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The Impact of Digital Mind Maps on Science Achievement among Sixth Grade Students in Saudi Arabia

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Abstract

The purpose of this study was to examine the impact of digital mind maps on science achievement among sixth grade students in Saudi Arabia. A total of female 44 students at the second-semester of the academic year 2012 /2013 participated in the study. The students were randomly assigned to two experimental groups to receive different treatments. The first group (DMM) utilized digital mind maps during their learning process, while the second group (PMM) utilized paper mind maps. The results revealed that using digital mind maps had a significant effect on students’ science achievement. Based on the obtained results, it was concluded that the utilization of digital mind maps for Saudi sixth students could be helpful in improving their achievement.

Keywords: Digital mind maps; paper mind maps; science; achievement

1. Introduction

Instructional design has moved through a series of development phases. The move from behaviorism through cognitivism to constructivism represents shifts in emphasis away from an external view to an internal view of learning. To the behaviorist, the internal processing is of no interest; to the cognitivist, the internal

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processing is only of importance to the extent to which it explains how external reality is understood. In contrast, the constructivist views the student as a builder of her knowledge (Terhart, 2003). This turning point of learning processes asks for designing of instruction that deals with students as builders not receivers of knowledge, students who construct knowledge through interaction and connecting their experiences and their prior knowledge with the current situations, and students who have learning strategies to help in building their knowledge and understanding. Therefore, effective instruction emphasizes on the teaching of strategies that enable students to learn with understanding.

Based on a constructivist approach principles, the utilization of mind maps facilitates meaningful learning (Akinoglu & Yasar, 2007, Buzan, 1993, Erdogan, 2008). Researchers confirmed that visual presentation is an essential for students to understand new knowledge. One of the most powerful tools for visual presentation is mind map which is a “useful tool for helping younger students with the process of building conceptual understanding of content and promoting achievement” (Mona & Khalick, 2008, p. 298). Buzan (1993, p.59), defined the mind map as “an expression of Radiant Thinking and is therefore a function of the human mind. It is a powerful graphic technique which provides a universal key to unlocking the potential of the brain”. The mind map has four essential characteristics: The subject attention is crystallized in a central image, the main themes of the subject radiate from the central image as branches, branches comprise a key image or key word printed on an associated line, and the branches form a connected nodal structure.

Learners who utilize mind maps are more likely able to learn effectively by organizing maps and add images and color to them (Nesbit & Adesope, 2006). Mind maps let learners to produce a visual image to enrich their learning (Budd, 2004). Farrand, Hussain, and Hennessy (2002) found that mind maps not only aided medical students in studying, but also encouraged a deeper level of learning, especially when paired with a problem-based learning curriculum. Mind maps have also been used as reflective tools that allow for broader associations to be made to the material (Budd, 2004). Moreover, utilizing mind maps aids teachers vary their teaching methods which may be more likely to reach diverse learners (Nesbit & Adesope, 2006). The utilization
of mind maps can be assisted with “the adoption of colors, images, codes, and multidimensional approaches to help human memory, so that one could concentrate the mind on the central part, which is, the crucial subject” Chen, 2008, p.1034). Buzan (1993) stated that mind maps help learners to use graphic representation which may help in the brainstorming process. McGriff (2000) confirmed that relating images to concepts is a creative task which requires thinking instead of memorizing. Adam and Mowers (2007) found that learners who could express their learning with visual skills had a 40% higher retention rate than that of just verbal learners.

Although many research findings (Akinoglu & Yasar, 2007; Buzan, 1996; Chiou, 2008; Erdogan, 2008; Farrand et al. 2002; Riley & Ahlberg, 2004) have showed the effectiveness of employing the paper mind maps, paper mind maps have been considered by some writers not to be a useful skill. For example, sometimes it could be time consuming for the teacher to present and for the student to understand, especially if the student is inexperienced, or uncreative (Buzan, 1993). In the digital word and the age of ICT, writing anything out long hand is unfavorable, and therefore, paper mind maps creation seems to be time consuming and a huge step backward. However, it is valuable to benefit from computer to create mind maps, namely, digital mind maps.

By utilizing digital mind maps, students can move objects and concepts around simply by drag and drop them, in contrast, with paper mind maps, students need to erase and rewrite again and again (Erdogan, 2008). Moreover, digital mind maps can be saved as files, the file can be shared among learners, and bits of it may be copied for other maps. Further digital mind maps enable students to include hyperlinks and email links to their maps. Students can also attach and view video clips, animated pictures, and images (Riley & Ahlberg, 2004).

1.1 Purpose of the study

To date, however, various research studies have been conducted to investigate the effect of paper mind maps on learning science. Research has provided relatively little insight into the role of digital mind maps on young learners' science achievement. Thus, the purpose of this study is to investigate the impact of digital mind
maps on science achievement among sixth grade students. Particularly, the study was conducted to investigate if there were any statistically significant differences in science levels between students who were taught and learned by utilizing digital mind maps (DMM) and students who were taught and learned by utilizing paper mind maps (PMM).

1.2 Research Question and Hypotheses
This study seeks to answer the following research question:

Does the utilization of digital mind maps make more significant difference on students’ achievement in learning science when compared to paper mind maps?

Based on the above research question the following hypothesis was formulated:

There is no statistical significant difference in science achievement between Students taught via the utilization of digital mind maps and students taught via the utilization of paper mind maps.

1.3 Significance of the Study
It is hoped that the findings of this study will contribute to further understanding of the role of digital mind maps in improving science academic achievement. If the utilization of digital mind maps proves its effectiveness in improving science academic achievement, teachers in Saudi Arabia will have additional instructional media that can be used to support students’ learning with understanding. Moreover, this will help educators in Saudi Arabia in their search for an effective and efficient pedagogical strategy or model for improving learning with understanding.

2. Method

It is important to note that everyday classroom instructions and all reading materials used in the participating school are in the Arabic Language (except for classes focused on the teaching of English). Therefore, all the materials and instruments used in this study were in Arabic.

2.1 Population and Sample
The population of this study comprised of all female sixth grade students enrolled in the National Guard elementary schools in the capital city of Saudi Arabia –Riyadh- during the second semester for the academic year
2012 / 2013. The National Guard Office includes (15) female elementary schools that comprise (729) sixth grade students. Schools in Saudi Arabia are not coeducational.

In order to implement this study in a naturalistic school setting, existing intact classes were selected. One school from the (15th) elementary schools was randomly selected and two classes from the selected school were randomly selected. The sample consisted of (44) female students who were studying in two sixth-grade classrooms. The size of the classes was similar (22 and 22) and the mean age of the students was 11.6 years. Students in the selected classes were from approximately equivalent socioeconomic status as defined by the National Guard Office.

2.3 Experimental Conditions

The two groups were different from one another in terms of the mind map type. The DMM group was taught and learned by using the digital mind maps. The PMM group was taught and learned by using the paper mind maps. The followings are the details of each group:

**DMM Group (N = 22):** In this group, the teacher and learners used digital mind maps two weeks before the formal experiment with practice lessons. In the present study, in each session, the teacher introduced and explained the new topic for about 10 minutes to the whole class by using and presenting digital mind maps. After the teacher’s explanation, students worked individually using the digital mind maps that guided and supported students to achieve the learning objectives. In other words, students under this condition were instructed and reminded frequently to use the digital maps to facilitate their learning. During the learning process, the teacher monitored each student and intervened by guiding student to the usage of the digital mind maps if necessary. At the end of the session, the teacher asked student to turn off their computers and assessed and evaluated students’ performance, discussed with the whole class to ensure that students carefully processed the effectiveness of their learning.
PMM Group \( (N = 22) \): In this group, the teacher and learners followed the same method in the DMM group, except they utilized the paper mind maps instead of digital mind maps, and at the end of the each session, the teacher collected all paper mind maps.

After three weeks of implementing the study, namely in the last science session of this experiment (session 15), students in both groups were asked to complete the science achievement test.

### 2.4 Instructional Materials

In order to investigate the students’ science achievement in a naturalistic setting of the classroom, the instructional materials that used in this study were based on the fifth unit from the science textbook (Matter) designed by the Ministry of Education for all fifth-grade students in Saudi Arabia, teacher’s lesson plans, digital mind maps, and paper mind maps. Both types of mind maps were developed by the researcher and one of his graduate students who have B.Ed. major in science.

### 2.5 Measurement Instruments

To measure students’ science achievement, a pre-test and a post-test were developed in this study. The pre-test and post-test questions were similar in content but their order and numbering were randomized. Two weeks before the beginning of this study, the pre-test was conducted; the results were collected and used as a covariate.

### 2.6 Test Validity and Reliability

Three experienced science teachers, two education science supervisors, and three science education university lecturers reviewed the test. Each viewed all question and rated their confidence in their response, using scale from 1 (very weak) to 5 (very strong). Only questions, which had received 4 or more scores from all evaluators, were selected as test questions. The evaluators’ suggestions, feedback, and comments were taken into account until there were no discrepancies among them. Prior to the beginning of the study, a pilot test was carried
out and the scores from the pilot study test were collected to determine the Cronbach’s Alpha reliability coefficient. Cronbach’s alpha reliability coefficient of the test was .91.

3. Results

Testing the study hypothesis: "There is no statistical significant difference in science achievement between Students taught via the utilization of digital mind maps and students taught via the utilization of paper mind maps".

Table 1 presents means and standard deviations of the pre-test and post-test by the group, DMM and PMM.

Table 1: Means and standard deviations of the pre-test and post-test by the group, DMM and PMM

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>DMM</td>
<td>22</td>
<td>5.93</td>
</tr>
<tr>
<td>PMM</td>
<td>22</td>
<td>6.25</td>
</tr>
</tbody>
</table>

Maximal Score: 20
a. Evaluated at covariate appeared in the model: pre-test = 6.0909

To examine if there was statistically significant differences in science achievement adjusted mean scores between the DMM and the PMM groups, while controlling the pre-test, analysis of covariance (ANCOVA) was conducted. Table 2 presents the results of ANCOVA.

Table 2
ANCOVA Results

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>.468</td>
<td>1</td>
<td>.468</td>
<td>.279</td>
<td>.600</td>
</tr>
<tr>
<td>Group</td>
<td>35.35</td>
<td>1</td>
<td>35.35</td>
<td>21.11</td>
<td>.000</td>
</tr>
</tbody>
</table>
The results of ANCOVA indicate that there is statistically significant difference between the groups (DMM and PMM). The \( F \) ratio was 21.11 (\( p = .000 \)). This means that the instructional method had a main effect on science achievement. These results indicate that the DMM students (Mean = 17.9, SD = .97, Adj.mean = 17.9) significantly outperformed the PMM students (Mean = 16.1, SD = 1.5, Adj.mean = 16.1) with an adjusted mean difference of 1.8.

4. Discussion and conclusion

The results of the current study indicate that the digital mind maps improved students' science achievement more than the paper mind maps. The improved science achievement could be referred to the following reasons:

- Digital mind maps had a much more consistent appearance than paper mind maps, and had the potential to appear much cleaner.
- Hide and show features helped students to concentrate on a specific idea and to avoid visual clutter.
- Digital mind maps supported students to arrange information in expandable and collapsible topic trees. This enabled students to store much more information without overwhelming them.
- Students saved digital mind maps as files, shared files with colleagues, and easily retrieved them.
- Multimedia (videos, sounds, and animations) reinforced students to use different senses, and therefore to learn with understanding (Lih-Juan, 1997).
- Hyperlinks, email links, file attachments, and pictures are essential features that enabled students to achieve higher. Riley and Ahlberg (2004, p.253) indicate that "ICT capacity enables storage and revisiting of mapping and automatic functions, and creating concepts and vectors enable immediate linking and labeling that increase the ease and speed of mapping".
• Colored pictures and videos may assist students' learning motivation and attention (Lamberski, 1980), and accordingly influence their performance (van Schaik & Ling, 2001).

• The use of keyboard and mouse as input devices, enabled students to navigate through the digital mind maps easily and faster than the paper mind maps.

• Digital mind maps offered a dynamic, distributed learning environment which expanded the physical learning space and afforded students a means of developing, organizing and structuring their ideas using higher-order thinking skills and thereby enhanced their understanding (Novak & Cañas, 2006, p.15)

It can be concluded that the utilization of digital mind maps enhanced students' science achievement.

When students actively employed the features of digital mind maps such as hyperlinks, hide and show, navigation, attachments, video, audio, animations, and file saving, they could achieve higher than employing the paper mind maps in science.

References


