The Usage of a Hybrid Course to Enhance Student Engagement and Success

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Abstract—Students typically get their first exposure to digital logic and hardware design in college courses. It is necessary to provide students with a platform for analyzing and testing circuits to enhance understanding and the overall learning experience. Using a computer application, the old model of breadboard design and testing can be replaced with a more rapid user friendly development tool. This research conducted in computer science at the University of Houston, relates to a level two undergraduate module (computer organization and assembly: COSC 2410) which consists of a mixture of digital logic, assembly language and hardware design. We decided to develop a semi-hybrid course by delivering online materials and activities related to the most extremely challenging module, circuit design. We were able to develop and implement an e-learning teaching material, so called Circuit Designer that encourages greater engagement and ensures student success. This tool will increase students’ performance as it is an off-campuss component and the students can use it at their own pace. The basic approach used is to engage student by the infusion of different technologies in a hybrid course and to promote intellectual honesty in students by offering convenience and potential to accomplish learning activities. This paper describes the semi-hybrid course design with focus on the circuit designer tool and outlines the initial assessment of both the tool and the design through action research applied to traditional module.

Index Terms—E-learning, hybrid course, engagement, motivation, teaching improvement

I. INTRODUCTION

Ninety five percent of the twenty first century learners had played games before they were 10 years old, and more than 48 percent of them were still playing games weekly. Sixty percent of cosc 2410 students spend more than two hours a week watching television and only 31 percent spend more than two hours per week reading anything other than assigned textbooks [16]. One would expect these technologically advanced students to be enthusiastic users of new media. They are expected to be able to create, consume, remix and share information with each other. Difficult questions arise with regards to how they learn and how to engage them. Thus, engaging digital learner has motivated a desire for redesigning the course of computer organization and assembly. Moreover, large-enrollment courses present a number of unique challenges that can impede students’ learning and exhaust faculty members teaching the class [6]. Large course redesign services are other motivators to help faculty members to efficiently manage courses through designing hybrid course using technology tools for e-learning. The rationale behind this approach has two primary aims: to enhance the quality of teaching and learning by allowing teachers to use pedagogies that are not possible with large numbers in a face to face environment, and to manage the delivery and administration of contents of learning through an electronic (on-line) medium.

The focus is on design, not technology [7, 14]. Our approach to design a hybrid course or a semi-hybrid course is based on the following concepts: (1) critically re-examine course goals and objectives and consider carefully how they can best be achieved in the hybrid environment [9], (2) develop new learning activities that capitalize on the strengths of the online and face-to-face learning environments, and (3) focus on the integration of the online and face-to-face components. The design should take into consideration teaching, learning and knowledge transfer strategies. Thus, connecting what occurs in class with what is studied online is critical so instructors do not end up teaching two parallel but unconnected courses [3,4].

The current traditional structure of the course is a problem when we are trying to help student develop the knowledge and skills to present information regarding computer hardware and logic design. The circuit designer tool is created as a support to a particular platform (course management system) for the purposes of management. This tool can have a profound impact on how likely it is to facilitate the use of alternative pedagogies. Thus, it is essential to develop a hybrid course that aligns with nowadays learners skills.

The design of the hybrid course (by combining different e-learning tools) presented in this paper is grounded on a practitioner action research approach as the guide for everyday work [1]. Action research is highly appropriate to the development of e-Learning where changes in delivery mode imply not only alterations in course models, but also development of new attitudes, in order to accommodate the new challenges posed. Educational researchers proposed that the most suitable approach for educational research in general and educational informatics in particular, is to use a 'methodological pluralism'[8]. Methodological pluralism is a process of distributed learning using different approaches. Therefore action research is more than the traditional interpretative research in the sense that the researcher is directly involved in the research setting and in the experience itself. More specifically, the action research presented in this paper draws on the framework suggested by Bodgan by collecting systematically information that is designed
to bring about change in teaching, learning and knowledge transfer [2]. The actual cycle comprises data gathering, data analysis and representation by evaluating the result.

While tools exist to aid the seasoned student, there is no simple easy to access cross platform system which targets new users [5]. Tools out there include digital works, Edison and TopSPICE and these lack some of the necessary features to engage students such as simplicity and the possibility to interactively edit and experiment with circuits, truth tables and flip-flops. This study was undertaken at University of Houston. It sought to ascertain students’ perceptions of the circuit designer as a learning tool and to identify the determinants of this perception. The following questions guided the direction of this study:

1. How do students perceive the use of circuit designer as a tool that supports learning?
2. How do students perceive the efficacy of circuit designer as a simulator?

The paper is organized in the following way: section two describes hybrid course design. Section three describes the circuit designer tool and other similar tools. Section four describes the method used to investigate the efficiency of using circuit designer to improve students’ outcomes and motivation. The results obtained based on one class experiments are presented in section five. Finally, section six discusses the results.

II. HYBRID COURSE DESIGN

Hybrid teaching is not just a matter of transferring a portion of a traditional course to the Web. Instead it involves developing challenging and engaging online learning activities that complement the face-to-face activities [17]. Hybrid courses have become increasingly popular in higher education for two reasons: they offer convenience and the potential to structure learning activities in a new way. Many learning activities are being used for the online portion of this course such as interactively edit and experiment with circuits, truth tables and flip-flops.

Using computer-based technologies, we use a hybrid approach to redesign some lecture or lab content into new online learning activities, such as tutorials, self-testing exercises, simulations, and online group collaborations. Our approach is based on enhancing the quality of teaching and learning. The student experience can be enhanced through improved delivery of teaching materials, improved access to learning resources and better communication. In particular we focus on learning design and activity-centered approaches. Towards this end many steps are taken to specify the goals of improving learning such as; enhancing instructional time spent on course management activities by posting lectures on Blackboard, enhancing instructional time spent on lecturing by posting stream videos on VNet, emphasizing on active learning activities by simulating the logic circuits by the development of circuit designer software, frequent assessment of students’ learning progress using clickers technology, highlighting the smooth running of the activities of the hybrid course by setting up an online discussion area.

The pedagogic design of this semi-hybrid course is identified by the key channels that maintain good communication between the different parts of the course [12]. Moreover, the online discussions allow students equitable access to the teacher’s time, and what will ensure that they can help each other without constraining all students to march in time together. The co-ordinary framework is provided by the design of the course, the sequencing and structuring of learning activities and resources based on the learning needs, the public target, the learning objectives, and the content. Moreover, the teacher/designer should have techno-pedagogical skills such as having her/his students developing technological skills, and learning how to gather tutorials and learning materials from the Internet and testing to what extent the approach used with this technology enhance teaching and learning.

The course schedule as meeting twice a week with an additional third session’s worth of work completed online. The online components of the course are carried out in circuit designer. Students use circuit designer to do assignments and post them in the blackboard. The hybrid frame forces students to work independently and to design more circuits. The focus of this paper is on the simulation of the electronic part of the course accomplished by the development of the software Circuit designer. Moreover, the efficacy of the software is verified by surveying students who had used Circuit Designer.

III. DESIGNING THE CIRCUIT DESIGNER MODULE

A. Useful tools

The circuit design module of COSC 2410 is extremely challenging for those who have not seen it before. While tools exist to aid the seasoned student, there is no simple easy to access cross platform system which targets new users. In this paper, we focus on the following tools: Digital Works, Edison and TopSPICE.

Digital Works is a graphical design tool that enables students to construct digital logic circuits and to analyze their behavior through real time simulation. Its intuitive, easy to use interface makes it the ideal choice for learning or teaching digital electronics; Edison is a learning environment for electricity and electronics. Teachers and students can use multimedia screens, virtual instruments, sound, and animation to create, test, and safely repair circuits. In addition, Edison automatically prepares a standard schematic diagram and displays it simultaneously; and, TopSPICE offers the most advanced simulator in its price range, compatibility, and a quick and easy to use integrated design environment from schematic capture to graphical waveform analysis.

B. The circuit designer

Looking at these similar tools, we were able to identify areas of the course content in COSC 2410 that were not accurately represented. We decided to create a tool of our own which included these key areas of the course, in addition to some features of service learning that do not exist in these tools, such as readily available, truth tables and K-maps. Not to forget the other tools cost lots of money for multi-licenses while the circuit designer is in-house software.

Circuit Designer is educational software to design, build, test and implement logic circuits. Circuits may be quickly prototyped to determine whether an implementation is correct and feasible in the given configuration, then it may be built into a full circuit.
Wiring connections is not meant to be tedious and may be quickly cleaned to display a clean circuit diagram which may then be tested and interacted with. Circuits may be tested by toggling inputs or by viewing a truth table of the current circuit in its current state. Circuit Designer features integrated circuits in addition to logical gates. Integrated circuits may be blackboxed and loaded from existing circuits, allowing the user to reuse components efficiently and effectively. Integrated circuits can also be designed by entering a truth table for their behavior, and transient ICs such as flip-flops are also supported.

Moreover this tool abide by the good practice in undergraduate education by encouraging contact between students and faculty, developing reciprocity and cooperation among students, by taking into consideration diverse talents and ways of learning, and by promoting active learning through participation, communication, voting and polling (surveys).

When using a tool like circuit designer, there is a tendency to use it simply as a drawing tool. The course design run more smoothly when content is organized by topics and activities; and ultimately that activities organization works best for students in both offline and hybrid courses.

We are confident that students will see increased performance in the areas this tool is designed to simulate provided they are motivated to use it.

IV. RESEARCH METHODOLOGY AND DATA ANALYSIS

A series of measurement items for each construct were adapted from previous literature and revised to measure students’ perceptions after direct experiences. Most of the items used a 5-point Likert scale system ranging from strongly disagree (1) to strongly agree (5).

The information elicited in the survey is intended to provide a general gauge of the product’s capability, special features and usage. This survey includes information about general perceptions on usefulness, ease of use, enjoyment, usefulness on learning, and satisfaction with the simulation methodology. The collected data and results are included in Table 1.

Table 1: Descriptive Statistics and Reliability Coefficients for Constructs

<table>
<thead>
<tr>
<th>Constructs</th>
<th>No. of Items</th>
<th>Mean</th>
<th>S.D.</th>
<th>Concept &amp; measures adapted from</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General Usefulness</td>
<td>3</td>
<td>4.47</td>
<td>0.81</td>
<td>Cumming et al. [8]</td>
</tr>
<tr>
<td>2. Ease-of-use</td>
<td>4</td>
<td>3.92</td>
<td>1.09</td>
<td>Hsu &amp; Lu [11]</td>
</tr>
<tr>
<td>3. Enjoyment</td>
<td>3</td>
<td>4.16</td>
<td>1.03</td>
<td>Nooriafshar [15]</td>
</tr>
<tr>
<td>4. Usefulness on learning</td>
<td>7</td>
<td>3.8</td>
<td>0.95</td>
<td>Ma &amp; Agrawal [13]</td>
</tr>
<tr>
<td>5. Satisfaction with the methodology of simulation</td>
<td>9</td>
<td>3.78</td>
<td>1.13</td>
<td>Gallardo et al. [10]</td>
</tr>
</tbody>
</table>

The sample population is very computer savvy. Thus the general usefulness about installation and the graphic user interface smoothness is highly rated. The Ease-of-Use construct is rated the average among all constructs. This identifies the fact that the circuit designer has a simple interface, easy to master. The enjoyment construct is always rated as the second highest among all constructs. This may mean that circuit designer can be effective in keeping student attention.

The Satisfaction with the methodology of simulation is ranked close to average. That may mean that we will need to enhance the graphic interface in novel way to link it clearly to the pedagogical issues of learning, consequently to increase its usefulness. In addition, the usefulness on learning is also ranked average. That may mean that students are not aware of the impact of online activities and hybrid courses on learning. For example, one use may be to input the student’s awareness of their relative progress. The first question may be to ask the students about what they think about their own performance in the class: first 20 percentile, second percentile, etc, the perceived performance. The test results are the actual performance and can be shown in some novel ways to highlight the difference to the students at the end. The satisfaction with the simulation methodology is rated as the lowest. This is due to the fact that students had never been exposed to such circuit designer applications in computer science before.

In more details, the survey of 66 students of COSC 2410 class found that the visual representation is clear (88%) and easy to navigate. On the other hand, many students recommended enhancement of the graphic interface. Only 45% agree that the environment is flexible to interact with.

Their understanding of the meaning of course material has been enhanced (more than 73 percent), but they remained suspicious of their problem solving skills (around 50 percent) as some students gave good comments without any explanation such as “great potential”, “good potential”, and “very high”.

However, other students wrote detailed comments about what they thought as the educational potential of this program. One student commented that “……circuit designer has much potential of helping students making learning easy”, others positive comments are observed such as: “To help reinforce things those were taught in class”, “fun way to involve students”, “I would be more motivated to study with this software”, “good way to review the material”, and “Students learn things while they playing”.

Interestingly, people raised in an era of instantaneous global communication, advanced technology like to learn by their own ways. Eighty one percent agree that the more they practice, the more confident they feel that they are going to achieve a good grade. Exactly what students learn from the circuit designer experience depends heavily on the goals teachers and software designers set for them. The cosc 2410 students express their enjoyment of learning by commenting such as “It is very interesting due to the fact that it increases knowledge when playing it”, “Makes learning more fun and drills the stuff into your head”, “Easy to learn, reinforces things I already knew.”, “It was fun and educating”. Besides, seventy percent of students consider that circuit designer improves their knowledge of major concepts, methods, and theories related to this course material. The students assign medium level of importance to the interactivity factor.
which is more powerful in boosting their motivation to learn. Fifty two percent think that the interactivity throughout the use of the circuit designer is a major feature which motivates them to use the tool. Experimentation, exploration and easiness obtain a pretty high percentage around eighty percent, while the usefulness for learning factor gets a hold of sixty six percent.

Several minority students were totally uninterested in using the software until they realized that it is used to fulfill assignments. Seventy seven percent stated that they enjoyed using this software to do homework problems, instead of doing them by hand.

The following section discusses some important observations.

V. DISCUSSION

Our software was evaluated by students in the spring 2011 offering of COSC 2410. Their feedback indicates that our software is targeted, easy to use, relevant to the course topics, extremely effective in solving and understanding the difficult homework problems, and provides deeper understanding of key course concepts. Therefore, as instructor, I believe my students learned more in the hybrid format than they did in the traditional class sections. As a result, they performed better on exams, and were capable of more meaningful discussions on course material.

Before using the circuit designer, students might not have a good grasp of the degree of difficulties in designing circuits. After they used the simulation software, they might find out that this program is relatively easy to use, as comparing to, for example, the complex software’s they need to master in many electronic courses. This is especially true for computer science students who have even more opportunity in using different software’s than the general population. This may mean that technology savvy students in general can learn to use any program very quickly.

Another interesting observation is the relatively strong results of enjoyment and satisfaction as determinants of student’s motivation.

This may have important implications for cosc 2410 educators, who may not be as accustom to interactivity. We are facing a generation of students who can master sophisticated equipments and software’s much quicker and values the enjoyment and satisfaction of the learning process much more. These facts point to the benefits of widespread adoption of tailor-made programs in computer science courses. Ninety five percent of students indicated that this tool was extremely effective in solving and understanding the difficult homework problems in their third assignment.

The results obtained so far indicate that using circuit design software is a positive step forward towards achieving the goal of effective learning in hybrid courses. One of the interesting observations we made was the students trust that their learning will be highly enhanced by adding to the E-learning framework environment the following features: experimentation and exploration.

The potential benefits of using circuit designer system in teaching and learning environment are: (1) students’ interactivity increased. Many students wrote comments such as “interactive participation to abstract ideas”, “It was interactive”, (2) students’ performance improved. Some students mentioned that they “think it's a good way to practice as many time as needed”, and (3) students were extremely attracted by the software’s time flexibility. One student said that he enjoyed building circuits in his free time with this software as it is available online.

VI. CONCLUSION

The power of the hybrid course model is its flexibility and its pedagogical effectiveness. Because it emphasizes active learning techniques, it increases student interaction with other students and the instructor. One of the most significant accomplishments of the Hybrid Course Project was its impact on the participating instructor. She stated that the hybrid experience would change their approach to all of their future teaching, whether in a traditional, hybrid or distance education class. Thus, hybrid courses can accomplish general faculty development goals and provide new and exciting teaching experiences for instructors and students. As the COSC 2410 instructor puts it, “Hybrid gives me the best of both worlds.”

Teaching hybrid courses faces two challenges change and time. Instructors are asked to change their way they teach and commit a significant amount of time and effort to the process. Changing to hybrid course requires motivation, especially because of the time needed to develop a first hybrid course. A successful hybrid course involves much more than simply transferring lecture material to the web. It requires the substantial time commitment required to course redesign.

Circuit designer is a tool that leads to fostering an education-prone environment. Although hybrid course model is not new, its potential in education is not yet fully explored. Instructors should design hybrid courses to accommodate their own teaching styles and course content. As instructor, I prefer redesigning all activities into online modules for the students to practice indefinitely, and support students by implementing online discussion forums that direct students to think critically and solve the activities.

In order to better understand the educational efficacy of circuit designer in learning, extensive evaluations are necessary. Evaluations should be done on different levels such as on usability issues of the application and/ or efficacy for supporting learning.

REFERENCES


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