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Effects of Using the Learning Stations Technique to Teach the Electrical Current Topic on Students' Physics Subject Performance*

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Abstract

The purpose of this study is to determine the effects of using the learning stations technique in teaching about the electrical current on students' physics course achievement. The sample of the experimental study designed with a pretest-posttest model consists of 50 10th grade students studying in a Science High School in Trabzon, in the 2016-2017 academic year. A multiple-choice achievement test with .80 reliability coefficient was used as the data collection tool. The obtained data were analyzed by applying the Wilcoxon Signed Ranks test in SPSS 20.00 program and a statistically significant difference was found between the experimental and control group achievement test scores in favor of the experimental group, which indicates that the learning stations technique practices performed to teach about the electrical current are effective in increasing the 10th grade students' physics course achievements.

Keywords: learning stations technique, electrical current, physics course achievement

1. Introduction

Current trends and developments in education requires students to learn how to find the relevant information rather than teaching the information itself. Therefore, it is important to encourage students to do research in science and improve their positive attitude toward science. Although the physics curriculum in Turkey has been altered many times since the 2000s, its primary purpose is to develop students' critical-thinking and problem-solving skills and encourage them to use the knowledge and skills they have acquired in solving the problems they encounter in daily life. In particular, the vision of physics curriculum, has been expanded in recent years, and now it aims to make students think creatively, innovatively and entrepreneurially. It also aims to make them record and analyze the data they have obtained by doing experiments and through learning experiences by acting on their creative and innovative ideas. Therefore, it aims to create a learning environment that enables students to actively engage in the learning process and adopt scientific thought as part of their lifestyle (Bozkurt & Olgun, 2005).

Previous studies have found that it is difficult for students to achieve meaningful learning in science education especially in physics education, and they experience learning difficulties in many subjects (Gürses, 2006). In addition, physics is regarded as a difficult subject to understand for many learners (Şimşek, 2010). The main reasons underlying this could be listed as the high number of the abstract concepts in the subject of physics, students' difficulties in relating these concepts to real-life situations, and the excessive number of formulas (Duit & Rhöneck, 1997). Unfortunately, the physics courses carried out using classical teaching methods fail to encourage students to think deeply about how the nature functions (Özel, 2004). Learners' failure to relate the concepts of math and physics subjects to their real-life situations may eventually cause them to develop a negative attitude toward these subjects (Gilroy, 2002; Mitchell, 1999; Telese, 1997). Thus, instead of applying teacher-centered methods and techniques which could be boring for students, it is advised to create student-centered learning environments by including interesting, concrete, and clear examples that are related to real-life (Geisz, 2005).

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Due to fact that most learning-teaching activities are performed in classrooms, the specific characteristics of the classrooms and teaching methods and techniques substantially affect the learning and teaching process. Further, the use of different learning methods and techniques in the classroom creates better learning opportunities for students with different learning styles (Meyers & Jones, 1993). The current education system pays more attention to students' individual differences than it did in the past. Especially in recent years, educators have been trying out new methods, techniques, and approaches to meet learners' needs by accounting for learner differences (Kryza, Stephens, & Duncan, 2007; Kan, 2013). As one such technique, the learning stations technique is applied to design activities at learning stations by taking individual differences of learners into consideration, and these activities create a learning platform which enable students to experience various equipment. Thus, students are provided with the opportunity to study in different learning environments and experience a self-learning process (Moore, 2000; Tseng, 2008).

First adopted by Montessori in the early 1900s, and later influenced by Piaget and Vygotsky's constructivist views, the technique of learning stations emerged as an important technique in the literature in the 1970s (Demir, 2008). Learning centers (Lebak, 2005); science centers, learning circle (Irwin, Nucci, & Beckett, 2003); science discovery centers or corners (Radeloff, 2001); station technique (Albayrak, 2016; Erdağı, 2014); learning technique in stations (Benek, 2012); learning stations (Bulunuz, 2006; Bulunuz & Jarrett, 2010) are some other terms that are interchangeably used in literature (Cited in: Karacalı, 2018, p.60). Manuel (1974) defines learning stations as "a technique designed for students to reach a specific goal, in which logical and sequential orientations are given and suitable for different student levels" (Korsacılar & Çalışkan, 2015, p.386).

1.1 Literature Review

When the national and international research conducted on the learning stations technique is reviewed, it can be seen that some studies focusing on various subjects including Physics, Science and Technology, Turkish, English, and Life Sciences have been conducted by applying qualitative, quantitative or mixed methods. These studies used stations with various types and sizes. The main findings of these studies reveal that the learning stations technique positively affects the student achievement, is effective in eliminating learner misconceptions, facilitates and supports permanent learning, is effective in high-level skill development, increases interest and enables students to enjoy the activities, and helps them develop a positive attitude towards the course. In addition, the learning stations technique has been found to be more effective on the academic achievement of the students than the traditional teaching methods. Furthermore, research has identified some problems with the application process of the learning stations technique such as students' difficulty in understanding written instructions in station centers, not making a significant difference in their long-term memory development, and some stations' failure to show the expected effect. Additional problems such as loss of learner interest in covering lengthy units and some difficulties in material use have also been identified.

Many international studies (Heilbronner, 1983; Becker, 1988; Becker, 1994; Stork, 1995; Baumert & Waltermann, 1999; Graf, 2000) state that the learning stations technique can be effectively used in teaching mathematics, physics, chemistry, biology, science, social studies, literature, philosophy, and sociology courses; and students can enjoy the learning process without getting bored or distracted; besides, original ideas can be expressed and products can be made by using this technique and thus creative thinking skills of students can be developed (Alacapınar, 2009). To use new student-centered learning techniques effectively during the learning process, the effects of these techniques on students' learning experience need to be considered as well. Review of the relevant literature reveals some studies implementing the learning stations technique especially with Turkish secondary school students (Karacalı, 2018). The study conducted by Bozpolat and Arslan (2018) on the use of the learning stations technique in teaching Turkish suggests conducting further research on using this technique at different teaching levels, different grade levels, and different courses. Korsacılar and Çalışkan (2015) recommend that further research needs to be carried out to examine the effects of using this technique at different grade levels and physics subjects to expand on the limited number of studies available on learning stations and teaching the physics subject in Turkey. Although there is already a copious amount of research which investigates the effects of different methods and techniques used in science and physics teaching in Turkey (Gürses, 2006), this research essentially aims to improve teacher guide materials rather than student materials. The current study, which aims to determine the effect of the practices designed according to the cooperative learning method based on learning stations technique, is expected to set an example for the implementation of the learning stations technique at the high school level by offering differentiation according to the learning levels of the students and thus act as a guidance for future studies.

1.2 Research Questions

The following research questions guided this study:

1. How do the activities developed based on the learning stations technique to teach about electrical current affect 10th grade students' physics subject performance?

2. Do learning stations developed to teach about electrical current affect students' physics subject performance in terms of gender?

2. Method

The study was designed and carried out as a pretest-posttest experimental study with an experimental and control group. To apply the learning stations technique, students should be at a minimum implementation level (Sönmez, 2007). Therefore, the sample of the study was formed with 50 students from two 10th grade classes in a Science High School in Trabzon, Turkey. The data were collected during the spring term of 2016-2017 school year. Students were randomly selected for each group. The experimental group consisted of 15 female and 10 male students and the control group consisted of 12 female and 13 male students, with a total of 25 students in each group.

2.1 Data Collection

Multiple-choice achievement tests developed by the researchers were used to collect data about students' performance before and after the experiment. To construct the achievement test items, various books on the subject of physics, supplementary physics books, and online materials were used. In addition, the items were developed by considering the outcomes stated in the Electric unit of the syllabus for the 10th grade physics subject. The content distribution and the graphs and tables in the test were evaluated by a lecturer who is an expert in the field and two physics subject teachers. The final version of the achievement test included 22 multiple-choice items. A pilot study was performed with 27 students with the aim of assuring validity and reliability. Based on the calculated values of the discriminatory indices of the items, four items were removed from the test. The Reliability index of the test with the remaining 18 multiple-choice items was calculated based on KR-20 formula, and found to be .80.

2.2 Research Procedure

To perform a learning stations activity successfully, each step must be planned in detail. In the process of designing station center activities, the teacher should consider many details such as which gains based on objectives in the teaching curriculum will be obtained, what the purpose of the station center is, which activities should be done, which tools and equipment are needed at the station center for the activities to be done, and how long it will take to finish the studies in the centers (Benek, 2012).

During the experimental process, "Electrical current", "Ohm's Law", "Measure of potential difference", and "Series and parallel connection of generators" topics were taught, and the implementation stage was completed within four weeks. For each topic, two class hours (80 min in sum) were allocated. The following steps were taken during the learning station practice shown in Figure 1.

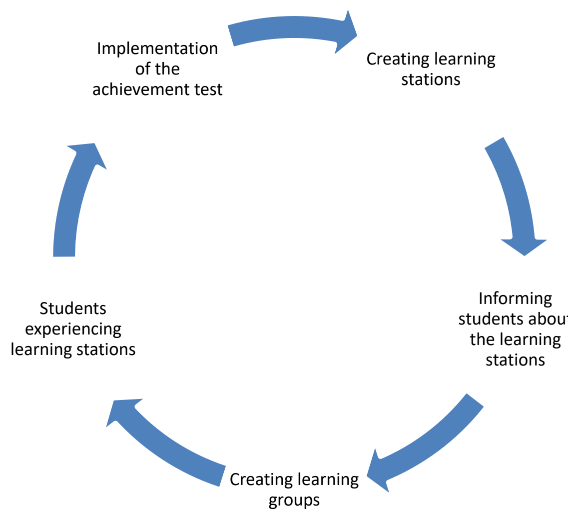

Figure 1. Implementation steps of the learning stations

After a detailed investigation of the 10th grade physics course book and receiving opinions from two physics teachers and a physics lecturer, the researchers decided to create six learning stations for the experiment. Groups were created heterogeneously and included four or five students. The six stations were sequenced according to the context of each topic for smooth transition (Figure 2). The details of these stations are shown in Appendix 1.

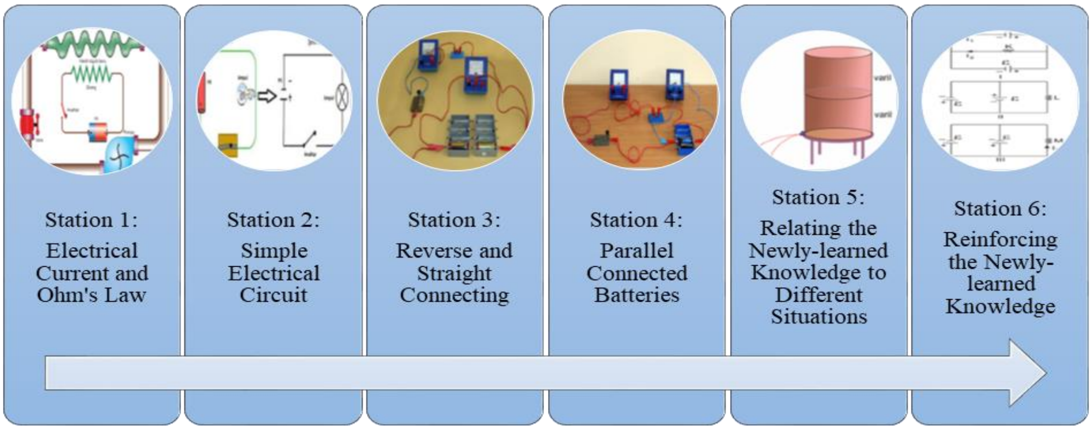

Figure 2. The stations in the implementation stage

The lab which held the experiment was organized carefully to prevent any difficulties during the experiment. Moreover, stations were carefully designed to be not only well-equipped, but also visually attractive for the students. Thus, the texts prepared for stations were pasted into large and colorful cartons, letters representing the formulas were prepared with colorful cartons, and the necessary settings for the amperemeter and voltmeter related to topics were prepared in the stations. Also, any equipment related to topic (voltmeter, bulb, key, amperemeter, plastic bottle, carton modelling etc.) was provided in the stations. The students carried out the required measurements in the stations and actively participated in the learning process through hands on application. Further, each station was designed and organized in a way to allow students to write their answers, solutions, and comments on the worksheets easily. Upon arriving the stations, the students were asked to carry out the experiment by reading the information on the colorful cartons and using the equipment in the station. Finally, they were asked to write their findings on the worksheets. The students recorded each of the experiments regularly, and they were allowed to check their notes and experiments from the previous stations if necessary. Students who completed the experiment in the current station could find out about the next station to go by checking the station-tracking instruction, and thus, after finishing all these individual experiments, they managed to complete all the subparts of the experiment.

2.3 Data Analysis

The activities developed for the 10th grade Electrical Current topic were conducted at the learning stations with an experimental group of 25 students. Before and after the experiment, a multiple-choice achievement test was administered to both the control and experimental group. The achievement test includes 18 item and each item weight is 5.5 points. The pre-test and post-test scores of the students were transferred to the SPSS program. SPSS statistical analysis was run for mean, median, and standard deviation. The Wilcoxon-Signed Rank test was run for inferential statistics.

3. Findings and Discussion

This study aimed to look at the effects of using the learning stations technique prepared to teach about the 10th grade Electrical Current topic on student performance. An achievement test specifically developed for this aim was given as a pre and post-test to both control and experimental group students. Table 1 presents the Wilcoxon-Signed Rank tests of the pre- and post-test scores of the experimental group students.

Table 1. Wilcoxon-Signed Rank Test analysis of the achievement test scores of the experimental group

Test Type	N	X_{mean}	Standard Deviation	Degree of Freedom	Asymp. Sig. (2-tailed)	Z
Pre-test	25	47.44	26.19	24	- 2.464[a]	0.010[b]
Post-test	25	84.48				

a. Based on negative ranks b. Wilcoxon Signed Ranks Test

The table above shows that the experimental group's achievement test average is X=47.44 for the pre–test and X= 84.88 for the post-test, thereby indicating a significant difference in the performance of the experimental group (Z=0.01). The Wilcoxon-Signed Rank test analysis for pre- and post-achievement test scores both in the control and experimental group is shown in Table 2.

Table 2. Wilcoxon-Signed Rank Test analysis of achievement test scores of the control and experimental group

Achievement Test Scores	N	X_{mean}	Standard Deviation	Degree of Freedom	Asymp. Sig. (2-tailed)	Z
Experimental Group	25	65.96	26.19	24	- 2.484[a]	0.012[b]
Control Group	25	60.02	14.17			

a. Based on negative ranks b. Wilcoxon Signed Ranks Test

Table 2 shows that the average rank of experimental group students for the achievement test is X= 65.96, and average rank of the control group students for the achievement test is X= 60.02. A significant difference between the achievement test scores of the control and experimental group was obtained (Z=0.01). Considering that this difference is in favor of the experimental group, it can be proposed that the experimental group students who used the learning stations technique in their learning process were more successful in the multiple-choice achievement test than the control group students who used the classic learning methods. In addition, taking Table 1 into consideration, it can be said that the learning stations had a positive effect on improving the student performance in the experimental group. Korsacılar and Çalışkan (2015) argue that the reason for learning stations technique's being more effective in increasing academic success could be that in using the learning stations technique, the teacher acts only as a guide, and that the students in each station learn by discussing the activities in cooperative groups and use different materials in a more active environment in which they are responsible for their own learning. This finding is consistent with a limited number of studies showing the positive effects of learning stations on academic achievement (Bulunuz & Jarrett, 2009; Demir, 2008; Güneş, 2009; Maden & Durukan, 2010; Mergen, 2011; Ocak, 2010). This finding is also in line with the research showing that active learning methods have a positive effect on academic achievement in physics teaching (Günel, Memiş, & Büyükkasap, 2010; Korsacılar & Çalışkan, 2015; Telli, Yıldırım, Şensoy, & Yalçın, 2004; Ünal & Ergin, 2006; Yeşilyurt & Gül, 2011). Learning stations improve third grade primary school students' performance (Furutani, 2007). In another study supporting these findings, Demirörs (2007) found that the use of learning stations to teach "Ohm's law" to 9th grade high school students contributed positively to their learning. In addition, research investigating the effects of using the learning stations technique for the seventh grade Science subject on students' performance (Benek, 2012; Erdağı & Önel, 2015) supports the main findings of this study. The results of the studies conducted by Sürücü, Özdemir, and Baştürk (2013), and Güç, Korkmaz, Çakır, and Bacanak (2016), which examined the effects of the learning stations technique activities on students' achievement, are not in line with these findings, which found no significant difference between the post-test mean scores of the experimental and control groups. Özyürek, Yüksel, and Demirci (2018) argue that this may have resulted from the ineffectiveness of the technique applied in increasing student achievement in the relevant subject.

It was also observed that while applying the learning stations technique in learning about the "Electrical Current" topic, the students actively participated in the learning process and took pleasure in being involved in this process, which may have had a positive contribution to the students' success enabled by the implementation. Köseoğlu, Tümay, and Üstün (2009) observed that the students were able to learn more easily and had more fun when they worked at stations (Korsacılar & Çalışkan, 2015). This is supported by Benek and Kocakaya's study (2012) on learning at stations in which the students found the learning stations technique useful, easily understood the subjects, enjoyed participating in the activities in the station centers, and believed that the learning stations technique increased the quality of learning. In addition, Alacapınar (2009) states that students enjoy carrying out the class activities through the stations technique; Gerçek (2010) found that most of the students had fun during the learning stations activities, and Demirörs (2007) indicates that the students spent their time in a quality way. Furthermore, students generally had positive opinions about the learning stations technique in the studies conducted by Güç et al. (2016), and Demir, Kartal, Ekici, and Bozkurt (2011).

To find out the effects of the learning stations focusing on the topic of "Electrical Current" on students' performance in terms of gender, female and male students' achievement test scores in the experimental group were analyzed, which are presented in Table 3 and 4.

Table 3. Wilcoxon-Signed Rank Test analysis of the pre-test scores in the experimental group in terms of gender

Group	Gender (N=25)	N	X_{mean}	Standard Deviation	Asymp. Sig. (2-tailed)	Z
Experimental Group	Female	15	51.64	15.68	- 2.569[a]	0.02[b]
	Male	10	43.24	12.96		

a. Based on negative ranks b. Wilcoxon Signed Ranks Test

As can be seen, the average of experimental group pre-test scores for females is X=51.64, and for males X=43.24. There is a significant difference between female and male student's pre-test performance, which indicates a gender advantage in favor of the females (Z=0.02).

Table 4. Wilcoxon-Signed Rank Test analysis of the post-test scores in the experimental group in terms of gender

Group	Gender (N=25)	N	X_{mean}	Standard Deviation	Asymp. Sig. (2-tailed)	Z
Experimental Group	Female	15	94.66	5.25	- 2.649[a]	0.01[b]
	Male	10	74.30	10.46		

a. Based on negative ranks b. Wilcoxon Signed Ranks Test

As can be seen, the experimental group post-test score average for females is X=94.66, and for males X= 74.30, which shows that there is a significant difference between female and male students' performance (Z=0.02).

The existence of the significant differences in favor of the females before and after the implementation and the increase in the success of male students at the end of the implementation indicates that this technique has a clear positive effect on the academic achievement of both female and male students (Table 3, Table 4). Although at the end of using the cooperative learning method the targeted academic achievement is expected to be achieved by the majority of students (Johnson & Johnson, 2017), the gender differences in the research group at the end of the experiment can be considered as natural since they were also present before the implementation. Based on the findings from Table 3 and 4, it can be proposed that female students in the experimental group are more successful than the male students in the experimental group considering that a significant difference remains increasingly in favor of the female students both in the pre- and post- achievement test scores in terms of gender. The learning stations prepared for this study allowed students to study in a lab environment and frequently use lab equipment. In this regard, female students' tendency to use and acquire psychomotor skills has a crucial role on their success. Therefore, it can be said that they are able to benefit from their learning environment more efficiently and are able to achieve higher cognitive learning outcomes compared to the male students. In a study focusing on the level of seventh graders' metacognitive awareness by gender, a significant difference was found in favor of female students (Bağçeci, Döş, & Sarıca, 2011). It is also posited that this meaningful difference can be a result of difference due to female and male students' daily routines, points of interests, and innate habits. For example, male students are generally more interested in activities including actions and technological materials whereas female students are more interested in naturally occurring events, their causes and surrounding facts.

4. Conclusion and Suggestions

In this experimental study, when the learning stations technique was used for a 10th graders' physics lesson on the topic of "electrical current", students enjoyed the learning process and were highly engaged with it. The experimental group students' scores on the multiple-choice achievement test given at the end of experiment were higher than those of the control group students. Accordingly, it can be concluded that the use of the learning stations technique is an effective way to boost students' performance in the physics subject. It can be argued that the fact that using equipment such as voltmeter and amperemeter in an entertaining way and introducing topics by modelling, students were more willing to learn and took an active part in the process. When the data were analyzed by gender, it was found that the female students were more successful than the males. Thus, it can be inferred that the learning stations technique is more effective in improving female students' achievement in comparison with that of the male students.

Based on these results, using the learning stations technique can be recommended to teach other subjects of the physics. When conducted with different grades and larger samples, more representative and extensive results can be reached for the use of learning stations technique. In addition, since learning stations is a novel technique to use in physics, in-service training by the National Ministry of Education might be provided for teachers who will benefit from this technique by applying it efficiently in their own classes.

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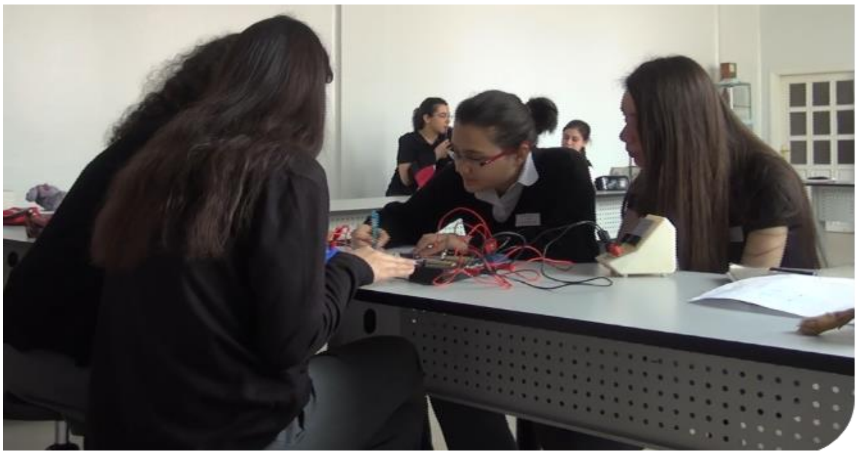
Appendix 1. The Content of the Stations in the Implementation Phase

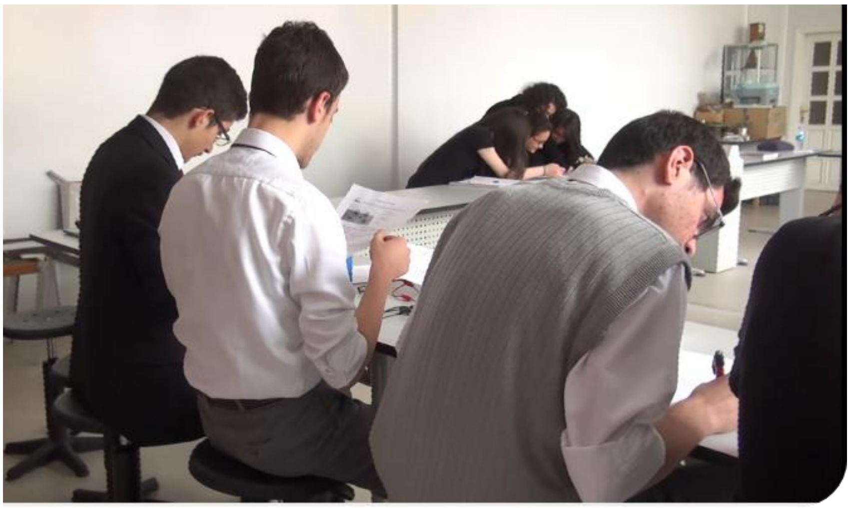
Station 1 (Electrical Current and Ohm's Law)	The students are expected to • Verbally express the direction of the electrical current, • Express Ohm's Law in terms of Resistance, Potential Difference and Current Intensity, • Place the concepts of V, I, R prepared and given as colored cartons into a triangle that is divided into three sections and express the formula in terms of each concept, • Interpret the resistance by drawing a Voltage-Intensity (V-I) graph, • Finally the researchers aimed to check the students' background knowledge of the topic.
Station 2 (Simple Electrical Circuit)	The experiment and activity aimed to lead the students to • Find out what the potential difference between the ends of the battery that meets the energy needs of electrical circuits means, • Learn about the internal resistance as a measure of the potential difference at the ends of the battery, and therefore of the circuit, that a portion of this energy is spent in the resistance.
Station 3 (Reverse and Straight Connecting)	At this station, the students were asked to • Observe the changes in the ampermeter and voltmeter by coupling the circuit reverse and straight, • Observe that when the batteries are coupled serially, there is a rise in the current intensity going through the same resistance.
Station 4 (Parallel Connected Batteries)	At this station, the students were asked to • Detect the changes in the voltmeter and ampermeter by observing the changes in the parallel-connected circuit, • Explain the results by comparing their detection of these changes and the results of their activity in the second station.
Station 5 (Relating the Newly-learned Knowledge to Different Situations)	At this station, the students were expected to • Apply the serial and parallel circuits that they have learned by conducting experiments in various other situations and observing the results, • Relate the concepts they have learned to various other situations.
Station 6 (Reinforcing the Newly-learned Knowledge)	At this station, the students were expected to • Consolidate the knowledge about the serial and parallel connected electrical circuits that they gathered from the previous stations by asking questions and thus retain their knowledge.

Appendix 2. Some photos from the implementation phase

(Station 3)



(Station 4)



(Station 4)