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Effect of Vee diagram on the achievements and attitudes of students in science laboratory course-II

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Abstract

The aim of this study is to examine the effects of Vee diagram on the achievements and attitudes of students in science laboratory course-II. Sample consisted of pre-service science teachers (N=59) of science teaching program at Faculty of Education in Afyon Kocatepe University in Turkey. A quasi experimental research was utilized as the research design. The teaching was realized through traditionally laboratory method with the control group, whereas through Vee-diagrams with the experimental group. Pre-service science teachers constructed Vee diagrams for presenting their experiment reports during whole laboratory process. The data were gathered through "Achievement Test (AT)" and "Attitude Scale for Science Laboratory (ASSL)". The findings indicated that although there is no significant difference ($p>.05$) between the pre-test achievement scores of groups, the result of the post-test exhibited that there is a significant difference among groups, which is favor of the experiment group ($p<.05$). The findings also indicated that there was no a significant difference between post-test attitude scores of the experimental group and control experimental group ($p>.05$).

Keywords: Vee diagram, achievement, attitude.

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1. Introduction

Science is taught as a core subject in most schools around the world (Turkmen & Bonnstetter, 2007). In terms of school establishments, the mission of science education has been to prepare individuals who would develop a certain level of scientific understanding after their formal education in school. These scientifically literate individuals would be capable of applying their knowledge and skills acquired in science, whenever personal or socially relevant issues demanded such understanding (Wang & Schmidt, 2001).

Today science and technology are developing with a rattling rate, and science education is performed with different techniques and methods. Among these methods, one of the most efficient ones is the laboratory method (Lawson, 1995). As one of the instruction methods used in science lessons, the laboratory method refers to the comprehension of the basic scientific knowledge by students through experiments that prove this knowledge carried out by the students themselves in laboratories (Morgil, Secken & Karacuha, 2005). Science laboratory is a spacious room where the students in groups carry out their experimental work. It provides many opportunities for students to talk and write about science. With a little thought and planning on the part of the students, laboratory activities can be the basis for building communication and problem solving skills (Safdar, Hussain, Shah & Tasnim, 2013). However, traditional approaches based on deduction do not help students learn science lessons in laboratories at all. Therefore, students cannot establish interaction between their previous knowledge and the new information they produce during laboratory studies (Tekes & Gonen, 2012). In addition, even if the exercise is well designed, and the student produces a set of results or observations, these are not readily related back in a meaningful way to the conceptual framework that underpins the experimental work. For this reason, in order to transform a laboratory into an environment in which meaningful learning is achieved, different instructional techniques should be used (Tekes & Gonen, 2012). As a solution, Vee diagram is an instructional device to link concepts and methods (Safdar et al., 2013).

Gowin developed the concept of Vee diagram to better understand the cognitive states of the students during laboratory works and eliminate the difficulties they face. Gowin argued that this diagram ensures forming relationships between theoretical knowledge and laboratory work for students, and it makes laboratory reports more understandable and useful (Ercan, 2014).

Students experiment and form their own conclusions, rather than try to reproduce the experiment to receive the same answers as their peers or what they read from the book. Through Vee diagrams, students are allowed to formulate their own decisions and create their own graphic organizer which fits their learning style (Roehrig, Luft & Edwards, 2001; Thoron & Mayers, 2010).

Think of a Vee diagram as a road map showing a route from prior knowledge to new and future knowledge. Conceptualize this road map in terms of the general questions listed below (Roth & Verechaka, 1993).

- What do we want to find out about? (focus question)
- What do we currently know about the topic? (associated words)
- What did we do to find answers to our questions? (experiments)
- What did we observe and measure? (data)
- What do our observations mean? (claims of knowledge)
- How are our ideas about a topic related? (concept map)

As showed in Figure 1, the Vee diagram, whose name is derived from its diagrammatic shape, structurally and visually relates an activity's methodological aspects to its fundamental conceptual aspects by converging on the concepts' salient role in learning and memory (Calais, 2009).

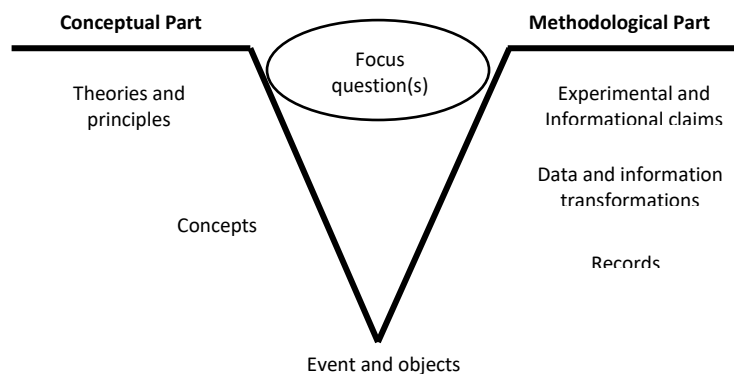


Figure 1. The Form and parts of the Vee diagram (Tekes & Gonen, 2012)

The Vee diagram starts with drawing a big V and separates theoretical/conceptual (thinking) on the left from the methodological (doing) elements of inquiry on the right. Both sides are interactional and interdependent because of the focus question(s) that is directly related to the events and/or objects (Calais, 2009). The conceptual part includes philosophy, theory, principles/conceptual systems, and concepts all of which are related to each other and to the events and/or objects. On the methodological part of the Vee, records of these events/objects are transformed into graphs, charts, tables, transcriptions of audio or videotapes, and so forth and become the basis for making knowledge and value claims (Alvarez & Risko, 2007). The need for instructional tools, such as the Vee diagram, to enhance conceptual learning has been stressed by researchers (Alvarez&Risko, 2007; Novak, 1990; Novak, Gowin & Johansen; 1983). These researchers suggested that Vee diagrams could aid students by focusing on the salient role of concepts in learning.

To sum up, V-diagrams are laboratory application and evaluation tools that contribute to the learning activity to demonstrate how to interpret the records obtained during the examination of the theoretical information in laboratories and to help determine and overcome students' misconceptions (Tekes & Gonen, 2012). Thus, the aim of this study is to the effects of Vee diagram on the achievements and attitudes of students in science laboratory course II. The following research questions, in turn, were posed the current study:

1. Are there any statistically significant differences between the experimental and the control groups' achievements in Science Laboratory Course II?
2. Are there any statistically significant differences between the experimental and the control groups' attitudes towards Science Laboratory Course II?

2. Methodology

2.1. Research design and sample

A quasi-experimental design with non-equivalent groups pretest-posttest control group (McMillan & Schumacher, 2010) was conducted with 59 pre-service science teachers in this study. The sample of this study were 59(51 female, 8 male) pre-service science teachers of science teaching program at Faculty of Education in Afyon Kocatepe University in Turkey. This study continued for 10 weeks in the spring semester of 2014-2015 year. Science Laboratory II lesson was conducted in a regular way as four hours per week. The teaching was realized through traditionally laboratory method with the

control group, whereas through Vee-diagrams with the experimental group. Pre-service science teachers constructed Vee diagrams for presenting their experiment reports during whole laboratory process.

2.2. Data collection tools

The data were gathered through “Achievement Test (AT)” and “Attitude Scale for Science Laboratory (ASSL)”. Achievement Test (AT), a 37-item multiple-choice test, was developed by researchers. During the developmental stage of the test, the instructional objectives of the subjects “sound, propagation ways of heat, expansion, electrostatics, electric current, and magnetic field” were stated. This step was carried out to define the content of the test. Then, items of the test were constructed and expert opinions were taken for content and face validity of AT. The pilot application was executed to determine the reliability of AT. For this aim, AT was initially applied to 53 pre-service science teachers who experienced this lesson previously. The reliability of AT was calculated with KR-20 and it was 0.90.

In order to determine pre-service science teachers’ attitudes, Attitude Scale for Science Laboratory (ASSL) was used. ASSL was developed by Yamak et al. (2012). The scale included 23 items in the three sub dimensions of seeking “the importance of laboratory”, “laboratory course and material usage” and “laboratory documents”. Authors expressed the reliability of this scale as 0.88.

3. Results

To answer the first research question “Are there any statistically significant differences between the experimental and the control groups’ achievements in Science Laboratory Course II?”, data from the AT are displayed in this stage. The treatment groups’ pre-test and post-test means, standard deviations and mean differences in AT were calculated as shown in Table 1.

Table 1. Means, standard deviations and mean difference of groups on AT before and after treatment

Groups	n	Pre-test \bar{X}	sd	Post-test \bar{X}	sd	Mean difference
Experimental	30	15.00	3.70	21.80	2.70	6.8
Control	29	14.40	3.86	15.93	4.33	1.53

Max. Score: 37

As seen in Table 1, the pre-test mean scores of experimental and control groups are close to each other. But, while the treatment brought a pretty appreciable increase of 45.33% in the experimental group’ post-test mean achievement score, it brought a little increase of 10.63% in the control group’ post-test mean achievement score. Additionally, an independent samples t-test was done in order to determine if there was a difference between groups’ pre-test achievements (Table 2). The t-test revealed that there was no a significant difference in groups’ pre-test AT in Science Laboratory Course II ($p > 0.05$). This finding has indicated that the students’ preliminary achievements in experimental and control group are same. However, it seems that there was a significant difference in groups’ post-test AT in Science Laboratory Course II in favor of experimental group ($p < 0.05$).

Table 2. Independent samples t-test results of groups on AT before and after treatment

Treatment	t	df	p
Pre-test	0.609	57	0.545
Post-test	-6.269	57	0.000*

* $p < 0.05$

To answer the second research question “Are there any statistically significant differences between the experimental and the control groups’ attitudes towards Science Laboratory Course II?”, data from

the ASSL are displayed in this stage. The treatment groups' pre-test and post-test means, standard deviations and mean differences in AT were calculated as shown in Table 3.

Table 3. Means, standard deviations and mean difference of groups on ASSL before and after treatment

Groups	n	Pre-test \bar{X}	sd	Post-test \bar{X}	sd	Mean difference
<i>Experimental</i>	30	3.10	0.21	3.15	0.16	0.05
<i>Control</i>	29	3.15	0.25	3.20	0.15	0.05

Max. score: 5

As seen in Table 3, the pre-test mean scores of experimental and control groups are close to each other. In other words, the treatment brought a little increase of 1.61% in the experimental group' post-test mean attitude score. The treatment also brought a little increase of 1.59% in the control group' post-test mean attitude score.

Additionally, an independent samples t-test was done in order to determine if there was a difference between groups' pre-test attitudes (Table 4). The t-test revealed that there was no a significant difference in groups' both pre-test and post-test ASSL towards Science Laboratory Course II ($p>0.05$). This indicates that treatment was no any influence on the attitudes towards science laboratory.

Table 4. Independent samples t-test results of groups on AT before and after treatment

Treatment	t	df	p
Pre-test	0.930	57	0.356
Post-test	1.243	57	0.219

4. Conclusion and discussion

This study is important to be able to determine the effect of Vee diagram on pre-service science teachers' achievements and attitudes in science laboratory course.

While the difference between the pre-test achievement mean and post-test achievement mean was found to be 45.33% for the experimental group, the same value was found to be 10.63% for the control group. Both of these values indicate a significant difference ($p<0.05$). Therefore, it can be said that usage of Vee diagram in the science laboratory courses increase the achievement. There are many other studies supporting this finding (Calais, 2009; Evren & Sulun, 2010; Roth & Verechaka, 1993). For example, Evren, Bati & Yilmaz (2012) investigated the effects of V-diagrams in Science and Technology laboratory teaching on preservice teachers' critical thinking dispositions. The findings from their study showed that using V-diagrams and routine teaching activities have different effects on preservice teachers' critical thinking dispositions in science and technology laboratory. In this scope, it can be said that the use of Vee-diagram in laboratory activities is a key element in substantiating the present aims of the science classes along with providing meaningful learning. At this point it is possible to conduct studies in order to identify the problems the preservice science teachers run into while using Vee-diagram in the laboratory practices and question the effect of the use of this tool in the laboratories on the various affective and cognitive features of the students (Yavuz & Balkan-Kiyıcı, 2014).

In addition, examining the students' attitudes towards science laboratory course II, it was found out that there was no a statistically significant difference between groups before and after the treatment ($p>0.05$). Based on results of the study, it can be said that there is not a significant problem regarding

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the usability of Vee diagram because pre-service science teachers' preliminary attitudes were already in high level, but some variables (motivation, interest etc.) should be worked.

Finally, the findings from this study are limited to pre-service science teachers. Therefore, the different studies can be done with different sample groups and these different studies may give more striking and more important results towards usage of Vee diagram.

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