Message from the editor-in-chief

Malaysian Online Journal of Educational Technology (MOJET) highlights the current issues in educational technology. MOJET is an international, professional referred journal in the interdisciplinary fields sponsored by Faculty of Education, University of Malaya. This journal serves as a platform for presenting and discussing the emerging issues on educational technology for readers who share common interests in understanding the developments of the integration of technology in education. The journal is committed to providing access to quality researches ranging from original research, theoretical articles and concept papers in educational technology.

In order to produce high quality journal, extensive effort has been put in selecting valuable researches that contribute to the journal. I would like to take this opportunity to express my appreciation to editorial board, reviewers and researchers for their valuable contributions to make this journal a reality.

Professor Dr. Saedah Siraj
July 2017
Editor in chief

Message from the editors

The Malaysian Online Journal of Educational Technology (MOJET) is aimed at using technology in online teaching and learning through diffusing information from a community of researchers and scholars. The journal is published electronically four times a year.

The journal welcomes the original and qualified researches on all aspects of educational technology. Topics may include, but not limited to: use of multimedia to improve online learning; collaborative learning in online learning environment, innovative online teaching and learning; instructional design theory and application; use of technology in instruction; instructional design theory, evaluation of instructional design, and future development of instructional technology.

As editor of the journal, it is a great pleasure to see the success of this journal publication. On behalf of the editorial team of The Malaysian Online Journal of Educational Technology (MOJET), we would like to thank to all the authors and editors for their contribution to the development of the journal.

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A New Tool to Facilitate Learning Reading For Early Childhood

Cita Puspitasari [1], Subiyanto [2]

ABSTRACT

This paper proposes a new android application for early childhood learning reading. The description includes a design, development, and an evaluation experiment of an educational game for learning reading on android. Before developing the game, Unified Modeling Language (UML) diagrams, interfaces, animation, narrative or audio were designed. Hardware and software requirements were also determined. After designing the game, 2D objects were created according to the interface design. After that, the animation and narrative or audio were created on these objects according to the animation and narrative or audio design. The animation given to these objects included translation, scaling, and rotation. To give an action on the objects, ActionScript 3.0 was added on them. Twenty-six kindergarten pupils have participated in this evaluation experiment. They were divided into two groups, namely. an experimental group that learned with the developed android educational game and a control group that learned with a reading book. The result of development game is a 2D educational game that applied the Belajar Membaca Tanpa Mengeja (BMTM) method. The game contains the rules, goals and objectives, outcomes and feedback, challenge, interactions and representations. The experiment results show that the post-test mean score of the experimental group is higher than that of the control group (the experimental group scored 18.92 while the control group scored 9.38) and the Gain score of the experimental group is 0.39; this score is in medium category. Finally, the android educational game can increase student’s reading ability, in the medium category. So, the developed android educational game is a better alternative tool that can be used by early childhood pupils for learning reading.

Keywords: educational game, mobile device, android, method of learning reading, early childhood

INTRODUCTION

Reading is one of the skills needed by children, especially for children who will continue study in elementary school (Noviana, 2013). Kindergarten pupils are introduced to reading skills. The introduction of this reading is not taught directly as their own learning to children, but through playing approach (Dikdasmen, 2009). According to Lely Tobing Mont, playing not only trains physical development, but also the brain; stimulation of the brain occurs when children play and this will develop their problem-solving skills, language skills, sharpening logic, as well as other basic concepts (Syamsuddin, 2014).

One method that can be applied for learning reading is a Learning Reading without Spelling method or in Indonesian: “Belajar Membaca Tanpa Mengeja” (BMTM). The BMTM method is taught to children through playing approach (Noviana, 2013). The method is in accordance with the principles of
implementation of education in kindergarten, which is playing while learning and learning while playing (Dikdasmen, 2009). To support the process of learning reading with the BMTM method, learning media is used. The media that can be used for learning reading with BMTM method is a reading book and the syllables cards.

Along with the increasing number of children who use mobile devices (Rende, 2013), many developed applications of mobile devices can be used as learning media, such as applications for learning mathematics, reading and others. Based on a study, the mathematics application of the mobile device used as a learning media can improve student achievement (Zhang, Trussell, Gallegos, & Asam, 2015).

Google Play is an Android market providing applications for mobile devices with an Android operating system. These applications can be downloaded from Google Play, either free or paid. One of them is an application for learning reading which applies the BMTM method (Google Play, 2015). The application can be downloaded for free at Google Play. So in addition to the reading books and syllables cards, applications on mobile devices can also be used as a media for learning reading, but the application still has a weakness because users can only learn the symbols and sounds of syllables (Google Play, 2015). There is no game page containing elements of the game accordingly with Prensky (2001), i.e. the rules, goals and objectives, outcomes and feedback, conflict/competition/challenge/opponent, interactions and representations on the application. This makes the application less entertaining and less interesting. Therefore, it is necessary to develop an android application for learning reading that is more interesting.

Android educational game can become an alternative for developing a learning reading media because the educational game is created not only for learning but also entertaining (E-learning Faculty Modules, 2012). According to some researchers, educational games used as learning media, can increase learning motivation, and also can improve student achievement (Chu & Chang, 2014; Hwang, Sung, Hung, Huang, & Tsai, 2012; Kordaki, 2011). Later studies conducted by Hung, Huang, and Hwang (2014), state that the achievement of students who learn using games on mobile devices is higher compared with students who use e-book applications in learning. Other studies on mobile learning indicated that using mobile phones for vocabulary learning is more effective than using traditional vocabulary learning tools (Basoglu & Akdemir, 2010).

Based on the abovementioned description, this research aimed at designing and developing a new android educational game that applied the BMTM method. The developed android educational game hopefully can be an effective tool for learning reading.

**Overview BMTM Method and Android Educational Game**

**BMTM Method**

Inventor of BMTM method is Intan Noviana. In her book, Intan Noviana mentions that reading ability is necessary for children, especially for children who will continue study to elementary school. In this method for learning reading, children are not taught reading, but invited to participate in playing, drawing, or other activity that they like. In this method, children are not directly introduced to the letters, because making them memorize the letters can burden the children’s mind (Noviana, 2013).

After children know some of the syllables, they are given a few words to read. If the children can read these words, they were given awards, for example with praise or with other positive things that can make them happy and feel valued. It can make children more enthusiastic to learn reading (Noviana, 2009).

The advantages of BMTM method, for example (Noviana, 2008) are:

a. Children are active, meaning that only by giving a sample for reading the children can learn to read independently.

b. Teachers can implement assistance system, with aid from other students with better reading ability.
c. By having a BMTM book, children can learn in school, and also in the home with the parent’s aid.

In practice book for reading with BMTM methods, children learn some syllables and many words. Syllables introduced in this book are (Noviana, 2008): a, ba, ca, da, ka, la, ma, na, sa, ja, ra, pa, i, bi, ci, di, ki, li, mi, ni, si, ji, ri, pi, u, bu, cu, du, ku, lu, mu, nu, su, ju, ru, pu, o, bo, co, do, ko, lo, mo, no, so, jo, ro, po, e, be, ce, de, ke, le, me, ne, se, je, re, pe, ta, wa, ga, ha, ya, fa, nga, nyo, vo, zo, te, we, ge, he, ye, ve, nge, nye, ve, ze, da-n, me-m, be-r, ku-s, ya-ng, wa-h, sa-i, ga-p, ra-f, sa-w, pa-k, ma-t, ka-v, ta-b, ma-g, ra-y, ta-j, ko-ny, kha, pro, sya, qu, tri, dwi, kra.

Android Educational Game

An educational game is a game designed to teach humans about a specific subject and to teach them a skill (Keeseer, 2012). Educational game is designed for learning and for entertaining (E-learning Faculty Modules, 2012). The educational game can maintain student motivation, and also can lead them to learn on their own, without requesting (Brawerman, Bortoloti, Guimaraes, Granato, Aroldi, & de Sauza, 2013). According to Prensky, games are a subset of play and fun; there are six structural elements of games, that are rules, goals or objectives, outcomes or feedback, conflict/competition/challenge, interaction, and representation or story (Prensky, 2001).

The Android is an operating system for mobile devices such as smartphones and tablet computers (Begin Android, n.d.). So, the android educational game is a game designed to support the teaching and learning that run on mobile devices with an Android operating system.

Some research about the effectiveness of using computer game in learning has been done. To improve the effectiveness of computer game, some research developed computer games that apply important concepts in learning. Socio-cultural and constructive approach, as well as the principles of computer game design applied in computer card game, the game result is a positive effect on motivation and learning for students to learn the concept of binary numbers (Kordaki, 2011). The concept of learning styles applied in a natural sciences game, can increase motivation and student achievement (Hung, Huang, & Tsai, 2012); the concept of two-tier test that applied in a natural sciences game was also effectively used in learning (Chu & Chang, 2014). Some researchers have developed educational games for mobile devices, for example, a math game. Educational game that was developed as a learning mathematics media effectively improved learning motivation and achievement in primary school pupils (Hung, Huang, & Fung, 2014). Additional research is about developing android games for learning reading (Brawerman, Bortoloti, Guimaraes, Granato, Aroldi, & de Sauza, 2013), but this game does not apply the BMTM method.

Basic Principles of Two-Dimensional Graphics

This theoretical review is adopted from Klawonn (2012). The objects made in this educational game is the two-dimensional graphics. The basic geometric objects in computer graphics are points, straight and curved lines and areas as well as character strings. Point are uniquely by their x- and y- coordinates. Lines, polylines or curves an be defined by two or more points. Areas are usually bounded by closed polylines or polygons. In addition to geometric objects, geometric transformations play a crucial role in computer graphics. The most important geometric transformations are scaling, rotation, shearing, and translation.

A scaling leads to stretching or shrinking of objects in the direction of the x- and y-axis. A scaling S(Sx,Sy) maps to the point (x,y) to the point (x’,y’) given by

\[
\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} Sx & 0 \\ 0 & Sy \end{pmatrix} \cdot \begin{pmatrix} x \\ y \end{pmatrix}
\]

The rotation is carried out anticlockwise around the origin of the coordinate system in case of a positive angle. A negative angle means that the rotation is carried out in a clockwise manner. The rotation
R(θ) by the angle θ maps the point (x, y) to the point (x',y') given by

\[
\begin{pmatrix}
    x' \\
    y'
\end{pmatrix} =
\begin{pmatrix}
    x \cdot \cos(\theta) - y \cdot \sin(\theta) \\
    x \cdot \sin(\theta) + y \cdot \cos(\theta)
\end{pmatrix} =
\begin{pmatrix}
    \cos(\theta) & -\sin(\theta) \\
    \sin(\theta) & \cos(\theta)
\end{pmatrix}
\begin{pmatrix}
    x \\
    y
\end{pmatrix} \quad \text{....(2)}
\]

A shearing requires two parameters, however, not on the main diagonal of transformation matrix, but on the other two positions. Applying a shear transformation S (Sx,Sy) to a point (x,y) yields the point (x',y') with the new coordinates

\[
\begin{pmatrix}
    x' \\
    y'
\end{pmatrix} =
\begin{pmatrix}
    x + Sx \cdot y \\
    y + Sy \cdot x
\end{pmatrix} =
\begin{pmatrix}
    1 & Sx \\
    Sy & 1
\end{pmatrix}
\begin{pmatrix}
    x \\
    y
\end{pmatrix} \quad \text{....(3)}
\]

A translation T(dx, dy) causes a shift by vector d = (dx, dy)T. This means the translation maps the point (x, y) to the point

\[
\begin{pmatrix}
    x' \\
    y'
\end{pmatrix} =
\begin{pmatrix}
    x + dx \\
    y + dy
\end{pmatrix} =
\begin{pmatrix}
    x \\
    y
\end{pmatrix} +
\begin{pmatrix}
    dx \\
    dy
\end{pmatrix} \quad \text{....(4)}
\]

Development android educational game for learning reading

**UML (Unified Modeling Language) Design**

Activity Diagram

Figure 1 describe the Activity diagram of android educational games. Activity diagram of an android educational game is designed with the book reference from Fowler (2003). When the user first opens an android educational game, the user can select one of 5 main menu options, namely start game, help, about, score history, and exit.
**Fig 1. Activity Diagram for Android Educational Games.**

When user chooses start game, user can open level 1 to level 5, and also bonus level 1 and 2. In each level user can choose the learning and playing menu. In playing page user must play the game in order to get a score. User must obtain score \( \geq 4 \), before he or she can continue play to the next level, until finished. If the score has not reached 4, the user must repeat playing in this level. Obtaining a score of each level will be displayed on the score history page. Score history page only displays the saved last score obtained by the user.

**Interface, Animation and Narrative or Audio Design**

This section describes interface design, animation design, and narrative or audio design. Interface design, animation design, and narrative or audio design of android educational game such as at Playing page design, is:

**Interface design**

![Interface Design of Playing Page](image)

**Fig 2. Interface Design of Playing Page**

The interface design of playing page is described in Figure 2. The page contains 5 buttons. The button back is for going back to previous page, button exit for exit the game, button repeat for repeat the question, and 2 buttons for answer choice.

**Animation design**

The animation is shown for the correct answer. If the answer chosen is correct, button answer will be enlarged with the scale \((S_x, S_y) = (1, 5 ; 1, 5)\). Start point coordinate of the button answer is:

\[
(x_1, y_1) = (0, 0)
\]
\[
(x_2, y_2) = (200, 0)
\]
\[
(x_3, y_3) = (200, 150)
\]
\[
(x_4, y_4) = (0, 150)
\]

Based on formula scaling (2) resulting new point coordinate of the button correct answer:

\[
(x_1', y_1') = ((0*0)+(0*(1,5)), (0*0)+(0*(1,5)))
= (0, 0)
\]
\[
(x_2', y_2') = ((0*0)+(200*(1,5)), (0*0)+(0*(1,5)))
= (300, 0)
\]
(x3',y3') = ((0*0)+(200*(1,5), (0*0)+(150*(1,5)))
= (300,225)

(x4',y4') = ((0*0)+(0*(1,5), (0*0)+(150*(1,5)))
= (0,225)

**Narrative or audio design**

The narrative or audio that given in this page is:

- Voice of the question.
- Voice *benar* if the answer is correct.
- Voice *oops* if the answer is wrong.

**Software and Hardware Requirements**

Software Requirements

Software used in producing of educational game are as follows:

1. Windows 8 Pro as an operating system
2. Adobe Flash Professional CS6 for making games
3. CorelDRAW X6 to create an image object
4. Android Kitkat 4.4.2 as a mobile operating system

Hardware Requirements

Hardware specifications used in producing educational games are as follows:

1. Processor: Intel (R) Celeron (R) CPU GHz N2840 2:16
2. RAM: 2 GB DDR3 L Memory
3. Hard Drive: 500 GB
4. Monitor, Keyboard, Mouse
5. Galaxy tab 3 8.0

**ActionScript**

Script that be used in game development is ActionScript3. Some ActionScript created in some sections are as follows:

1. ActionScript to open start game menu
   
   ```javascript
   mulai.addEventListener(MouseEvent.CLICK,start1);
   ```
function start1(event:MouseEvent):void
{
  orang_1.gotoAndPlay(2);
  mov_judul.visible=false;
  mulai.visible=false;
  buttona.visible=false;
}

2. ActionScript to create a score storage

var skor_game1 :SharedObject = SharedObject.getLocal("skor_gamel");
var skor_game2 :SharedObject = SharedObject.getLocal("skor_game2");
var skor_game3 :SharedObject = SharedObject.getLocal("skor_game3");
var skor_game4 :SharedObject = SharedObject.getLocal("skor_game4");
var skor_game5 :SharedObject = SharedObject.getLocal("skor_game5");
var skor_game6 :SharedObject = SharedObject.getLocal("skor_bonus1");
var skor_game7 :SharedObject = SharedObject.getLocal("skor_bonus2");

3. ActionScript to move next question and increase score in playing page

MovieClip(this.parent).nextFrame();
MovieClip(this.parent.parent).posisi++;
MovieClip(this.root).bintang++;
MovieClip(this.root).skor_game1.data.count=MovieClip(this.root).bintang;

Implementation of educational game development

Android educational game created using Adobe Flash Professional CS6 software. The steps of created educational game are make a 2D object, make animation or audio on object, and add script on the object.

The first step was to make 2D objects accordingly with the interface design. After that, create the animations for these objects accordingly with the animation design which has been made before. The animations used a transformation. The transformations consist of translation, rotation or scale. To determine the position of the object (x, y) and size of the object that created in this game, was set on the position and size panel. Last, the ActionScript was added on the objects that need a script.

Result of developed android educational game for learning reading

The Android educational game for learning reading is an educational game created specifically for smartphones or tablets with an Android operating system that applies the BMTM method. This educational game is a 2D game because the objects in this game are the 2D objects. This educational game introduces 60 syllables: a, ba, ca, da, ka, la, ma, na, sa, ja, ra, pa, i, bi, ci, di, ki, li, mi, ni, si, ji, ri, pi, u, bu, cu, du, ku, lu, mu, nu, su, ju, ru, pu, o, bo, co, do, ko, lo, mo, no, so, jo, ro, po, e, be, ce, de, to, le, me, ne, se, je, re, pe.
The developed educational game contains the structural elements of games, namely the rules, objectives, outcomes and feedback, conflict/competition/challenge/opponent, interactions and representations.

Educational game was created with the adventure model, which consists of 7 levels namely level 1, level 2, level 3, level 4 and level 5, and 2 bonus levels. Figure 6, 7, 8 and 9 display the appearance level 1 of guess word game. The mission of this adventure is to open the whole key by answering questions at each level. At the beginning of the game the whole key level will be locked, but the key on level 1 is opened. At each level there is a choice of two buttons (play button and learn button). Learn button is used to access the learning page, while the play button is used to access the playing page. On the learning page 12 symbols of syllables and sound of the syllables are introduced. At level 1 the child learns syllables: a, ba, ca, da, ka, la, ma, na, sa, ja, ra, pa. Level 2 kids learn syllables: i, bi, ci, di, ki, li, mi, ni, si, ji, ri, pi. Level 3 children learn syllables: u, bu, cu, du, ku, lu, mu, nu, su, ju, ru, pu. Level 4 children learn syllables: o, bo, co, do, ko, lo, mo, no, so, jo, ro, po. While level 5 children learn syllables: e, be, ce, de, to, le, me, ne, se, je, re, pe.

While on the playing page the children were given 10 questions. There is a sound of the question; the child must listen carefully and then choose the correct word. But children can repeat the question by choosing the button repeat. Children must answer a minimum of 8 questions correctly to get a 4 star and can unlock the next level. If the children answered all the questions correctly, they will obtain 5 stars. If the children have not managed to answer the questions and get less than 4 stars, the key to the next level cannot open, so they must repeat the game.
If the children can answer the questions correctly, the word will be scaled bigger, and then it would display the smile expression and sound “pintar” (smart), while if the answer is wrong it will display the sad expression and sound “ups”. It is as feedback that children get.

In the bonus levels there is only a playing page. In this level there are 10 questions. Children must sort the syllables correctly. They can shift syllables one by one and sort them in the box provided. The words of three syllables are used in these levels.

In this game there is also a help page that can help the player. Before the game is used directly by the children, it would be good for the teacher or parent to understand the instructions, so that they can explain it to the children.

EXPERIMENT DEVELOPED ANDROID EDUCATIONAL GAME FOR LEARNING READING

Design evaluation experiment

The experimental sample consisted of 26 children in Mutiara Hati Kindergarten. Mutiara Hati Kindergarten was chosen as the experimental sample because the kindergarten’s students have less reading ability. Students will be divided into two groups: 13 students in the experimental group and other students in the control group. The experimental group used an android educational game on tablet or smartphone as a learning medium, while the control group used reading book as learning medium. Each group was taught by one teacher in kindergarten.

The research instrument used was the pre-test and post-test sheets. Pre-test sheet was used to measure student’s reading ability before the treatment. Pre-test sheet consists of 40 words that must be read by the students. Total score for the pre-test is 40. The post-test was used to measure student’s
reading ability after receiving treatment; the questions were the same with the pre-test, the difference is that the words that should be read by students were randomized. The correct answer gets 1 score, while the wrong answer will get 0 score.

Students were divided into an experimental group and a control group. After being divided into two groups, each group will get a pre-test. The pre-test was conducted by kindergarten teachers together with the observer. In the pre-test, students were tested one by one to read the words written in the pre-test sheet. After the pre-test, the experimental group will use an android educational game on a tablet or smartphone media in the learning process, while the control group will use the reading book in the learning process. Each group will be taught by one teacher. Before starting the learning process, teachers in the experimental group were given training on how to use the android educational game.

After the learning process for approximately 240 minutes, the students get a post-test; post-test implementation is equal to the pre-test, where students are tested one by one to read the words written in the post-test sheet. The results of pre-test and post-test in the experimental group and the control group will be analyzed with quantitative analysis. The flow diagram of the experiment design is shown in Figure 10. The flow diagram is modified from Hwang et al. (2012).

![Flow diagram of the experiment design](image)

**Fig 10. The Procedure of experimental diagram**

**Experiment result and discussion**

Data analysis was conducted to analyze the differences in reading ability between the experimental group and the control group, and also to determine how much influence the use of android educational game had on the experimental group. The result of pre-test for experimental group and the control group is shown in Table 1. While the graph of pre-test mean and post-test mean between the experimental group and the control group is shown in Figure 11.
Table 1. Results of Pre-test and post-test experimental group and the control group

<table>
<thead>
<tr>
<th>Student’s Code</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest Score</td>
<td>Posttest Score</td>
</tr>
<tr>
<td>E-01</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>E-02</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>E-03</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>E-04</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>E-05</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>E-06</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>E-07</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>E-08</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>E-09</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>E-10</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>E-11</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>E-12</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>E-13</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>Sum</td>
<td>74</td>
<td>246</td>
</tr>
<tr>
<td>Mean</td>
<td>5.69</td>
<td>18.92</td>
</tr>
</tbody>
</table>

Fig 11. Graph of pre-test mean and post-test mean of the experimental group and the control group

From Figure 11 it can be seen that the pre-test mean of the experimental group is slightly lower than for the control group; the experimental group had pre-test mean score 5.69, while the control group had pre-test mean score 5.85. However, the post-test mean of the experimental group was higher than for the control group; the experimental group had post-test mean score 18.92, while the control group had post-test mean score 9.38. Based on the experimental result, the increase in the pre-test mean and post-test mean between the experimental and the control group can be calculated. Increase in the mean score of the experimental group was calculated from the difference between the mean scores of post-test minus the mean pre-test score was 13.23. While the increase in the mean score of the control group, calculated from the difference between the mean scores of post-test minus the mean pre-test score was 3.54. When compared, the difference of mean score of the experimental group was higher than for the control group.
To determine the improvement of student reading ability in the experimental group, an analysis was conducted on the results of the pre-test and post-test. Analysis used is the formula average normalized gain (g) is as follows (Hake, 1998):

\[
(g) = \frac{(%G)}{(%G)_{\text{max}}}
\]

\[
(g) = \frac{[(%\text{posttest}) - (%\text{pretest})]}{[(100\%) - (%\text{pretest})]}
\]

\[
= \frac{18.92 - 5.69}{40.00 - 5.69}
\]

\[
= 0.39
\]

The result of gain score of student’s reading ability in the experimental group, an increased by 0.39 is located at 0.3 ≤ g ≤ 0.7; hence the result is in medium category.

CONCLUSIONS

The research and development resulted in the new android educational game for learning reading. The educational game applied the BMTM method and it contains the structural elements of games, namely the rules, objectives, outcomes and feedback, conflict/competition/challenge/opponent, interactions and representations. The developed educational game was evaluated with the evaluation experiment. There are two groups in this evaluation, that is experimental group which used the android educational game, and the control group which used a reading book. The results of the evaluation experiment showed an increase in post-test scores in both groups. However, the experimental group had a higher post-test score mean than the control group. The experimental group had a post-test score of 18.92, while the control group had a post-test score of 9.38. The experimental group gain score increased by 0.39, an increase in the medium category. From the experimental results, it can be concluded that developed android educational games can improve students’ reading ability in the medium category. Thus, the android educational game can be used as an alternative tool for learning reading which is better than a book. For further research it is suggested to develop an android educational game using all syllables in BMTM method for learning reading.
REFERENCES


ABSTRACT

The role of educational technologies, in the current processes of teaching and learning is becoming more prevalent and accepted in terms of being a mainstream pedagogical tool. During the past three decades, ICT has found its way into English language classrooms. In this study, a quantitative design was used to examine the attitudes of the English as a Foreign Language (EFL) students towards the use of iPads. A cross-sectional survey was conducted to obtain data from participants. The sample of this research comprised 109 English language learners at Majmmah University. Gender, age, and students’ academic year were selected as student demographic variables for this research. The data were analyzed by calculating frequencies, percentages and conducting t-test and One-Way ANOVA. The analysis revealed that most of the participants had positive attitudes toward iPad use in language learning. No statistically meaningful differences were seen in participants’ attitude toward iPads with respect to gender, age and academic level. Some useful implications are discussed based on the research findings.

INTRODUCTION

Technology use in the learning and teaching process has been a central issue in second language acquisition, because it has a major positive effect on language learning (Ferlazzo & Sypnieski, 2012). Recently, increasing interest has been shown in incorporating iPads in different educational contexts, mainly in language learning (Colker, 2011; Itayem, 2014; Leis, 2013). It is well known that iPads can offer different forms of information during language learning. Positive attitudes are considered as an important indicator of technology integration. Previous research suggests that individuals’ attitudes should be assessed because attitudes can influence technology acceptance and future actual usage behavior. The focus in this article is to examine the attitudes of EFL students toward iPad use in language learning. Users’ attitudes are considered as an important indicator of technology integration. Previous research suggests that individuals’ attitudes should be assessed because attitudes can influence technology acceptance and future behavior regarding the actual usage. Yet only a few studies have been conducted in the Arab World to investigate learners’ attitudes towards the use of iPad in language learning.

Related Literature

Attitude towards technology use in language learning is considered as an important element. Greenwald (1989) defined attitude as “an individual’s reaction to or evaluation of something or someone in a positive or negative fashion”. Gardner (1980) reported that attitude is the overall feelings of a person toward any particular thing. Vishwanath et al. (2009) described attitude as the most important factor that effect the of use technologies. According to Agarwal and Prasad (2000), attitudes toward technology use represent the degree to which an individual likes various attributes of a given technology. Watson (1998)
believes that developing positive attitude towards technology use is a key element not only for enhancing technology integration but also for avoiding user resistance to technology use.

The previous researches have supported a claim that modern technologies have a significant positive impact on the learners’ skills (Al-Zaidiyeen et al., 2010; Payne & Whitney, 2002). Technologies in general offer new possibilities for providing better learning experiences and more learning opportunities in education (Al-Zaidiyeen et al., 2011). One of these technologies is called iPad, which is considered as a new source of learning. The iPad can be defined as a portable wireless personal computer with a touch screen. According to Miller (2012), “The iPad is a multipurpose mobile computing device. The ability to read electronic texts, in particular, makes the iPad an attractive device for colleges and universities. With the average cost of a print textbook significantly higher than that of its electronic counterpart, the e-reading potential of the iPad is not lost on students, faculty, librarians, and higher education administrators”. According to Sheppard (2011) the iPad has “the features of an eBook reader, it also allowed access to the myriad resources of the internet; allowing users to seamlessly switch from one text to another or to delve beyond the text itself”.

Using iPads in the classroom can increase motivation to learn. Many researchers have examined the role of iPads in language learning. For example, Kim, Rueckert, Kim, and Seo (2013) conducted a study on TESOL students’ perception of using mobile phones for language learning and they found that TESOL students were willing to adopt mobile learning in their language learning process. Harmon (2012) conducted an empirical study to investigate the impact of using of iPad on reading and writing. The results were in favor of the experiment group who used iPad in different ways such as students accessed their materials via iBooks, wrote journals, completed formative assessments, and used educational apps to collaborate with each other. The findings also revealed that the experimental group scored better in their reading comprehension, and language use tests.

Furthermore, McClanahan, Williams, Kennedy, and Tate (2012) also found a positive result in using the iPad in reading and writing. Likewise, Lys (2013) found the iPad very suitable to practice listening and speaking skills, and for enhancing learner interaction. The findings also showed a favorable attitude towards using iPad in their course. Dyer (2013) conducted a study to examine the impacts of iPads on college students in terms of their cognitive skills, motivation to learn, and organization. According to Dyer, the research participants reported various positive outcomes including: increased processing skills, improved memory of information, and faster information access. Recently, Wang, Teng, and Chen (2015) conducted a study to examine students’ attitude toward the use of iPad in English Vocabulary Learning. The results showed that students had positive attitude toward using iPad in in English Vocabulary Learning.

**Intent and Research Questions**

A number of studies investigated people’s attitudes towards technology. The release of the iPad is relatively new; therefore, only few empirical studies have been conducted to examine the role of iPad in education. The reason for measuring the attitudes of English language learners towards the use of iPad is related to the fact that attitudes play an important role in the actual use of iPad in language learning. The research concentrated on answering the following questions:

1) What are the attitudes of EFL students towards the use of iPads in language learning?

2) Are there any differences in the attitudes of EFL students according to their gender?

3) Are there any differences in the attitudes of EFL students according to their age?

4) Are there any differences in the attitudes of EFL students according to their academic year?
RESEARCH METHOD

Design of the Research

This study was carried out to examine the attitudes of EFL students towards iPad use in language learning. This study adopted a quantitative research method. A questionnaire was used to collect data from the research participants. After the pilot study, the questionnaires were distributed to the students in the classroom using random sample technique.

Sampling

The data were collected at Majmmah University during academic the Year 2015-2016. The participants for this study were 109 (male and female) students who study English as their major subject out of the approximately 500 population at Majmmah University.

Instruments

This is a quantitative study aimed at examining the attitudes of EFL students toward the use of iPad in language learning. Most questionnaire items were modified from previous researches, (such as Albirini, 2006; Itayem, 2014; Leis, 2014; Wang, Teng, & Chen, 2015). One hundred and nine EFL students had completed a survey containing 30 items. Answers were arranged in a five-point Likert-type scale. The survey contained two sections: (1) general information; and, (2) attitudes towards the use of iPad in language learning. The first section of the survey required respondents to provide basic demographic information such as gender, age and the academic year. The second part of the instrument is composed of 30 items. This measurement tool which was of the Likert type is made up of the following options; ‘Strongly Disagree’, ‘Disagree’, ‘Undecided’, ‘Agree’, and ‘Strongly Agree’.

Validity and Reliability of Scales

The face validity and content validity of the questionnaire were assessed individually by four experts in educational technology. Also, pilot study was performed in order to detect the internal consistency and reliability of utilized questionnaire. Cronbach’s reliability analysis was performed to test internal consistency of the variables. The reliability of the attitudes scale has been approved by Cronbach’s alpha coefficient of around .85.

Data Analysis

The data collected from the questionnaire items were analyzed using SPSS 22.0 for Windows. Descriptive statistics, Sample t-test and ANOVA were used.

RESULTS

Tables 1 through 4 present the Means, Std. Deviations, and Percentages for the demographic variables contained in the survey instrument. EFL students characteristics are presented in terms of demographic information, including gender, age, and the academic year.

Demographic Variables

Table 1, shows the number of male and female EFL students participated in this study.
Table 1. Distribution of Respondents by Gender Groups

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>62</td>
<td>56.9</td>
</tr>
<tr>
<td>Female</td>
<td>47</td>
<td>43.1</td>
</tr>
<tr>
<td>Total</td>
<td>109</td>
<td>100.0</td>
</tr>
</tbody>
</table>

In terms of age (28.4%; n = 31) of the respondents were within the 18-20 age range, 45.0% (n= 49) of them were within the 21-23 age range, 19.3% (n=21) of them were within the 24-26 age range, and only 7.3% (n = 8) of participants were above 27 years old.

Table 2. Distribution of Respondents by Age Groups

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-20</td>
<td>31</td>
<td>28.4</td>
</tr>
<tr>
<td>21-23</td>
<td>49</td>
<td>45.0</td>
</tr>
<tr>
<td>24-26</td>
<td>21</td>
<td>19.3</td>
</tr>
<tr>
<td>&gt;27</td>
<td>8</td>
<td>7.3</td>
</tr>
<tr>
<td>Total</td>
<td>109</td>
<td>100%</td>
</tr>
</tbody>
</table>

Participants’ responses on their academic level showed that (20.2%; n=22) of them were first year students, (39.4%; n=42) were second year students, (26.6%; n=29) were third year students, and (13.8%; n=15) were fourth year students.

Table 3. Distribution of Respondents according to the academic year Groups

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td>22</td>
<td>20.2</td>
</tr>
<tr>
<td>Second Year</td>
<td>43</td>
<td>39.4</td>
</tr>
<tr>
<td>Third Year</td>
<td>29</td>
<td>26.6</td>
</tr>
<tr>
<td>Fourth Year</td>
<td>15</td>
<td>13.8</td>
</tr>
<tr>
<td>Total</td>
<td>109</td>
<td>100%</td>
</tr>
</tbody>
</table>

Attitudes Toward iPad Use

Respondents were asked to answer the questionnaire items related to their attitudes toward the use of iPad. Table 4 reports the results of descriptive statistics (Means, and Std. Deviations).
Table 4. Means and Std. Deviations of the English language learners Attitudes

<table>
<thead>
<tr>
<th>Items</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Using iPad in language learning is a pleasant experience.</td>
<td>4.09</td>
<td>1.20</td>
</tr>
<tr>
<td>2. Using iPad in English Language learning is enjoyable.</td>
<td>2.96</td>
<td>1.64</td>
</tr>
<tr>
<td>3. Using the iPad gives me many benefits.</td>
<td>4.39</td>
<td>0.86</td>
</tr>
<tr>
<td>4. iPad enhances language learning.</td>
<td>4.25</td>
<td>1.02</td>
</tr>
<tr>
<td>5. iPad helps me take to control over the homework assignments</td>
<td>4.01</td>
<td>1.24</td>
</tr>
<tr>
<td>6. iPad helps me quickly view the homework assignments.</td>
<td>4.05</td>
<td>1.15</td>
</tr>
<tr>
<td>7. iPad can be very useful to improve my writing.</td>
<td>3.60</td>
<td>1.27</td>
</tr>
<tr>
<td>8. iPad can be very useful to improve my reading.</td>
<td>4.05</td>
<td>1.09</td>
</tr>
<tr>
<td>9. iPad can be very useful to improve my listening.</td>
<td>4.23</td>
<td>1.26</td>
</tr>
<tr>
<td>10. iPad can be very useful to improve my speaking.</td>
<td>4.18</td>
<td>0.90</td>
</tr>
<tr>
<td>11. iPad is helpful to study the reading and writing materials.</td>
<td>4.05</td>
<td>1.16</td>
</tr>
<tr>
<td>12. iPad is helpful to study the speaking and listening materials.</td>
<td>4.05</td>
<td>1.03</td>
</tr>
<tr>
<td>13. iPad helps me to organize my work better.</td>
<td>4.35</td>
<td>1.02</td>
</tr>
<tr>
<td>14. iPad makes it possible to work more productively.</td>
<td>3.85</td>
<td>1.10</td>
</tr>
<tr>
<td>15. iPad saves time when I use it in English learning.</td>
<td>3.61</td>
<td>1.28</td>
</tr>
<tr>
<td>16. iPad is a fast and efficient source of getting information.</td>
<td>4.05</td>
<td>1.40</td>
</tr>
<tr>
<td>17. I frequently use the iPad during English language learning.</td>
<td>2.83</td>
<td>1.48</td>
</tr>
<tr>
<td>18. I use the iPad for my coursework most of the time.</td>
<td>2.92</td>
<td>1.53</td>
</tr>
<tr>
<td>19. I enjoy using the iPad in English language learning.</td>
<td>4.00</td>
<td>1.12</td>
</tr>
<tr>
<td>20. I use iPad in different context.</td>
<td>2.39</td>
<td>1.50</td>
</tr>
<tr>
<td>21. I am happy to use the iPad for English language learning.</td>
<td>3.96</td>
<td>1.16</td>
</tr>
<tr>
<td>22. I find it useful to have an iPad when I am studying.</td>
<td>3.67</td>
<td>1.22</td>
</tr>
<tr>
<td>23. I would like to learn more about the use of iPads.</td>
<td>3.76</td>
<td>1.14</td>
</tr>
<tr>
<td>24. I would recommend my friends to use the iPad.</td>
<td>2.91</td>
<td>1.41</td>
</tr>
<tr>
<td>25. I am satisfied with my iPad.</td>
<td>3.35</td>
<td>1.64</td>
</tr>
<tr>
<td>26. The iPad is useful.</td>
<td>4.00</td>
<td>1.23</td>
</tr>
<tr>
<td>27. The iPad is easy to use in English language learning.</td>
<td>3.93</td>
<td>1.40</td>
</tr>
<tr>
<td>28. It is useful to use the iPad to search for educational resources.</td>
<td>4.37</td>
<td>0.94</td>
</tr>
<tr>
<td>29. It is fun to use the iPad.</td>
<td>3.85</td>
<td>1.24</td>
</tr>
<tr>
<td>30. It is easy to download the English language books using iPad</td>
<td>3.25</td>
<td>1.64</td>
</tr>
</tbody>
</table>

Overall Mean and Std. Deviations

| Overall Mean and Std. Deviations                                      | 3.76 | 0.51 |

As illustrated in Table 4, the EFL students responded to 30 items related to their level of attitudes toward iPad. However, the most frequent positive attitudes towards the use of iPad were that, “Using the iPad gives me many benefits” ($M = 4.39$; $SD = 0.86$), “It’s useful to use the iPad to search for educational resources” ($M = 4.37$; $SD = 0.94$), “iPad helps me to organize my work better” ($M = 4.35$; $SD = 1.02$), “iPad enhances language learning.” ($M = 4.25$; $SD = 1.02$), and “iPad can be very useful to improve my listening” ($M = 4.23$; $SD = 1.26$).

On the other hand, the most percent negative attitudes toward the use of iPad were, “I use iPad in different context”($M = 2.39$; $SD = 1.50$), “I frequently use the iPad during English language learning” with Mean score ($M = 2.83$; $SD = 1.48$), “I would recommend my friends to use the iPad” ($M=2.91$; $SD=1.41$), “I use the iPad for my coursework most of the time” ($M = 2.92$; $SD = 1.53$), and “Using iPad in English Language learning is enjoyable” ($M=2.96$; $SD = 1.64$). The overall average for the Means of English language learners attitudes towards the use of iPad was ($M=3.76$) and the Std. Deviation ($SD=0.51$) indicating that the English language learners have positive attitudes towards the use of iPad in language learning.
As it can be seen in Table 5, the EFL students responded to items related to their level of attitudes towards iPad. However, the most frequent positive attitudes towards the use of iPad were that, “Using the iPad gives me many benefits” (88.8% of the participants answered “agree or strongly agree” with that statement), “It’s useful to use the iPad to search for educational resources” (86.9% of the participants answered “agree or strongly agree” to that statement), and “iPad helps me to organize my work better” (86.6% stated they “agree or strongly agree” with that statement). The lowest percentages of the English language learners attitudes towards the use of iPad were scored for the items, “I use iPad in different context” (26.9% of participants answered “strongly disagree or disagree” to that statement), “I frequently use the iPad during English language learning” (35.1% answered that they “agree or strongly agree” with that statement), and “I would recommend my friends to use the iPad” (38.8% of the participants “agree or strongly agree” with that statement).

5.3 Differences in the Attitudes of participants according to the Demographic Variables

In terms of the differences in respondents’ level of EFL students attitudes towards the use of iPads based on their gender, the results showed no statistically significant differences in respondents’ attitudes towards the use of iPads in language learning. The male group reported a Mean (M = 3.81) with Standard Deviation (SD=0.47), while the female group reported a Mean (M=3.78) with Standard Deviation of (SD =
A $t$-test between the Means gave ($t$ (107) = 0.257, at $p = 0.798$). The findings revealed almost no significant gender differences in attitudes toward iPad use. In other words, male and female students do not differ in their attitudes toward using iPad.

Table 6. Independent Samples $t$-Test Results According to Gender

<table>
<thead>
<tr>
<th>Attitudes</th>
<th>Levene’s Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gender</td>
<td>Mean</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>3.81</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>3.78</td>
</tr>
</tbody>
</table>

ANOVA test was used to determine if there was statistical significant difference in participants’ attitude based on the different age groups. In terms of the differences on the respondents attitudes towards the use of iPads based on their age groups, the results indicated that there were no statistically significant differences in the respondents’ attitudes towards iPads according to the age groups.

Table 7. Means, Std. Deviations, and ANOVA Results based on the Age Groups

<table>
<thead>
<tr>
<th>Attitudes towards iPad</th>
<th>Age Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18-20</td>
<td>3.74</td>
<td>0.54</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21-23</td>
<td>3.81</td>
<td>0.50</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24-26</td>
<td>3.84</td>
<td>0.44</td>
<td>21</td>
<td>$F(3,105)=0.214$, $p=0.886$</td>
</tr>
<tr>
<td></td>
<td>More than 27</td>
<td>3.82</td>
<td>0.34</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

The ANOVA test was used to find out if there were significant differences in the attitudes of participants according to the different academic year-groups. Results displayed in Table 7, show that there were no statistically significant differences in the mean of academic year groups in the respondents’ attitudes toward using iPad.

Table 8. Means, Std. Deviations, and ANOVA Results According to Academic Year Groups

<table>
<thead>
<tr>
<th>Attitudes towards iPad</th>
<th>University Level Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Year</td>
<td>3.85</td>
<td>0.44</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second Year</td>
<td>3.82</td>
<td>0.43</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Third Year</td>
<td>3.86</td>
<td>0.45</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fourth Year</td>
<td>3.54</td>
<td>0.69</td>
<td>15</td>
<td>$F(3,105)=1.716$, $p = 1.68$</td>
</tr>
</tbody>
</table>

CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

The purpose of this study was to examine the attitudes of EFL students toward the use of iPads in language learning and to examine differences by gender, age and academic level in the attitudes of English language learners toward the use of iPads in language learning. The findings are consistent with the Technology Acceptance Model (TAM) by Davis (1989) as a basis. The technology acceptance model describes the relationship between psychological variables such as attitudes, beliefs, and behavioral intention and actual system usage (Davis, 1989). Results suggest that participants had positive attitudes with regard to using iPads in language learning. This result conforms with the findings from a survey research conducted by Brand, Kinash, Mathew, and Kordyban (2011). To explain in more detail, nowadays students are very familiar with iPads and they use iPads in their daily lives. Positive attitudes towards the use of iPads will lead to greater effort and desire to learn the language; also, it leads to higher intentions to
integrate technology in language learning. Moreover, the results showed that there are no statistically meaningful differences in the participants’ attitude toward the use of iPads with respect to gender, age and academic level.

Technology will contribute to improving student achievement and performance; it will also increase their participation and interaction with their teachers. The present study has its limitations. Given the small sample size of the study, it is recommended that further studies with larger samples be undertaken to develop more understanding of students’ attitudes toward using iPads in language learning. Since this research was quantitative in nature, the findings cannot be generalized to the whole population. Hence, replication of the present study with a larger number of participants may provide more reliable findings. It is recommended that future research investigate learners’ attitudes toward the use of iPads in private colleges to see if there are any significant differences between government and private institutions. Furthermore, it is recommended that qualitative studies be done to find out the factors affecting attitudes of the English language learners toward iPad use in language learning.

Acknowledgements

I am very grateful to the College of Science and Humanities-Rumaah Majmaah University for the support received during the research process.

REFERENCES


Measuring Usability Compliance of a Stand-alone Educational Tablet: The Users’ Perspective, Nigeria

Olawale Kazeem Tijani [1]

ABSTRACT

This study assessed usability compliance of Opón-Imò Technology Enhanced Learning System (OTELS), Nigeria. Specifically, the study investigated: students’ satisfaction with the OTELS; its efficiency; retentiveness; learnability and capacity to reduce errors. Being a survey study, samples were drawn from six secondary schools across the three Senatorial districts of Osun state, Nigeria. 701 students were purposively selected as sampled for the study. A researcher-constructed questionnaire: Usability Compliant Questionnaire was used for data collection. The instrument was administered on 40 selected students outside the sample location through test-retest strategy; it yielded reliability value of 0.87 through Pearsons Product Moment Correlation statistics. Data were analysed with frequency counts and percentages to answer research questions one to five. Results revealed that 70% of respondents expressed satisfaction with the OTELS; 73% found the OTELS efficient; 68% found it retentive; 76% found the OTELS learnable; and 59% agreed that the OTELS is capable of reducing errors when in use. The study concluded that the OTELS is usable for learning among secondary school students in the state. It was recommended among others that Osun state government may constantly update the learning system to sustain its use among secondary school students.

Keywords: Education, Information Communication Technology, E-learning, Usability assessment, Opón-Imò Technology Enhanced Learning System (OTELS).

INTRODUCTION

Education remains the bedrock of every national development (Abiogu, 2014; Ezeani & Urama, 2014). It is the singular index of measuring national prosperity and human development. Without a functional system of education, most national aspirations whether in science, art or economics would forever remain a pipedream. A functional education in this study is defined from the point of access and quality (Abraham, 2011; Ladan, 2015). The numbers of willing students seeking formal education in Nigeria is on the increase while employers of products from the country’s educational system are in doubt as per the quality of such products to be able to deliver when it matters. These reasons among others necessitated the embrace of ICT for instructional delivery to expand access to education and make students learn more in less time without reducing qualities (Andersson & Grönlund, 2009). ICT has been judge one of the best things to happen to education in this century in that it facilitates quality education and expand access for hitherto denied persons (Adeyemi & Olaleye, 2010; Adesote & Fatoki 2013; Ololube, Ubogu & Ossai, n. d.). ICT is a family of technological products and process used for the collection, processing and transmission of information from one person to the other (Olaore, 2014). Embracing ICT for education will enthronre an efficient way of managing educational administrative processes. Specifically, ICT facilitates effective education administration in the area of curriculum development and circulation, instructional delivery, school business operations, re-energising procedures for evaluating school programme among others (Adeyemi & Olaleye, 2010). On the other hand, ICT when appropriately used can facilitate improved students achievements. According to Adesote and Fatoki (2013), embracing ICT increases learners’
engagement and motivation in learning activities and assists them in acquiring basic skills. The romance between technology and education birthed the concept of E-learning.

Although its origin remains uncertain, E-learning has become a veritable strategy to meeting the educational needs of the future in a more efficient way through contemporary teaching aids. It has the potential to redefine the way teaching and learning businesses are conducted world over (Moore, Dickson-Deane & Galyen, 2011). E-learning are all learning activities facilitated through electronic means such as the internet, the intranet, satellite broadcast, audio/video tape, interactive TV, CD-ROM, computers (desktops, laptops, tablet) and computer accessories (Kakoty, Lal & Sarma, 2011; Birzina, 2013). However in this study, E-learning refers to all learning activities through electronic means including the tablet computers. Some of the benefits derivable from E-learning include its cost effectiveness; it also assures flexibility of time and space, gives learners the latitude to choose from wide range of available courses and creates access and collapse walls of social inequity among learners (Song, 2010; Kakoty, Lal & Sarma, 2011). The authors stated further that once student-centeredness is given priority when designing e-learning, it encourages self-paced learning and ensures active participation of the learners in the process of learning.

The evolution of ICT and in particular of mobile technologies has revolutionized the world as we know it, and devices, such as tablets, have gained popularity so quickly in the general public and in various age groups that it is impossible not to try to imagine what such devices can lead to when used in education. Mobile technologies, and in particular tablets and smartphones, with their innate versatility are becoming increasingly indispensable in today’s learning environment (Kakoty et al., 2011). According to MacFarlane, Sim and Horton (2005), to determine whether software is suitable for use in education depend on usability. Usability determines the quality of interaction between a user and a variety of technological products and processes which include software application, mobile application among others (Hasan, 2014). According to Ali, Alrasheedi, Ouda and Capretz (2014) quoting ISO 9241-11, usability is defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. The inference from this is that, unless a technological system can be accessed, used by a specific user to achieve established objective with ease, such system cannot be said to be usable. As submitted by Costabile, De Marsico, Lanzilotti, Plantamura and Roselli (2005), it is more beneficial to a learner of technological system when his or her concentration is on the learning contents rather than how to access such contents. According to the authors, rigidity, slowness and unpleasant user experience usually account for high dropout rate from e-learning. Nielsen (2012) however increased the usability parameters to five upon which the present study was based: efficiency, retentiveness, learnability, error prevention and user satisfaction.

According to Hasan (2014), usability evaluation when properly formulated and implemented, could engender positive attitude towards a given software, ensure accuracy thereby reducing errors and boost students’ confidence thereby helping to sustain patronage of the system among the users. Two major usability evaluation methods stand out: Usability evaluation and usability testing (Joshi, Arora, Dai, Price, Vizer & Sears, 2009). While usability evaluation involves usability experts interacting with a system of interest in order to detect usability problems, usability testing on the other hand involves actual system users using the system to perform a specific task with a few to finding out its usability or otherwise (Mathew, 2012). This study employed the later usability method.

Opón-ímò, a Yoruba word which literally means “tablet of knowledge” is an E-learning system deployed in 2013 by the government of Osun state in Nigeria to assist Senior Secondary School (SSS) teachers and students in teaching-learning situations. The learning system tagged Osun Technology Enhanced Learning System (OTELS) which does not require any form of connectivity for optimisation has three distinctive learning environments: the e-book library, virtual environment and integrated tests zone. The e-book library contains electronic copies of approved textbooks while the test zones housed practice questions. Similarly, the virtual classroom has audio-visual materials meant to serve students who might not be comfortable learning through texts alone (Osun.gov.ng, 2013; Tijani, 2016). Learning with this system finds relevance in M-learning which evolves from E-learning (Kakoty, Lal & Sarma, 2015).
Theoretically, this study finds relevance in Constructivism. Constructivism being one of the three most popular learning theories in a way explains the embrace of technologies in today’s classrooms especially at the secondary school levels (Ford & Lott, 2009; Ebert, 2009). According to Jones and Brader-Araje (2002), different explanations for constructivism exist; however, a common thread that connects all is the emphasis on active learner’s participation in teaching-learning situations if qualitative learning is the focus of such engagement. This position promotes knowledge as a process rather than a product; and such process entails individual learner playing a greater role in terms of meaning construction rather than fact memorisation (Kharade & Thakkar, 2012). Therefore, the OTELS which requires maximum participation of individual user in order to achieve positive learning experience rest on constructivism theory which empasises active learners’ participation in every learning situation.

Statement of problem

Technological inventions are numerous in education, however, the rate at which users abandon such systems due to poor usability calls for concern. Usability is a basic parameter for the evaluation of technological innovations; it ensures the quality of e-learning devices and put the users and their needs at the center of technological development (Zaharias, 2004). Any system which is difficult to use will attract less number of users to itself. The OTELS like other learning systems used by a large group of students with no pre-deployment training or post-deployment supports must be tested for its usability as a matter of duty to promote positive user experience (Ali, 2013). Also, a widely accepted heuristics and evaluation
methodologies for measuring usability of e-learning is still being developed by usability researchers, this study therefore provides an empirical usability report of a standalone learning system as an addition to the growing body of usability evaluation literature (Costabile et al., 2005; Granića, & Ćukušić, 2011).

**Research questions**

1. To what degree are students satisfied with the OTELS?
2. To what degree do students find the OTELS efficient?
3. To what degree do students find the OTELS retentive?
4. To what degree do students find the OTELS learnable?
5. To what degree do students found the OTELS capable of reducing error rate?

**METHODOLOGY**

The study was a descriptive research of the survey type. Study population was all Senior Secondary School 3 students in government-owned secondary schools across Osun state, Nigeria. These set of students were the beneficiaries of the learning system as at the time of conducting this study. Politically, the state is divided into three Senatorial districts; Osun Central, Osun East and Osun West. Purposive sampling method was used to select two Local Governments Areas from each of the senatorial districts; one school each from the selected LGAs; and 1,100 students who had received their learning systems from the six selected schools. Nevertheless, only 701 students out of the 1,100 selected were available as at the time of visit by the researcher to the selected schools. A researcher-constructed Usability Compliant Questionnaire (UCQ) was used for data collection. The questionnaire, using the 4-point Likert scale of Strongly Agree = 4, Agree = 3, Disagree = 2 and Strongly Disagree = 1, was constructed based on selected usability parameters as stated by Nielsen (2012). The questionnaire was divided into sections A and B. Section A contains questions on respondents’ demographic information while section B which was further subdivided into six: B1, B2, B3, B4, and B5 contained questions which bother on students’ assessment of the OTELS as a learning system based on the selected usability parameters.

The UCQ was given to six experts for validation; two English language teachers from Osogbo high school, three lecturers (two Educational technology and one Information and communication) from the University of Ilorin, Ilorin, Nigeria. To ensure the reliability of the instrument for the study, a test-retest reliability method was adopted. The instrument was re-administered to 40 Senior Secondary School three (SS3) students of Osogbo High School, Osogbo three weeks after the first date of administration on the same group. Data collected from this exercise was analysed with Pearson Product Moment Correlation and it yielded a reliability coefficient value of 0.87 which indicated the suitability of the instrument for the study. The researcher obtained necessary pass from the school authorities and thereafter administered the instruments on the respondents with the help of his assistant. 701 copies of the questionnaire were administered to the respondents, however 668 (95.3) were retrieved and found usable. The remaining 33 copies were not properly completed or more than one response options were selected. Data gathered from the UCQ were analysed with percentages and frequency counts.
RESULTS

Table 1. Demographic data of students based on gender

<table>
<thead>
<tr>
<th>Variables</th>
<th>A Total</th>
<th>Percentage</th>
<th>B Total</th>
<th>Percentage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stds’ Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>362</td>
<td>54.2</td>
<td>Female</td>
<td>306</td>
<td>45.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>668</td>
</tr>
</tbody>
</table>

Table 2. Distribution of students by school location

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>238</td>
<td>35.6</td>
</tr>
<tr>
<td>Urban</td>
<td>223</td>
<td>33.4</td>
</tr>
<tr>
<td>Sub-Urban</td>
<td>207</td>
<td>31.0</td>
</tr>
<tr>
<td>Total</td>
<td>668</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 2 shows respondents’ school locations, out of 668 respondents that were sampled, 223 (33.4%) were based in the urban areas (Osogbo & Ile-Ife), 207 (31.0%) were based in the sub-urban areas (Ire & Ede) while the remaining 238 (35.6%) were based in the rural areas (Ile-Ogbo & Osu).

Research Question 1: To what degree are students satisfied with the OTELS?

Table 3. Students’ satisfaction with the OTELS

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th></th>
<th>SA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1  The OTELS has all the features I need for my learning</td>
<td>210</td>
<td>31.4</td>
<td>458</td>
<td>68.6</td>
</tr>
<tr>
<td>2  The OTELS provides suggestions I need for correct usage</td>
<td>163</td>
<td>24.4</td>
<td>505</td>
<td>75.6</td>
</tr>
<tr>
<td>3  The OTELS is rigid to interact with</td>
<td>228</td>
<td>43.1</td>
<td>288</td>
<td>47.9</td>
</tr>
<tr>
<td>4  I am satisfied with the functions offered by the OTELS</td>
<td>323</td>
<td>48.4</td>
<td>345</td>
<td>51.6</td>
</tr>
<tr>
<td>5  The terminologies that have been used in the OTELS are familiar to me e.g. bookmark</td>
<td>176</td>
<td>26.3</td>
<td>492</td>
<td>73.7</td>
</tr>
<tr>
<td>6  The arrangement of subjects on the OTELS is perfect and should not be changed</td>
<td>199</td>
<td>29.8</td>
<td>469</td>
<td>70.2</td>
</tr>
</tbody>
</table>

Note: Agree and strongly agree were merged into strongly agree while disagree and strongly disagree were merged into strongly disagree.

Table 3 revealed that 68.6% of the respondents strongly agreed that the OTELS had all the features they needed for their learning while 31.4% strongly disagreed. 75.6% of the respondents strongly agreed that the OTELS provided suggestions they needed for correct usage while 24.4% also strongly disagreed. A total of 56.9% of the respondents strongly agreed that the OTELS was rigid to interact with while 43.1% strongly disagreed. Also, 51.6% of the respondents strongly agreed that they were satisfied with the functions offered by the OTELS while 48.4% strongly disagreed. Similarly, a total of 73.7% of the respondents also strongly agreed that the terminologies that were used in the OTELS were familiar to them e.g. bookmark while 26.3% strongly disagreed. More so, 70.2% of the respondents strongly agreed that the arrangement of subjects on the OTELS was perfect and should not be changed while 29.8% strongly disagreed. The inference from this is that, the students were satisfied with the OTELS as a learning tool as.
demonstrated by 70% of the total respondents.

**Research Question 2:** To what degree do students find the OTELS efficient?

**Table 4. Efficiency of the OTELS**

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I find navigating around the OTELS very easy</td>
<td>95</td>
<td>14.2</td>
<td>573</td>
</tr>
<tr>
<td>It is easy to switch from one zone to the other on</td>
<td>110</td>
<td>16.5</td>
<td>558</td>
</tr>
<tr>
<td>the OTELS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can effectively complete my work using the OTELS</td>
<td>145</td>
<td>21.7</td>
<td>523</td>
</tr>
<tr>
<td>It takes little time to bookmark learning contents</td>
<td>249</td>
<td>37.3</td>
<td>419</td>
</tr>
<tr>
<td>on the OTELS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can efficiently complete my work using the OTELS</td>
<td>138</td>
<td>20.7</td>
<td>530</td>
</tr>
<tr>
<td>I can navigate within the OTELS using available short codes</td>
<td>326</td>
<td>48.8</td>
<td>342</td>
</tr>
</tbody>
</table>

Note: Agree and strongly agree were merged into strongly agree while disagree and strongly disagree were merged into strongly disagree.

In Table 4, 85.8% of the respondents strongly agreed with the fact that they found navigating round the OTELS very easy while 14.2% strongly disagreed. Similarly, 83.5% of the students strongly agreed that it was easy to switch from one zone of the OTELS to the other while 16.5% thought otherwise. In like manner, 78.3% of the total respondents strongly agreed that they could effectively complete their work using the OTELS while 21.7% strongly disagreed. A total of 37.3% of the respondents strongly disagreed with the fact that it took little time to bookmark learning contents on the OTELS while 62.7% strongly agreed. Also, 79.3% of the students strongly agreed that they could efficiently complete their work using the OTELS while 20.7% strongly disagreed. The respondents’ opinions about the availability of shortcodes on the OTELS were sharply divided; while 51.2% strongly agreed, 48.8% of the respondents strongly disagreed. From the analysis presented, it can be inferred that the students found the OTELS efficient as a learning tool as demonstrated by 73% of the total respondents.

**Research Question 3:** To what degree do students find the OTELS retentive?

**Table 5. Retentiveness of the OTELS**

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I don’t need any expert’s help to use the OTELS the</td>
<td>243</td>
<td>36.4</td>
<td>425</td>
</tr>
<tr>
<td>second time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can easily locate the E-book library, Test-zone and</td>
<td>80</td>
<td>12</td>
<td>588</td>
</tr>
<tr>
<td>Virtual classroom on the OTELS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I usually mistaken the Mock exam for the Practice test</td>
<td>363</td>
<td>54.3</td>
<td>305</td>
</tr>
<tr>
<td>on the OTELS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can mention the basic zones of the OTELS without</td>
<td>196</td>
<td>29.3</td>
<td>472</td>
</tr>
<tr>
<td>seeing them</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remembering how to navigate within the OTELS is very</td>
<td>138</td>
<td>20.7</td>
<td>530</td>
</tr>
<tr>
<td>simple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I need to read my user’s guide each time I want to</td>
<td>279</td>
<td>41.8</td>
<td>389</td>
</tr>
<tr>
<td>use the OTELS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Agree and strongly agree were merged into strongly agree while disagree and strongly disagree were merged into strongly disagree.
Table 5 presents the students' responses as regards their opinions concerning the retentiveness of the OTELS as a learning tool. Whereas 63.6% of the total respondents strongly agreed that they did not need any expert's help to use the OTELS the second time, 36.4% of them strongly disagreed. In the same vein, 88% of the students strongly agreed that it was easy to locate the three zones of the OTELS while 12% strongly disagreed. Also, 54.3% of the total respondents strongly disagreed with the fact that they usually mistook the mock exam on the OTELS for practice test while 45.7% strongly agreed. Similarly, 29.3% of the respondents strongly disagreed with the fact that they could mention the basic zones of the OTELS without seeing them while 70.7% strongly agreed. Meanwhile, 79.3% of the total respondents strongly agreed that remembering how to navigate within the OTELS was very simple while 20.7% strongly disagreed. Furthermore, 58.2% of the respondents strongly agreed that they needed to read their user's guide each time they want to use the OTELS while 41.8% strongly disagreed. It can be deduced from the presented analysis that the students found the OTELS retentive as a learning tool as demonstrated by 68% of the total respondents.

Research Question 4: To what degree do students find the OTELS learnable?

Table 6. Learnability of the OTELS

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 Opening the OTELS is very easy</td>
<td>86</td>
<td>12.9</td>
</tr>
<tr>
<td>20 It is easy to locate the contents of the virtual classroom</td>
<td>86</td>
<td>12.9</td>
</tr>
<tr>
<td>21 In the OTELS, remembering icons and their functions is very difficult for me</td>
<td>424</td>
<td>63.5</td>
</tr>
<tr>
<td>22 Understanding the different categories in the OTELS is easy for me</td>
<td>138</td>
<td>20.7</td>
</tr>
<tr>
<td>23 I can easily take test while reading my e-books</td>
<td>121</td>
<td>18.1</td>
</tr>
<tr>
<td>24 While listening to the Virtual classroom, I can pause and continue later</td>
<td>111</td>
<td>16.6</td>
</tr>
</tbody>
</table>

Note: Agree and strongly agree were merged into strongly agree while disagree and strongly disagree were merged into strongly disagree.

In Table 6, the analysed data showed that majority (i.e. 76%) of the respondents found the OTELS learnable as a learning tool. For instance, 87.1% of the respondents strongly agreed that opening the OTELS was very easy, while 12.9% strongly disagreed. Also, 87.1% of the respondents strongly agreed that it was easy to locate the contents of the virtual classroom while 12.9% strongly disagreed. In the same vein, 63.5% strongly disagreed with the position that remembering different icons and their functions was very difficult for them while 36.5% thought otherwise. 79.3% of the respondents also strongly agreed that it was easier for them to understand different categories in the OTELS while 20.7% strongly disagreed. Similarly, 81.9% of the respondents strongly agreed that they could take a test easily while reading the e-books while 18.1% strongly disagreed. Following the same trend, 83.4% of the total respondents strongly agreed that while listening to the virtual classroom, they could pause and continue later while 16.6% strongly disagreed.
Research Question 5: To what degree do students found the OTELS capable of reducing error rate?

Table 7. Reduction of error rate when OTELS is in use

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th></th>
<th>SA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>31  When using the OTELS, I can reverse any error(s) I commit</td>
<td>233</td>
<td>34.9%</td>
<td>435</td>
<td>65.1%</td>
</tr>
<tr>
<td>32  There is a user guide on the OTELS to prevent me from committing errors</td>
<td>281</td>
<td>42.1%</td>
<td>387</td>
<td>57.9%</td>
</tr>
<tr>
<td>33  When am using the OTELS, I cannot commit any error</td>
<td>325</td>
<td>48.7%</td>
<td>343</td>
<td>51.3%</td>
</tr>
<tr>
<td>34  Any error I commit while using the OTELS is always reversible</td>
<td>261</td>
<td>39.1%</td>
<td>407</td>
<td>60.9%</td>
</tr>
<tr>
<td>35  It is not possible to commit error while using the OTELS</td>
<td>374</td>
<td>56%</td>
<td>294</td>
<td>44%</td>
</tr>
<tr>
<td>36  I cannot commit any error because all icons on the OTELS are properly labeled</td>
<td>185</td>
<td>27.7%</td>
<td>483</td>
<td>72.3%</td>
</tr>
</tbody>
</table>

Note: Agree and strongly agree were merged into strongly agree while disagree and strongly disagree were merged into strongly disagree.

Presented in Table 7, is the analysis of students responses to questions bothering on the OTELS capacity to minimise errors while in use. Whereas 65.1% of the respondents strongly agreed that they could reverse any error committed when using the OTELS, 34.9% of them strongly disagreed. Also, 57.9% of the respondents strongly agreed that there was a user guide on the OTELS to prevent them from committing errors while 42.1% strongly disagreed. Similarly, 51.3% of the respondents strongly agreed that they could not commit any error when using the OTELS while 48.7% strongly disagreed. In the same vein, 60.9% of the respondents strongly agreed that they could reverse any error they committed when using the OTELS while 39.1% strongly disagreed. Also, 44% of the respondents strongly agreed that it was not possible for them to commit any error while using the OTELS while 56% thought otherwise. Similarly, 72.3% of the total respondents also strongly agreed that they could not commit any error while using the OTELS because all icons were properly labelled while 27.7% strongly disagreed. From the foregoing, it can be concluded that the respondents strongly agreed that the OTELS was capable of reducing error rate when they used it for learning purposes. This was demonstrated by 59% of the total respondents.

Figure 6: Graphical illustration of the students’ responses (strongly agreed) to the SUEQ

IM = Impression, SA = satisfaction, EF = efficiency, RE = retentiveness, LE = learnability and ER = error rate
CONCLUSION

Discussions of findings

This discussion centered on findings on how effective the students found the OTELS, its efficiency, its learnability, retentiveness, students’ level of satisfactory and their opinion about the capability of the OTELS to reduce error rate when using it. Findings revealed that majority of the students wished they could take notes with their OTELS during classroom work; this might be as a result of their awareness of similar mobile technologies which could perform similar function. It might also be that the introduction of OTELS has not brought any significant change to the prevailing teaching methodology in the schools; students were still made to copy notes on paper books even though they already exist on the OTELS.

The result of the analysis on students’ satisfaction with the OTELS indicated that students were satisfied with the learning system. Although, many of the respondents felt dissatisfied with the OTELS as it is and would like to see some changes, most of them still agreed that they were satisfied with the system as it is. This result can be linked to another where most respondents agreed that the OTELS is rigid and therefore not easy to interact with it. Another explanation for this finding might be due to limited freedom allowed an OTELS user in terms of contents manipulation, personalisation of icons and some other features. It should be noted that many of the respondents might have personal computer systems which allows greater manipulation than the OTELS presently does.

The terminologies used on the OTELS also received respondents supports as majority agreed they could easily identify with them. This is so because the OTELS kept in focus the industry standards as confirmed by the usability experts’ rating in terms of match between OTELS and the real world. Majority of the respondents agreed that current style of subjects arrangements on the OTELS should be left unchanged. The explanation for this might be that the students enjoy having access to learning contents on subjects other than the ones they offer at their different arms. For example, an Art student can access contents on science subjects such as physics and chemistry and vice-versa.

Similarly, findings revealed the efficiency of the OTELS in learning situations. Majority of the respondents claimed they could move from one zone of the system to another with ease within short period of time. Interactivity is important if the system is to be used optimally. There are three zones on the OTELS which are interconnected and interrelated, for the system to achieve its objectives; users must be able to navigate seamlessly from one zone to the other. Similarly, a very high percentage of the respondents confirmed that they could complete their academic work within short period of time. This result is in line with the expectation that the introduction of the OTELS will allow users to have unrestricted access to enormous learning contents.

Also, some of the respondents agreed that they spent more time to perform actions such as bookmark while majority thought otherwise. Again, this might not be unconnected with the respondents’ computer skills. Except an OTELS user possess some kinds of computer skills, bookmarking and retrieving bookmarked contents might pose some challenges to him/her. It is worthy of note that, no accelerators was available on the system for an expert user. With the absence of an accelerator, navigating round the OTELS requires more time than necessary which may constitute a major source of frustration.

The result on retentiveness of the OTELS as a learning system indicated that respondents found the OTELS retentive. As shown in the result, about two-third of the students affirmed they do not need expert’s guidance on how to use the OTELS after the initial training. Even though this number is good, about one-third of the students still wished they could receive more experts’ guidance while using the system. This could be due to inadequacy of initial training given to the users. Following-up from this were the opinions of close to half of the total respondents who claimed they usually mistaken different zones on the OTELS for another. This might also be connected to the initial training and the design of the different icons. Although, usability experts rated the icons well in terms of colour and design, many of the students still found them hard to memorise.
Similarly, result also indicated that more than one-third of the total respondents prefer to read the user’s guide anytime they want to use the OTELS. Although higher number of the respondents thought otherwise, many of them still displayed low retention of the OTELS. This could be tied to inadequate training, icon design and colour coding. Findings in relation to the learnability of the OTELS indicated that respondents found the system learnable. For instance, a larger percentage of the respondents agreed they could easily launch the software and access the contents. Also, the result showed that majority of the respondents does not think the OTELS is difficult to operate; this can be linked with earlier result on satisfaction where majority of them claimed the system is easier to use. It might also be connected to the initial training received and the prevalence of other mobile devices within their environments. Another important result is that almost all the respondents supported the fact that they could perform two or more operations on the OTELS simultaneously.

Findings on capability of the OTELS to reduce error rate while the system is being used indicated that it does reduce error rate. For instance, about two-third of the respondents were of the opinion that errors committed while using the system are reversible, while the remaining one-third thought otherwise. The one-third is particularly of interest, the implication of this is that one out of every three users of the system gets stuck one way or the other while using the system and without a user guide and help menu installed on the system for proper guidance.

Although, slightly above half of the total respondents believe they can not commit any error when using the system, close to half of total respondents thought otherwise. With this number being afraid of committing errors while using the system, optimal system usage might be difficult to achieve. This lends credence to the submissions of many of the respondents interviewed who for fear of damaging the systems had refused to use them completely. This again re-echoed the importance of help menu and user’s guide on the system.

**Summary of findings**

The conclusion resulting from the findings of this study is mostly positive across the areas covered in the study. Areas such as users’ satisfaction with the system, its learnability, efficiency, retentiveness and error reduction. It was discovered that students found the OTELS learnable, efficient, retentive and capable of reducing error rate. It was also discovered that the students were satisfied with the OTELS and have positive impressions about learning system.

**Implication of findings**

The following implications were drawn based on the findings of this study: Majority of the students expressed satisfaction with the functionality of the OTELS as indicated by the result of this study. This means that the chance of students abandoning the system is slim. This momentum should however be sustained by extending technology to other areas of the students’ academic activities and also through quick response to challenges that might come up in the course of using it.

Furthermore, positive results were recorded in terms of efficiency of the OTELS when students use it in learning situations. The implication of this is that with further upgrade to the system, students could benefit more from it which might in turn leads to improved academic achievements. It was also discovered that students found the OTELS retentive. The implication of this is that terminologies and concepts used in the system were easily understood by the students. It could also be of immense benefit if this is further built on in subsequent versions of the system.

Respondents also found the system learnable, although those who thought otherwise were substantial. This implied that many users were underutilising their systems; therefore, efforts should be made towards implementing structured training that would ensure that all users mastered the act of using the OTELS as expected. Also, findings that the OTELS reduce error rate when in used was positive. Many of the respondents also expressed negative opinions about the error prevention capability of the system. What this implied is that, whereas majority of the users might be able to navigate the system effortlessly,
slightly above one-third of them would be struggling to cope. Efforts should be intensified to make available help menu and user guide on the system to cater for this category of users.

**Recommendations**

1. Since it was discovered that majority of the respondents were satisfied with the learning system, government may wish to put in place strategies that will ensure periodic review of the system to keep abreast of the development in mobile learning application to ensure its contemporariness in order to sustain students’ satisfaction with the system.

2. Majority of the respondents attested to the efficiency of the OTELS in learning context, however, there is need to embark on certain review to ensure greater efficiency. The system could also be made internet ready, other accelerators such as short codes, calculator, subject/language dictionaries (English and Yoruba) may also be provided on the system.

3. Effort could also be made by the government to ensure that current icons (e.g. icons representing SS1 to SS3 in the E-book library) on the system are redesigned and terminologies and concepts which are familiar to the students are given priority. That is, the OTELS could be indigenised to further aid its retentiveness.

4. Obviously, many students might be under utilising their OTELS due to poor learnability. Efforts could be geared towards scaling up the user-training process so as to ensure that majority of students properly have a grasp of how to use the OTELS efficiently.

5. The findings of this study also revealed that there were no help menu and user guide on the OTELS, this is very important since these two remain majorly the source of information and support to the user especially those in the rural areas. Government may see to it that these are promptly provided to reduce errors and provide supports to the students.

**REFERENCES**


The Effect of The Teaching Practice Course on Pre-Service Elementary Teachers’ Technology Integration Self-Efficacy

Erhan Ünal [1], Ahmet Yamaç [2], Ahmet M. Uzun [3]

ABSTRACT

The aim of this study is to examine the effect of the teaching practice course on pre-service elementary teachers’ TISE level. In this research both qualitative and quantitative research methods were used. The participants were 43 pre-service elementary teachers from a state university in Turkey. In the quantitative part of the study, these pre-service elementary teachers filled in the TISE scale before and after the teaching practice course. Also, semi-structured interviews were carried out with 13 voluntary pre-service elementary teachers about the sources of TISE. The results indicated that the TISE level of pre-service elementary teachers was increased during the teaching practice course. The sources of pre-service elementary teachers’ TISE was discussed based on the sources of self-efficacy stated by Bandura.

Keywords: self-efficacy, technology entegration, and elementary school teacher education.

INTRODUCTION

Information and communications technology (ICT) has undergone continuous changes. These innovations and changes in ICT have led to changes and developments in education and its stakeholders such as national and international organizations, school administration, teachers, curriculum and students. ICT use in education ensures the learning and teaching process is conducted more effectively and more efficiently. The aim of instructional technology is to facilitate learning by activating appropriate technological processes and resources (AECT Definition and Terminology Committee, 2008). For this reason, ICT use in education provides benefits and advantages. Within this framework, there are projects about ICT integration in education all over the world. For example, in Turkey, the FATIH Project was been started to introduce technology use for learning and teaching (Ministry of National Education, 2013). In the USA, similar projects have been carried out. In different states, within one computer per student and per one teacher project, it is aimed to integrate technology into the curriculum (Gateway, 2004; Ingram, Willcutt, & Jordan, 2008). In Singapore, the Ministry of National Education prepared five-year plans on technology integration. Recently, the Singapore Ministry of Education (2015) has published the fourth master plan for ICT in education. Likewise, Korea introduced the 5th four years Master Plan for ICT in Education (The Korea Education and Research Information Service, 2014).

Technology integration, in which many countries have invested, is an important issue for education. For the success of these projects, teachers’ technology integration in the teaching and learning process is a matter of great importance. Since today’s teachers should use their technological knowledge and skills effectively, the Ministry of National Education (2008) in Turkey as well as the International Society for Technology in Education [ISTE] (2008) have prepared standards for determining teachers’ competence with regard to technology use for learning and teaching. Teacher training programs have great
responsibilities to equip teachers with this competence; indeed, the success of technology integration is
directly related to the quality of teachers. Teacher training programs should train pre-service teachers on
the use of technological tools and skills and knowledge about technology integration into education
(Gulbahar, 2008). The teacher training programs should provide opportunity for realizing the potential of
available technologies and their use in education (Choy, Wong & Gao, 2009).

Pre-service teachers’ views about technology integration affect their future use of technology. In this
way Ertmer (1999) and Hew and Brush (2007) consider that teachers’ knowledge, skills, thought, attitude
and self-efficacy of technology integration were barriers toward technology integration. Therefore pre-
service teachers’ instructional beliefs and self-efficacy influence their instructional decisions and classroom
practices (Pajares, 1997).

Technology Integration

Different definitions of technology integration exist in the literature. Hew and Brush (2007) defined
technology integration as using computers, laptops, personal digital assistants (PDAs), software and
Internet for instructional purposes at schools. Technology is a tool to facilitate learning. Therefore
technology integration is related to technology use in the teaching and learning process (Perkmen, 2008).
Reigeluth (2003) explained technology integration as using technology to enhance the quality of the
teaching and learning process. According to these definitions, technology integration is seen as using
technology to enhance the quality of instruction in classrooms. Therefore the learning and teaching process
will be more effective and more efficient.

Self-Efficacy and Technology Integration Self-Efficacy

Bandura theorized self-efficacy and defined perceived self-efficacy as “people’s beliefs about their
capabilities to produce designated levels of performance that exercise influence over events that affect
their lives.” (Bandura, 1994, p. 71). Self-efficacy beliefs have an impact on people’s behaviors, because
people who have a high self-efficacy belief tend to select challenging tasks, engage in tasks and persist in
them (Pajares, 1997). Bandura (1977) stated that perceived self-efficacy is related to the emergence of
behaviors and is important for developing new behaviors. Self-efficacy affects the selection of activities,
persistence on difficulties, effort and performance.

Bandura’s self-efficacy theory provides four sources of self-efficacy, mastery experiences, vicarious
experiences, social persuasion and physiological and emotional states. These sources are appropriate ways
of increasing a person’s self-efficacy. Mastery experiences are the most effective way to promote self-
efficacy because successful performance has a positive effect on a person’s self-efficacy belief; in contrast,
performance failures have a negative effect on self-efficacy belief. Another source of self-efficacy,
“vicarious experiences”, is explained as people observing other people’s behaviors, and judging the
successful and unsuccessful performances and evaluating these performances. After that people develop
beliefs how to achieve a similar performance. “Social persuasion” is another source of self-efficacy. From
people’s friends, families and colleagues encouragement about their successes or failures in terms of
performances affects their self-efficacy. The last source of self-efficacy is “physiological and emotional
states”. People’s mood, stress, anxiety may affect a person’s beliefs about judgements of related
performance. Positive feelings about performance increase people’s self-efficacy; in contrast, negative
feelings decrease a person’s self-efficacy (Bandura, 1994).

On the other hand, in the literature different forms of self-efficacy are discussed. One of them is
teacher self-efficacy. Ashton (1984) described teaching self-efficacy as “the extent to which teachers
believe that they have the capacity to affect student performance” (p. 28). Teaching self-efficacy was
described as teachers’ belief in their ability to change students’ performance. Therefore teacher education
programs should develop pre-service teachers’ teaching efficacy. In other words, a teacher education
program should develop relationships between teacher efficacy beliefs and teacher behavior (Ashton,
1984).
The other form of self-efficacy is technology integration self-efficacy ([TISE]). According to the literature, teachers’ use of technology in education has been affected by different variables. One of these variables is teacher beliefs (Albion, 1999). Pajares (1992) reported a relationship between pre-service teachers educational beliefs and plans and instructional decision and practices. Consequently, teachers beliefs about the capacity of technology use in education demonstrate their instructional activities (Teo, Chai, Hung, & Lee, 2008). Teacher beliefs about technology use in education can be described as TISE. In another definition, TISE is perceived as the confidence of teachers and pre-service teachers while integrating technology in education (Nathan, 2009).

Teacher Training Programs

In Turkey the teacher training program is developed by the Higher Education Institution. While developing this program, entrance to the profession, general culture, subject matter teaching and pedagogical formation are taken into consideration, according to the law numbered 1739 issued by the Ministry of National Education. Teacher training programs contain lessons about subject area, general culture and the profession of teaching.

In general there are similar courses for the teaching profession. One of them is the teaching practice course. This course is aimed at providing pre-service teachers with experience on the teaching profession by implementing what they have learned from courses such as general culture, subject area and the profession of teaching (MoNE, 1999). From this course, pre-service teachers gain experience from primary schools, secondary schools or high schools.

All teaching training programs include the teaching practice course. Therefore, in the primary school teaching program it is carried out in the 7th and 8th semesters. This course lasts 8 hours per week in practicing primary schools under a practicing teacher and university advisor supervision. The goal of this course is for pre-service teachers to gain experience about the culture of the school, examine the educational environment, observe the teachers, study with student groups and individuals, participate in the other activities and internalize the teaching profession. By the end of this course, pre-service teachers learn about the curriculum, course books, student files, measurement and assessment. Consequently, pre-service teachers have the chance to practice theoretical knowledge in real life via practicing schools.

The teaching practice course affects pre-service teachers’ beliefs (Al-Awidi & Alghazo, 2012), because pre-service teachers prepare lesson plans and materials before presenting a lesson; they solve any problems occurring in the class during the teaching practice. In this regard pre-service teachers’ TISE level could be developed during this process, because Bandura (1994) reported that the sources of self-efficacy are mastery experiences, vicarious experiences, verbal persuasion and physiological and emotional states. Therefore, in this practice process the experiences gained by pre-service teachers such as presenting a lesson (mastery experiences), observing university advisors, instructors, practicing teachers, friends (vicarious experiences), encouragement and support of university advisors, instructors, practicing teachers, friends (verbal persuasion), feelings and thoughts (physiological and emotional states) will affect their TISE level (Al-Awidi & Alghazo, 2012; Albion, 1999; Bandura, 1994).

Research on Technology Integration

A variety of studies related to technology integration abound in the literature. One of the research areas related to technology integration is research on technology integration barriers. These studies on technology integration barriers include: access to hardware, lack of technical support and administration support, (Çakır & Yıldırım, 2009; Inan & Lowther, 2010; Wacha & Keengwe, 2011; Yıldırım, 2007); teachers’ skills and beliefs about technology (Inan & Lowther, 2010); lack of technological leadership and support (Strudler & Wetzel, 1999; Yıldırım, 2007); barriers related to social, environmental, personal and curriculum matters (ChanLin, Hong, Horng, Chang & Chu, 2006); inadequate technological tools and insufficient training about technology integration (Koçak-Usluel, Kuşkaya-Mumcu & Demirarslan, 2007; Yıldırım, 2007), and insufficient collaboration between teachers (Yıldırım, 2007).
The other research field of technology integration is about identifying technology integration efficiency. In these studies, technology integration practices were evaluated by pre-service teachers, teachers, and administrators. The studies show that teachers had positive views about technology integration (Göktaş, Yıldırım & Yıldırım, 2008); pre-service teachers had a positive attitude toward technology integration (Brush, Glazewski & Hew, 2008); there was a relationship between pedagogical beliefs and technology integration (Chen, 2008; Ertmer, Ottenbreit-Leftwich, Sadık, Şendurur & Şendurur, 2012; Hermans, Tondeur, Braak, & Valcke, 2008; Kim, Kim, Lee, Spector, & DeMeester, 2013; Liu, 2011) in these studies.

On the other hand, there are few studies on developing teachers’ or pre-service teachers’ beliefs about technology integration after a course or training program (Al-Awidi & Alghazo, 2012; Brinkerhoff, 2006; Kopcha, 2012; Uslu & Bümen, 2012; Wang, Ertmer, & Newby, 2004). Therefore, in Turkey, further studies are needed aimed at evaluating the effect of teaching practice course on pre-service teachers’ TISE level. In particular, it is necessary to examine pre-service teachers’ development of beliefs about technology integration. In the technology integration literature research on TISE has not sufficiently concentrated on pre-service teachers’ TISE level after the teaching practicing course. In this context, the problem of this research is “What is the effect of the teaching practice course on pre-service classroom teachers’ TISE level?”.

The Aim of the Study

The aim of this study is to examine the effect of the teaching practice course on pre-service elementary teachers’ TISE level. The questions in the current study which we aim to answer are:

1. Is there a significant difference between the TISE level of pre-service elementary teachers before and after the student teaching experience?
2. What are the sources of pre-service elementary teachers’ TISE level?

Significance of the Study

Projects have been carried out on technology integration into the curriculum all over the world. In this regard, different ICT tools such as hardware (computer, laptop, tablet PC, smart board, internet connection etc.), software and access to these technologies are provided, inservice teachers training programs are carried out and also to equip pre-service teachers with the necessary skills for technology use in education teacher training programs are updated (Lawless & Pellegrino, 2007). These projects are expected to be useful and increase the quality of education. The success of these projects depends on many factors. Teacher training programs are one of them. Therefore pre-service teachers should be equipped with technology integration skills and belief in using them. In this research pre-service teachers’ development of TISE will be revealed. In other words, we will examine how pre-service teachers’ beliefs are developed while integrating technology by using the necessary knowledge of general culture, special field and teaching profession. Through this research the effect of teacher training programs on pre-service teachers’ TISE level will be evaluated. In addition, the success of technology integration projects will be predicted.

METHOD

Research Design

In this study both qualitative and quantitative research methods were used in order to answer research questions. “Mixed-methods research involves the use of both quantitative and qualitative methods in a single study. The use of both methods provides a more complete understanding of research problems than does the use of either approach alone” (Fraenkel, Wallen, & Hyun, 2012, p. 557). Among mixed method designs, the convergent mixed methods approach was used in this study. The purpose of convergent mixed methods design is to collect quantitative and qualitative data, analyze data and interpret
data. In this method, collecting two different datasets has the strengths of both quantitative and qualitative methods. Therefore data gathered from different sources will be interpreted and compared together (Creswell & Plano-Clark, 2007).

For the quantitative part of the study, TISE Scale was conducted in pre-service classroom teachers before and after the teaching practicing course. For the qualitative part of the study, after the teaching practicing course semi-structured interviews were conducted with pre-service elementary teachers. The semi-structured interviews aimed at determining pre-service elementary teachers’ development sources of TISE. Therefore in the interview form open ended questions were prepared based on Bandura’s (1994) view about the sources of self-efficacy, namely mastery experiences, vicarious experiences, verbal persuasion and physiological and emotional states. With these quantitative and qualitative methods we aimed at examining pre-service elementary teachers’ sources of TISE during the teaching practice course.

Participants

The participants of this research were 43 pre-service elementary teachers at a state university in Turkey. These pre-service classroom teachers filled in the TISE scale before and after the teaching practice course. On the other hand, semi-structured interviews were carried out with 13 voluntary pre-service elementary teachers about the sources of TISE.

Data Collecting Tools

To collect quantitative data, the TISE scale was used. The scale was developed by Wang, Ertmer, and Newby (2004) and adapted into Turkish culture by Ünal (2013). The TISE scale has 19 items in Turkish. The scale used a five-point Likert Scale ranging from 5 (strongly agree) to 1 (strongly disagree). Higher scores in the TISE scale mean that a pre-service elementary teacher has a higher TISE level. In this research Cronbach alpha value which indicates the reliability of the scale was estimated as .90 in the pre-test and .87 in the posttest.

To collect qualitative data, a semi-structured interview form was prepared. The questions were related to the sources of TISE and were based on Bandura’s views on sources of self-efficacy namely mastery experiences, vicarious experiences, social persuasion and physiological and emotional states (Al-Awidi & Alghazo, 2012; Bandura, 1994). These questions were:

1. Which personal experiences affected your beliefs to integrate technology in your class?
2. Who affected your beliefs about integrating technology in your class?
3. How did people encourage you to use technology in your class?
4. How do you feel while integrating technology in your class?

Data Analysis

The data gathered from the TISE scale were analyzed using SPSS 18.0. To examine pre-service elementary teachers change of TISE level before and after teaching practice the paired sample t-test was used.

In the qualitative part of the study, data were collected about the sources of TISE. Therefore all interviews were recorded and then transcribed. The interviews were analyzed based on the sources of self-efficacy stated by Bandura. According to Marshall and Rossman (2011), data reduction and data interpretation are the purpose of data analysis in qualitative research. Researchers reduce data by separating collected data into manageable sections and make sense of participants’ views and actions before interpreting data. Creswell (2013) stated that qualitative analysis is an inductive process. Therefore researchers are able to obtain codes and themes from collected data.

In this research, first of all interviews were reviewed and transcribed. Then the transcribed data were
read. While reading the data, two researchers took theoretical and thematic notes on the basis of word, sentence or paragraph. After that a code list was generated and these codes were categorized according to Bandura's view about the sources of self-efficacy, namely mastery experiences, vicarious experiences, social persuasion and psychological and emotional states. The two researchers’ analysis results were compared and agreement or disagreement on the results were determined and a resolution was then made. To ensure the reliability of data analysis, the \( \frac{\text{Agreement}}{\text{(Agreement + Disagreement)}} \times 100 \) formula was used (Miles & Huberman, 1994) and the reliability of this analysis was calculated as 79%. According to Miles and Huberman (1994), the reliability of data analysis should be above 70%. Therefore the data analysis in this study was accepted as reliable.

RESULTS

Question 1: Is there a significant difference between the TISE level of pre-service elementary teachers before and after the student teaching experience?

In order to determine if there was a significant difference between the TISE level of pre-service elementary teachers before and after the student teaching experience, the paired sample \( t \)-test was conducted and the results are shown in Table 1.

Table 1. Paired Samples \( t \)-Test Results for TISE level

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>( t )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( M )</td>
<td>( SD )</td>
<td>( M )</td>
<td>( SD )</td>
</tr>
<tr>
<td>TISE</td>
<td>69.47</td>
<td>8.21</td>
<td>74.88</td>
<td>6.77</td>
</tr>
</tbody>
</table>

\( *p < .005 \)

As seen in Table 1, the TISE level of pre-service elementary teachers increased during the teaching practice course \( (t (42)= -3.72, p < .005) \). The \( p \)-value was significant showing that there is a significant difference between the mean scores of TISE level before and after the teaching practice course. The means of the pre-test and post-test TISE scores were \( X = 69.47 \) and \( X = 74.88 \).

Question 2: What are the sources of pre-service elementary teachers’ TISE level?

Pre-service elementary teachers’ sources of TISE were categorized according to Bandura’s view. Therefore the main categories, sub-categories and frequencies of pre-service elementary teachers’ sources of TISE in each category are presented in Table 2.
## Table 2. Categories and Sub-Categories of Pre-Service Elementary Teachers’ Sources of TISE

<table>
<thead>
<tr>
<th>Category/ Subcategory</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery Experiences</td>
<td>18</td>
</tr>
<tr>
<td>Microteaching practices</td>
<td>7</td>
</tr>
<tr>
<td>Teaching activities in practice school</td>
<td>8</td>
</tr>
<tr>
<td>Activities at university</td>
<td>3</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>14</td>
</tr>
<tr>
<td>Teacher educators</td>
<td>5</td>
</tr>
<tr>
<td>Practice teacher in school</td>
<td>5</td>
</tr>
<tr>
<td>Friends</td>
<td>4</td>
</tr>
<tr>
<td>Social Persuasion</td>
<td>9</td>
</tr>
<tr>
<td>Teacher educators</td>
<td>5</td>
</tr>
<tr>
<td>Family</td>
<td>3</td>
</tr>
<tr>
<td>Practice teachers in school</td>
<td>1</td>
</tr>
<tr>
<td>Psychological and Emotional States</td>
<td>14</td>
</tr>
<tr>
<td>Happiness/ positive/ Emotional relief</td>
<td>9</td>
</tr>
<tr>
<td>Anxiety/the difficulties of class control</td>
<td>5</td>
</tr>
</tbody>
</table>

**Mastery Experiences**

As seen in Table 2, the most effective sources of pre-service elementary teachers’ TISE were mastery experiences (f = 18). Bandura (1994) stated that the most effective way for a strong self-efficacy belief is mastery experience. Therefore, in the context of pre-service elementary teachers, the TISE level was mostly affected by their personal experiences such as micro-teaching at university, teaching activities conducted in the practice school and other activities in university.

In addition, Bandura (1994) implies that an individual’s successes as a result of his or her interaction with the environment led to enhanced self-efficacy. According to Pajares (2002), individuals are involved in various tasks and activities in their routine life. They make interpretations based on the results of their behaviors and form a belief of “self” in terms of their efficacy. In their subsequent actions individuals act in accordance with previously developed beliefs (Pajares, 2002). Against this background, one of the sources of TISE, mastery experiences, is explored in this study in order to clarify the following question: “What kind of personal experiences affected pre-service primary school teachers’ TISE development”? Based on the interview results, the majority of the pre-service primary school teachers (n = 8) indicated that technology integration efforts during school experiences are the most effective factor which contributed to their TISE development. Some students (n = 7) indicated that micro-teaching practices they experienced in their university had an effect on their TISE development, while others indicated that other practices they experienced in university affected their TISE development. For instance, a teacher candidate discussed the contribution of school experiences as follows:

“I have tried to improve myself by using various technologies which were demonstrated in the micro-teaching courses I took at university. In addition, before starting the teaching experience, based on my observations, I realized that students liked technology-supported instruction. For this reason, I tried to use technology in my lessons.”
Another teacher candidate stated his/her opinions as follows:

“While I was teaching children to tell the time, using the clock application became effective. Students were engaging in the course. However, when I drew the clock on the blackboard, I didn’t see the students actively participating in the lesson. After seeing this, I decided that the use of technology is beneficial.”

Regarding the contribution of micro-teaching that pre-service teachers experience in their university, one pre-service teacher said:

“The micro–teaching practices that we experienced in our university supported my usage of technology in my teaching experiences. It supported my teaching, resulting in effective teaching.”

In terms of other experiences about technology usage, one pre-service teacher said: “I made different presentations in the courses that I took at my university. During these presentations, I made use of computers, which made my work easier.”

Interviews revealed that the mastery experiences of pre-service teachers contributed to their TISE development. The teacher candidates plan their teaching on a weekly basis by using their observations about the teaching activities they have witnessed. Thus, the teacher candidates gain experience leading to improvements in their TISE. Likewise, the pre-service teachers obtain skills in terms of technology usage in their micro-teaching experiences which contributed significantly to their TISE development. As a result, these findings are consistent with Bandura’s (1994) view about self-efficacy development: “The most effective way of creating a strong sense of efficacy is through mastery experiences”.

Vicarious Experiences

Another source affecting individuals’ self-efficacy development is vicarious experience. Students develop a belief of self-efficacy by observing and modeling other people’s behaviors. If individuals do not have any particular experiences about the related task or the activity, they regard other successful people as “models”. The successful outcomes and actions modeled thorough other behaviors affect the development of the student’s self-efficacy (Bandura, 1994; Pajares, 2002). Seeing successful people with similar characteristics promotes the observer’s belief that the observer has the same capability to achieve a specific goal. In the same manner, seeing other peoples’ failure decreased the observer’s perception of his or her efficacy. The degree of the perceived similarity to the model being observed has a serious impact on perceived self-efficacy. In this context, as one of the sources of TISE, vicarious experience is investigated based on the following main question: Who affected your technology use in your teaching activities? The teacher candidates reported that the most influential factor affecting TISE beliefs stems from modeling the instructors of their universities and the mentors of their practice schools (n = 5) and then modeling their peers who apply in the same practice schools (n = 4). Regarding the TISE beliefs that were developed through modeling the instructors of the pre-service teachers who work in their university, one student reported:

“The instructors who used technology in classroom encouraged me to utilize technology in my teaching activities. My instructors told me how to use technology in an efficient manner, such as the pros and cons of a specific technology. Therefore, I used technology since I believed that technology would be beneficial for my students.”

In a similar way, another pre-service teacher said:

“In the math class, the instructor told us how to use the Geogebra program and computer-assisted mathematics instruction. Thereby, he provided me with the ability to use the technology effectively.”

Regarding the source of vicarious experiences of TISE development related to the mentors in practice schools, one of the pre-service teachers said:
“My mentor in the practice school made students watch a video in the lessons and he asked questions about what the students had learnt. He projected the course book he used on to the blackboard.”

Another pre-service teacher reported:

“My mentor in the practice school fully utilized technology in his lessons. He tried to find related videos from the internet, making students watch the videos that he recorded himself. As a result, all the students understood the lesson. This kind of technology usage seriously affected me. Thus I learnt how I could teach with the help of technology.”

In addition, one pre-service teacher indicated that they obtained various experiences by modeling their peers. For example, one of the pre-service teachers stated her beliefs as follows: “A friend of mine was teaching phonics. She was making students listen to the song that she prepared by using the technology.”

When pre-service teachers’ views are analyzed, it could be said that they built their TISE beliefs by modeling other people in their environment, because, in situations when individuals regard themselves as incompetent, they observe models who they think are more competent. In this way, it could be postulated that pre-service teachers develop TISE beliefs vicariously (Pajares, 2002). When pre-service teachers see that other people are capable of using technology in their teaching activities, they realize that they are also capable of utilizing that technology for their teaching activities.

**Social Persuasion**

Social persuasion is also regarded as an important source of self-efficacy development. If individuals are convinced verbally that they have the ability to perform a given task, their self-efficacy beliefs are promoted and they are more likely to exert extra effort to achieve a specific goal (Bandura, 1994). Pre-service teachers’ views about social persuasion were explored based on the following question: “How did the people around you encourage you to use technology in lessons?”

According to the views of pre-service teachers, the social persuasions of their instructors at their university were the most influential factor in contributing to their TISE development (n = 5). Then the social persuasions of their families contributed to their TISE development (n = 3). Finally, pre-service teachers reported that the social persuasions of their mentors in practice schools contributed to their TISE development (n = 1). Regarding the persuasions and encouragements of their instructors, one pre-service teacher reported:

“My instructors at university gave special attention to technology. For example, one of my instructors said that using an animated car instead of a toy would be more effective. When I tried this, I realized that my teaching was more effective.”

Regarding family encouragement and persuasion, one pre-service teacher said:

“My father uses technology very effectively. He uses computers, tablets and cell phones very well. This affected me. In addition, he has the belief that: if you are going to be a teacher you should have knowledge about this which made me be ambitious.”

It could be argued that the TISE beliefs of pre-service teachers are slightly affected by the social persuasions of their environment. In this regard, it was found that family and instructor support in terms of social persuasion contributed positively to pre-service teachers’ TISE development.

**Psychological and Emotional States**

Psychological and Emotional States are another source of self-efficacy. Emotional states such as anxiety, stress and moods affect individuals’ beliefs about their capabilities to achieve a certain task (Bandura, 1994). The effect of psychological and emotional states on pre-service teachers’ TISE
development was explored based on the following questions: How did you feel while you are using technology in your class? What kind of positive and/or negative emotions did you experience? How did these emotions affect your technology use? The majority of the pre-service teachers reported that they were in a positive emotional state (n = 9), while some of them said they were in a negative emotional state (n = 6). One of pre-service teachers who was in a positive emotional state reported: “Technology appeals to many senses. For this reason, it is logical for me to conduct technology-supported lessons which also give me pleasure.”

Likewise, another pre-service teacher said:

“Since technology captures my students’ attention very well, I feel calm myself. Since all of my students are engaged in listening to the lesson, I feel calm myself. As a result I become happy.”

Regarding negative emotional state, one of pre-service teachers reported his anxiety:

“When I use technology, I sometimes feel anxious. For example, if I cannot project the presentation at the blackboard, or if similar problems occur, I feel tense because, at such times, I believe that I will fall behind the lesson plan.”

In sum, individuals’ experiences of emotional states while they are performing a certain task can affect their self-efficacy about that task in a positive or negative manner (Bandura, 1994). The pre-service teachers’ emotional states affect their belief of TISE. For example, pre-service teachers who possessed positive emotional states are more likely to use technology in their class than other pre-service teachers who possess negative emotions. A pre-service teacher who has negative emotional state about using technology is less likely to use technology in his/her class.

DISCUSSION AND CONCLUSION

This study explored the effect of the teaching practice course on pre-service elementary school teachers’ TISE level. This research was designed as a mixed method study. For the quantitative part of the study, pre-service elementary teachers filled in the TISE scale before and after their teaching practice course. Quantitative data indicated that, pre-service elementary teachers’ TISE level increased from the pre-test to the post-test. Furthermore, semi-structured interviews were conducted with 13 pre-service elementary teachers to examine the sources of their TISE. The semi-structured interview form was prepared in accordance with Bandura’s view about sources of self-efficacy, namely mastery experiences, vicarious experience, social persuasion and psychological and emotional states. Qualitative data showed that all sources were effective on pre-service elementary school teachers’ TISE and mastery experiences was the most effective one.

Similar findings related to effect of the field experiences and professional development programs on pre-service teachers’ beliefs have been reported in the literature. Hoy and Spero (2005) found that pre-service teachers’ teaching self-efficacy increased during the teaching practice course; Gao, Xiang, Chen, and McBride (2013) noted that teaching experience increased pre-service physical education teachers’ teaching self-efficacy; Kopcha and Alger (2011) reported that pre-service teachers’ teaching self-efficacy increased after a technology supported curriculum during field experience; Flores (2015) found that a field based science method course influenced pre-service teachers’ teaching self-efficacy level. Şimşek (2008) designed a technology integration program for pre-service teachers and found that pre-service teachers’ attitudes towards technology were positive and enhanced. Wang, Ertmer, and Newby (2004) stated that vicarious experiences and goal setting increased pre-service teachers’ TISE level while Al-Awidi and Alghazo (2012) also found that the teaching experience course increased pre-service teachers’ TISE level.

In this study, the results showed that pre-service elementary teachers’ TISE level increased after their teaching practice course. The course enabled them to gain some experience in technology integration and these affected their beliefs about integrating technology. The experiences which pre-service teachers gained by themselves, in particular, greatly affected their TISE development. Their experiences of micro-
teaching at university, teaching activities in their practice school and other activities in university influenced their TISE level. This study found that mastery experiences, as Bandura (1994) stated, are the most effective way to gain self-efficacy.

The other source of TISE is vicarious experience. So, in this context, pre-service elementary teachers observed different people for technology integration such as instructors at university, practice school advisors and peers. By observing these people technology integration practices, they increased their TISE level.

Verbal persuasion and psychological and emotional states affected pre-service elementary teachers’ TISE development. In this study, verbal persuasion by practicing school teachers was shown to have a serious effect on pre-service elementary teachers’ TISE development, because encouragement and support about integrating technology into education from practicing school teachers could help develop pre-service elementary teachers’ beliefs. Also, people such as instructors at university, peers and others should support and give feedback to pre-service elementary teachers about technology integration. In this way their TISE level could be increased. On the other hand, pre-service elementary teachers’ feelings influenced their TISE development, because their positive feelings could influence their technology integration in a positive way. Likewise, negative feelings could influence their technology integration in a negative way.

LIMITATIONS AND SUGGESTIONS

Technology integration is affected by different barriers. Ertmer (1999) and Hew and Brush (2007) stated that teachers’ self-efficacy belief about technology integration is one of these barriers. For successful technology integration, these barriers should be eliminated. In this regard, the teaching practice course is seen as important because pre-service teachers have the chance to practice what they have learned about the subject area, general culture and profession of teaching in a real learning environment. In the real environment, pre-service teachers interact with practicing school teachers, instructors at university, and their peers. Therefore pre-service teachers’ technology integrated teaching plans and activities in lessons should be examined and observed seriously by practicing schools and instructors so that students get feedback and advice about technology integration practices. Since pre-service teachers’ TISE level could be influenced positively, they should take as their models instructors, teachers, peers and other people around them who integrate technology into education successfully. These people should encourage pre-service teachers to use technology so that pre-service teachers can integrate technology into education in the future.

Finally, there are some limitations in this study. Firstly, this study was conducted with only 43 pre-service elementary teachers. It could be conducted with more pre-service teachers from different departments in future studies. Secondly, this study is limited because it only used data gathered from the TISE scale and the semi structured interview form. Future studies using observation and document analysis may reveal pre-service teachers’ TISE level in more detail.

REFERENCES


The Effects of Computer Algebra System on Undergraduate Students’ Spatial Visualization Skills in a Calculus Course

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ABSTRACT

This study aimed at determining the effects of using a computer algebra system (CAS) on undergraduate students’ spatial visualization skills in a calculus course. This study used an experimental design. The “one group pretest-posttest design” was the research model. The participants were 41 sophomore students (26 female and 15 male) studying at an undergraduate program in the department of mathematics in the west Anatolia region of Turkey. In order to determine students’ spatial ability, The Purdue Spatial Visualization Test: Visualization of Rotation (PSVT-R) was used as the pre-test and post-test. This test consists of 30 multiple choice items and it assesses the skills of mental rotation of objects. The results of the study showed that using CAS in a calculus course had a positive effect on developing students’ spatial visualization abilities. The results also showed that spatial visualization skills can be a predictor for success in a calculus course. The results have some important implications for education. First is that spatial visualization skills can be improved through training with relevant content. Second is that proper instruction by using some computer software such as MAPLE is effective for improving spatial visualization skills.

Keywords: Spatial ability, undergraduate students’ spatial abilities, calculus course

INTRODUCTION

Spatial ability is assumed as one of the most important components of mental ability (Linn & Petersen, 1985). It refers to an individual’s mental ability to visualize, transform and manipulate nonverbal information such as figures, 2-D and 3-D objects based on visual stimuli (e.g., Linn & Petersen, 1985; McGee, 1979, Olkun, 2003). Various researchers (e.g. Carroll, 1993; Linn & Petersen, 1985; McGee, 1979) have identified distinct components of spatial ability. Although there is no definite consensus regarding the number of distinct spatial abilities, there are several categories. One of the most widely used categories belongs to McGee (1979) who classified spatial ability into two sub-categories of spatial orientation and spatial visualization.

McGee (1979, p. 6) stated spatial orientation as “the comprehension of the arrangement of elements within a visual stimulus pattern and the aptitude to remain unconfused by the changing orientation in which spatial configuration may be presented” and defined spatial visualization as “the ability to mentally rotate, twist or invert pictorially presented visual stimuli”. Therefore, spatial orientation refers to the ability to retain spatial orientation with respect to one’s location while spatial visualization refers to the ability to imagine rotations and manipulations of objects (Kaufman, 2007). However, Linn and Petersen (1985) referred to a different classification to examine gender differences in spatial ability in a meta-
analysis. They distinguished three categories of spatial ability as spatial perception, mental rotation and spatial visualization. Maier (1998) referred to five categories of spatial ability as mental rotation, spatial perception, spatial orientation, spatial relations and spatial visualization. McGee (1979) regarded mental rotation as a sub-component of spatial visualization while Linn and Petersen (1985) and Maier (1998) considered it to be a separate component of spatial ability. Olkun (2003) also stated that spatial ability has two basic components in the form of spatial relations and spatial visualizations. Spatial relations involve the skills to understand 2-D and 3-D rotations of the shapes. Mental rotation is sometimes referred as spatial relations (Hegarty & Waller, 2004). Mental rotation involves a cognitive process to mentally rotate two or three dimensional objects rapidly and accurately (Linn & Petersen, 1985). This ability is a less complex ability than spatial visualization (Kauffmann, Steinbügl, Dünser & Glück, 2005, Olkun, 2003). Mental rotation and spatial visualization are the two most commonly agreed upon categories in the literature.

Spatial ability is closely related to teaching many subjects in mathematics and geometry (Hoffer, 1981; Karakuş & Peker, 2015; Kösa, 2016a, 2016b; Kurtuluş, 2013). In these studies, a positive relationship between success in mathematics and spatial ability is often emphasized (e.g. Gunderson, Ramirez, Beilock & Levine, 2012; Kayhan, 2005; Kösa, 2016a; Turgut & Yılmaz, 2012). Moreover, spatial abilities are also related to mathematical problem solving (e.g., Grattoni, 2007; Kösa, 2016a, 2016b; Markey, 2009; McLeay, 2006; Olkun, 2003). From this perspective, the NCTM (2000) emphasized the importance of spatial abilities in mathematics education and noted that spatial ability was important and included 2D and 3D objects’ mental representation and manipulation with the perception of different perspectives of the objects.

Although some studies ask whether spatial abilities can be improved with teaching (e.g. Hoong & Khoh, 2003) most studies showed significant change in students’ spatial abilities using different instruction methods and materials (Akasah & Alias, 2010; Arıcı & Aslan-Tutak, 2015; Baki, Kösa & Güven, 2011; Çakmak, 2009; Güven & Kösa, 2008; Huang, 2013; Kurtuluş, 2013; Miller & Halpern, 2013; Sevimli & Delice, 2010; Sorby, Casey, Veurink & Dulaney, 2013; Yıldız 2009; Yolcu & Kurtuluş, 2010). However, some studies (e.g., Boakes, 2009; Ferrini-Mundy, 1987) found no significant effect of instruction on spatial ability. Researches examining spatial ability changes often focus on geometry and engineering, whereas only a few studies (e.g. Delice & Ergene, 2015; Ferrini-Mundy, 1987; Huang, 2013; Sevimli & Delice, 2010; Travis & Lennon, 1997) investigated the changes in students’ spatial ability in calculus courses. Ferrini-Mundy (1987) investigated the effects of spatial training on calculus achievement, spatial visualization ability and the use of visualization in solving problems about solids. He found that there were no treatment effects on calculus achievement or spatial visualization ability. In contrast, Travis and Lennon (1997) designed an environment including 3-D representation using Maple software in a Calculus II course and found that this environment enhanced students’ spatial skills and academic success. Similarly, Sevimli and Delice (2010) investigated students’ preferences for representation as they tried to evaluate definite integral given in different representations and found that they had low spatial visualization ability. Additionally, they determined that the pre-service teachers who had low spatial visualization ability used algebraic representations. Sevimli and Delice (2010) and Huang (2013) investigated both students’ problems related to visualization and determined what type of visual images they use while solving problems in definite integral. The results showed that students who had high visualization ability used geometric representations along with algebraic representation in solving definite integral problems. However, students who had low visualization ability used memory images more. Furthermore, students who had high visualization ability were more successful than others when solving definite integral problems. Delice and Ergene (2015) focused on examination of drawing of university students during the solving process of integral volume problems. They found a relationship between spatial visualization skills and problem solving.

Most of the concepts and many problems of calculus can be represented differently such as through graphic or diagram as figures. Although many different representations are used in teaching concepts in calculus, few of the examples or problems are designed to develop the students’ ability to represent or solve problems graphically. The teaching of calculus focused on more algebraic representations, and the importance of visualization was neglected. In this case, students have difficulties when solving graphical and non-routine problems and building conceptual learning (Silverberg, 1999). Zimmermann (1991) discussed the role of visualization in calculus: “the role of visual thinking is so fundamental to the
understanding of calculus that it is difficult to imagine a successful calculus course which does not emphasize the visual elements of the subject” (p. 136). Moreover, it is almost impossible to understand a majority of problems (especially, find the areas of regions that lie under the graphs of functions and the volume of a solid or calculate triple integrals) in calculus without adequate visual representation. To understand calculus a student should be able to represent and interpret the graphical representation of data (Zimmermann, 1991).

The growth of computer technology presents a new and important element in any discussion of visualization in mathematics. In particular, integrating computers into the calculus courses helps to design an environment where graphical, numerical and analytic representation can be combined (Salleh & Zakaria, 2013). For that purpose, the computer algebra systems (CAS) such as Derive, Mathematica or Maple can be used as a tool for developing calculus success. CAS is a software program enabling students to solve equations and to perform different algebraic operations such as calculating limit, derivative and integral (Thompson, Byerley & Hatfield, 2013). CAS assisted learning environments have a significant effect on the students’ mathematics success especially on calculus concepts (Kabaca, Aksoy, Aktümen, & Mirasyedigölu, 2009). Moreover, CAS is a visualization tool that helps students form different representations and find the relationships among them (Mallet, 2007; Pierce & Stacey, 2004). In studies dealing with the effects of using CAS in teaching calculus subjects, the focus is mostly on how to use CAS in the classes (e.g., Mathews, 1990; Wiwatanapataphee, Noinang, Wu & Nuntadilak, 2010), the development of students’ operational and conceptual knowledge (e.g. Aksoy & Bulut, 2004; Godarzi, Aminifar & Bakhshalizadeh, 2009; Meagher, 2005) and change in students’ attitude and interest towards mathematics (Noinang, Wiwatanapataphee & Wu, 2008). A few studies (e.g. Travis & Lennon, 1997) examined the effects of using CAS on the students’ spatial ability.

The purpose of the study

Researches examining the changes in spatial ability often focus on geometry and engineering; only a few researches have examined the changes in students’ spatial ability in calculus courses. Moreover, some researches have implemented training programs using computer software such as Cabri 3D or GeoGebra to improve spatial visualization skills and found that such programs were successful in developing spatial visualization skills (Baki et al., 2011; Karakuş & Peker, 2015; Kösa, 2016a, 2016b). A few studies have examined the relationship between spatial ability and mathematics achievement. Although many studies on spatial visualization and geometry exist, calculus course and spatial visualization skills together was less studied. Moreover, there is no evidence of any research intended for showing whether spatial visualization skills can predict success in calculus.

The purpose of the present study was to determine the influence of using a CAS on undergraduate students’ spatial visualization ability in a calculus course. One group of participants received instruction using MAPLE computer software in the calculus course. The following research questions were addressed:

- Does using a CAS help undergraduate students to improve their spatial visualization skills?
- Can spatial visualization skills be a predictor of undergraduate students’ grades in a computer aided calculus course?

METHOD

A “one group pretest- posttest” design was used in this study. In this design, a single group is measured or observed not only after being exposed to a treatment of some sort, but also before (Fraenkel, Wallen & Hyun, 2011). This design should be used when the number of participants may be limited and it may not be possible to involve more than one group (Creswell, 2012). It is suitable for examining change in an entire system where it would be difficult to find a control group. Although many uncontrolled threats may affect the internal validity of a one group pretest-posttest design, some certain conditions such as reliable instrument and short pretest-posttest time intervals may minimize these threats (McMillan &
Moreover, this study was also a correlational research. It also assessed the relationships between academic success and spatial visualization skills. Correlational designs provide an opportunity to predict scores and explain the relationship among variables (Creswell, 2012).

The research was not to investigate the advantages or disadvantages of the CAS-based environment rather than traditional environment. Instead, we investigated the influences of doing CAS-based activities on undergraduate students’ spatial visualization skills in a calculus course, enabling them to evaluate the effectiveness of a CAS in a calculus course.

Participants

The participants were 41 sophomore students (26 females and 15 males) studying at an undergraduate program in the department of mathematics at a university in the west Anatolia region of Turkey. These students took the calculus IV course during the 2013-2014 spring academic semester. The pre-test and the post-test (as the same test) were administered to all of the students.

Instrument

The Purdue Spatial Visualization Test (PSVT) was developed by Guay (1977) with three subtests as follows: developments, rotations, and views which contain a total of 36 items. Each subtest of PSVT also has an independent extended version of 30 items entitled Purdue Spatial Visualization Test: Visualization of Developments (PSVT-D); Visualization of Rotation (PSVT-R) and Visualization of Views (PSVT-V). Among these three extended versions of the PSVT, the PSVT-R is a 20-minute test used for students to measure spatial visualization ability in 3-D mental rotation (Guay, 1980). In each item of PSVT-R, there is an object in two different positions. The object on the left shows the starting position, and the same object on the right has been rotated on the X, Y, and Z axes. Students are first asked to find the pattern of rotation, and then to select the representation of the object whose position represents the next rotation in the pattern. A sample item from PSVT-R is given in Figure 1.

![Figure 1. A sample item from the PSVT-R.](image)

The PSVT-R has been used mainly in research in different educational settings, such as science, technology, engineering and mathematics. The PSVT-R has been shown to be a valid and reliable instrument. Guay and McDaniel (1978) used PSVT-R test with 101 undergraduate students and reported...
that Kuder-Richardson reliability coefficient as .86. Battista, Wheatley, and Talsma (1982) used the test on 82 pre-service elementary teachers enrolled in a geometry course and found the Kuder-Richardson reliability coefficient was .80. Similarly, Sorby and Baartmans (1996) used the PSVT-R on 492 freshmen engineering students and found that the Kuder-Richardson reliability coefficient was .82.

**Procedure**

The calculus IV course is one of the basic lessons in the department of mathematics, and students take this course for six hours a week. The content of the calculus IV course includes double integrals and application of double integrals, triple integrals, triple integrals in cylindrical and spherical coordinates, change of variables in multiple integrals, vector fields, and line integrals. In this research, only the computer-based activities using MAPLE were prepared about the topics that were triple integrals, triple integrals in cylindrical and spherical coordinates, and change of variables in triple integrals. At the beginning of the study, the undergraduate mathematics students were administered the PSVT-R test as a pre-test. Before the treatment, the students were trained on how to use the MAPPLE software. They learned the basic commands and functions of the menu, such as how to draw the cone, parabola, sphere, plane or intersection of planes. An example of the activities is shown in Figure 2. In this activity, students drew the paraboloid $z = x^2 + y^2$ and plane $z=10$.

![Figure 2. Screenshot of the paraboloid and plane.](image)

The content of the course is presented in Table 1.

<table>
<thead>
<tr>
<th>Week</th>
<th>Course content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
<td>Learning about MAPLE. Forming basic objects (cone, parabola, sphere, plane, intersection of planes, etc.)</td>
</tr>
<tr>
<td>2nd week</td>
<td>Definition of triple integrals and drawing solid region</td>
</tr>
<tr>
<td>3rd week</td>
<td>Triple integrals, triple integrals in cylindrical and spherical coordinates</td>
</tr>
<tr>
<td>4th week</td>
<td>Change of variables in triple integrals</td>
</tr>
<tr>
<td>5th week</td>
<td>Free exercises</td>
</tr>
</tbody>
</table>

During the treatment, the students received instruction in the computer laboratory. They individually studied triple integrals using MAPLE, along with course worksheets. Since it was difficult to draw figures in triple integrals and define their projections on a plane, the focus of the worksheets were mostly on drawing...
figures and determining their projections on a plane. One of the worksheets that students took can be seen in the Appendix. They received guidance from the instructor, who was an expert at using MAPLE in teaching calculus concepts. At the end of the five weeks, the students were administered the same test as the e-post-test.

**Data analysis**

Before the data analysis, it was examined whether the data are normally distributed. The normality of data before and after intervention is shown in Table 2.

<table>
<thead>
<tr>
<th>Test scores</th>
<th>Kolmogorov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>.094 61 .200 .988 41 .940</td>
<td></td>
</tr>
<tr>
<td>Post-test</td>
<td>.123 41 .119 .962 41 .189</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 showed that the data were in accordance with normal distribution.

On the PSVT-R, one point was given for every correct answer, and no points were given for every incorrect or blank answer. We used the paired sample *t*-test statistical procedure with *α* = .05 on the undergraduate students’ PSVT-R scores to determine the mean differences between their pre-test and post-test scores.

To form a general impression of students’ spatial visualization ability, descriptive statistics were used before and after the treatment. Additionally, the students may take the lowest score “0” and highest score “30” from the PSVT-R test. The score range was divided into three equal intervals: low, average, and high. Table 3 shows these intervals and score ranges.

<table>
<thead>
<tr>
<th>Levels</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (1)</td>
<td>0 – 9</td>
</tr>
<tr>
<td>Moderate (2)</td>
<td>10 – 19</td>
</tr>
<tr>
<td>High (3)</td>
<td>20 – 30</td>
</tr>
</tbody>
</table>

With the help of Table 3, it was aimed to define the changes in levels of students pre-test and post-test scores. Thus, we had a general view about the effectiveness of the implementations. In order to determine relationship between the students’ spatial visualization skills and success in the computer aided calculus course, the Pearson correlation coefficient was calculated. Different authors suggest different interpretations for understanding the value of the correlation coefficient; however Cohen (1988) suggests the following guidelines: if *r* = .10 to .29 then the relationship is small; if *r* = .30 to .49, the relationship is medium and if *r* = .50 to 1.0 the relationship is large (pp. 79-81). In this study, Cohen’s guidelines were used to interpret the relationship.

**RESULTS**

In this section, the undergraduate students’ PSVT-R results are presented to illustrate the changes in their spatial visualization skills before and after the intervention. Table 4 presents the values of the mean and standard deviation of the scores of groups that were obtained from the PSVT-R.

<table>
<thead>
<tr>
<th>Before intervention</th>
<th>After intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
</tr>
</tbody>
</table>
Table 4 demonstrates that the undergraduate students’ mean post-test scores were higher than their pre-test scores. In order to determine whether the differences in the averages of pre- and post-test scores were statistically significant, a paired sample t-test was applied to the data obtained from the entire test at a significance level of .05. Table 5 summarizes the results of the paired sample t-test analysis for the pre- and post-test.

Table 5. Paired sample t-test results of pre- and post-test scores within groups

<table>
<thead>
<tr>
<th>N</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>40</td>
<td>-3.600</td>
<td>.001</td>
</tr>
</tbody>
</table>

According to the results shown in Table 5, there was a significant difference between pre-test and post-test scores of undergraduate students. Based on the statistical results, it can be said that the computer-based activities in the calculus course had a positive effect on the students’ acquisition of spatial abilities.

To take a general picture of the changes of students’ spatial visualization ability according to the pre-test and post-test scores, the levels of students’ PSVT-R scores was used. Figure 3 summarizes the changes of students’ PSVT-R levels in terms of pre-test and past-test scores.

Figure 3. Changes of students PSVT-R levels in terms of pre- and past-test scores.

According to the changes of students’ PSVT-R levels shown in Figure 3, the number of students in the first and second levels decreased, but the number of students in the third level increased.

The second problem of this study concerned whether spatial visualization skills could be a predictor of students’ grades in a computer-aided calculus course. The relationship between students’ spatial visualization skills and their performance in the computer-aided calculus course is demonstrated in Table 6.

Table 6. The relationship between the students’ spatial visualization skills and performance in a computer-aided calculus course.

<table>
<thead>
<tr>
<th>Spatial visualization skills</th>
<th>Computer-aided calculus course performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>1</td>
</tr>
<tr>
<td>p</td>
<td>.334*</td>
</tr>
<tr>
<td></td>
<td>.033</td>
</tr>
</tbody>
</table>
According to Table 6, the correlation coefficient between spatial visualization skills and performance in the calculus course was $r = .334$, with a significant level of .05. This case shows that there was a positive relationship between students’ spatial visualization skills and their performance in the calculus course. According to the guidelines proposed by Cohen (1988) for interpreting correlation coefficient, given correlation coefficient value denotes medium effect. In this case, it can be concluded that there was a medium relation between spatial visualization skills and calculus course success.

DISCUSSION AND CONCLUSIONS

This study investigated whether a CAS-based calculus course had an effect on developing undergraduate students’ spatial visualization skills. The paired sample $t$-test result shows that the PSVT-R scores were significantly higher at the end of the course than at the beginning. This result indicates that the CAS-based courses had a positive effect in terms of improving spatial visualization skills. Travis and Lennon (1997) similarly designed an environment including 3-D representation using Maple software in a Calculus II course and this environment enhanced students’ spatial skills and academic success. In a traditional calculus course, the teaching of calculus focused on more algebraic representations, and the importance of visualization was neglected. In addition, in a traditional calculus course, static drawing of a solid region on two-dimensional paper may be incomplete, thus causing erroneous perceptions. Several studies have shown that students have difficulties in interpreting static diagrams representing three-dimensional geometric objects as a result of these limitations (Delice & Ergene, 2015; Kösa, 2016a). The CAS has brought about a significant change in the way that teaching of calculus concepts Most CAS use programming languages and allow users to write programs for tasks. CAS also has a numerical system for visualization of 2D and 3D plots. In the treatment, students performed implementations such as rotating curves in space and observing the geometric objects from different viewpoints using MAPLE. The differences in their scores may be attributed to these implementations. A number of previous studies have demonstrated that instruction using computer-based visualizations can help students in developing spatial visualization skills (Baki et al., 2011; Güven & Kösa, 2008; Huang, 2013; Karakuş & Peker, 2015; Kösa, 2016a, 2016b). However, the instruction used in the present study was not directly designed to improve students’ spatial visualization skills.

Results show that CAS had a positive impact in changing students’ spatial visualization levels. It was determined that there were some changes in the students’ PSVT-R levels in terms of pre- and post-test scores. Students in the low PSVT-R level passed through moderate level and also students in moderate level passed through high level during the course. A key factor in the change of students’ spatial visualization skills could be the feature of MAPLE that enables the drawing and animation of a curve in 3D graphic on a two dimensional screen. In the implementation, students drew curves in triple integrals and defined their projection on the plane by using rotating or imagining views from different perspective that could improve spatial skills. This means that spatial visualization skills can be developed using a computer algebra software in the context of a calculus course. Moreover, Güven and Kösa (2008) explained that student mathematics teachers’ spatial visualization skills were low in Turkey. However, Sevimli and Delice (2010) found that spatial skills of pre-service teachers who studied with define integral were at the moderate level. In this research, it was found that undergraduate students had mostly moderate level spatial ability both before and after the course similar to the finding of Sevimli and Delice (2010).

Another purpose of this study was to determine whether spatial visualization skills could be a predictor of calculus course grades. In order to determine the relationship between students’ spatial visualization skills and their performance in the calculus course, the Pearson correlation coefficient was

<table>
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<th>N</th>
<th>41</th>
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<tbody>
<tr>
<td>Computer-aided calculus course performance</td>
<td>$r$</td>
<td>.334$^*$</td>
<td>1</td>
<td></td>
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<tr>
<td></td>
<td>$p$</td>
<td>.033</td>
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<td>N</td>
<td>41</td>
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calculated. The correlation coefficient between spatial visualization skills and performance in calculus was $r = .334$ with a significance level of .05. This shows that spatial visualization skills can be a predictor for success in a calculus course. On the other hand, there is no evidence that spatial visualization skills alone can be a predictor for success in a calculus course.

Some studies (e.g., Carlson, Jacobs, Coe, Larsen, & Hsu, 2002; Eisenberg & McGinty, 1977; Thompson, 1994; Turner, 1982) have found spatial ability to be a predictor of performance in calculus. For example, Eisenberg and McGinty (1977) explained that spatial visualization test scores were higher among students in calculus course than other courses. Moreover, Turner (1982) found that calculus students with high spatial ability tend to perform better than those with low spatial ability. Similarly, Huang (2013) investigated both students’ problems related to visualization and determined what type of visual images they use while solving problems in define integral subject. The results showed that students who had high visualization ability used imagination images along with algebraic representation in solving define integral problems. However, students who had low visualization ability used memory images more. Furthermore, students who had high visualization ability were more successful than others when solving define integral problems. Balomenos, Ferrini-Mundy, and Dick (1987) stressed that in order to solve calculus problems, students should have adequate understanding of visual representations and ability to make connections between analytic and graphical representation. Therefore, well-developed spatial skills are crucial in a calculus course. However, other factors such as teaching methods, preliminary knowledge, attitudes and beliefs toward mathematics, etc. are important factors in mathematics achievement as well as spatial visualization skills. The present study indicated that spatial visualization skills explained the success in calculus in moderate level.

The present study investigated effects of using CAS on students’ spatial visualization skills in teaching triple integrals in a calculus course and whether spatial visualization skills can be a predictor of calculus course success or not. The results of the study showed that using CAS in a calculus course had a positive effect on developing students’ spatial visualization abilities. Additionally, the result of the study showed that spatial visualization skills can be a predictor for success in a calculus course. In future, additional studies may be carried out with respect to other factors that may influence spatial visualization skills and success in a calculus course.

RECOMMENDATIONS AND EDUCATIONAL IMPLICATIONS

In this study, we investigated whether a CAS-based calculus course could promote undergraduate students’ spatial visualization skills. The results showed that the course had a positive effect on developing the students’ spatial visualization skills. The results have some important implications for education. First is that spatial visualization skills can be improved through training using relevant content. Second is that proper instruction by using some computer software allowing users to construct lines, curves or solids in 3D on the screen are effective tools for improving spatial visualization skills. The third is that a positive relationship exists between spatial visualization skills and calculus success. For that reason if a student has a high spatial visualization skill, the calculus success could be high. Future studies may investigate whether CAS-based calculus courses or traditional calculus courses are more effective for improving spatial visualization skills. Moreover the results showed that at the beginning of the calculus course, students’ spatial skills were low. It is surprising that although the students study with three dimensional objects from early stages of elementary school to university, their spatial ability skills are still low. The reason may be examined in future research. Another result of this study indicated that spatial visualization skills can be a predictor for achievement in calculus courses. Future researchers may examine whether gender plays a role in spatial visualization skills as a predictor for success in calculus courses.

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APPENDIX

An example of a worksheet on triple integrals with MAPLE

(The left part shows the worksheet given to the students, and the right part shows the explanations about the solution of the integral).

Subject: Definition of triple integrals and drawing solid region

<table>
<thead>
<tr>
<th>Worksheet</th>
<th>The explanations about the solution of the integral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the triple integrals to find the integral $\iiint_{0}^{1} 12x y e^{y^2} dz dx dy$</td>
<td>Students cannot find this integral according to the $z$ immediately. Therefore, it is necessary to change the order of integration</td>
</tr>
</tbody>
</table>

Draw the bounded region using MAPLE
Find the projection of region onto the xz-plane, xy-plane and yz-plane to change the order of integration.

Choose one of the projections onto the planes and rearrange order of the triple integral.

Students can choose the projection on the yz-plane.

Now find the integral.