

AN ASSESSMENT OF COMPUTER SCIENCE ANIMATIONS: A CASE STUDY

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ABSTRACT

Several approaches have been tried with some success in animating and visualizing computer science basics such as architecture and data representation. In a set of five online modules using interactive animations the developers leveraged their experience in multimedia design and usability to create instructional materials for computer science non-majors. The developers then surveyed 95 student-users¹ from three different educational venues to determine whether their efforts generated positive results in terms of what the students learned about computer science and the role of online learning in the curriculum.

KEYWORDS

Computers and education, computer science education, multimedia, visualization, CS0, online learning

INTRODUCTION

In computer science, online instruction manifests itself in many ways. In the past few years, practices have included Alice, the 3-D tool for visualizing an object-oriented programming environment as described in [1], virtual textbooks with programming components as described in [6], e-books as described by [5] or in courses that focus on teaching computer science in tandem with related media technology as described in [14], [2]. Many of these case studies describe their approaches as well as their successes and shortcomings. Another thread of these studies centers on the educational aspects of online instruction. In other words, do students learn as well or are equally engaged (less likely to withdraw) with online, interactive curriculum as compared to a traditional lecture or classroom settings [4], [7], [3]?

No one case study could begin to address all these elements; however, our work using online multimedia to engage students in the basics of computer science crosses many of these manifestations. Moreover, we present a slightly different perspective — by examining the role of design for enhancing the educational experience.

¹ Note: A total of 95 students took part in the survey. In some cases, students did not answer every question, therefore the sums by category did not always add up to 95.

Background

A course introducing computer science to non-majors (CS0) provides an excellent opportunity for using multimedia animation. Moving images are able to demonstrate continuity and dimensionality in transitions and illustrate changes over time [9]. Developing animations to demonstrate programming enhances the understanding of the complexities of several computer science basics, which are often far too complex for beginning students to grasp from a single lecture. Fundamental concepts such as computer organization, networks, and data representation can readily be presented as processes.

In this series of five related (and somewhat sequential) animated modules, built with Macromedia Flash MX 2004, students had an opportunity to experience these basics through hands-on interaction instead of by rote learning through lecture or textbook. The animations were set in a narrative framework — scientifically accurate, interactive, and as visually stimulating as



Figure 1: A screen shot explaining input and output devices of a computer.

possible. (See Figure 1 or visit www.cs.utk.edu/modules) Almost all the artwork and photography was created specifically for these modules. Besides eliminating many copyright issues, creating your own art allows the presentation to better match the message [10]. Also, it was our shared opinion — especially considering that our team included a professor who had done multimedia design for WGBH in Boston and a project manager who had worked on several high-end multimedia projects for major textbook publishers — that the design of the interface and execution of

the animation be a caliber on par with that of the expectations of today's student population. There are two

underlying issues driving the need to be forward-thinking in the techniques used for delivering digital educational content. First, it is safe to assume that the format in which we receive information today (i.e., books, publications, internet, etc) will change as technology changes. Thus, interfaces will continually look/act/feel/interact differently, and how knowledge is integrated with presentation technology will continue to evolve. Secondly, each year the student population grows more and more computer savvy, producing both increasingly higher expectations of visual presentation and a stronger reliance on digital media as an educational tool. While there are tried-and-true methods for achieving desired outcomes, these methods need to be continually reevaluated in a manner that keeps up with the expectations of the students but continues to retain value for the overall experience. Therefore this project valued the design and execution of the modules as much as the content itself.

In terms of usability and effectiveness of multimedia, beauty is more than skin deep. Cognitive studies conducted on games and game designs indicate that if “the learner enjoys or is interested in the content, he or she may increase the cognitive elaboration and effort put forth in processing that material.” [12] Furthermore, specific studies have been done in mathematics where a student's interest translates into positive attitudes and better performance in mathematical problem solving [12]. The importance of good usability in creating a positive experience cannot be discounted either as the user interface design community has long maintained that “effective

interfaces generate positive feelings of success, competence, mastery and clarity in the user community” [11]. In the computers in education literature, both attitude and usability are mentioned as possible factors in affecting the educational impact of visualization [8].

With respect to content, the modules were initially developed with CS0 students in mind but we were hopeful it would be an appropriate level for a wider audience larger than just computer science non-majors. We felt that these modules could be used as material in a computer literacy or information technology course at a high school or junior college level. In this era of declining enrollments in computer science [15], there is sufficient motivation to create materials that can present some of the principles of computer science in an engaging manner to a wider audience in hopes of generating more interest in the discipline.

THE SURVEY

The modules were constructed throughout the 2005 calendar year with department faculty, staff and graduate students providing the necessary subject expertise. The modules were beta-tested in the Spring 2006 semester. Twenty-six students from a local area high school (21 from a computer science class and 5 from a calculus class), 8 information technology students and 4 CS0 students from a nearby junior college, and 57 students from a university CS0 class were assigned to look at a minimum of two modules and complete a 19 question survey, which was linked to the home page of the modules. Of the 95 students who participated in the survey, 51 were male and 44 were female. Seventy percent of the students were between the ages of 18 and 25 and 18% were age 17 or under. Eleven students were over the age of 25.

After the initial demographic questions, the students were asked to record their level of experience with online learning and computers/technology. Because we were beta-testing these modules in terms of usability and working to implement a digital experience that would resonate with the user, we also asked questions about the clarity of the instructions, navigation, and the overall design (color, artwork, text size). Although we understood that the survey was not designed to measure their learning per se, we were curious about their opinions of how much they thought they learned and whether they found the module(s) informative or educational and how they thought the modules could be best used (replace lecture, extra credit, supplemental material, or assigned as part of the class). We also allowed them numerous opportunities to comment throughout the survey. The survey was taken over a period of three weeks in February, 2006. The instructors at the four year institution and the two year school both preferred that the students looked at the modules after the material was covered in lecture.

RESULTS

In general, student attitudes in all the demographic categories (age, gender and educational level) about the modules were positive. Overall, 90 % of the respondents characterized the modules as both informative and educational. Comments included: “It provided me a lot of knowledge about how my computer works and the processes it undergoes” and “they helped me better understand converting decimals to binary and vice versa.” Of the 95 students, 52 or 55% said they “learned some” from the modules and another 35% said they learned “quite a bit.” Interestingly, 25 of the 26 high school students (and potential computer science candidates) admitted that they learned some or quite a bit about computers from the modules. (See Table 1. Learned-By Gender)

In terms of their appeal of the overall design of the modules (color, artwork, text size, etc), of the 94 students who responded, 32 (34%) rated the modules as “appealing” and another

Table 1: Learned – By Gender

	MALE	FEMALE	TOTAL
Nothing	2	1	3
Don't Know	7	0	7
Some Learning	29	23	52
Quite a Bit	13	20	33
Total	51	44	95

42 (45%) rated the modules as “somewhat appealing.” The total percentage who found the modules either “appealing” or “somewhat appealing” was higher for females (86%) than males (72%). (See Table 2. Rate Design: By Gender) Admittedly, not all were impressed – “Please stop making life difficult by trying to make learning `fun`. It isn't,” commented one student.

Table 2: Rate Design: By Gender

	MALE	FEM ALE	TOTAL
Somewhat Unappealing	4	2	6
Neither appealing or unappealing	10	4	14
Somewhat appeal	23	19	42
Appealing	13	19	32
Total	50	44	94

Although the students in general found the modules educational and appealing, the majority did not want to see more online instruction 56% to 44%. With respect to gender, 61 % of the males did not want more online instruction and 39 % were in favor of receiving more online instruction. For females, the split was 50-50 (At first this wide appeal/limit the use result seems contradictory), but examination of the student comments from that specific question indicate that the students interpreted the question differently from the survey's initial intent. The students interpreted the question as “What *other* kind of lessons/topics (i.e., java, another subject) would you like to see put online? Of the 32 write-in responses to this question, there was not a single indication that online instruction was undesirable. In another question about using the modules, the students suggested that the modules be assigned as a part of lecture and class time (30 %) or to supplement lecture and class time (41%). (See Table 3. Best Use) Only one student said they shouldn't be used at all. A couple of students suggested that the animations should be used in lecture.

Table 3: Best Use

Replaces lecture and class time	12
Assigned part of lecture or class time	28
Supplements lecture or class time	38
Used as extra credit only	10
Should not be used	1
Other suggestions	4
Total	93

DISCUSSION AND FUTURE DIRECTION

The developer's initial motivation for the survey was as a feedback mechanism for the beta tests to make improvements in the module. According to the students, navigational and instructional issues were not a problem since only three respondents reported navigational problems and all of the students said the instructions were clear. One design element that bears some re-evaluation is adding more color. Thirteen students specifically suggested adding more color to make the modules more visually appealing. Five students mentioned they'd like to see sound introduced to the modules.

We think some of the positive reaction to the modules can be attributed to the look and feel of the modules, which received as much planning and consideration as the content. We are further encouraged by the recent announcement of the collaboration from the creators of Alice at Carnegie Mellon University with Electronic Arts, the makers of the popular simulation game, "The Sims." The two parties have agreed to bring EA artwork into Alice, which will propel the object-oriented programming tool into "a new level of effectiveness." [13] We hope to add more content and more animations to the modules, so they can be used more widely in high schools, junior colleges and CS0 classes.

The survey results are consistent with other findings and perhaps can act as a data point to some other studies of online learning and use of multimedia in the classroom. More specifically, this survey supports research that students are not necessarily in favor of having classes that are completely online [3] but as a supplemental tool that can be used conveniently. It also suggests that multimedia can play a role in widening the appreciation of computer science especially since females found the online modules more appealing than their male counterparts.

It is our hope that these five modules will serve as an example of how online learning might be better implemented and that those who create these type of materials, whether they visualize animations or develop online e-books, incorporate usability designers to assist in the development of these materials.

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