Proceedings of the XIII IOSTE Symposium on

The Use of Science and Technology Education for Peace and Sustainable Development

21-26 September 2008
Pine Bay Holiday Resort - Kusadasi - TURKEY
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The Use of Science and Technology Education 
for Peace and Sustainable Development 

September, 21-26, 2008 
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EFFECT OF INQUIRY-BASED LABORATORY ACTIVITIES ON STUDENTS’ ATTITUDES TOWARDS LABORATORY AND THEIR OPINIONS

Meryem Nur AYDEDE, Dokuz Eylül University, Institute of Educational Sciences, Department of Science Education, Izmir, Turkey, mnur.aydede@deu.edu.tr

Teoman KESERÇİOĞLU, Dokuz Eylül University, Faculty of Education, Department of Science Education, Izmir, Turkey, teoman.koglu@deu.edu.tr

\textbf{Abstract}

The purpose of this study was to determine the effect of inquiry based laboratory activities on students' attitudes towards laboratory course and their opinions about inquiry based laboratory activities. The study was implemented in Adana, Turkey in 2005-2006 education period. IFN 224 Biology Laboratory Course II was choosen for the research. 32 students participated in the student study group in all, consisting 16 students in the experimental group and 16 students in the control group and the study lasted 9 weeks. The lessons were performed according to the inquiry-based laboratory activities in the experimental group and expository (cookbook) approach in the control group. The study was organized according to experimental design, having pretest and posttest with control group. In the study, "Laboratory Scale" was used to collect data. The scale was developed by Abraham (1982) and adapted to Turkish by Tümay (2001). The alpha reliability coefficient of this scale was .86, consisting of 22 items. Mann Whitney U test for independent samples was used to analyze the quantitative data and content analysis technique was used to analyze the qualitative data. At the end of the research, according to posttest grades obtained from laboratory scale, there were statistically significant differences supporting the experimental group. Qualitative analysis results showed that students find useful the inquiry-based laboratory activities to develop their knowledge, skills and attitudes. Furthermore, students indicated that they felt empowered by taking responsibility on their learning process in laboratory course and these activities can cause them to acquire the habit of using the scientific study method in their researches.

\textbf{Key Words} Inquiry based laboratory activities, attitudes, science education.

\textbf{Introduction}

In the traditional approach, instructors come to class with highly structured curricula and activity plans and they determine which information is important. The topics are prearranged in a particular order and each lesson is devoted to the concepts that are to be covered. But according to traditional teachers, students just listen and take notes. They do not think about the content they are learning or about the purpose of learning it. In a traditional classroom, the teacher is the one who controls the learning process while students are passive and dependent learners. In traditional classrooms, teachers are usually the ones who control the pace of the lesson and students are expected to follow along with the teacher's instructions. However, in an inquiry-based classroom, students are encouraged to be active participants in the learning process. They are encouraged to think critically, analyze information, and make connections between concepts. In an inquiry-based classroom, the teacher's role is more of a facilitator than a controller. The teacher helps students to explore and discover new ideas, rather than just telling them what to learn.
and projects which have been decided for the children to learn and master are driven and evaluated by instructor or administrator. In contrast, recent reforms in science education have given importance to teaching and learning strategies through scientific inquiry-based activities in science education. It has been argued that meaningful learning of science should involve not only performing investigations to collect data, but also the construction and evaluation of scientific assertions (National Research Council, 2001). It means that when students participate in active learning exercises their understanding of science is improved. Inquiry-based activities are driven by students and instructors who act more as guides and facilitators so as to help learners on their learning process. For this reason, inquiry-based activities can be one of the way of involving students into active learning environments. When instructors are to take advance of inquiry-based activities they must have the same particular abilities and thinking skills in inquiry-based learning environment (Baumfield, 2006). The ability to carry out a rigorous systematic process of inquiry and the capacity to apply the skills which were acquired in a range of different contexts needs to be developed (Brew, 2003). Instructors who adopt an inquiry-based approach help students identify and refine their “real” questions in learning projects or opportunities (Hume, Coll, 2007). In addition instructors must have abilities on implementing modern technology and related pedagogical innovations in classrooms. Detailed analysis of interaction processes should be undertaken within the larger structures of activities and lessons, and within the institutional and social context (Lakkala, Ilomaki, Palonen, 2007).

The aim of inquiry-based science activities is not only to achieve content of the curriculum for students, but also emphasis is on skills in solving problems and constructing new knowledge (Lakkala, Ilomaki, palonen, 2007). In inquiry-based learning the students are guided to form their own questions about the phenomena and create their intuitive studying and working plans as explanations to answer the questions. When students choose the questions in inquiry-based learning, they are motivated to learn and they develop a sense of possession about the project. These stages are undertaken before using authoritative information sources, to challenge the students’ own thinking. The learning community acquires new information by exploiting various information sources after having evaluated the produced ideas and explanations together. The process will be repeated gradually with deepening cycles of formulating subordinate study questions and more accurate theories and knowledge products. The model is not meant to be followed rigidly, but it offers conceptual tools to discuss, organize and make the strategies and activities in the inquiry practise visible (Lakkala, Ilomaki, Palonen, 2007). Thus successful inquiry techniques depends on the knowledge and experience held by the students involved, and their ability to draw on appropriate and relevant information (Hume, Coll, 2007).

In Turkey the 2005 primary science teaching program which was completely implemented according to the constructivist learning approach completely changed the roles of the instructors and students in the learning process. After implementing this program in 2005-2006 period, the knowledge-supplier role of the instructor in the traditional class changed into a role which guarantees the environment in which the students can study in collaboration and plan their own experiments. Neverthe-
less, recent researches in Turkey showed that instructor doesn't give opportunity to students to plan their own experiments and therefore present teaching approaches need significant rethinking and development if achievement of scientific literacy goals through inquiry-based learning is to be achieved. (Hume and Coll, 2007). The success of that approach can be related to the quality of instructors who are the appliers. Therefore, we felt a requirement for contrasting the inquiry-based methods with expository method for the undergraduate science education students in IFN 224 Biology Laboratory Course. This study defines inquiry as a question-driven learning process involving conducting scientific investigations, documenting and interpreting narrative or numerical data, and summarizing and communicating findings in order to help students learn science.

PROCESS OF INQUIRY BASED LABORATORY

IFN 224 Biology Laboratory Course II content includes evolution and diversity, structure and function within the horizon of organisms, response of the organisms to their biological and physical environments and basic concepts in ecology.

A framework was developed for inquiry-based learning that involves seven phases: asking and deciding questions (seeking questions in the processes of creating knowledge), searching for information (having the technical knowledge), designing investigations (plans ideas), carrying out investigations, analyzing data and making conclusions, creating artifacts, and sharing and communicating findings. These phases are not steps to take in a linear fashion and students can go through the phases in complex ways. Additionally, due to the nature of inquiry some scientific investigations do not involve all seven phases. For example, analyzing data from a weather database and constructing explanations of phenomena such as global warming and climate change. With these a topics students do not only collect empirical data by themselves but also they carry out hands-on experiments. Students should be provided with opportunities to appreciate and understand various forms of scientific inquiry (Wu, H-K., Hsieh, C.E., 2006; McGinn & Roth, 1999; Brew, 2003; Lakkala, Iломатпсалонен, 2007).

METHOD

The study was organized according to quasi-experimental design, one of the experimental designs, having pretest and posttest with a control group. Experimental design is used to investigate possible cause-and-effect relationships by exposing one or more experimental groups and comparing the results to one or more control groups using random assignment of students (Isaac, Michael, 1982). The research was conducted for 9 weeks with undergraduate science education students in Adana, 2005-2006 education period. The lessons were carried out by the researchers on both research groups. The lessons were performed according to the inquiry-based laboratory activities in the experimental group and traditional teacher-centered approach in the control group. At the beginning of the study, an awareness-raising program was applied to the study group in order to assist with their adaptation to inquiry-based laboratory activities. This awareness program also covered activities which help students in the study group to develop behavior suitable for the method applied during the experimental period.
Dependent and Independent Variables: In this context, it was aimed to test the effect of independent variables (inquiry based laboratory activities, expository) on dependent variables (attitudes towards laboratory, students’ opinions).

STUDY GROUP
While determining the research group, the techniques of simple random sampling was used. The simple random sampling of all the students in the defined population give an equal and independent chance of being selected as a member of the sample (Borg, Gall, 1989). 32 students participated in the study group in all, consisting 16 students in the experimental group and 16 students in the control group.

PURPOSE
The purpose of this study was to investigate the effectiveness of inquiry-based laboratory activities on undergraduate students’ attitudes towards biology laboratory course and to get their opinions about inquiry-based laboratory activities. Other questions associated with the main purpose were as follows:

1. Is there a significant difference between average scores of experimental and control groups in terms of attitudes towards laboratory?
2. What are the students’ opinions about the effect of inquiry-based laboratory activities on biology laboratory course?

DATA COLLECTING TOOLS
In the study, ‘laboratory scale’ and ‘student negotiation form’ was used as means of collecting data.

LABORATORY SCALE
In the research, “Laboratory Scale” was used. The scale was developed by Abraham (1982) and adapted to Turkish by Tümay (2001). The alpha reliability coefficient of that scale was 0.86, consisting 22 items with one factor (adapted by Tümay to Turkish) At the same time, the reliability of that scale was computed for this research too. That scale was used with the science education students of Cukurova and Mersin Universities to calculate reliability value. Because the factor-load value was less than 0.30, nine items were excluded from the scale. The rest of twelve items were exposed to factor analysis again and for the 12 items the cronbach alpha value was calculated as 0.88.

STUDENT NEGOTIATION FORM
In the study, negotiation form was used to find out the opinions of the experimental group students about inquiry-based laboratory activities on biology laboratory course at the end of the study. While developing the form, local and foreign literature was reviewed and the students’ opinions were taken. By means of the data gained from the literature review and students’ opinions, the items for trial have been composed.
Data Analysis: Mann Whitney U test for independent samples was used to determine whether there was any difference between the pretest and posttest points of experimental group and control group in terms of attitudes towards laboratory class. 05 was accepted as a level of significance while interpreting the quantitative data. Content analysis technique was used to analyse the students’ negotiation form.

FINDINGS AND ADVICES
The purpose of this research was to investigate the effects of inquiry-based laboratory activities on students’ attitudes towards laboratory course and on their opinions about inquiry-based laboratory activities. While getting posttest scores, inquiry-based laboratory activities were applied to the experimental group and expository manner (cookbook) was applied to the control group. At the beginning of the research “The Attitudes toward Laboratory Course Scale” were applied. According to the results of Man Whitney U-test analysis of “The Attitudes toward Laboratory Course Scale” before the instruction, there was no significant difference between the scores of the experimental group, and the control group (U: 108, p=.46). Data obtained from the analysis of posttest were shown on the table one.

Table 1 Man Whitney U-test Results for the Attitudes Toward Laboratory Course

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean rank</th>
<th>Sum of ranks</th>
<th>U</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>16</td>
<td>20.69</td>
<td>331</td>
<td>61</td>
<td>.011</td>
</tr>
<tr>
<td>Control</td>
<td>16</td>
<td>12.31</td>
<td>197</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After the instruction, the mean scores of students in the experimental group increased more significantly than the mean scores of students in the control group (U:61, p=.011). This shows that there were statistically significant differences supporting the experimental group (p<.05). Concluding from the laboratory scale posttest scores, it was observed that inquiry-based laboratory activities are more effective on the attitude of students towards the IFN 224 Biology Laboratory Course than the (cookbook) approach.

During the interview, the students indicated that inquiry-based laboratory activities provide an opportunity for them to learn concepts in a more enjoyable, willing and more meaningful way. One of the students stated that: “...I enjoy talking science with other people except for the instructors, ... I enjoy doing plans about and for my learning process, … I feel myself important when I search something else about biology”. These statements indicate that, the students want to use inquiry-based laboratory activities in Biology Laboratory Course.

Qualitative analysis results showed that inquiry-based laboratory activities are useful for students to develop their knowledge, skills and attitudes. Furthermore, students indicated that they felt dominant by taking responsibility on their learning process in laboratory course and these activities can prompt them to acquire the habit of using the scientific study method in their researches.
Depending on the research results, we can advise that:
1. Inquiry-based laboratory activities should be used in laboratory courses.
2. This teaching program should be used for other different courses.
3. This study investigated the effects of inquiry-based laboratory activities on students’ attitudes towards laboratory class. This study should be expanded to investigate the effects of inquiry-based laboratory activities on students’ creativity, scientific skills and critical thinking skills etc.

REFERENCES