Communications of the IIMA

Volume 9 | Issue 2 Article 2

2009

Improve Teaching and Learning: Comparison between Web Pages en Multimedia-Interactive Systems

Esteka Lizbeth Muñoz Andrade
Universidad Autónoma de Aguascalientes

Juan Manuel Gomez Reynoso
Universidad Autónoma de Aguascalientes

Improve Teaching and Learning: Comparison between Web Pages and Multimedia-Interactive Systems

Estela Lizbeth Muñoz Andrade
Universidad Autónoma de Aguascalientes
MEXICO
elmunoz@correo.uaa.mx

Juan Manuel Gómez Reynoso
Universidad Autónoma de Aguascalientes
MEXICO
jmgr@correo.uaa.mx

ABSTRACT

The education field is in a process of change driven by new developments in multimedia technology, which is being used as a complementary-alternative for teaching purposes. This paper describes an exploratory study comparing the effect of using two different teaching approaches: Web pages and multimedia-interactive systems. The objective is to find out whether the use of a multimedia-interactive system delivers better outcomes in teaching complex subjects (data structures) than Web pages approach. Descriptive statistics results show that there are significant differences in students' performance that used multimedia. We found out that, specifically in this study the multimedia tool improves the learning of binary trees. It is concluded that multimedia can effectively be used to help students learn binary trees.

INTRODUCTION

The education field is in a process of change driven by the new developments in technology; such developments determine the relationship between technology and education (Salinas, 1997). Educational institutions are adapting their teaching and learning processes to the technological advances (Cabero & Salinas, 2000). In addition, such advances are providing revolutionary tools like Web pages and multimedia-interactive systems. These tools can be integrated as a new way to teach (Bartolomé, 1998).

A previous study (Jones & Buchanan, 1996) suggests that teacher-led instruction methods are proving "ineffective and inefficient for the diverse student population" which institutions must contend with today. Other studies (Bannan & Milheim, 1996; Parson, 1998; Simbandumwe, 2001) suggest that there has been widespread increase in the level of interest and use by academics of on-line; particularly Web based instructional systems, such as Web pages.

The Web is being used effectively to provide a resource base for support, discussion and illustration of teaching and learning techniques as well as the methodologies for their successful creation, application and use (Corderoy & Lefoe, 1996).

A multimedia-interactive system is a combination of two elements: multimedia and interactivity. Multimedia presents information through a variety of media, such as music, videos and animation (Boyle, 1997; Fowler, 1980; Najjar, 1996). The interactivity allows users to participate and control information (Estebanell, 2002). Touch screen buttons, for example, can be used to create exercises. Interactivity allows users to decide when and what information is presented (Rodríguez, 2000).

Studies supports the use of instructional practices that address the unique and varied ways that people learn (Bransford, Donovan, & Pellegrino, 2003). Advances in multimedia technology provide students opportunities to use digital media to gain and share knowledge (Lambert & Cuper, 2008). Implementing modern information systems and communication technology into teaching lessons enables an entirely new approach for education (Buch & Bartley, 2002; Kekäle, Pirolt, & Falter, 2002; Simon, 1999). There are tutorials available and many possibilities for gaining suitable teaching packages and multimedia presentations that are used to teach (Moral, Esteruelas, Ezpeleta de la Fuente, & Martínez, 1995).

A multimedia-interactive system has the potential to revolutionize the way we work, learn and communicate (Stemler, 1997). Although, multimedia-interactivity is related to traditional and computer-aided learning systems, many of its aspects are arguably different from sequential media and computer-based instruction, as well as from hypertext (Park & Hannafin, 1993).

There is evidence in previous studies (Bagui, 1998) showing that, in some cases, computer-based multimedia can help people assimilate information better than Web pages systems, and multimedia-interactive systems allow the learning of complex subjects (Rodríguez, 2000), such as data structures (Brookshear, 1993).

The subject of learning data structures has been studied under different approaches as a software tools (Del Puerto & Ruiz, 2002). Previous studies of teaching data structures are classified based on their interactivity such as tutorials with hypertext (Martí-Oliet & Palomino, 2005; Warendorf, 1997), Websites or Web pages (Del Puerto & Ruiz, 2002; Pita & Del Vado, 2007) and interactive systems (Karavirta, Korhonen, & Stalnacke, 2004; Park & Hannafin, 1993).

Even though the subject of learning data structures has been widely studied under different situations, we did not find evidence that a multimedia-interactive system exists, specifically designed to teach binary trees (Karavirta, Korhonen, & Stalnacke, 2004).

In order to do so, we exposed a group of students to this technology (in a limited time frame), and a second group was taught using the Web page approach. Thus, the hypothesis of this study is as follows "a multimedia-interactive tool specifically designed to teach binary trees deliver better outcomes compared to the Web page approach".

METHODOLOGY

An exploratory study was conducted in the Universidad Autónoma de Aguascalientes (UAA), México. Two groups composed by thirty students participated in the study. Participants were randomly assigned to either one of the groups. One group used Web pages (WPG); and a second group used a multimedia-interactive system (MG) purposely developed for this study.

Students in their third-semester of a Computer Science bachelor program were invited to participate in the study. At the moment of the study, all participants had taken the basics in programming languages (sequence, decisions, loops, pointers and dynamic memory) and the basics in data structures (arrays and data structures). The content of the lesson was focused on the subject of binary trees. This subject was selected because it coincided with both the literature (Martí, Ortega, & Verdejo, 2003; Peña, 2005) as a difficult topic to learn and because students from the UAA have high failure rates in that topic. Before and after the session, participants answered a written test so that we could discover whether they learned something that they did not know at the beginning of the study.

In order to control teaching styles differences, all groups were taught by the same professor. Participants received the same lecture, examples and exercises so teaching materials differences were controlled. In addition, participants had feedback from the instructor in both cases. In order to measure whether participants learnt about the subject, the same test was applied before and after the lecture. Times were recorded for each section in both cases.

PILOT TEST

As a first step for our study, a measurement instrument was developed. This instrument was evaluated trough a pilot test with a group of thirty participants (see Table 1). Participants were asked to answer a written test (the measurement instrument had no effect in their grades). The complete test was to sum up a maximum score of 10 points. This measurement instrument was applied before and after the study and consisted of two sections:

- First section evaluates theoretical concepts of binary trees, such as depth, degree and type of operations that can be performed with them. This section had four multiple choice questions. Each question had a value of one point.
- Second section had three exercises: one to demonstrate knowledge on node insertion, another for node deletion, and the last one to search a node in a binary tree. Each exercise had a value of two points.

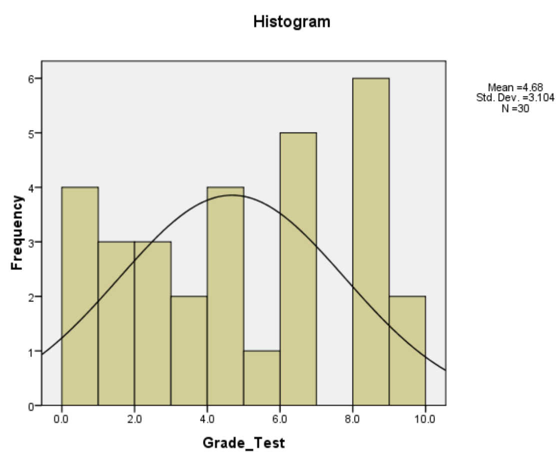
Table 1: Pilot test descriptive statistics.

Grade_Test		
N	Valid	30
	Missing	0
	Mean	4.679
	Median	4.727
	Mode	6.5
	Std. Deviation	3.1041
	Skewness	-.088
	Std. Error of Skewness	.427
	Kurtosis	-1.361
	Std. Error of Kurtosis	.833
	Minimum	.0
	Maximum	9.6

Grade_Test		
N	Valid	30
	Missing	0
	Mean	4.679
	Median	4.727
	Mode	6.5
	Std. Deviation	3.1041
	Skewness	-.088
	Std. Error of Skewness	.427
	Kurtosis	-1.361
	Std. Error of Kurtosis	.833
	Minimum	.0

Results for each test show a normal distribution behavior (see Figure 1). Thus, we can argue that the instrument had a proper design and could be used to measure performance in our study.

Figure 1: Histogram grades for the measurement instrument.



FULL STUDY

As a second step for our study, an experiment was applied. The experiment consisted on two groups with thirty participants each one. In order to control technological differences both groups received the same lecture about binary trees in the same computer laboratory. Each group received the same examples and exercises, both groups had individual free time to study/use the corresponding learning materials, and had time to make questions and receive feedback from the instructor. Finally each group had to answer a written test before and after the experiment. Times were recorded for each section: Instruction from the professor (lecture): 20 minutes, examples and exercises: 30 minutes, individual free time for students: 15 minutes, time for doubts and feedback: 15 minutes, and time to answer the test: 60 minutes. Before the experimental sessions, a test was applied to each group as a reference about previous knowledge of the subject. The test had a 60 minute limit.

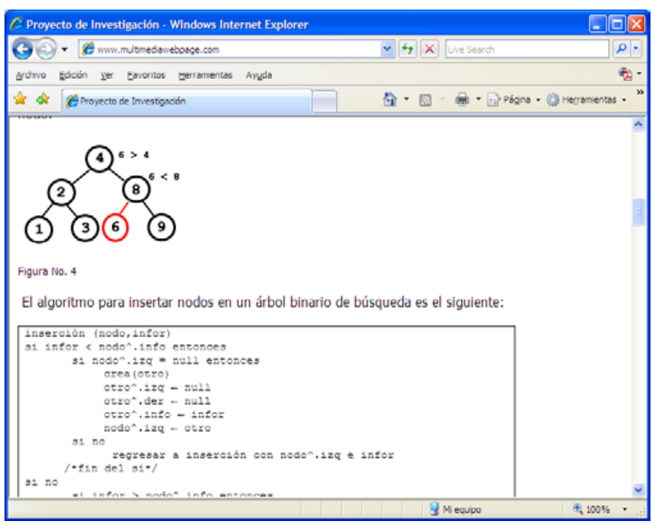
Specific Characteristics for both Groups

Both groups were taught by the same professor. For the Web page group (WPG), the instructor gave the lecture using a projector and a Web page as learning media; in this case, participants had to solve written exercises. For the multimedia-interactive group (MG) the instructor gave the lecture using a projector and a multimedia-interactive system as learning media, in this case participants did not solve written exercises. Contents of the lecture for both groups were exactly the same so we controlled teaching materials differences.

Learning Materials Characteristics

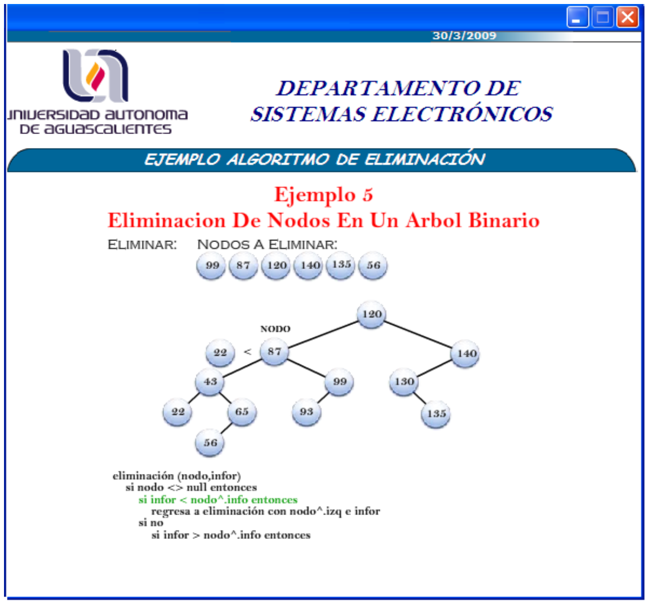
Learning material was written to our Spanish-speaking audience. The Web pages interface (see Figure 2) consisted primarily of text to show information about the topic, some images as examples and hyperlinks for navigation purposes (to go forward and backwards through the material) as suggested by previous literature (Shiavi, Brodersen, Bourne, & Pingree, 2000). In this case, the professor checked and evaluated the students' exercises.

Figure 2: Snapshot of the web page.



The multimedia-interactive system (see Figure 3) had the same contents as the Web page and also included examples and interactive exercises. There are some interaction differences: animation and sounds as explanatory sections of each topic (insertion, deletion and searching nodes) as suggested by literature (Fulton, Glenn, & Valdez, 2004). Also, this tool included interactivity where students had the ability to answer exercises by moving data and images (Bosco, 1986; Fletcher, 1990). Finally, previous literature (Almeida, Blanco, & Moreno, 2003; Karavirta et al., 2004) suggests that an output section showing exercises results for students must be included, which we did. In this case the system showed a screen with different items (nodes) that the student used to create a binary tree. The student dragged and moved the items in order to create a binary tree. The tool was responsible of verify the resulting tree. That is the reason that the professor did not check and evaluate the students' exercises. The system had a feature for this purpose.

Figure 3: Snapshot of the multimedia-interactive system.



RESULTS

The study was conducted as described in previous section. Table 2 shows descriptive statistics for the study. A written test was applied to participants before the study. Tests were graded using a scale from 0 to 10. The mean in both groups are similar. In addition, Table 3 shows a t-test for these results. We can argue that both groups have similar performance (p=.336), which means that both groups are homogeneous. Thus, previous knowledge differences were controlled.

Table 2: Descriptive statistics before the study.

Group		N	Mean	Std. Deviation	Std. Error Mean
Grades: Before study	WPG	30	5.6667	2.62394	.47906
	MG	30	5.0000	2.70376	.49364

Table 3: t-test results before the study.

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	.065	.800	.969	58	.336	.66667	.68788	-.71028	2.04361
Equal variances not assumed			.969	57.948	.336	.66667	.68788	-.71030	2.04364

In addition, a written exam was applied to participants after the lecture. Descriptive statistics are shown in Table 4. We can notice that both groups have different outcomes; this is the first indication that our multimedia tool designed specifically for this study has significant difference in participants performance under the conditions described before.

Table 4: Descriptive statistics after the study.

Group		N	Mean	Std. Deviation	Std. Error Mean
Grades: After study	WPG	30	6.5333	1.53653	.28053
	MG	30	7.7200	.92490	.16886

In order to test whether teaching using a Web page or multimedia-interactive system approaches makes a difference in learning binary trees, a t-test was applied to those results from the post-lecture test. Table 5 shows results of such test.

Table 5: t-test results after the study.

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	16.058	.000	-3.624	58	.001	-1.18667	.32743	-1.84209	-.53124
Equal variances not assumed			-3.624	47.577	.001	-1.18667	.32743	-1.84517	-.52817

Table 5, shows that there is a significant difference ($p<=0.001$) in performance due to the multimedia-interactive teaching approach. Hence, we can conclude that our multimedia tool specifically designed for this study contributes to improve the learning about binary trees. Thus, these results support our hypothesis that the multimedia-interactive tool specifically designed for this study is a better option than the Web page approach.

DISCUSSION AND FUTURE WORK

Two approaches to teach data structures were used in this study: Web pages (Almeida, Blanco, & Moreno, 2003; Del Puerto & Ruiz, 2002; Pita et al., 2007; Shiavi, Brodersen, Bourne, & Pingree, 2000) and a multimedia-interactive system (Stemler, 1997). Variables, such as content, teaching style, motivation, attitudes of the students, completion time, technology, written tests and time of exposure were controlled. One difference was that the Web page group did exercises in a written form while the multimedia group did exercises through the system. The results of this exploratory study seem to indicate that the Web page group did not show any significant differences in the performance of the participants. However, a multimedia-interactive group did show significant differences due to the combination of multimedia and interaction under the specific conditions mentioned previously.

This study address a weakness detected in our previous study. In such study, our teaching tool has a different design than of the Web page. Thus, we did not know whether performance was influenced by this issue. By having exactly the same design in both tools we can argue that multimedia does improve performance.

The multimedia-interactive systems field can be benefited with more experimental studies measuring achievement students', learning material design such as the same colors, sounds, images, etc. to give students a clearer vision about the studied topic. Under those circumstances this kind of systems could be more effective to academic performance.

For future studies, we propose to develop and empirically test a multimedia-interactive system based on design principles (Najjar, 1996) with an emphasis on usability, and with an easy to use, fun and stimulating interface (Uden, 2000).

REFERENCES

Almeida, F., Blanco, V., & Moreno, L. (2003). *EDApplets: Una Herramienta Web para la Enseñanza de Estructuras de datos y Técnicas Algorítmicas*, Departamento de Estadística, I. O. y Computación. Universidad de La Laguna, Tenerife.

Bagui, S. (1998). Reasons for Increased learning using multimedia. *Journal of Educational Multimedia and Hypermedia, 7*, 3-18.

Bannan, B., & Milheim, W. D. (1996, October 15-19). *Design, Development and Delivery of Instructional Materials over the Internet.* Paper presented at the WebNet Conference 96, San Francisco, C.A.

Bartolomé, A. (1998). Los Ordenadores en la Enseñanza están cambiando. *Comunicación y pedagogía: Nuevas tecnologías y recursos didácticos*, *154*, 22-28.

Bosco, J. (1986). An analysis of evaluations of interactive video. *Educational Technology, 25*, 7-16.

Boyle, T. (1997). Design for Multimedia Learning. In P. Hall (Ed.).

Bransford, J., Donovan, S., & Pellegrino, W. (2003). *How people learn: brain, mind, experience, and school.*

Brookshear, J. (1993). *Teoría de la computación*. Wilmington, DE: Addisson Wesley Iberoamericana.

Buch, K., & Bartley, S. (2002). Learning Style and Training Delivery Mode Preference. *Journal of Workplace Learning, 14*(1), 5-10.

Cabero, J., & Salinas, J. (2000). *Nuevas Tecnologías aplicadas a la Educación.* Madrid, España.

Corderoy, R., & Lefoe, G. (1996). *Tips and Secrets for Online Teaching and Learning: An Inside View*. Paper presented at the ASCILITE 96 University of Adelaide.

Del Puerto, M., & Ruiz, P. (2002). *DSTool: prototipo para la enseñanza, evaluación y depuración de estructuras de datos basados en mecanismos de reflexión estructural*, Congreso Iberoaméricano Informática Educativa.

Estebanell, M. (2002). Interactividad e interacción. *RELATEC: Revista Latinoamericana de Tecnología Educativa, 1*, 15-25.

Fletcher, D. (1990). *The effectiveness and cost of interactive videodisc instruction in defense training and education*, Alexandria, Institute for Defense Analyses.

Fowler, B. (1980). *The effectiveness of computer-controlled videodisc based training*, University of Iowa.

Fulton, K., Glenn, A., & Valdez, G. (2004). *Teacher Education and Technology: Planning Guide.* Paper presented at the North Central Regional Educational Laboratory with funds from the Institute of Education Sciences (IES), U.S. Department of Education.

Jones, D., & Buchanan, R. (1996). *The Design of an Integrated Online Learning Environment.* . Paper presented at the ASCILITE 96 University of Adelaide.

Karavirta, V., Korhonen, L., & Stalnacke, K. (2004). *MatrixPro: A Tool for On-The-Fly Demonstration of Data Structures and Algorithms.* Paper presented at the Third Program Visualization Workshop, Helsinki University of Technology. Department of Computer Science and Engineering, Finland.

Kekäle, T., Pirolt, K., & Falter, C. (2002). IT Tools in Personnel Training in Small Enterprises: Results of the Project "Apply". *Journal of Workplace Learning, 14*(7), 269-277.

Lambert, J., & Cuper, P. (2008). Multimedia technologies and familiar spaces: 21st-century teaching for 21st-century learners. *Contemporary Issues in Technology and Teacher Education, 8*(3).

Martí-Oliet, N., & Palomino, M. (2005). *A Tutorial on Specifying Data Structures in Maude.* Paper presented at the Electronic Notes in Theoretical Computer Science, Departamento de Sistemas Informáticos y Programación, Universidad Complutense de Madrid.

Martí, N., Ortega, Y., & Verdejo, A. (2003). Estructuras de datos y métodos algorítmicos: Ejercicios resueltos. In P. P. Hall (Ed.).

Moral, J., Esteruelas, A., Ezpeleta de la Fuente, D., & Martínez, A. (1995). *Sistemas multimedia en la enseñanza.* . Paper presented at the En AULA de Innovación Educativa.

Najjar, L. (1996). Multimedia Information and Learning. *Journal of Educational Multimedia and Hypermedia, 5(2)*, 129-150.

Park, I., & Hannafin, M. (1993). Empirically based guidelines for the design of interactive multimedia. *Education Technology Research and Development, 41(3)*, 65-85.

Parson, R. (1998). *An Investigation into Instruction Available on the World Wide Web.* . Paper presented at the Master of Education Research Project.

Peña, R. (2005). *Diseño de programas. Formalismo y Abstracción.*

Pita, I., & Del Vado, R. (2007). *Estudio de una experiencia de aprendizaje interactivo para la asignatura de estructura de datos.* Paper presented at the Jornada Campus Virtual UCM.

Rodríguez, J. (2000). *Presentación de experiencias de innovación docente universitaria soportadas por Multimedia.* Paper presented at the IV Jornada sobre decencia universitaria., Barcelona, España.

Salinas, J. (1997). Nuevos ambientes de aprendizaje para una sociedad de la información. . *Revista Pensamiento Educativo. Facultad de Educación, Pontificia Universidad Católica de Chile, 20*, 81-104.

Shiavi, R., Brodersen, A., Bourne, J., & Pingree, A. (2000). *Comparison of instructional modalities for a course. Introduction to Computing in Engineering.* Paper presented at the Frontiers in Education Conference. FIE 2000. 30th Annual.

Simbandumwe, J. (2001). *Tools for Developing Interactive Academic Web Courses.*

Simon, J. (1999, 5-7 Julio). *Experiencias multimedia en la docencia.* . Paper presented at the Comunicación oral. I Jornadas Multimedia Educativa. , Barcelona, España.

Stemler, L. (1997). Educational Characteristics of Multimedia: A literature review. *Journal of Educational Multimedia and hypermedia, 6(3/4)*, 339-359.

Uden, L. (2000). *Integrating Modality Theory in Educational Multimedia Design.* Paper presented at the Proceedings of the AAAI Spring Symposium on Intelligent Multi-Media Multi-Modal Systems.

Warendorf, K. (1997). *ADIS-an Animated Data Structure Intelligent Tutoring System on theWWW.* Paper presented at the International Conference on Information, Communications and Signal Processing.