Control Grouped Pedagogical Experiment to Test the Performance of Second-generation Web Maps and the Traditional Maps at the University of Debrecen

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Abstract

Almost every component of the information society is influenced by elements built on communication technology. Learning also tends to be related to the dynamic usage of computers. Nowadays, a number of applications (online or offline) are also available that engage large groups of potential users and simultaneously provide a virtual environment to facilitate learning.

This study introduces the self-developed interactive blind map teaching-examining e-learning system of the University of Debrecen. Results of testing the system with a control group are also presented.Both experimental and control groups of students were required to sita test of topographic knowledge following a semester of study. The pass mark for the test was 80%. The experimental group used the new digital environment to study, while the control group prepared for their exam using paper maps in the traditional way. The key research questions addressed by the study were to determine whether exam results obtained by the group using the 'digital' method better than those of the control's; and if there were a difference between the exam performances of the two groups, was this statistically significant and, therefore, likely to occur in other similar scenarios?

Keywords: Web map; e-learning; education of geography.

Introduction

Both bachelor and master students majoring in geography have to significantly develop their knowledge of topography during their university studies. One of the most fundamental courses for bachelor students is Topography. This establishes knowledge of physical and social geography during the first year. In the next semesters (Table 1) studies focus on specific geographic entities and are confined to a smaller geographical region. For example, in the case of Physical Geography of Hungary students have to be able to locate lands, rivers, mountains on a blind map during the exam. Passing a topography test is a prerequisite of entering several colloquiums, so insufficient knowledge prevents the students even registering for examinations.

Earlier experience shows that students often incorrectly position entities in the blind map. One reason may related to insufficient cartographic and map reading skills. However, maps used for practise are usually created by students who, often, do not pay enough attention to map projection. If the projections of the maps used for preparation and in the exam are different, then it is unlikely that students will be able to correctly locate entities using the blind map. The maximum number of allowable mistakes to pass an exam depends on the course. Nevertheless, the level of aggregation in the blind maps is not standardized. For example, in the case of physical geography tests, recognition of the location of a river or a mountain may help to place additional entities, while in social geography tests (with settlements, buffer zones) not only the physical objects but also cadastral and other borders have to be taken into consideration.

Traditionally, tests are paper-based in all cases. This requires a huge quantity of paper. There are approximately 100 students enrolled on each of the five years and a topography test may be retaken twice in a semester (Table 1). Thus, currently some 10 000 sheets are printed and stored. This volume continues to grow from year to year and The Institute of Earth Sciences has no remaining capacity to archive this information.

Table 1. List of courses with a topography test as a prerequisite

Course name	Semester	Degree	Number of tests	Estimated number of students	Estimated number of tests
Topography	I.	BSc	**18**	**100**	**1800**
The principles of social geography I.	I.	BSc	**1**	**100**	**100**
The principles of economical geography.	III.	BSc	**2**	**100**	**200**
Physical geography of Hungary	IV.	BSc	**7**	**100**	**700**
Social geography of Hungary	IV.	BSc	**2**	**100**	**200**
Physical geography of Europe	IV.	BSc	**3**	**100**	**300**
Social geography of Europe	IV.	BSc	**1**	**100**	**100**
Physical and social geography of the Earth I.	V.	BSc	**2**	**100**	**200**
Physical and social geography of the Earth II.	V.	BSc	**1**	**100**	**100**
Conservation of geo heritage	Autumn	MSc	**1**	**15**	**15**
Total					**3715**

As a result of the above issues, a suggestion was made to design and develop an easy-to-use blind map based application that could also support the process of learning and teaching. Additionally, this could provide measurable data for further methodological research.

The main aim of application development was to support the work of the Institute of Earth Sciences, and to support teaching-learning processes using online interactive environments (Zichar, 2011). However, an additional benefit is that educators no longer have to correct tests manually, because the application performs it in a few seconds and also suggests an appropriate grade.

Literature Review

E-Learning

Holmes and Gardner (2006) refers to e-learning, as the use of new multimedia technologies and the internet to improve the quality of learning, by facilitating access to resources and services as well as remote exchange and collaboration. This can take place completely online in virtual environments, or, using a combination of virtual and face-to-face environments. E-Learning has potential to influence education positively. It provides great opportunities for both the educators and learners to enrich their educational experience (Albon, 2005; Al-Harbi, 2011). In addition, supported by the openness and flexibility of the internet, e-learning provides the opportunity for teaching and learning transactions with almos unlimited information, and is also relatively unaffected by pressures of time and constraints of distance (Holmes & Gardner, 2006; Oya & Uchida, 2013).

This section provides an overview of the key advantages and disadvantages of e-learning based on the work of Ozuorcun & Tabak (2012).

Advantages of e-learning:

- Class work can be scheduled around personal and professional work, resulting in flexible learning.
- Learners may have the option to select learning materials that meets their level of knowledge and interest.
- Learners can study whenever and wherever they have access to a computer and the internet.
- Self-paced learning modules allow learners to work at their own pace.
- Successful completion of online or computer-based courses builds self-knowledge and self-confidence and encourages students to take responsibility of their learning.

E-learning uses a special teaching/learning model that has limitations too (Mohammedi et al., 2010).

- E-learning requires less contact between the students, and also between the teachers.
- Knowledge about general computer usage and the e-learning system are prerequisites.
- Learning requires a computer and internet access as well.
- E-learning implies different teaching/learning processes and some teachers may have less experience and acquaintance about this processes.
- Lack of face-to-face interaction with a teacher can imply negative impact.

Educational web maps in Hungary

The use of digital maps in education has increased significantly in Hungary (Dombóvári et al., 2010). Maps are also used in areas such as history, biology, natural history, social sciences and medical epidemiology. This trend appears, of course, in our everyday life, when we navigate while travelling or even walking around large shopping centres (Gede et al., 2013; Zentai & Kovács, 2013). Considering such widespread use, learning to read and interpret maps can be regarded to be a general life skill (Jones et al., 2004). According to Neumann (2008), web maps are fundamentally digital maps which are optimized and displayed on a monitor and appropriate for web claims. It is widely accepted that application of these maps is of service regardless of their generation and type. (Kraak, 2001; Zentai & Dombóvári, 2005; Plewe, 2007).

One of the first web map applications was "The Blind Mouse", published in 2005 and used to support education nationally throughout Hungary (see Figure 1). The program developed at the Eötvös Loránd University is appropriate for checking topographic knowledge. In the course of using this program, one must place the objects appearing on the screen as accurately as possible. The level of difficulty (primary school, high school, and university) can be set in advance. It is important to note that turning on the layers (hydrography, relief and border) clearly helps orientation. A new version of Blind Mouse, "Blind Mouse 3D" was published in 2010 (Dombóvári & Gede, 2010). Although the program remained essentially unchanged, the underlying web map has been updated from a second generation digital map to a fourth generation virtual globe platform. Many elementary and high schools in the country include this application in their education because of its free availability and innovative characteristics.

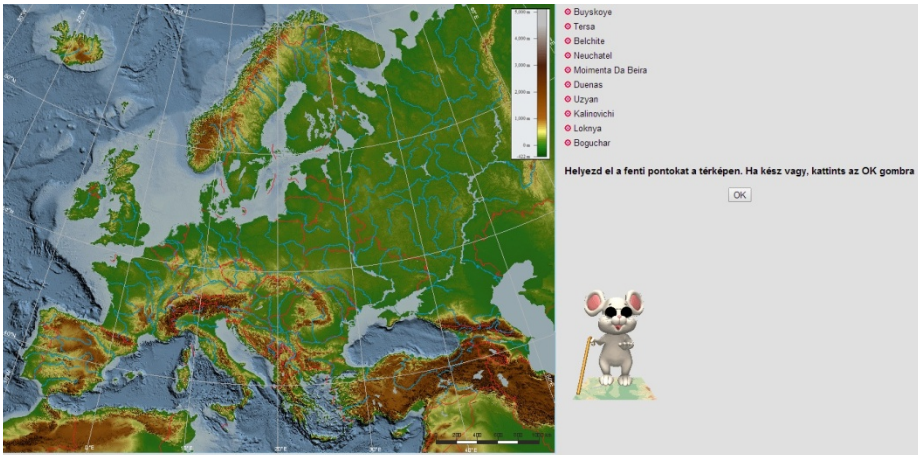


Figure 1. "The Blind Mouse"

The efforts to design a self-developed interactive blind map teaching-examining e-learning system began in 2010 at the University of Debrecen. The new digital environment for practising, the prearranged control maps and the opportunity to edit the online curriculum are valuable services for numerous students majored in geography. The new e-learning application based on J 1.0 was planned to be used in education and exams as well (Balla, 2012).

Methodology and methods

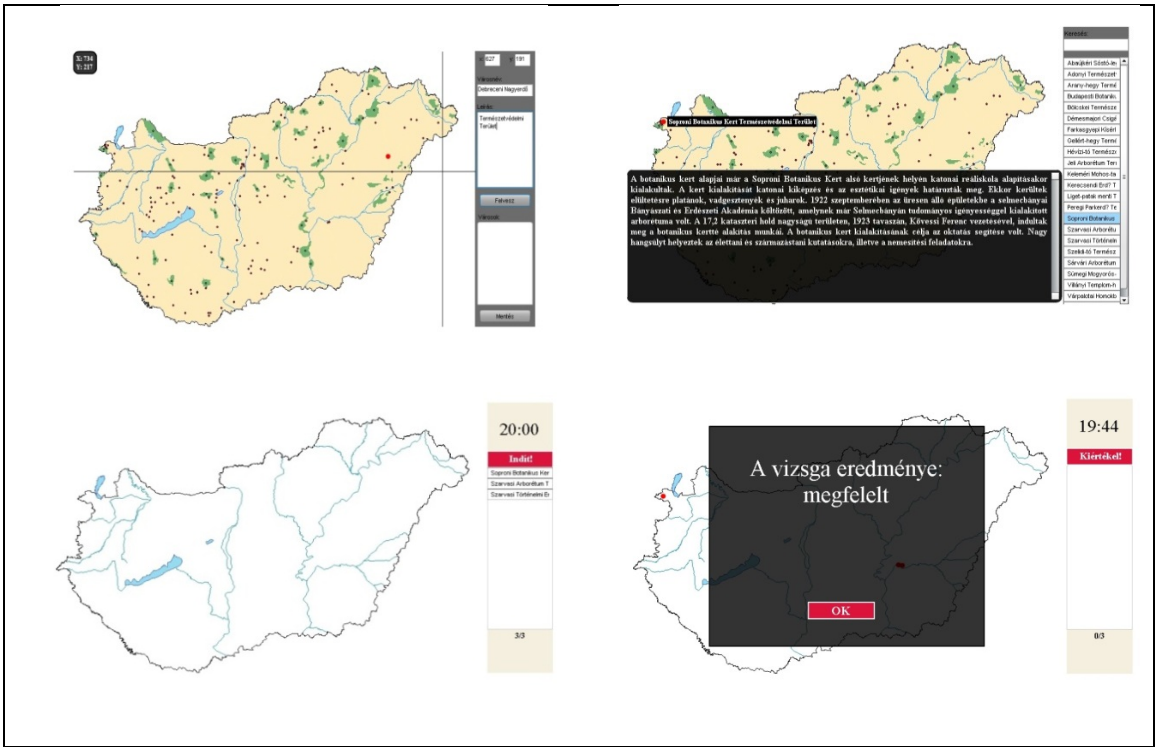
The implementation steps

Implementation was in two stages. First, the layers of the digital base map are determined. This is followed by creating the teaching maps, including the natural conservation areas and landscape districts in Hungary, using ArcMap 10. The second stage concerned completing programming tasks, creating the database and testing the application after establishing the web server. Selection requirements for development technologies included open access and capability for locating geographical objects on a blind map; presenting the attributes of selected objects; round-the-clock availability; and with secure password-protected login user privilege administration facilities.

Layers of the digital base map	Development tool	Statistical Analysis
Nature conservation areas represented by points	PHP (PHP Hypertext Pre-processor)	Analysis of variance
Lakes and rivers represented by lines	Flash	F-test
Nature conservation landscapes represented by polygons	HTML (Hyper Text Markup Language)	• two-sample t-test • Welch-test

The program J1.2

The online user interface of the program, named J 1.2 (supported browser: Mozilla Firefox) is published on a webpage (http://webgis.web44.net/program.php?tipus=oktato). This distinguishes two user types: students and teachers. Teachers may specify new exams by providing administrative data, pass-mark (percentage) and fault tolerances (in pixels). The database can be extended to include the locations of new objects at any time. The student user interface is designed for exam practise as well as for formally sitting examinations. Student scores are stored and may be retrieved for individuals and for entire exams. With the help of the interactive mapquiz interface, the geographic objects stored in the database may be browsed and inspected (see Figure 2). The aim of the application is to check and evaluate student knowledge concerning the location of named geographic entities; this following earlier study using the same application. Although level of difficulty is not assigned to the items, teachers are free to select the items to be used in an examination. This, therefore, provides a means for creating tests with different levels of difficulty (Balla, 2013).



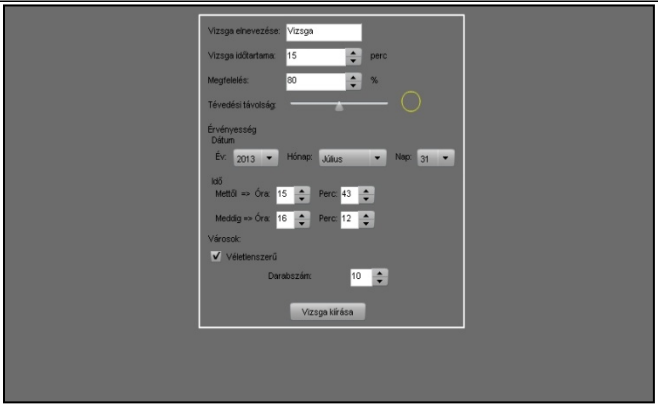


Figure 2. The user interface of "J1.2"

The web maps were designed to be used for tests issued on a course concerning the conservation of geoheritage. The database stores information on nature conservation and landscape protection areas. This comprises some 181 records (with attribute data such as id, name, rank, description). Of these 143 records concern nature conservation areas and the remaining 38 are of landscape protection areas. During the collection of core data a key intention was to develop student geographical knowledge, with a focus on contemporary (live) and physical (inanimate) values of geology in Hungary.

Creation of the experimental and control group

The study was based on rwo groups of master students, registered for the course "Conservation of Geoheritage". From representative sampling it was apparent that the groups were similar (not significantly different) in their composition. The two groups are identified by X and Y notation. The group Y completed a paper test in traditional way in December 2012. One year later every student from the group Y was assigned a unique account for online application, after collecting data necessary for registration. Since our objective was to compare the results of the two groups, both groups completed the same test.

Results

Test results of the control group and experimental group

The group X and Y had 5 minutes to complete the test. During this time they had to place 10 objects on a blind map as accurately as they could. A pass mark of 80% was required to pass the test. If objects placed on a blind map had point geometry, it was also necessary to also specify a fault tolerance for distance. Here a tolerance of 1 cm was set as the the maximum allowable distance between the true object location and the position specified by the student. Using these criteria, 54 % of students in the control group (Y) passed the test with marks of 80% or greater.

The most common errors were due to inaccurate placing. In 3 or 4 cases, the placement might have been accepted if fault tolerance had been increased slightly.

Contrastingly 77% of the digital test group (X) passed with marks greateror equalt to the 80% threshold. On further examination findings revealed that most group X students either scored highly or had only failed to pass by a narrow margin. The overall average score for group X was 8.62, compared to 7.31 for control group Y (see Figure 4).

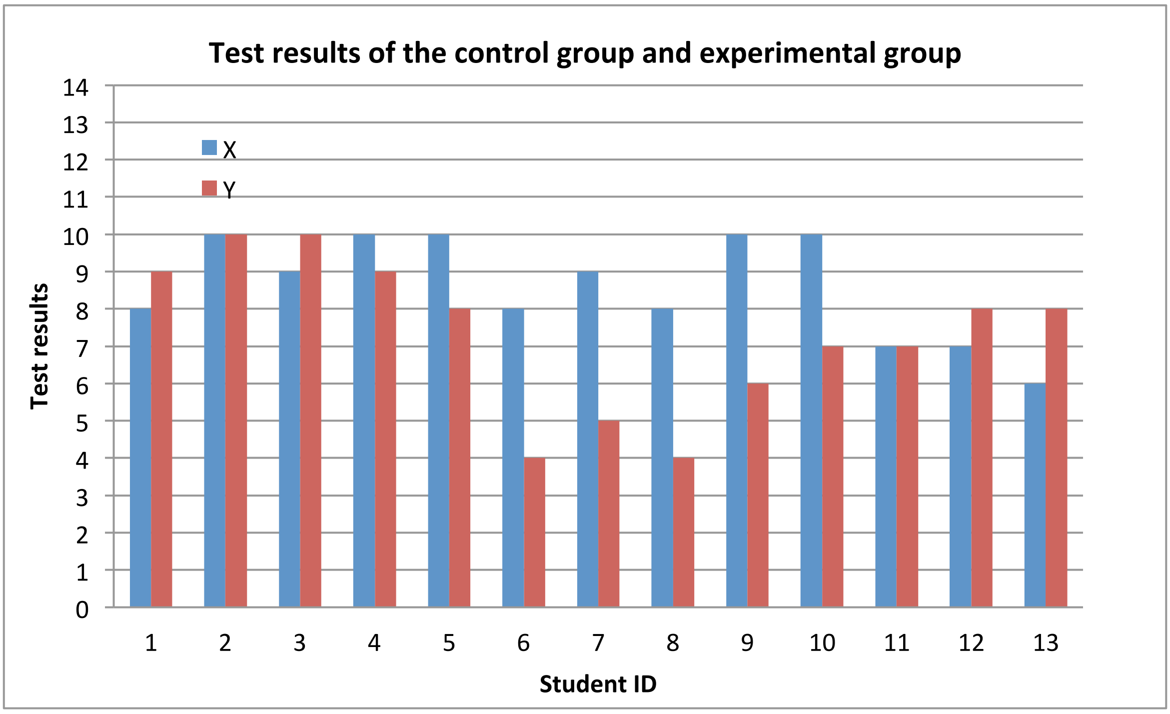
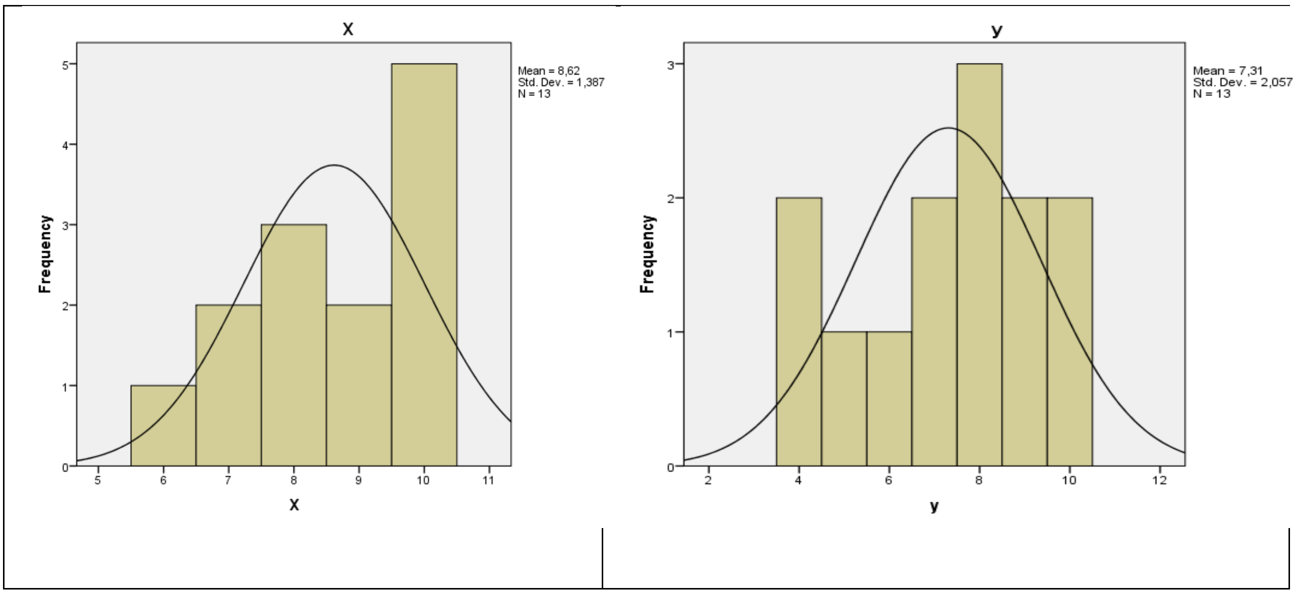


Figure 3. Test results of the control group and experimental group

The result of the hypothesis study

The experimental group consisted of 13 students, just like the control group. The two groups can be considered homogenous according to their main properties. The students had to solve the same test in both groups after a two-month-long practicing period. We are referring the results of the experimental group by X, and that of the control group by Y. The Figure 4 shows that both data lines are of normal distribution despite of the few element numbers. The experiment of the control group begins with examining the variance, than it continues with 2 samples T-test or Welch-test depending on the results (Lóki & Demeter, 2009; Falus & Ollé, 2000).



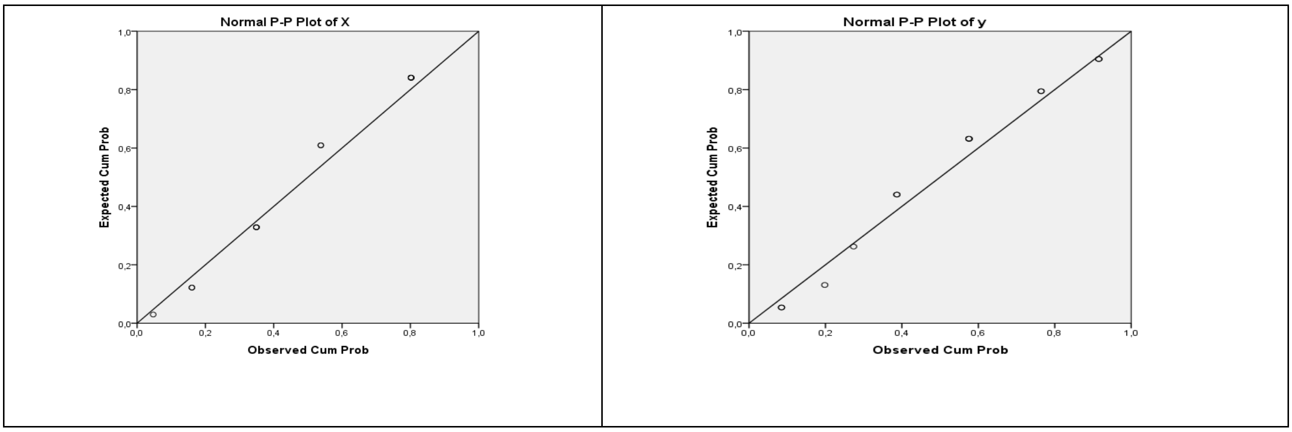


Figure 4. Histograms and plots of group X and Y

The computation highlights that the variance value of the examined samples do not differ from each other significantly, which means that the two-sample t-test can be performed to compare the results (Guilford, J.P., 1965; Peers, I., 1996).

Table 2. demonstrates the result of the two-sample t-test t”=1.901 (the degree of freedom is 24). The probability belonging to this value is 0.69, which means a level of 93.1%. Since the calculated t-value is less than the appropriate value from the table (t_{table}=2,064) we have to claim that the difference of the arithmetic means calculated from the results of the two examined samples was random and cannot be explained only by introducing the new methodology.

To sum up, the performance of the students in the experimental group was really better than in the control group, but unfortunately the difference is not significant enough to prove that the better results are related to the new method and that its applications would lead to better results with the given probability.

Table 2.The result of the two examined samples calculated

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Result	Equal variances assumed	1.889	0.182	1.901	24	0.069	1.308	0.688	-0.112	2.728
	Equal variances not assumed			1.901	21.041	0.071	1.308	0.688	-0.123	2.738

Conclusion

This paper presents a self-developed interactive blind map teaching-examining e-learning application of the University of Debrecen, and the test results with a control group.

One of the greatest advantages of using e-learning is that it gives university students greater flexibility in time and place to enhance their knowledge. Moreover, e-learning systems increase motivation; users are more likely to adopt and use e-learning if they deem it makes the process of studying easier (Giraudo & Peruch, 1992; Golledge, 1992; Ndubisi, 2006; Al-Harbi, 2011). This study had to address certain limitations.

First, e-learning had not yet been widely adopted in the University Of Debrecen at the time of the study. Secondly, the current study relied on onecohort that may not be completely representative of the wider student body, thus unavoidably affecting the confidence with which findings could be generalized to other circumstances. Thirdly, findings are similar to that of Rittschof & Kulhavy's (1998). It was also found that a high degree of familiarity with the real regional geography is necessary in order that students acquire a consistent and undistorted knowledge of their geographical environment.

The following conclusions concern key two aspects of the J1.2 teaching program:

Firstly, despite non-significant differences between test scores of control and experimental groups, results of the pedagogical experiment were promising. This was because of the good exam results achieved with a digital platform, and the experience gained during preparation and delivery of the exam. Although statistically unproven, the direction of findings remains consistent with the view that digital maps enhanced learning experience, and this should be perhaps explored further in more detailed studies drawn on larger samples. It also appeared that computer supported teaching and examination could be more efficiently delivered for the 'digital' experimental group than for the control one.

Secondly, concerning the production of digital learning blind maps, GIS software was used to create maps based on a selected area, where geographical entities were represented by using different layers (e.g. hydrography, country border, conservation areas, etc.). GIS and map properties, such as aggregation level, map projection and resolution and the number and type of layers used, all greatly influence the user experience and dynamic of interaction with the mapping application. Thus it is important not to overcrowd maps with large numbers of overlapping elements. This not only undermines the visual experience, but is also an obstacle to processes of understanding and studying. These issues are concerns for the future development of this system. Immediate priorites are to focus on development of the user interface to enhance interactivity and overall experience. At the same time it is hoped that this application will be applied in other courses (such as topography examinations), thereby further disseminating it as an effective and safe environment to support the work of both students and educators.

Future directions

In addition to introducing the mapping application into other areas of education, the following enhancements are also planned.

- Designing a more developing a more attractive graphical user interface
- Creating and applying web maps of third and fourth generation
- Extension of the application to be able to manage line and polygon objects too
- Opportunity for student feedback
- Accuracy tests in maps with different scale
- Increasing interactivity
- Hypothesis study

Acknowledgements

This research was supported by the European Social Fund in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program' of European Union for Hungary.

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