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A Study on the Use of Interactive Web-Based Maps in the Learning and Teaching of Geography

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ABSTRACT

The rapid development in information and communications technology (ICT) has changed the methodology of teaching and learning geography in secondary schools. This paper tries to study the effectiveness of using web-based interactive animated maps in geography teaching and learning. For this purpose, a web-based interactive animated map was developed. The main features of the animated map were to test the students' ability in map reading, map feature recognition and understanding of main geographical concepts. A sample of this study consisting of 106 Form Four students (16 years old) was randomly selected and categorised into two groups. The experimental group was exposed to interactive animated maps whereas the control group used standard computer-delivered static maps without the animated features. The results of the post-test show that students using web-based interactive animated maps outperformed students using the standard computer-delivered static maps. The findings will be discussed especially those pertaining to the imbedded features of animated maps as a new approach of teaching geography that challenges and enhances student understanding.

INTRODUCTION

Geographic maps have been used as aids in classroom for decades. Research has shown that geographic maps can be used as cognitive tools to increase the recall of related texts (Kulhavy & Stock, 1996). A model developed by Kulhavy et al. (1993) based on Paivio's Dual Coding Theory (1986) stated that geographical maps contain two types of information, namely, the feature information that includes icons, pictures and words used to describe and depict the features on the map and secondly, the structural information which includes the metric distances between features located on the map and the map's borders and between one feature and another (Kulhavy & Stock, 1996). The model concludes that the ability of learners to create an intact image of a map gives them a processing advantage that aids in the learning of related information.

Animation is now becoming widely used in cartography. Its popularity as a data display method has grown since Tobler (1970) first published the results of computer animation in cartography. Since the 1990s, geography has witnessed more projects, papers, theses and dissertations devoted to the subject. This paper thus focuses on how animated maps can improve students' understanding of geographical information. A web-based courseware was designed and developed to test students' achievement in a post-test.

The Internet is an interesting medium used to present and disseminate geospatial data. The information on the web is virtually platform independent, unrivalled in its capacity to reach many users at minimal costs. The web puts new life into the map as a metaphor. Maps can be defined as graphic representations of our environment. However, web maps are maps presented in a web browser which allows for the dynamic and interactive dissemination of geospatial data. Thus it offers new mapping techniques compared to traditional printed maps. Web maps can be classified into two main categories, static and dynamic web maps. Each of these categories is subdivided into "view only" and interactive maps. Most maps of the former category are scanned and put as "bitmaps" on the Internet. The Internet offers several options to display dynamic maps via animations which can be created by using programming tools such as Java, Java Scripts, Visual Basic, or via virtual environments (VRML) which allow three dimensional data.

In terms of learning, studies have shown that the Internet-based map reading may motivate the students to learn, enjoy learning and stimulate the eagerness to learn more. Kozma & Croninger (1992) described several ways in which technology may help to address cognitive, motivational and social needs of so-called "at-risk" students. Further, the Internet-based activities make students cooperative, able to work in small groups and develop hypermedia products as well as conduct research projects using video discs and multimedia. In this study, it was hypothesised that if infusing Internet-based technology into the curriculum could engage students and allow them to build upon their own knowledge in a hands-on environment, a greater percentage of students could reach the mastery level on understanding geographical concepts.

Previous research shows that achievement increases when students utilise computer technology in the classroom because it individualises the educational process and uses constructivist learning strategies that accommodate individual needs, interests and learning styles (Hativa & Becker, 1999). Gregg (1994) distinguishes the three methods of drawing information from maps – map reading, map interpreting and the inferential use of maps. She argued that map reading involves retrieving information explicitly included in the maps. According to Gregg, interpreting is the mere integration of two pieces of information presented on the map to determine connections and patterns. Mennecke et al. (2000) argued that map reading occurs when a reader has fully internalised the map to support problem solving. Peterson (1995) suggested that humans store information from maps by creating associations and storing the information to be used later. In short, map reading occurs if a student is able to identify, gather, record, organise and interpret geographical information from a map. Piaget (1956) assumed that children's cognitive development depends on interaction with one's physical and social environment. He describes a set of skills necessary for the full development of spatial understanding and transferring it to graphical representations. Bruner's (1966) cognitive theory expanded and complemented Piaget's theory that students develop in three stages towards mastery of map reading. In Bruner' model, students must go through a period of concrete interaction with space, moving to the ionic. Bruner felt that students were more likely to understand and remember concepts they discover in the course of their own exploration. Interactive animated maps allow students to interact and explore maps individually.

This study takes into account the above learning theories and designed them according to the students' ability in reading maps. Two types of maps were used to assess students' performance. One was the static map and the other, the animated and interactive map. The static maps present geographic information in a single image which is unable to provide adequate information to support a decision on a particular geographic issue. Muir (1985) suggested that multiple pages of related images may enhance learning. Computer-delivered, interactive maps may begin with a blank map of an area of interest and offer students the possibility of overlaying the area and line data with topography, vegetation, political boundaries, and print maps or towns and cities. Peterson (1995) suggested a model allowing interactivity in cartography, taking into account the capacities of the human mind in manipulating mental representations of cartographic information.

An assessment of students' map reading ability must measure their ability to apply the techniques learned to novel problem solving with unfamiliar maps (McCoy, 2003). The assessment used in this study challenges a student's ability to solve problems through evaluation and explanation. Map reading occurs only when the reader has sufficiently internalised the map to support decision making and problem solving (Mennecke et al., 2000).

METHODOLOGY

In this study, computers were used as an instrument to conduct the intervention. The control groups used computer-delivered static maps whereas experimental groups used animated interactive maps via computers. The integration of computer technology and appropriate instructional strategies may result in students performing at higher mastery levels (Bransford et al., 1999). The researchers used frame-based animations which were developed by using Macromedia Flash MX. The contents of the lessons corresponded to the latest Form Four geography syllabus.

A quasi-experimental design was used in this study. Four existing Form Four classes of sixteen and seventeen year olds from the urban schools around the Kulim district were used as experimental and control groups. One group of students (2 classrooms, 46 students) received instructions using web-based animated maps while the remaining (2 classrooms, 52 students) students received instruction using computer-delivered static maps. The former was the experimental group while the later was the control group. All maps, regardless of treatment of condition, were assessed via a computer interface to avoid novelty influence. Each student used a computer with access to the maps giving them control over their lesson. The researchers facilitated the classroom activities. This approach was to ensure that all students had equal and adequate exposure to the content.

Both groups used three maps each to test their geographical skills appropriate to Form Four students: to identify symbols, map reading and to interpret geographical information. The first map contained different types of symbols, categorised into five types, such as dot symbols, line symbols, area symbols, pictorial symbols and abbreviations. Students in both the control and experiment groups were expected to identify these symbols after the instruction. The experimental group used animated maps whereas the control group used computer delivered static maps. With the second map, students learnt to draw sketch maps after the instruction. A series of animated sketch maps was presented via the web to enable the experiment group to read and identify geographical information on the map. The third map was to enable the students to identify and interpret geographical information on the presented map. In this lesson, students were able to compare two identical maps but projected at different years. The control group and experimental group were able to answer questions related on interpreting and gathering geographical information after the instruction.

A post-test was administered to determine the differences among the two assessment groups. The questions were designed to measure map reading skills, feature recognition and interpreting geographical information. In this test, students were presented with a series of ten questions to identify symbols from the map of a local place. These questions were posed in a multiple-choice format. Next, the students were asked to sketch maps illustrating attributes such as drainage, relief and communications. These two portions of assessment addressed the skills identified by Gregg (1994). The first task reflects the students' map reading ability of a simple recognition of symbols on maps. The second addresses skills involved in map interpretation. The third portion of the pre-test, fifteen matching questions, required students to match terms and their definitions. This was essentially used to grant a base line score to students performing poorly on the other two tasks.

RESULTS AND DISCUSSION

The pre-tests on the individual questions' reliability were measured. Each question was correlated, using Pearson's-R (Garson, 2003) to the total scores of each student. The map reading and geographical sub-tests showed a moderate relationship between map reading items and geographical concepts. All correlations were positive and significant indicating moderate to strong correlations between items and their respective subset totals. Another test of internal consistency, Cronbach's alpha, was calculated at 0.79. Table 1 shows the relationship between items and total scores on the pre-test for map reading, feature recognition and geographical concepts.

Table 1: Relationship between the sub-tests and total pre-test scores

	Map Reading	Feature Recognition	Geographical Concepts
Map Reading Pearson Correlation	1.00	0.41	0.45
Feature Recognition Pearson correlation	0.41	1.00	0.58
Geographical Concepts Pearson Correlation	0.45	0.58	1.00

*All correlations were significant at the 0.05 alpha level (n = 106)

Most of the indicators showed a moderate relationship among the sub-tests and total scores. Inter-correlations of 0.3 to 0.7 are regarded acceptable (Presley et al., 2000). Therefore, the questions contained in the pre-test were reliable in this study. Students were grouped by both instruction and assessment types for analysis of the pre-test. A multivariate analysis of variance (MANOVA) compared performance as suggested by Keppel & Zedeck (1989). The results are shown in Table 2.

Table 2: Multivariate analysis of variance for pre-test sub-tests

Source	Sub-test	df	F	*p*
Instruction (I)	Map Reading	1	2.14	.14
	Feature Recognition	1	1.13	.27
	Geographical Concepts	1	2.34	.11
Assessment (A)	Map Reading	2	1.28	.12
	Feature Recognition	2	1.32	.15
	Geographical Concepts	2	1.44	.67
I × A	Map Reading	2	1.32	.36
	Feature Recognition	2	1.38	.14
	Geographical Concepts	2	1.57	.13

Indicators in the table show that no results were significant at the alpha = .05 level (n = 106)

Once intervention was completed, the post-test was correlated to overall scores to determine reliability of the individual questions. As in the pre-test, the results were grouped into three sub-test scores. Table 3 shows that all correlations were moderate to strong and all significant at the .05 alpha levels.

Table 3: Relationship between the sub-tests and total scores in the post-test

	Map Reading	Feature Recognition	Geographical Concepts
Map Reading Pearson Correlation	1.00	0.40	0.52
Feature Recognition Pearson Correlation	0.40	1.00	0.56
Geographical Concepts Pearson Correlation	0.52	0.56	1.00

*All correlations were significant at the 0.05 alpha level (n = 106)

The post-test scores were analysed using the multivariate analysis of variance (MANOVA). The MANOVA identified the portion of the variance due to the instructional condition, the assessment condition and each of the sub-tests. The results are presented in Table 4.

Table 4: Multivariate analysis of variance of post-test results

Source	Sub-test	df	F	*p*
Instruction (I)	Map Reading	1	0.12	.17
	Feature Recognition	1	0.15	.23
	Geographical Concepts	1	0.07	.11
Assessment (A)	Map Reading	2	6.77	.00*
	Feature Recognition	2	1.85	.25
	Geographical Concepts	2	0.53	.55
I × A	Map Reading	2	1.95	.37
	Feature Recognition	2	1.57	.18
	Geographical Concepts	2	0.66	.13

*Significant at the .05 alpha level

As shown in Table 4, the three sub-tests were treated as dependent variables with assignment to assignment and assignment to instruction used as fixed factors. The map reading score was the only significant item in this MANOVA when analysed for the assessment type.

The results proved that students who were exposed to animated maps outperformed students exposed to static maps. The results also indicated that those students attempting to solve questions about any geographical problems were more successful when using animated maps. Within the experimental limitations, the new instructional technologies have been shown to be able to enhance the learning process in the field of geography as shown in this study. It is evident that the Internet-based animated, interactive maps appeared to help student to understand the contents. A number of factors might have mediated the findings in this study. This includes the medium (i.e., the computer as a delivery system), students' previous experience both with computers and maps, web applications, students' motivation for success, the content presented in the maps with regard to instruction and assessment, the efficacy of the materials and quality of the measures. Each of these factors may have impact but isolating each and determining individual impacts is beyond the scope of this study. However, efforts were made to control for these factors while others were not because of their elusive nature. Randomisation during assessment was used to control for variation in student experience and perception with both computers and maps in problem solving.

In undertaking this study, a careful consideration on the quality and appropriateness of the measures were taken. Students' past experience and perceptions were not measured since most of them were from different backgrounds and places. Some variables, such as motivation and students' map management, are difficult to measure. Nevertheless, it appears that students using the Internet-based animated, interactive maps were less affected by such problems. Another threat to this study is the short duration of the intervention. This was proven by the students' performance on the geographical concepts. Performance might have been affected because students were aware that there was no personal gain to be derived from the post-test. In short, there was no relation between performance and subject grade. In spite of the above limitations, it is important to recognise the outcome of the study. The Internet-based animated, interactive maps are easily accessible and students who have not been trained to use them have been successful in addressing map reading exercises.

CONCLUSION

This study needs further investigation on the impact of Internet-based map reading. A transition from static maps toward Intenet-based animated, interactive maps for geography instruction in secondary schools should be advocated and pursued. This move significantly improves the performance of students as they attempt to read maps and solve spatial problems embedded in the maps. As educators increasingly rely on computer-based materials, taken must be taken to ensure that these materials are at least as effective, and possibly more effective, than paper-based materials.

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