Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 93 (2013) 1593 – 1597

Procedia
Social and Behavioral Sciences

3rd World Conference on Learning, Teaching and Educational Leadership (WCLTA-2012)

Spatial Training using Digital Tablets

Jose Luis Saorin *, Jorge de La Torre, Norena Martín ,Carlos Carbonell

Departamento de Expresión Gráfica en Arquitectura e Ingeniería, Universidad de La Lagunas, España

Abstract

The spatial skills are a core competency in the new engineering degrees belonging to the European Space for Higher Education. This work aims to find out the improvement of spatial abilities using a workshop held on digital tablets (iPad). For this purpose, the choice of a web-based spatial training course for mobile phones developed at University of Laguna for mobile phones was adapted for this research having in mind the dimensions of the digital tablet. The hypothesis is that expanding the size of the screen strengthens the spatial abilities of students also improving satisfaction rather than previous experiences. The workshop installed in a learning virtual environment (moodle) and has several difficulty levels. The pilot test for this material took place on agricultural engineering students during 2011-2012. Using the iPad given to every student, the workshop happened outside class hours. For measuring the spatial skills before and after the workshop, we used different technical drawing exercises used in the Spanish university admission exams over the last few years. Besides, students answered a questionnaire for assessing their opinion regarding course's format.

Selection and peer review under responsibility of Prof. Dr. Ferhan Odabaşı

Keywords: spatial abilities; mobile learning; digital tablets; spatial visualization; engineering education.

1. Introduction

During October 2008, at La Laguna University (Spain), it was performed a web-based Spatial Training workshop through Apple iPod Touch (Martín-Dorta & Saorín, 2011). The results obtained were quite satisfying, both in the spatial skills and user's satisfaction fields. Unfortunately mobile devices available that year (Apple iPod or similar) were limited to 3.5" maximum. The arrival of digital tablets in 2010 gives us a new mobile device of higher dimensions than ever before, nicely suited for graphics applications.

The New Media Consortium & EDUCASE Learning Initiative (Horizon Report, 2012), identifies the technologies which will be widely used at schools in the forthcoming years. We detect for a one-year period all applications for mobile devices and tablets as digital technologies subject to implementation. For a period of two years, game-based learning is one of the selected technologies. Because of this, the spatial online training developed for smartphones was adapted for use in digital tablets (Tablet-VIZ application). This allows the use of a methodology based on informal learning for students and its design is close to real games.

With the arrival of multitouch digital tablets, another way to interact with graphics software appears. The mobility, gestural possibilities, three-dimensional interactions are new aspects to analyze. The mobility and accessibility of network resources in schools is increasing significantly with the use of these devices. The weight,

* Jose Luis Saorin. Tel.: +34-629-565-731
E-mail address: jlsaorin@ull.es

1877-0428 © 2013 The Authors. Published by Elsevier Ltd.
Selection and peer review under responsibility of Prof. Dr. Ferhan Odabaşı
doi:10.1016/j.sbspro.2013.10.087

size, battery life, start-up times, network access via Wi-Fi, gestural interaction on the touch screen as well as keyboard interaction characteristics are quite impressive. Besides, the profusion of specific low cost applications and its easy access and install can turn them into much more than a computer or even a collection of books, music and videos becoming a media consumption device that is properly oriented with educational criteria creating a new paradigm in the methodology of teaching in education systems.

The spatial skills may be associated with success in scientific areas (Smith, 1964). Non-academic activities, such as playing with construction toys as a young child and playing three dimensional computer games seem to have strong ties with spatial visualization ability. Our work aims to determine the influence on the improvement of spatial abilities of the workshop on digital tablets, as well as student satisfaction while using the new device.

2. Spatial abilities and improvement tools

Over the last half century, spatial abilities received increased recognition and, despite the fact that they received less attention than verbal and numeric abilities, the research accentuates their importance in the traditional fields of engineering, technology and art, as well as in almost every other aspect of life. The spatial abilities remain an active field of study as they have repercussions over almost every scientific and technical field, especially in the engineering area. As a component of intelligence throughout history, the spatial ability is the ability of manipulating objects and their parts mentally in a two-dimensional and three-dimensional space. From the quantification point of view, we can define it as the ability to imagine rotations of 2D and 3D objects as a whole body (Spatial Relations) and the ability to imagine rotations of objects or their parts in 3D spatial by folding and unfolding (Spatial Visualization) (Saorín, 2006).

Some authors have based their work on the hypothesis that spatial abilities may be improved if the right tools are used; i.e. ones that ease the understanding of the concepts and the relations between two and three-dimensional representations. The appearance of new technologies has meant that, since the mid-nineties, several different research groups have suggested new tools for improving spatial abilities. Since 2004, the Dehaes Research Group at La Laguna University has developed several lines of research focusing on the study of spatial abilities in engineering students. (Saorín, Martín-Dorta, Martín, Navarro, & Contero, 2009).

This paper focuses on new user interfaces offered by Digital Tablets, in an informal online learning context, aiming for development of the spatial visualization. Tablet-Viz application will be used to make a web based spatial training workshop.

3. Digital tablets in education

The digital tablet is a recent technology so there are few documented experiences about its use in teaching. Some investigators (El-Gayar & Moran, 2011) studied about the factors influencing student´s acceptance of digital tablets in an educational setting. Concretely, in 2010 there was a study about the iPad at San Francisco University where 40 faculty members from the ITS Center for Instruction and Technology took part in it. This study is a six-month research project that will review, share and experiment with potential uses of the iPad in higher education (Bansavich & Yoshioka, 2011).

The main issues analyzed among others, were if iPad applications were available for teaching and learning support at courses and the issue of iPad's usability for reading, writing, communicating and creating contents. Several applications are currently under development for teaching through digital tablets. In the graphic engineering field, it should be underlined the 2011 compilation about digital tablets for teaching, drawing, design and visual arts (Saorín, et.al., 2011),where 3D models viewers are analyzed as well as vector drawing applications, raster plots and CAD.

4. Pilot study

This pilot study aim to determine the effect of a web based spatial training running over digital tablets. It is only tested with first year engineering students with underdeveloped abilities at the beginning of their second term at university. The general objective is that, by the end of the course, participant students can achieve a minimum level

determine by Spanish university entrance exams of technical drawing. The specific objectives of this research are to analyze the effects that training, based on the teaching material described in this work, can have on spatial visualization and rating the satisfaction of users with the digital tablets.

4.1. Participants

The pilot study held at Agricultural Engineering degree of University of Laguna comprised involved 41 first year students who took part in this experience. In order to measure the spatial abilities of participants, the chosen exercises belonged to the Spanish university admission exams because of their relation with technical drawing. There were two types of exercises. The first one was an isometric perspective which students should draw their matching orthogonal views meanwhile the second one was the opposite; from the orthogonal views students must draw the isometric perspective. The chosen exercises measured the spatial ability, as a relationship exists between the ability to perform these exercises and the results of the spatial abilities test. In Table 1 the results obtained by all the students participating in the test are shown. From these results came the choice of the 10 students who were unable to answer correctly any of the exercises.

Table 1: Selection of participants

	Orthogonal views exercise (Correct answers %)	**Perspective exercise (Correct answers %)**
All the students (41)	63 %	48%
Students chosen for performing the Spatial training workshop (Tablet VIZ) (10)	0%	0%

4.2. Materials

The course's structure has five modules of several levels. The first module "Building with blocks", is composed of block model exercises. The students have to identify the number of blocks that match the one indicated in a drawing (level 1), choosing from four models the one that matches a given numeric coded plan (level 2) or distinguish whether the proposed figures are possible to build in the real world or not (level 3). "Identification of Sides and Views", the second module of this teaching material, contains exercises in which the students have to identify surfaces and orthogonal views when they have the axonometric view of an object. The third module, "Object Discrimination", consists of three levels in which the students must try to link isometric sketches of the object with the correct orthogonal views. The fourth module, "Rotations", addresses mental rotations with exercises in which the students have to identify the orthogonal views or isometric sketches that rotated 90, 180 or 270 degrees from a given axis. The fifth and final module, "Cross Sections", requires students to identify cross sections made of the objects shown. Each level has an explanatory video that reviews the needed contents for tackling the exercises proposed. These videos have been designed with Adobe Flash © (Adobe, 2009) and Apple QuickTime Pro © (Apple, 2008).

4.3. Hardware and Software

Although the original material was designed and implemented on iPod Touch and iPhone devices, the course is accessible from any PC, PDA or from any mobile device which screen size is 3.5 inches or more and preferably with a tactile screen (connection via Wi-Fi, GPRS, 3G, etc.). The device's internet browser must be HTML, CSS, and ASP code compatible. The course is available on the website of the Dehaes Research Group (digilab.es) as a moodle course packaged as SCORM

4.4. Pre- and post-test

Each student had two spatial skills measures, before and after the workshop. The chosen exercises in both cases belonged to Spanish university admission exams from several years, ensuring a standard level of difficulty.

5. Procedure

Ten students who compose the experimental group were those obtaining the lowest results at the pre-test performed by 41 students. The training program took place along a week, in non-school hours. Each day, the students completed one of the five modules proposed (from Monday to Friday) and then they had two additional days to complete the exercises that they were unable to do on the date set for whatever the reason. The week before training, students do the pre-course test and fill in a user data survey. The experimental group met in a university classroom and after providing them with the course's programme, they do a short practice session for getting used to their devices. The week after the training, students complete the post-course test and fill a satisfaction survey.

6. Data Analysis and Results

In table 2 are shown the spatial abilities results obtained by the students taking part in the experience. All the students participating in the pilot study can solve correctly the university admission exams of technical drawing. To complete the study, students fulfilled a questionnaire, with the following results (Table 3).

Table 2: Spatial abilities results

	Orthogonal views exercise (% of improvement)	**Perspective exercise (% of improvement)**
Before workshop (Tablet VIZ)	11%	11%
After workshop (Tablet VIZ)	100%	100%

Table 3: Satisfaction questionnaire

	% Of affirmative answers
Would you have chosen to do the course on a mobile device such as iPhone?	17%
Do you think you have improved your spatial ability with the course?	100%
Would you have preferred undertaking the course on paper?	0%
Would you rather perform the course in PC?	0%

7. Conclusions

Once the pilot study was completed, we can draw the following conclusions:

- The workshop Tablet VIZ allows the students with the lowest spatial abilities to achieve an optimal level. After the training, all participants can solve correctly the university admission exams of technical drawing.
- Students prefer (83%) holding this workshop in large screen devices (such as iPad type) rather than small screen devices (iPod touch type or mobile phone)
- All students prefer the workshop (Tablet VIZ) in digital tablet format rather than paper format.

- Every student felt that the workshop (Tablet VIZ) has improved their spatial skills (which is a real perception, as we have already seen in table 2).

Acknowledgements

Support for this work provided by funds from the project: "Improving spatial and visual reasoning through advanced technology tools" (ESREVIC). Ministry of Education, National Plan I + D + I (2008-2011). TIN2010 Ref-21296-C02-02.

References

Bansavich, J. C., & Yoshioka, K. (2011). *The iPad: implications for higher education*. 2011 EDUCASE annual conference. October, 19. University of San Francisco. San Francisco. USA.

El-Gayar, O., & Moran, M. &. (2011). Students' acceptance of tablet PCs and implications for educational institutions. *Educational Technology & Society , 14* (2), 58-70.

Martín-Dorta, N., & Saorín, J. L. (2011). Web-based spatial training using handheld touch screen devices. *Educational Technology & Society , 14* (3), 163-177.

New Media Consortium (NMC) & EDUCASE Learning Initiative (ELI). (2012). *Horizon report: 2012 higher education edition*. New Media Consortium.

Saorín, J.L., de la Torre, J., Martín-Dorta, N., & Carbonell, C. &. (2011). Tabletas digitales para la docencia del dibujo, diseño y artes plásticas. *Revista teoría de la educación: educación y cultura en la sociedad de la información (TESI) , 12* (2), 259-279.

Saorín, J.L. (2006). *Estudio del efecto de la aplicación de tecnología multimedia y del modelado basado en bocetos en el desarrollo de las habilidades espaciales*. Universidad Politécnica de Valencia, Departamento de Ingeniería Gráfica, Valencia, España.

Saorín, J. L.; Martín-Dorta, N.; Martín, J.; Navarro, R. & Contero, M.. (2009). La capacidad de visión espacial y su relación con la ingeniería. *DYNA Ingeniería e Industria, 84(9*), 721-732.

Smith, I. (1964). Spatial ability-Its educational and social significance. Developmental Psychology , 128-136.