Available online at www.sciencedirect.com
ScienceDirect
Procedia Social and Behavioral Sciences 2 (2010) 2310–2314
Procedia
Social and Behavioral Sciences

WCES-2010

The effect of implementation of science writing heuristic on students' achievement and attitudes toward laboratory in introductory physics laboratory

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Received October 20, 2009; revised December 29, 2009; accepted January 11, 2010

Abstract

The aim of this study was to evaluate the effect of implementing the Science Writing Heuristic (SWH) approach in the introductory physics laboratory and to learn students' views about the SWH. Such implementation and investigation was conducted on mechanic unit by measuring students' conceptual understanding of subjects and attitudes towards implementation. The study was carried out with 42 freshman students who were admitted to science education department in a university at Eastern Turkey. Results indicated that the SWH approach and the reporting format significantly increased students' mechanic unit achievement, conceptual understanding of the unit and attitudes toward laboratory.

Keywords: SWH approach; inquiry-based learning; physics education; laboratuary activitey; physics.

1. Introduction

The changes and improvement about human life put forward by natural Sciences lead to give more importance to the teaching of natural sciences in most of the countries. The most striking side of teaching of natural science is that it is based on the learning by observing and experiencing and especially in science laboratory activities (Fensham, Gunstone, & White, 1994). Also, in most of the research literature, it is stressed that laboratories should be used actively in science lessons. Providing opportunities for students to gain the skills of generalization, examination, and problem solving are among primary aims for science education. But, in our present day, the fact that science education based much more on memorizing, and that theoric lesson and laboratories become based on the measuring are orienting to how good the students make a memorization. And, this problem is one of the most important problems which are tried to be solved in science education (Driver, 1986). In Turkish education setting, similar problem arises for science education researches. As Simsek (2000) states that in Turkey science teaching and assessment are mainly focused on memorizing of facts.

Science education researchers have been continuously conducting the research to find effective ways with the aim of helping students making of science concept and principles sense. In order for students to learn to think the same as scientists, science teachers should reduce the number of the lectures given and should avoid to use cook-

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doi:10.1016/j.sbspro.2010.03.327

book type lab activities (Carillo et al., 2005). For this reason students should be encouraged to involve with inquiry lab activities. Furthermore, students need guidance relating to how to think through inquiry lab. One of the approaches supplied this requirements is the SWH approach devised by Hand and Keys (1999) (see Hand, Wallace, Prain and Collins, (1999) for technical details about the approach). The SWH approach includes a guidance to support of thinking and prompting student reasoning about data (Hand et al., in press). Laboratory activities which use the SWH improved the pupils' conceptual understanding and logical thinking (Keys et al. 1999; Hand & Keys 1999). When the students were taught by using guided inquiry laboratory approach such as the SWH where students complete science lab. activities with peer discussion, and inquiry writing it was found that the students had significant knowledge gain and there was meaningful changing in their attitudes (Carillo et al. 2005; Hand & Prain, 2002).

According to constructivist theories, one reason of writing laboratory reports is to bridge prior knowledge with new learning (Keys et al., 1999). But in a standard laboratory report, the students are requested to complete the sections, such as title, purpose, procedure, data, calculations, results and discussion, and are asked to verify science concepts which had already been explained to them. This situation seems resemble the general characteristics of science education that is memorizing the facts and procedures. One way that the students can learn required science concepts from laboratory activities is to let them determine the result of on investigation activity while presenting their laboratory reports by using a more flexible format (Pickering 1987). The SWH student laboratory report template prompts students to generate questions, claims and evidences for their claims. This template also asks students to compare their findings with others, including text books, other students, internet and different sources (Hand et al., in press).

In the SWH approach interactive, guided-inquiry lab activities are accompanied with student-centered classroom pedagogy including intra-and inter-group discussions and students' nontraditional writings. The learners discuss meaning from experimental data and the things they observe. Students structure concepts and the ideas by claiming and supplementing findings from their empirical work. Several empirical studies pointed out that students display deeper understanding of science and positive attitude toward science when the teacher effectively implemented the SWH within mainly biology and chemistry (Gunel, 2006; Akkus, Gunel, & Hand, in press). Yet, the literature is limited in terms of research studies conducted in physics area.

The Science Writing Heuristic	
Standard Report format	SWH Student Template
1. Title, purpose. 2. Outline of procedure. 3. Data and observations. 4. Discussion. 5. Balanced equations, calculations,graphs.	1. Beginning Questions-What are my questions? 2. Tests-What did I do? 3. Observations-What did I see? 4. Claims-What can I claim? 5. Evidence-How do I know? Why am I making these claims? 6. Reading- How do my ideas compare with other ideas? 7. Reflection-How have my ideas changed?

Figüre 1. Comparing student report formats for the Science Writing Heuristic and traditional laboratory.

1. Method

1.1. Participants

The study was carried out with 42 freshman students who were admitted to science education department in a university at Eastern Turkey. There was one classroom and had two sections. The sample was randomly assigned as control group consisted of 20 students and experimental group consisted of 22 students.

1.2. Research design

The aim of this study was to evaluate the effect of implementing the SWH approach in the introductory physics laboratory. Such impact was investigated on students' physics achievement measured with factual questions, conceptual understanding of subjects and attitudes towards laboratory. The study was framed around the following questions:

1) Does the SWH approach implemented in physics laboratory affect the students' factual understanding of mechanic unit?
2) Does the SWH approach implemented in physics laboratory affect the students' conceptual understanding of mechanic unit?
3) Does the SWH approach and student laboratory report template effect the students' ideas about their learning and attitudes towards laboratory?

2.3. Method of analysis

A mixed research design was used in this study. This study was carried out with the first year science education students who attended introductory physics laboratory in a large university at the East of Turkey. The first year science education students consisted of 42 freshmen within 2 classrooms. There was one classroom and had two sections. The sample was randomly assigned as control group consisted of 20 students and experimental group consisted of 22 students. The overarching unit was mechanic. In the control group the experiments were conducted by following the lab text book and under didactic guidance of instructors during eight weeks. In this group, experiments were pre defined and lab procedures were given by the text book. The control group prepared their laboratory reports according to their laboratory books. Such reports were traditional and they were fill in the blanks type of reports that can be described as typical lab report nationally and internationally. On the other hand, in the treatment group, the SWH approach was used in the laboratory where students made their claims and supported them with evidence from the experiments they own designed. Treatment groups prepared their reports according to the SWH student template which included beginning questions, claims, observations, evidences and their reflecting subtitles. During the study only at the beginning of the semester, first two-week 20 minutes instructions were given to both groups (treatment and control) about lab implementation and how to prepare their reports. All reports were evaluated by independent teaching assistant and provided feedback to students. Pre-post test consisted of 40 multiple choice tests and 3 conception questions. The answers of multiple choice questions were evaluated as wrong (0) and correct (1). Concept questions answers were evaluated as wrong (0), a bit correct (1), somewhat correct (2) and exactly correct (3). For face validity of the test, 2 professors, and 2 research assistants evaluated the questions. The same questions were used both for pre-test and post-test. Additionally at the end of the study, a likert scale inventory was applied in both treatment and control groups to measure the students' attitudes towards their thinking, reasoning, laboratory activities and laboratory report formats. A 1-6 likert scale (1= don't agree ; 6=totally agree) was employed for the codification of answers. The data were analyzed by using descriptive analysis method. The pre-post test and survey data were evaluated by applying t- test in SPSS program.

2. Results (Findings)

Before discussing findings emerged from the study, authors would like to state few limitations and conditions of the study. This study conducted in a university where laboratory experiments were run under traditional didactic approach and all experiments conducted by strictly using a book. Also students had to prepare their laboratory report by using traditional laboratory format.

Independent samples t-test method was used to measure differences between groups on pre and post test scores (McMillan and Schumacher, 2006). Results from pre-test analysis indicated that there was no significant difference between treatment and control group students on multiple choice questions (Table 1).

Table.1. Means, Standart Deviations and t value of pre-test scores on multiple choice questions

Groups	N	Mean	SD	t
Treatment	22	18.77	3.939	-1.311
Control	20	20.35	3.843	

p>.05

Additionally, there was no significant difference between treatment and control group students on concept questions (Table 2).

Table.2. Means, Standart Deviations and t value of pre-test scores on concept questions

Groups	N	Mean	SD	t
Treatment	22	1.45	.912	-.429
Control	20	1.60	1.273	

$p > .05$

After the implementation, result for the post-test analysis indicated a significant difference between groups on multiple choice and concept questions in favor of treatment groups (Table 3).

Table.3. Means, Standart Deviations and t value of post-test scores on multiple choice and concept questions

Groups	N	Mean	SD	t
Multiple Choice Questions				
Treatment	22	25.55	3.528	3.585^{*}
Control	20	21.55	3.692	
Concept Questions				
Treatment	22	4.05	1.731	2.384^{*}
Control	20	2.90	1.334	

$^{*}p < .05$

There were some interesting findings emerged from attitude and perception survey. In the inventory, first of all, when treatment students were asked to compare which approach of the laboratory they prefer, %70.4 of them preferred the SWH approach over traditional approach. However, %95.3 of the students in treatment group pointed out that the SWH approach increased their learning and they found laboratory format educative (%23.2 somewhat agree, %51.4 agree, %20.7 totally agree).

According to analysis of the SWH student laboratory report template, %87.6 of the treatment group indicated that this report format developed their problem solving ability (%42.4 somewhat agree, %33.5 agree, %11.7 totally agree).

In contrast, students in control groups didn't find the traditional teaching approach and the laboratory format educative. %64.5 of the students indicated that designing their own experiments would be more beneficial for learning (%25.8 somewhat agree, %12.3 agree, %26.4 totally agree). Additionally, %71.6 of the students pointed out that preparing traditional laboratory report format was boring (%23.8 somewhat agree, %19.4 agree, %28.4 totally agree).

3. Discussion

Results of this study showed that the SWH approach increased students' mechanic unit achievement, conceptual understanding and attitude towards physics laboratory. When we think about the possible explanations of why there were meaningful differences between groups, there are couples of possible explanations come forward. The first, students' constructing their own questions and designing their own experiments effect learning positively. Because having control over the activity leads to have confidence in knowledge and preparation. The second, the SWH laboratory format encourage students to develop conceptual understanding by discussing their claims and evidence. Majority of the students expressed the SWH format increased their learning. However, the traditional report format is found boring by students since it confirms the concepts from previous lectures (Rudd, Greenbowe and Hand, 2001).

On the other hand, recent studies in chemical and biology education have the same findings with this result (Hohenshell and Hand, 2006; Rudd, Greenbowe and Hand, 2001). It is important to argue that the SWH approach is beneficial for physics learning. Such findings can help us to use the SWH approach in all science laboratories. The reason of it is all science branches (physics, biology and chemistry) depend on laboratory experiments. Students learn science concept by experiments. So, effective approaches must be used in laboratory experiments to increase conceptual learning.

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