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THE IMPACT OF ACTIVE LEARNING WITH ADAPTIVE LEARNING SYSTEMS IN GENERAL EDUCATION INFORMATION TECHNOLOGY COURSES

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ABSTRACT

An adaptive learning system is an effective educational tool that meets the individual needs of students, but it is limited in fostering student learning by itself. With active engagement, students learn better than with adaptive learning systems alone. In this study, we investigate the impact of an adaptive learning system with active learning projects on student learning in general education information technology courses. We believe that today's classroom calls for adaptive learning to serve the needs of diverse student populations. Active learning through real-life hands-on learning activities can enhance student learning by allowing them to apply their knowledge to authentic projects. In the classroom, we often find that learning computing with authentic hands-on activities is not only useful, but it contributes to improving student motivation and confidence.

Keywords

Active learning, adaptive learning, adaptive learning system, project-based learning, general education, Information technology course.

INTRODUCTION

Numerous research studies support that learning-centered, learner-centered, learning by design, and learning through experience help students learn better (Walker & Park, 2008; Dewey, 1997) because the framework under which the students learn is more meaningful (Bandura, 1997). All of these methodologies are to motivate students to learn better and more consistently. Over time, there were continual changes in teaching methodologies as educators strived to be innovative in their classes. In the 1980s, research about technology adoption or acceptance (Davis, 1989) was burgeoning in the business area, and later this study was applied to the area of education as well.

Some research studies examined the impact that technology had on student learning and teacher instructional methods. There were arguments about whether technology could be part of teaching methodologies or just a tool to make the instruction or learning happen more smoothly (Thieman, 2008). Using technology does not always improve learning because there are many factors that impact the learning process. For instance, the use of technology with a diverse student population can be difficult because different groups interact with technology in various ways, thereby influencing learning (Tomlinson, 2001).

Research in human-computer interaction (HCI) has found that adaptive learning is the future of learning in many subject areas (Quiroz, Salazar, and Ovalle, 2016). Therefore, many educators have started using adaptive learning approaches, such as adaptive computer learning systems, in their classrooms.

ACTIVE LEARNING WITH ADAPTIVE LEARNING SYSTEMS

An adaptive learning system is a system that dynamically adjusts its content based on user responses. Due to this dynamic feature, adaptive systems can provide various learning environments and benefits such as faster student progression, student engagement, and the flexibility of time. All of these benefits produce a personalized learning experience that improves the student learning experience (Bristol, 2017). To make adaptive learning effective and easy to use, the field of HCI has become

increasingly more important. HCI has gradually contributed to the production of easily accessible software and hardware, due to the involvement of scientists from different disciplines (Kiyichi, 2011).

Bandura and Walters (1963) established the social learning theory with the principles of observational learning and reinforcement. Bandura's Social Learning Theory postulates that people learn from others' behaviors via observation, imitation, and modeling. In this perspective, learners are products of social systems which learn better with active and interactive learning tools and methodologies.

These active learning settings can be successfully applied to general education IT courses. Project-based learning is considered task-based learning that connects abstract knowledge to authentic learning in any educational discipline, including computer programming education (Peng, Wang, and Sampson, 2017). The promising benefits of this type of learning environment are reflected in student achievement in subject knowledge and programming performance, as well as in their perceptions and motivation to learn. Active learning by projects in IT courses is an important and promising approach that converts abstract knowledge to hands-on learning.

METHODOLOGY

The purpose of this study is to discover the differences between using an adaptive learning system as a sole learning tool and using an adaptive learning system with active engagement, such as authentic projects. We hope to discover which methodology uses an adaptive learning system to its fullest potential in general information technology courses.

This experiment was implemented in a four-year state-funded institution in a metropolitan area in the southern United States. We selected an introduction to computing course, which is a required course for all students at the institution. The course has multiple sections, which covers basic topics of computer technology in a general education course. Specifically, the course contents cover computer theories such as hardware, system software, application software, networking, and security. In addition, the course covers application packages such as word processing, spreadsheets, database management, presentation, and web design applications. Three chapters covering software, security, and emerging technologies employed an adaptive learning system with authentic simulation activities, while the other three chapters covering hardware, internet, and networking used the adaptive learning system with an interactive lecture in class.

The adaptive learning system we used is a web-based learning tool that covers conceptual information of six topics of the course to first-year undergraduate students and a few upperclassmen. The course is designed and refined every year by the course committee. The adaptive learning system provides the students lessons while also asking the students questions about the material being studied. The site also builds its questions and the amount of time spent on material based on each student's speed and accuracy in answering the questions. The questions consist of multiple choice, matching, and fill in the blank. The result of this adaptive system is that each student is tested to his or her full ability.

The system in this course does provide questions with multiple chances and also re-words the questions differently. This is particularly useful, for example, for students who typically do not do well on multiple answer questions. The system may reword the questions, add pictures or even change the questions to one answer questions, which helps students who are critical thinkers, visual learners, or just great test-takers. As each student progresses through the assignment, the adaptive system "adjusts" its plan to conform to each student's abilities and weaknesses. It accomplished this adjustment by asking the student to provide feedback at the bottom of the screen as to whether the student knows, thinks they know, are unsure or have no idea about the answer to each question. By clicking these buttons, the program refocuses itself to concentrate on the student's weaknesses, thereby providing an individualized learning experience.

For active learning engagement, three authentic simulation projects were designed to augment the course content for each respective chapter. The instructor used the Little Man Computer to introduce basic programming skills. The Little Man Computer (LMC) is an instructional model of a CPU simulator that emulates modern computer architecture, and it is widely used as a teaching tool (Englander, 2014). In this simulation project, students become a little man in the mail room. Each computer in the classroom becomes an individual mailbox, which corresponds with memory. Once students understand what execution is and how to fetch the information processed, students learn simple arithmetic programming. Then students simulate the coding by becoming a little man and computing the arithmetic problem sets. By participating in this task, students, whether they are non-information technology majors or information technology majors, experience coding actively. As an authentic project for the security topics, the instructor uses Kleopatra of Gpg4Win, which is encryption software that enables users to transport emails and files securely. Students are asked to download the instructor key and create a file to answer simple questions after they learn how to encrypt and decrypt a message on their computers. Students complete a scavenger hunt game by using Kleopatra, enabling students to engage in more active learning because they are motivated to solve the problem by

using a cryptographic mechanism. For the emerging technology topics, the students create a unique business brand which they form into a "non-profit or for-profit organization." While students are creating their branding for their business, they explore the most recently available technologies on campus including VR, AR, mixed reality, and 3-D printing. They are able to experience each technology by themselves in the lab. After doing so, they create the brand logo, by using a 3-D printer, and the brand's web pages. Then, students create PowerPoint presentations to deliver the information about their company to general audiences.

DATA ANALYSIS

We collected student quiz score data for 102 student subjects. Quiz data was collected for each chapter of the course to investigate whether an adaptive learning system with interactive lectures (group 1) and an adaptive learning system with hands-on, authentic learning activities (group 2) differ in regards to theory concept learning achievement. There were 295 samples for group 1 and 273 samples for group 2.

	N	Min	Max	Mean	Std. Deviation
Group 1 (ALS alone)	295	0	100	76.44	19.53
Group 2 (Active engagement with ALS)	273	0	100	84.36	16.47

Table 1. Descriptive Statistics

Analysis of variance (ANOVA) was used for data analysis and hypothesis testing. As seen in Table 2, The Test of Homogeneity of Variances, the assumption of equal variances is not violated for the score.

	Levene Statistic	df1	df2	Sig.
Based on Mean	.065	1	566	.798
Based on Median	.051	1	566	.821
Based on Median and with adjusted df	.051	1	541.85	.821
Based on trimmed mean	.019	1	566	.890

Table 2. Test of Homogeneity of Variances

A one-way ANOVA was used to show that there is a significant difference between group 1 and group 2 in scores (F=27.105, p= 000), as seen in Table 3. The actively engaged students with adaptive learning systems (group 2) performed better than students with the adaptive learning system alone (group 1) ($\mu_2 = 84.36$ vs. $\mu_1 = 76.44$).

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8902.77	1	8902.77	27.105	.000
Within Groups	185902.65	566	328.45		
Total	194805.42	567			

Table 3. ANOVA Results

DISCUSSION

Adaptive Learning Systems and Flexibility

There were several features of the self-paced system that were very useful for students because it allowed them to have flexibility in managing their learning experience.

The course content is displayed in several ways to aid students with different learning styles. There are informational slides that students can read, and there is an audio file that reads aloud descriptions of the information on the slides. Depending on how the student learns best, they can listen to the information, mute the audio and read at their own pace, or both listen to and read the information at the same time. The ability to alter how the information is presented is very helpful for students who need to go at a slower pace as well as for the students who learn very quickly. The system allows students to choose how much information they want to learn at one time and gives instantaneous feedback throughout the exercise. They can choose to learn the content until they get four questions correct in a row, until they get ten questions correct in total, until they complete one main topic, or they can choose to do the whole lesson at one time.

The system shows a progress wheel of what they have learned and the percentage of the assignment they have finished. After every question a student completes correctly, the system updates the progress at the bottom of the screen, such as one might read 71% complete. This allows the student to efficiently divide their time such as 25% for four days or 50% for two days and also gives feedback so that the student is not "left in the dark" as to how much of an assignment they have completed. Once an assignment is complete or at 100%, a student cannot go back and access the assignment again. Instead, they have a "recharge" feature that allows the students to go back and review the course material. These features of the adaptive learning system make it a good virtual learning tool that learners can use to control their own pace. In summary, the flexibility of adaptive learning systems that allows learners to manage their own learning pace and modify course content, such as how the information is displayed, supports the positive learner-centered learning experience.

Active Learning Engagement via Authentic Projects

Due to the nature of this general education information technology course, we have various student groups that have different starting points and needs in technology-related contents. We found that the advantage of authentic projects is that they engage students successfully who are at different learning levels, motivation levels and confidence levels with respect to technology. We found that when students are given a hands-on experience in programming, such as the Little Man Computer exercise, they further solidifying their introduction to computer software. We found that being able to encrypt and decrypt their own messages, allowed students to gain a deeper understanding of computer security. We also found that by allowing students to investigate new technologies by creating their own brand, it gave them a clearer understanding of the future of information technology. This is all demonstrated by the significant differences in quiz scores between the group of students that were given authentic projects and those that were not.

Active learning through authentic hands-on learning activities can enhance student learning by allowing them to apply their knowledge to authentic projects. In the classroom, we often find that learning computing with authentic hands-on activity is not only useful because it promotes the abstract knowledge creation and transfer processes, but it contributes to improving student motivation and confidence.

CONCLUSION

An adaptive learning system is effective to use in the classroom because it provides a personalized learning environment which increases student learning. However, this study showed that when using an adaptive learning system in conjunction with authentic learning methods, student learning is improved. This implies that an adaptive learning system can be a supportive educational tool, but it is somewhat limited.

With active engagement, students learn better than with an adaptive learning system alone. In this study, an adaptive learning system with authentic learning methods was proven to work better than one with just instruction or lecture. Because learning computing can be very abstract, often students do not truly understand the material they have been taught until they apply it to real-life cases. This in turn contributes to improving student motivation, confidence and success rates in classes.

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