Teaching Statement

Eric Shaffer, 6/12/2019

We live in an age of truly staggering innovations in education. As of 2018, the Massive, Open, Online Courses (MOOCs) offered by the University of Illinois have attracted 3,200,000 learners from over 100 different countries[1]. While there is justified skepticism about the effectiveness of MOOCs, it is undeniable they demonstrate that we can develop and deploy tools and resources for learning that were utterly infeasible only two decades ago. This tremendous opportunity challenges educators to discover how best to incorporate technology in teaching. More generally, this is an opportunity to again examine what methods of and approaches to teaching are most effective for our current society.

I believe my approach to teaching is best described as aspirational pragmatism. That counter-intuitive sounding phrase is meant to express that it requires effort to examine if your current methods are achieving the desired goal, and to change them if they are not. Moreover, I believe pragmatism is reflective of an understanding that the way students learn best may not be the way one desires to teach or feels they should teach. This more student centered approach is concisely expressed by Herbert Simon when he wrote “Learning results from what the student does and thinks and only from what the student does and thinks. The teacher can advance learning only by influencing what the student does to learn.” [2].

Since joining the Computer Science Department at the University of Illinois as full-time instructional faculty in 2014, I have taught 6 different on-campus courses, typically teaching two courses per semester. This experience has been a tremendous opportunity to learn about teaching. What I have learned has informed my efforts in substantially re-designing the 4 courses of which I have ownership. Emblematic of these efforts has been my experience working with CS 419 Production Computer Graphics, which is essentially an entirely redesigned course. Framed within the principles of the authoritative “How Learning Works” by Ambrose et al. [2], many of the innovations in the course fall into the categories of *motivation*, *organization*, and *developing mastery*.

In terms of *motivational* changes, I felt it was important for the students to feel they were learning about current technology. The field of computer graphics exhibits relatively rapid innovation, and I have added lectures and curricular material on topics like high dynamic range (HDR) imaging, motivated by explaining what technical specifications for a new HDR TV actually meant . Similarly, I’ve added material on real-time ray tracing and recent advances in physically based rendering detailed by talks at recent conferences. Demonstrating to the students that they can now understand a paper from Pixar is in some sense the capstone to the course. To get there, the course proceeds in a deliberate and focussed manner, with students implementing their own physically-based renderer. Using this activity as the backbone of the course provides both an *organization* of the concepts and requires the students attain *mastery* of the theoretical concepts by integrating them in a functional simulation of light transport. The results have been very positive. Student satisfaction with the course is generally high, with the course being listed by CITL as Excellent twice[3]. Moreover, the final renders produced by the students are generally very impressive, demonstrating through creativity mastery of technical aspects of the course [4].

I applied many of these same principles when updating CS 519 Scientific Visualization. We switched to using modern JavaScript for assignments. In general, the students have embraced this, recognizing it as a useful skill for those who wish to create and share visualizations using current technology. At the same time, assignments such generating line integral convolution vector field visualizations stress a fundamental of the technical issues involved in visualization. The lecture set is almost all new, organized by the characteristics of the underlying data to be visualized. In addition, the course is augmented by several in-class team-based exercises, and survey of recent best papers from the IEEE Vis conference. Again, course satisfaction has been high, being listed by CITL as Excellent twice[3].

CS 418 Interactive Computer Graphics has also seen extensive revision. The course now employs WebGL as the fundamental vehicle for creating interactive graphical applications. WebGL is a modern API that exposes students to GPU programming and so provides significant insight into how modern rasterization systems are both performant and flexible. While the lecture set covers many of the same topics as before, they are now framed in terms of WebGL and numerous lab exercises and examples were created to aid student understanding. Other changes to the course have been driven by the recognition that the audience differs in terms of size and preparation from the students taking CS 419. In addition to creating many in-class exercises, I have shifted some core topics to inquiry-based learning[5] rather than lectures. Initial results, as assessed by exam performance, are very promising. One of my current projects is to expand the set of topics using an inquiry-based approach and to better support those activities by providing web-based tools to explore the topics.

The most recent addition to my teaching portfolio is CS498VR Virtual Reality (VR). The key element of the course is a requirement that students complete a substantial project working as part of a 3 to 5 person team. The projects can be student proposed, but we also solicit sponsorships from other faculty on campus who wish to use VR in their work. I believe the project element of the course addresses an incredibly important element of education, namely the ability to apply skills, knowledge, and techniques to a new problem. One of the greatest struggles students have is being faced with a problem that lacks a known solution. These struggles are understandable...developing a new piece of software is a challenging task. In recognition of this, I have expanded the amount of time devoted to the project in course to cover almost the whole semester. In addition, I recruited a veteran gaming industry manager, Dan Cermak, to co-teach the course as we introduce a formal design process as used in industry.

In addition to expanding the project and design elements of the course, I have updated the technical content. These updates include new lectures on audio for VR, VR-specific rendering technology, tracking, and physics simulation among others. In terms of course mechanics, I have switched to computer-based testing for exams and have experimented with the use of second-chance testing.This latter feature allows students to retake an exam they did poorly on. While they cannot receive full-credit on the retake, they can recoup a significant amount of credit. Certainly, second-chance testing is controversial among educators, but I feel it has worked well in the VR course, in which a very broad set of topics makes it difficult for students to know what they don't understand. Future work in the VR course will involve a greater integration of the theoretical and development aspects of the course.

Coming full-circle to again address the opportunities provided by technology, one very exciting aspect of VR is its potential use in education.I am currently involved in two efforts exploring such applications. The first of these is the use of VR to motivate computer science education. I am co-designing a 3 day workshop [6] for high school computer science teachers in which we will implement a simple VR application and discuss how such an activity can be used to teach computer science fundamentals. In addition to this, I am also the co-PI on a recent internal grant from the College of Engineering at the University of Illinois to build VR exercises for use in a course on electromagnetism. More generally, I think VR and augmented reality (AR) with their ability to visualize 3D phenomena, have tremendous potential to impact education in physical sciences. I am looking forward to helping lead that effort at the University of Illinois.

References

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[3] "Teachers Ranked as Excellent" University of Illinois, 12 June 2019, https://citl.illinois.edu/citl-101/measurement-evaluation/teaching-evaluation/teaching-evaluations-(ices)/teachers-ranked-as-excellent

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