperative learning can be defined as a learning approach in which students help one another on an academic subject, in small mixed groups formed both in class and in non-class environments, which helps individuals gain more self-confidence and develop their communication skills and problem solving and critical thinking abilities, and through which all of the students actively participate in the learning-teaching process (Bolling 1994; Bowen, 2000; Elks, 2005; Lin, 2006; Gardener and Korth, 1996; Gillies, 2006; Hennessy and Evans, 2006; Levine, 2001; Prichard et al., 2006; Prince, 2004). The main aim of forming cooperative learning groups is to motivate the students to take on their learning responsibilities by making good use of the social relations between students and their significant effects, and to run learning processes in a way that is much more complex than is the case in any of the other classroom models (Sharan et al., 1980).

Cooperative learning has recently started to gain attention as an alternative to education strategies applied in universities and high schools. The reason for this attention is that during the group work, through the strategies and problem solving methods used, students can learn a lot from each other by comparing their own perspectives with those of others, and by collaborating in providing definitions and making decisions (Bearison et al., 1986; Doymuş et al., 2005; Maloof and White, 2005; Peterson and Jeffrey, 2004).

Studies that examine cooperative learning methods show that these methods, used in both theoretical and laboratory settings, can help students improve their academic and social skills by ensuring their active participation in learning processes (Carpenter, 2003; Chung-Schickler, 1998; Johnson and Johnson, 1999; Lord, 2001; Mark et al., 1991; Tlusty, 1993).

This study aims to identify the effects of the cooperative learning method on the academic achievements and laboratory equipment identification skills of students who take the science-technology laboratory applications course. In this process, answers to the following research questions were sought:

1. Are the academic achievements of students in the cooperative learning group significantly higher than the academic achievements of students in the traditional laboratory group in the science-technology laboratory applications course?
2. Are the laboratory equipment identification skills of students in the cooperative learning group significantly higher than the laboratory equipment identification skills of students in the traditional laboratory group in the science-technology laboratory applications course?
3. Are the attitudes towards science held by students in the cooperative learning group significantly higher than the attitudes towards science held by students in the traditional laboratory group in the science-technology laboratory applications course?
METHODS

Sample
The study was conducted with the participation of a total of 43 sophomores who attended, in two separate groups, the science-technology laboratory applications course in the 2010 to 2011 academic year in the Department of Primary Education of the Faculty of Education at Ağrı Ibrahim Çeçen University. One of the groups was identified as the cooperative (experimental) group in which the cooperative learning method was used (n = 21), and the other group was identified as the (control) group in which the traditional laboratory method was used (n = 22).

Data collection tools
Pre-test data for the study were gathered using the Preliminary Knowledge Test (PKT) for the identification of preliminary knowledge students had prior to the application of the respective methods; the science-technology course attitude scale (STCAS) to gauge the attitudes they had towards the science-technology course; the science-technology laboratory achievement test (STLAT) to measure their academic achievements in laboratory applications; and the identification of experimental equipment test (IEET), to test whether and how much the students could recognize and identify the equipment to be used in experiments. Post-test data were gathered using the “science-technology course attitude scale” (STCAS), science-technology laboratory achievement test (STLAT), and the identification of experimental equipment test (IEET).

Preliminary knowledge test (PKT)
A 50-item multiple-choice PKT was designed for the study, which contained the main subjects covered in the science-technology course; a likely source of influence on whether and how the experiments to be conducted in the science-technology laboratory will be understood by the students. The aim of the preliminary knowledge test was to measure the level of information that students have concerning the science issues that will serve as the foundation to build upon when conducting the experiments in the science-technology laboratory. To examine the reliability of the PKT, senior students majoring in science education and who did not participate in the study were asked to fill out the questionnaires, and the reliability coefficient (Cronbach’s alpha) of the test was found to be 0.79. Scores for this test were calculated by assigning two points to every correct answer the students have provided, and zero points for incorrect answers or for questions left unanswered.

Science-technology course attitude scale (STCAS)
This scale was developed by the researcher to identify the attitudes of students in primary education towards the science-technology course. In the first step, a 50-item question pool was created, making use of professional experience and the relevant literature. The scale contained items on internalizing, enjoying, and perceiving science. Then, 35 students majoring in science education were asked to read and rate the questions. Based upon their responses, 15 questions were selected and a 5-point Likert type scale was created. Care was taken to make sure that the questions are impartial, easily intelligible by the students, not offensive to anyone, and contain as many variables as possible. Response options for the scale were as follows: “completely disagree, disagree, neither agree nor disagree, agree, and completely agree”. The completely disagree option was rated 1, the disagree option was rated 2, neither agree nor disagree was rated 3, agree was rated 4, and the completely agree option was rated 5. The scale was then filled out by 125 sophomore, junior, and senior students majoring in science education and who agreed to participate. The Cronbach’s alpha method was used to calculate the internal consistency of the scale. This method aims to test, for each item, whether that item is consistent with the scale and whether the item should be included on the scale or not. With this purpose, correlations between each individual item and the scale were examined and the Cronbach’s alpha value calculated. The Cronbach’s alpha value was found to be 0.79 for all items of the scale, and the scale was thus considered to have internal consistency.

Science technology laboratory achievement test (STLAT)
The science technology laboratory achievement test (STLAT) consists of five groups of items, each of which represents an individual experiment. There are four groups, representing, respectively, the experiment on the buoyancy of the water (Experiment A), the experiment on the temperature change when the same amount of heat is given to different amounts of water, and when different amounts of heat is given to the same amount of water (Experiment B), the experiment on the effect of pressure on boiling point (Experiment C), the experiment to find out an unknown resistance making use of the Ohm law (Experiment D), and the experiment on the reflections of rays of light on a concave mirror from different directions (Experiment E). For each experiment (group), one open ended and four multiple choice questions were prepared, making a total of 25-items for the STLAT. All of the multiple choice questions in the test are about the experiments made in the science-technology laboratory. Each question was designed to highlight a single gain concerning the experiments made in the laboratory, but for some of the gains, there was more than one question form. The STLAT thus created were filled out by a student group who had learnt about the relevant experiments, and the internal consistency coefficient of the scale (Cronbach’s alpha) was found to be 0.69. The criteria and the scale for the open-ended questions of the STLAT were adapted from the scale developed by Williamson (1992). To check the validity of the STLAT, opinions of the faculty teaching the science-technology course and of other experts were collected. Expert opinion confirmed that the validity of the test for measuring the benefits of the relevant experiments was high.

Identification of experimental equipment test (IEET)
The IEET was developed to test whether students can identify the equipment used in experiments. This test covers the laboratory equipment in the five experiments to be conducted in the science-technology laboratory course. All of the equipment involved is equipment for the experiments included on the calendar. The IEET consists of 25 questions on identifying equipment. The IEET was filled out by students who had covered the relevant experiments, and its reliability coefficient (Cronbach’s alpha) was found to be 0.72. Concerning the validity of the IEET developed, opinions from two faculty members with Ph.D.s in science education and three science teachers were collected. These experts stated that the test developed has high validity for measuring the benefits of relevant tests.

Implementation
Prior to laboratory work, both the experimental group in which the cooperative learning method was to be used, and the control group in which the traditional laboratory learning method was to be used were asked to fill out the IETT, STCAS, and PKT, so as to be able
to see if there were any pre-test differences between the two groups with regards to the identification of experimental equipment, attitudes towards the science-technology course, and preliminary knowledge about the science-technology course. After the pre-tests, the laboratory work with the experimental and the control groups started. In both groups, laboratory work was carried out by the researcher and the students two hours a week for six weeks.

Students in the experimental group in which the cooperative learning method was used were divided into five groups, four of them consisting of four students, and one consisting of five students. Each group was then asked to choose a group leader and a group name. Then, group forms were distributed to the groups, which had fields for the name of the group, number of group members, the experiments to be conducted each week, the topics to be studied by the group members, and the tasks that the group members were responsible for carrying out prior to the laboratory hour each week. Through group leaders, individual members of each group were assigned specific topics and responsibilities for each experiment.

For example, in Experiment A on “The Buoyancy of Water” to be conducted in the first week, one of the group members was held responsible for providing theoretical information concerning the experiment, another group member was responsible for the equipment to be used in the experiment and their characteristics, another for the setting up of the experimental apparatus, and the remaining member for the actual conducting and completion of the experiment. Group members were asked to make necessary preparations for carrying out their responsibilities prior to coming to the laboratory. Laboratory work was started each week only after the researcher checked whether the students in each group were prepared to carry out their individual responsibilities. Members who were not prepared were told by the researcher that their behavior would have a negative effect on the performance both of the group and themselves, and the missing parts were provided by the researcher. Then, each group conducted their experiments with members carrying out their individual responsibilities. In this stage, first, the student responsible for theoretical information provides the theoretical background to other group members, and checks their learning. Then, the second student brings the experimental equipment from the cabinets in the laboratory to the desk where the experiment is going to be conducted and introduces the equipment to be used and talks about their characteristics. The experiment is then completed with each student carrying out their responsibilities in turns. During the laboratory work, the researcher observes the groups, and provides precautions, help, and support when necessary. After the experiment is completed, the groups are asked to talk about, discuss, and go over all the actions involved in the experiment among themselves. The researcher walked from group to group at this stage as well, observing their discussions and intervening when necessary. Each week, groups conducted the laboratory experiments in the presence of a faculty member and a laboratory assistant. The same procedure was followed each week, with the individual responsibilities of the group members changing according to the experiment conducted.

Students in the control group were similarly divided into randomly selected groups of four or five. Groups were asked to make necessary preparations before coming to the laboratory each week by reading the textbook. Laboratory work began only after the researcher checked whether every student had made preparations.

During their work, groups made use of experimental apparatus already set up, and completed their work by preparing experiment reports. In the first five weeks, experiments were conducted, and in the final week, students who missed some of the experiments for various reasons conducted make up experiments.

In both the control and experimental groups, students were asked to answer module tests about the experiment just completed. Thus, it was possible to make observations about the learning of the students in relation to the experiment being conducted that week.

Once all five experiments were completed in both groups, students were asked to fill out post-test IEETs, STCASs and STLATs. The data gathered were analyzed using an SPSS statistical package.

**RESULTS AND INTERPRETATION**

Here, we present the results of the study and an interpretation of the findings. Pre-test and post-test data from the IEET were analyzed using one way MANOVA, data from the multiple choice questions of the STLAT were analyzed using an independent samples t-test, and the open ended questions of the STLAT were analyzed using student responses and percentages for these responses. In addition, descriptive statistics and an independent samples t-test were used to analyze the data from the pre-test and post-test STCAS. MANOVA results for the IEET data are reported in Tables 1a and 1b.

Table 1a shows that there is a statistically significant difference between the IEET scores of the experimental and control groups [Wilks’ Lambda = 0.745 and F(2.40) = 6.840, p<0.05]. To identify the direction of this difference, one-way MANOVA results were analyzed.

Table 1b shows that there is not a statistically significant difference between the pre-test IEET scores of the cooperative and the control groups [pre-test DMTT F(1.43) = 0.195, p = 0.661]. These results indicate that prior to the laboratory work, experimental and control group students had equal levels of skills in identifying laboratory equipment. Analysis of the post-test IETT data, on the other hand, reported on the same table, shows that there is a statistically significant difference between the groups [F(1.43 ) = 13.651, p = 0.001]. According to the post-test results, the cooperative group received higher IEET scores compared to the control group [X^2 cooperative = 81, 28, X^2 control = 67.09]. The higher post-test IEET mean scores received by the cooperative group students, compared to the control group students, may be attributed to the fact that cooperative group students had to find and set up the laboratory equipment by cooperating among themselves and without outside help, unlike the control group students who used experimental apparatuses that were already set-up. The results of this test parallel the findings of studies by Mark et al. (1991),

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**Table 1a. Wilks’ Lambda values from the one-way MANOVA analysis for pre-test and post-test IEET.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>P</th>
<th>Partial Eta squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilks’ Lambda</td>
<td>0.745</td>
<td>6.840</td>
<td>2.000</td>
<td>40.000</td>
<td>0.003</td>
<td>0.255</td>
</tr>
</tbody>
</table>

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Table 1b. Results of the one-way MANOVA analysis for pre-test and post-test IEET.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Groups</th>
<th>Mean square</th>
<th>X</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMTT pre-test</td>
<td>Control</td>
<td>3.946</td>
<td>7.273</td>
<td>0.195</td>
<td>0.661</td>
</tr>
<tr>
<td></td>
<td>Cooperative</td>
<td>6.667</td>
<td>6.667</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMTT post-test</td>
<td>Control</td>
<td>2164.873</td>
<td>67.09</td>
<td>13.651</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Cooperative</td>
<td>81.286</td>
<td>81.286</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Independent samples t-test results for STLAT.

<table>
<thead>
<tr>
<th>Experiments</th>
<th>Groups</th>
<th>N</th>
<th>Mean&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Sd</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Cooperative</td>
<td>21</td>
<td>7.52</td>
<td>3.400</td>
<td>1.001</td>
<td>0.323</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>22</td>
<td>6.45</td>
<td>3.595</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Cooperative</td>
<td>21</td>
<td>18.10</td>
<td>13.660</td>
<td>2.406</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>22</td>
<td>10.91</td>
<td>3.069</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Cooperative</td>
<td>21</td>
<td>13.90</td>
<td>3.192</td>
<td>2.818</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>22</td>
<td>11.27</td>
<td>2.931</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Cooperative</td>
<td>21</td>
<td>14.76</td>
<td>3.254</td>
<td>2.449</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>22</td>
<td>12.73</td>
<td>2.097</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Cooperative</td>
<td>21</td>
<td>12.48</td>
<td>3.790</td>
<td>3.106</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>22</td>
<td>9.36</td>
<td>2.718</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Maximum score = 20.

Hilosky et al. (1998) and Doymuş et al. (2007).

Table 2 reports the analysis of the data from the multiple choice questions of the STLAT. Analysis reported in this table shows that there were significant differences between the control and experimental group students with regards to their responses to questions on Experiment A, Experiment B, Experiment C, and Experiment D [Experiment B (t = 2.406; p = 0.021), Experiment C (t = 2.818; p = 0.007), Experiment D (t = 2.449; p = 0.019), and Experiment E (t = 3.106; p = 0.003)]. With regards to responses to questions on Experiment A, on the other hand, there were no statistically significant differences [Experiment A (t = 1.001 p = 0.323)]. The higher scores received by the cooperative group from questions on Experiments B, C, D, and E may be attributed to the relations the students formed due to the method used and the creation of a positive class environment, which in turn helped students understand the experiments better and fill in their knowledge gaps. Results concerning these experiments parallel the findings of studies by Maloof and White (2005), Barrier (2005), and Doymuş et al. (2007). In Experiment A, on the other hand, the achievement levels of the two groups were the same. This may be attributed to the fact that cooperative group students were being introduced to this method for the first time, because in all the following experiments, starting with Experiment B, the cooperative learning group scored significantly higher. In addition, it could be argued that Experiment B required a relatively smaller amount of theoretical knowledge to be successfully carried out. This may be another factor explaining why a significant difference was not observed in this experiment between the achievements of student groups with different teaching methods.

Table 3 reports the frequencies and percentages of the answers given by students to the open-ended questions of the STLAT.

Experiment A: What are the factors that affect the buoyancy exerted on an object in a fluid?

Answers to this question by students in the two groups are reported in Table 3.

When we look at the student responses reported in Table 3, we can see that 100% of the students in the cooperative group, and 87% of the students in the control group gave the correct answer, by citing the density of the fluid and the volume of the submerged part of the object.
Table 3. Frequencies and percentages of student responses to the open-ended question of Experiment A.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Student responses</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative</td>
<td>* Density of the fluid and the volume of the submerged part of the object</td>
<td>21</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>- No answer</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>* Density of the fluid and the volume of the submerged part of the object</td>
<td>19</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>- Density of the object</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>- No answer</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

* Scientifically correct answers.

Table 4. Student responses to the open-ended question of Experiment B.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Student responses</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative</td>
<td>* When the same amount of heat is given to objects made of the same material with different masses, the temperature change in the object with the smaller mass will be greater. Change in temperature is inversely proportional to mass.</td>
<td>19</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>* When the same amount of heat is given to objects of equal mass but made of different materials, temperature change would be different because their specific heats are different. - No answer or incorrect answer.</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>*When the same amount of heat is given to objects made of the same material with different masses, the temperature change in the object with the smaller mass will be greater; and when the same amount of heat is given to objects of equal mass but made of different materials, temperature change would be different because their specific heats are different. - No answer or incorrect answer.</td>
<td>15</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>32</td>
</tr>
</tbody>
</table>

* Scientifically correct answers.

object.

Experiment B: What are the factors that affect the change in temperature when the same amount of heat is given to different amounts of water and different amounts of heat is given to the same amount of water?

Answers given by the groups to this question are reported in Table 4.

The findings reported in Table 4 show that 90% of the students in the cooperative group, and 68% of the students in the control group gave the correct answer to the question on the factors that affect the change in temperature when the same amount of heat is given to different amounts of water, and different amounts of heat is given to the same amount of water; whereas 10% of the students in the cooperative group and 32% of the students in the control group either failed to provide an answer or gave incorrect answers.

Experiment C: Explain the effect of pressure on boiling point.

Responses of the students from the two groups to this question are reported in Table 5.

Student responses reported in Table 5 show that all of the students in the cooperative groups and 77% of the students in the control group gave the correct answer to the question on the effect of pressure on boiling point.

Experiment D: How can you find an unknown resistance using the Ohm law?

Responses to this question given by students from the two groups are reported in Table 6. Responses reported in Table 6 show that 72% of the students in the cooperative group and 55% of the students in the control group gave the correct answer to the question. In both groups, the percentage of correct answers is lower compared to the percentage of correct answers for the previous open-ended questions. This might be explained by the fact that there would be errors in mathematical calculations and exact results would not be reached if the values displayed by the measurement tools used in the experiment were not read correctly.

Experiment E: How do light rays on a concave mirror with different angles reflect?

The answers given by the students in the two groups to this question are reported in Table 7. Responses reported in Table 7 show that 95% of the students in the
Table 5. Frequencies and percentages of student responses to the open-ended question of Experiment C.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Student responses</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative</td>
<td>* Change in pressure changes the boiling point of a fluid. As the pressure increases, so does the boiling point.</td>
<td>10</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>* As the pressure on the fluid decreases, so does the boiling point.</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>* If we want to decrease the boiling point, we should decrease the pressure on the fluid.</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>- No answer or incorrect answer</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Control</td>
<td>* As the pressure increases, so does the boiling point of the fluid; and as the pressure on the fluid decreases, so does the boiling point.</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>* The boiling point of a fluid is proportional to the pressure.</td>
<td>7</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>- No answer or incorrect answer</td>
<td>5</td>
<td>23</td>
</tr>
</tbody>
</table>

* Scientifically correct answers.

Table 6. Frequencies and percentages of student responses to the open-ended question of Experiment D.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Student responses</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative</td>
<td>* Because the current through a conductor between two points is directly proportional to the potential difference across the two points in most conductors, we can find the resistance by first measuring the current after forming the electric circuit, and then dividing it by the potential difference displayed by the voltmeter.</td>
<td>15</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>- No answer or incorrect answer</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td>Control</td>
<td>* I first find the current through the circuit, and then divide the potential difference by the current to find the resistance.</td>
<td>12</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>- No answer or incorrect answer</td>
<td>10</td>
<td>45</td>
</tr>
</tbody>
</table>

* Scientifically correct answers.

Table 7. Frequencies and percentages of student responses to the open-ended question of Experiment E.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Student responses</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative</td>
<td>* Light rays that follow the principal axis are reflected following the same path</td>
<td>20</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>* Light rays that fall upon the peak of the mirror forming an angle with the principal axis are reflected with the same angle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Light rays that parallel the mirror are reflected through the focal point of the mirror.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- No answer or incorrect answer</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Control</td>
<td>* Light rays that follow the principal axis are reflected following the same path, light rays that fall upon the peak of the mirror forming an angle with the principal axis are reflected with the same angle, and light rays that parallel the mirror are reflected through the focal point of the mirror.</td>
<td>18</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>- No answer or incorrect answer</td>
<td>4</td>
<td>18</td>
</tr>
</tbody>
</table>

* Scientifically correct answers.

cooperative group and 82% of the students in the control group gave the correct answer to this question. The percentages of correct answers in both groups are quite high, which may be attributed to the fact that light rays on a concave mirror are easy to visualize.

Table 8 reports the results of the independent samples t-test conducted on the data from the pre-test and post-test STCAS to examine the differences between the attitudes held by the students towards the science-technology course prior to and after the laboratory work with the traditional method and the cooperative learning method.
technology course, it was observed that students in the
2007). Maloof and White, 2005; Tlusty, 1993; Doymu-
learning method (Carpenter, 2003; Mark et al., 1991;
previous studies on the effects of the cooperative
learning activities. These findings parallel those of
face communication, creating positive dependency, and
laboratory learning processes by encouraging face to
findings, it can be argued that the cooperative learning
method makes a positive contribution to student
achievement by giving responsibility to the students in
the traditional laboratory method. This may be attributed
to the presence of intra-group assistance and support,
active participation, and higher levels of success that
come with the cooperative learning method. These
findings are also in line with the findings of previous
studies on the effects of cooperative leaning on attitudes
towards various topics (Okebukola, 2002; Altıparmak and
Nakipoğlu, 2002; Venman et al., 2002; Gök et al., 2009;
Zakaria et al., 2010).

In conclusion, it can be argued that the use of
coop erat ive learning methods in laboratory applications
positively affects the academic achievements, laboratory
experiences, and laboratory skills of the students. Taking
into consideration the findings concerning the effects on
academic achievements and equipment identification
skills of the students in the cooperative and control
groups, the following suggestions can be made:

1) Future studies should examine the effects of this
method not only in science-technology laboratories, but in
Physics, Biology, and other laboratories as well.
2) Due to the fact that it would make a positive
contribution to the academic and laboratory skills of
students, the use of this method in different topics and
experiments should be encouraged.

Table 8. Results of the independent samples t-test for pre-test and post-test STCAS.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Groups</th>
<th>N</th>
<th>Mean*</th>
<th>Std. Deviation</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test attitude</td>
<td>Cooperative</td>
<td>21</td>
<td>49.81</td>
<td>8.548</td>
<td>1.929</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>22</td>
<td>45.09</td>
<td>7.476</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test attitude</td>
<td>Cooperative</td>
<td>21</td>
<td>62.81</td>
<td>5.202</td>
<td>4.844</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>22</td>
<td>49.68</td>
<td>11.328</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Maximum score = 75.

Table 8 shows that there are no statistically significant
differences between the mean pre-test STCAS scores of
the experimental and the control groups (t = 1.929; p = 0.610). There is, however, a significant difference
between the post-test STCAS scores of the experimental
and control groups (t = 4.844; p = 0.001). These results
indicate that the cooperative learning method has
positively affected the attitudes of the students towards
the course.

CONCLUSION AND SUGGESTIONS

This study examined the effects of the cooperative
learning method on the academic achievements and
laboratory equipment identification skills of students who
took the science-technology laboratory application
course. The findings of the study indicate that the
cooperative leaning method makes a more positive
contribution to developing students’ academic
achievements compared to the traditional laboratory
method. This conclusion is in line with the conclusions of
previous studies that find the cooperative learning method
to result in significantly improved academic
output compared to the traditional learning method (Doymuş et al., 2004; Gillies, 2006; Hennessy and
Evans, 2006; Lin, 2006; Nattiv, 1987; Prichard et al.,
2006; Prince, 2004; Gök et al., 2009; Zaet al., 2010).

Furthermore, the students in the cooperative learning
group developed their skills in identifying laboratory
equipment more than the students in the group in which
the traditional learning method was used. Based on these
findings, it can be argued that the cooperative learning method makes a positive contribution to student
achievement by giving responsibility to the students in
laboratory learning processes by encouraging face to
face communication, creating positive dependency, and
ensuring the active participation of all students in the
learning activities. These findings parallel those of
previous studies on the effects of the cooperative
learning method (Carpenter, 2003; Mark et al., 1991;
Maloof and White, 2005; Tlusty, 1993; Doymuş et al.,
2007).

With regards to the attitudes towards the science-
technology course, it was observed that students in the
group in which cooperative learning methods were used
developed more positive attitudes towards the course
than was the case with the students in the group in which
the traditional method was used. This may be attributed
to the presence of intra-group assistance and support,
active participation, and higher levels of success that
come with the cooperative learning method. These
findings are also in line with the findings of previous
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towards various topics (Okebukola, 2002; Altıparmak and
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