Effects of Hands and Minds on Activities Accompanied with Computer Simulation on Students’ Biology Achievement and Attitudes Toward Science

Hilal AKTAMIŞ, Ercan AKPINAR, Yasemin GÜNAY, Ömer ERGIN
Dokuz Eylül University, Buca Faculty of Education
Department of Science Education, Izmir, Turkey
hilal.askar@deu.edu.tr, ercan.akpinar@deu.edu.tr, yasemin.gunay@deu.edu.tr, omer.ergin@deu.edu.tr

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Abstract. The purpose of this study was to investigate effects of hands-on and minds on activities accompanied with computer simulation on students’ biology achievement in a biology topic (animal and plant cells, the structure of plant, the systems of human body etc.) in a primary science lesson. The sample of this study consisted of 50 students in a primary school in Izmir in Turkey. The students in one class were referred to as experimental group (n=25) and the students in other class were referred as control group (n=25). The experimental group received hands-on and minds on activities accompanied with computer simulation and control group received traditional instruction (lectures and discussion). The data of this study has been collected by biology achievement test and science attitude scale which their validity and reliability were tested. T-test Analysis was used to test the hypotheses of the study. The present study indicated that the experimental group scored significantly higher than the control group with respect to biology achievement, and showed more positive attitudes toward science.

Keywords. Constructivism, hands-on minds-on activities, materials, experiments, computer simulation.

1. Introduction

Research of cognitive psychologists and science educators has shown that real understanding of science concepts, as well as other concepts, occurs only students participate fully in the development of their own knowledge. That is, they must construct their own knowledge. This idea that students must build their own knowledge from their own experiences and thought is called constructivism. In constructivist theory, learners are responsible for their own learning and knowledge is not transmitted directly from one person to another, but actively constructed by the learner. Learning is an active process that requires both action and reflection on the part of the learner [1] [2] [3] [4] [5] [6] [7].

When the primary science programs of highly developed countries are viewed, it can be seen that these countries have developed students centered science programs and put into practice them since the middle 1970s [8]. These programs were impressed by constructivist theory. In contrast, in Turkey the primary science programs had been under the effects of behaviorist view from 1924 to 1989. Although the program applied in 1992 had some constructivist views, it was heavily based on behaviorist views and continued to be employed until 2000 [9].

In 2000, The Ministry of National Education has changed the primary science program radically and that program has been continued since 2001. When viewed, it is seen that this program has been under the constructivist theory [10] [11] and given up former programs' perspectives. The latest one has been a student centered program [12]. This program offers students engage in hands on and minds on activities and have students construct meaningful knowledge based on their own prior knowledge and experiences. In this program, student has some responsibility such as learning to learn, discovering, making research. Moreover, it offers students work cooperatively and share their knowledge and experiences with each other. When the science teacher begins course, the most important thing he or she should make is to determine prior knowledge and experience of the students and regard this lesson. In addition to
this, it gives a role to science teacher as a facilitator. The science teacher is not the transporters of knowledge but is a learner who is actively engaged in the classroom activities as if he or she is learning with them and preparing a self-learning environment to students [13]. It is seen obviously the constructivist curriculum gives a great responsibility to science teacher to achieve its goals [9].

In this program, the science teacher's role is to mediate the learning of students. If teachers see themselves as mediating the learning of students, they will have two critical components of their role are to monitor learning and provide constraints so that student thinking will be channeled in more productive directions. To undertake such a role, teachers must interact with students to a greater extent that in traditional classroom to ascertain what they know and what they are thinking. As a mediator, the science teacher need to ensure that students are provided opportunities for quality learning experiences that provide a solid base for learning with understanding. There are other things a teacher can do to promote the learning of students. Planning and implementing tasks is an important role, and teachers should remember that they can only constrains the thinking of students. Students thinking needs to be stimulated by providing time to think: students need time to engage in the processes required to evaluate the adequacy of specific knowledge, make connections, clarify, elaborate, build alternatives, and speculate. A most significant role of the teacher, from the constructivist perspective, is to evaluate students learning. So teacher should develop ways of assessing what students know and how they can represent what they know [5].

A good science teacher must know that primary students love hands-on learning. That is the natural way to learn; the science teacher's main task is to provide the situation and teach them how to function within its boundaries. In such a context, science ideas will be concrete rather than abstract, and teacher's role will be to guide learning experience rather than to tell about or explain concepts. This program offers that student should build their own knowledge from their own experiences, from both doing and thinking. "Hands-on" must be accompanied by "Minds-on". Having interesting things for the children to do is not enough; thinking and talking about what they have done must be part of the science program, as well. By this way, children build their own knowledge from their own experiences [1]. In additional to hands-on and minds-on activities, computer-based technologies provide powerful means for meaningful learning. Computer has the capacity to support to design interactive learning climate and help students learn especially abstract concepts by making them visible.

The applications or uses of computers have infiltrated all levels and areas of education to help in improving teaching-learning process. As instructional applications have developed, numerous research studies have evolved, in which attempts have been made to determine the effectiveness of computer-assisted instruction in terms of student affect and achievement [14].

Choi and Gennero (1987) [15] found that computer stimulated experiences were effective as hands-on laboratory experiences, and that males, having hands-on laboratory experiences, performed better on the protest than females.

Simmons and Simpson (1992) [16] determined whether combining computer assisted instruction with hands-on science activities could significantly increase students' outcomes on the cognitive and affective assessments. In this study, hands-on activities appeared to increase both knowledge of and attitudes toward science and computer. The kinds of learning experiences which involve hands-on and computer assisted instruction appear to enhance attitudes of students toward science and computer. Windschitl & Andre (1998) [17] found that Computer simulations have an effect to enhance conceptual change. Besides some studies indicate that computer simulation and animation have a great contribution on students' science achievements [20] [21].

The main purpose of this study was to compare the effectiveness of hands-on and minds-on activities accompanied with computer simulation based on constructivist approach over traditionally designed science instruction on 6th grade students' biology achievement and their attitudes toward science as a school topic.

In this study, hands-on and minds-on activities accompanied with computer simulation based on constructivist approach were used as a supplement to the regular classroom instruction. There are a few studies comparing the effectiveness of hands-on and minds-on activities accompanied with computer simulation over traditionally designed science instruction on students’ achievement and attitudes toward science.

So, the aims of the present study were:
1. To determine the evolution of students’ pre and post achievements in two different learning situations: a) a traditional teaching environment and b) a learning environment supported by materials

2. To determine the evolution of students’ pre and post science attitude scales in two different learning situations: a) a traditional teaching environment and b) a learning environment supported by materials

3. To investigate students’ ideas about activities and materials in a biology topic (animal and plant cells, the structure of plant, the systems of human body etc.)

2. Method and Sample

The empirical methods are used in this research. The sample of this study consisted of (N=50) 6th grade students in a state primary school in Izmir in Turkey. The students in one class were referred to as experimental group (n=25) and the students in other class were referred as control group (n=25). The experimental group was taught by using various teaching materials (1 scenario, 3 games, 14 experiments, 1 simulation and 5 models). Children worked in small groups of 4-5 persons by using worksheets and prepared materials and had a lot of discussion about their personal ideas.

The students of the traditional class had been taught biology topic in the traditional /conventional way (the teacher is the dispenser of knowledge, he is lecturing and the students pay attention to him, the experiments done and explained, usually by instructor, the children do not co-operate and do not interact with each other etc.).

The research lasted about 12 weeks. Before and after the study both groups were given multiple choice achievement test and science attitude scale. In addition to these, an interview was conducted over six students randomly selected from experimental group. The collected data were analyzed statistically.

2.1. Biology Achievement Test

The biology achievement test consisted of 35 items was developed by researchers. The test items were eliminated by item discriminations so the researchers deleted some items. This test’s reliability was determined by computing the KR-20. The test was developed as 20 items and reliability 0,64.

2.2. Science Attitude Scale

This scale was developed as 15 items and likert type by Geban, Ertepınar, Şahpaz, Altan (1994) [18] and was determined by computing the cronbach Alpha coefficient of internal consistency (0,86) by Yavuz (1998) [19]. Items of attitude scale got for “completely agree with” 5 point, “agree with” 4 point, “undecided” 3 point, “ not agree with” 2 point and “completely not agree with” 1 point.

2.3. Interview

The researchers used semi-constructed interview protocol. The aim of using interview is to investigate students’ ideas about activities and materials in a biology topic.

The collected data were analyzed statistically by SPSS computer program.

3. Results

The first aim as to determine the evolution of students’ pre and post achievements in two different learning situations: a) a traditional teaching environment and b) a learning environment supported by materials. Comparisons were made in terms of the experimental and control groups’ pre-post test achievement score means with independent and paired samples t-test analyze.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>t</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>Pre</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Experimantal</td>
<td>25</td>
<td>6.40</td>
<td>2.02</td>
<td>1.752</td>
<td>.086</td>
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<td>5.44</td>
<td>1.85</td>
<td></td>
<td></td>
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<tr>
<td>Post</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Experimantal</td>
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<td>10.00</td>
<td>3.17</td>
<td>2.805</td>
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<td>7.76</td>
<td>2.42</td>
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</table>

*Significant at the 0.05 level

As shown in table 1, experimental and control groups pre test scores means (6.40 and 5.44) nearly same and significance is higher than 0.05. So the experimental group and control group was same. Experimental group posttest scored
significantly higher than did control group (significant at the 0.05 level). We can conclude that the achievement of these primary school students increases with the prepared materials and activities. In addition, the experimental and control group pre and post test scores were compared within themselves and the students’ achievement for two groups is higher than before research (experimental group t=6.397, p=.000, control group t=4.004, p=.001).

The second aim as to determine the evolution of students’ pre and post science attitude scales in two different learning situations: a) a traditional teaching environment and b) a learning environment supported by materials. Comparisons were made in terms of the experimental and control groups’ pre-post test science attitudes score means with independent and paired samples t-test analyze.

Table 2. Science attitudes score’s comparisons.

<table>
<thead>
<tr>
<th>GROUP</th>
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<th>Mean</th>
<th>S.D.</th>
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<th>P</th>
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<td>Experimental-tal</td>
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<td>60.26</td>
<td>9.53</td>
<td>.832</td>
<td>.409</td>
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<td>Control</td>
<td>25</td>
<td>58.15</td>
<td>8.87</td>
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<td></td>
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<tr>
<td>Post Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental-tal</td>
<td>25</td>
<td>63.23</td>
<td>7.67</td>
<td>3.530</td>
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<td>56.40</td>
<td>6.05</td>
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</table>

* Significant at the 0.05 level

As shown in table 2, experimental and control groups pre test scores means (58.15 and 60.26) nearly equal. Significance is higher than 0.05. So the experimental group and control group was equal. Experimental group posttest scored significantly higher than did control group (significant at the 0.05 level). We can conclude that the science attitude scale of these primary school students increases with the prepared materials and activities.

The third aim as to investigate students’ ideas about activities and materials in a biology topic (animal and plant cells, the structure of plant, the systems of human body etc.). The researchers selected randomly six students from experimental group. There give some interview examples;

More admire activity and material;

The activity is better with computer. Because there are a lot of things about plant and animal cells

I am enjoying activity with computer because, people understand better with seeing.

I am enjoying the game because we learnt plant’s tissues.

More Attention Activity;

We played a game with to draw a line because I learnt tissues there.

The computer activity was more to keep in the memory. We saw plant and animal cells.

We played a game with to draw a line. We were charge our friends.

Not Admire Activity;

I enjoyed whole activity because we make whole activity with seeing and living.

Generally I enjoyed whole activity.

I enjoyed whole activity because I learnt new knowledge from whole activities.

A traditional teaching environment or a learning environment supported by materials?

The lesson should support by materials. We studied together friends.

The lesson was more beautiful with materials. The lesson was better with materials. Because A things learnt with living.

The effects of worksheets;

Some subjects were difficult.

I felt beautiful things with studying worksheets. Because we were studying with cooperate. So we learnt differently things about subjects.

Everybody thinks different things.

Computer supports the lesson;

The computer was attracting attention. It was help me while I learnt the subject.

I studied better with the computer.

These students’ ideas are show us that the students like the prepared materials.

4. Conclusions

A first important point to establish -a prerequisite to taking our research enterprise forward- is that teachers were comfortable with the prepared materials. A view of pupils as active constructors of knowledge rather than passive receivers is fundamental to prepared materials.

Children’s scores of the experimental class have been improved substantially after the learning environment supported by materials. Students’ ideas have been supported their achievements.

When educational games, experiments and computer simulation are used together in an active learning environment, high significant
difference was recorded in science achievement and students’ science attitudes in this study.

Reflecting on materials in a classroom context draws attention to the possibility of useful reusable external representations in the form of conventional science models, descriptions, simulations, games and empirical experiences that may be culturally promoted.

9. References


[21] Ardac, D., Akaygün, S. Effectiveness of Multimedia-Based Instruction That Emphasizes Molecular Representation on Students’ Understanding of Chemical