MISSING EXPERIENCES IN EDUCATION: HOW CODEVA CAN IMPROVE THE EDUCATIONAL MODEL

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ABSTRACT

Educational systems direct people to specialize into increasingly niche domains, and people begin to compartmentalize the different fields into separate, unrelated topics. The result is a poor understanding of how technology and society shape each other. CodeVA, a Richmond-based non-profit organization aimed at teaching students technological literacy, provides an effective approach for resolving this issue in traditional educational settings. It provides an active learning environment through the use of projects and student driven activities that resolve many of the issues found in traditional teaching practices such as lectures and the modularization of materials.

A college level course at the University of Virginia (UVA), Human Computer Interactions, employs teaching practices similar to CodeVA. However, its adherence to traditional educational practices is detrimental to the effectiveness of the course. CodeVA's focus on technological literacy, group projects, and the centering of students in the classroom provides a strong teaching model that can be implemented into all educational levels.

1. INTRODUCTION

The information that people internalize and remember is heavily influenced by having a direct experience with it. Experiential learning is an effective tool for cultivating invested students who have a strong desire to understand the subjects they are taught. By having experiences related to the topic at hand, one can relate these experiences to the new ideas presented and experiment with them rather than passing it off as another fact.

CodeVA, a non-profit organization whose aim is to bring equitable computer science education (About Us CodeVA, n.d.), employs experiential learning through project-based classes, the acceptance of failure, and the centering of technology. Understanding CodeVA's teaching practices can provide valuable insight into how to improve the current traditional educational model used in most educational institutions.

In the analysis of CodeVA's teaching, the technical paper will also discuss the teaching practices used by a UVA course, Human Computer Interactions (HCI) at UVA. The comparison between CodeVA and HCI will provide valuable insight into ways to restructure the traditional teaching practices modelled in HCI.

2. RELATED WORKS

In chapter 2 of *Projects as Socio-Technical Systems in Engineering Education*, Simpson and Solms examine the role of project-based learning in engineering education, specifically within South Africa. One of the

problems they attempt to solve is an apparent mismatch between the skills learned in universities and the skills required in industry.

The major issues of the existing educational model in engineering lie in its use of lectures, and the modularization of engineering practices into distinct courses and units. This does not encourage critical thinking in its students, and does not facilitate the skill of relating technical information to real world situations.

Active learning on the other hand employs technical skills that students need, and cultivates out of the box thinking skills (Simpson & Solms, 2018, p. 17). They highlight project-based learning as an effective way to achieve active learning because it can easily connect theory and practice, and allow for student-driven inquiry that can guide the learning experience. Open-ended projects particularly lend themselves to innovations as they require students to identify problems and propose viable solutions (Simpson & Solms, 2018, p. 19).

Some challenges they foresee however also comes from the open-ended aspect. Students can be overwhelmed and frustrated when clear goals are not given. It can also be difficult to ensure even learning across all groups, as some groups might be better at time management or have better group cohesion than others (Simpson & Solms, 2018, p. 21).

3. PROCESS DESIGN

3.1 CodeVA's Teaching Practices

CodeVa effectively cultivates a creative space in which its students can learn. These creative spaces are marked by experiential learning through hands-on-projects and the acceptance of failure. The process of learning is focused around the student's individualized project, which gives students more control over pursuing topics that fascinate them. Having a tangible project also gives the student something to experiment with mentally and physically while being taught new information.

Teaching moments arise naturally as students progress through their project. For example, in a week-long class about game making at CodeVA, students were tasked with creating their own game that they would work on throughout the week. After making a controllable character, one student wanted to create an enemy that would move up and down to block the player, but did not know how to make it happen repeatedly. This was a great opportunity to teach the student about "while-loops," one of the most important building blocks to programming and coding logic. Suddenly, the student had a new tool to apply to other ideas. More importantly, the student gained hands-on experience with knowing when to solve a problem with a "while-loop" and how to apply it.

What is very effective about the project-based teaching at CodeVA is that students have a concrete artifact to take home with them. Students create something they can have pride in, that they can show to their friends and families. Consequently, parents are easily able to see how much their child learned at CodeVA.

To support project-based learning, CodeVa fosters a low stakes environment to its students. Designing an entire game can feel daunting to students; so if a teacher sees a student struggling to commit to something, teachers will ask the students for ideas that they might have. In this encounter, teachers are actively listening to the students, and encouraging their ideas, as well as giving them a good place to start to realize their ideas.

3.2 Human Computer Interactions Teaching Practices

Similar to CodeVA, HCI is mostly concentrated around a group project where the goal is to design a product that can assist a specific societal function or group such as transportation or educators. Professor Apostolellis states in his syllabus: "We will be following a rigorous software design process in order to design-prototype-evaluate (in groups) some interactive product or system that is useful, effective, and a pleasure to use," (Apostolellis, 2021). The class itself is a mix between traditional lecture and activities focused on practicing the material taught in the lecture. Groups are left on their own to complete the project outside of class.

HCI chooses to incorporate the traditional lecture style that is utilized in most other college level courses. It also has in-class activities which are closely related to the topics taught in lecture, and students work in the same groups that they are in for the main project. This is a crucial aspect, as it requires active engagement from the students and allows them to practice aspects of the design process as a group (Simpson and Solms, 2018, p. 17). Apostolellis's expectation is that students will have practiced these skills in class, so that they can later use them outside of class for their projects.

HIC, however, still does not take full advantage of the principle of having a project-based course. The lecture and activities in class take the focus away from the project, and students compartmentalize the in-class material with the projects they work on outside of class.

3.3 What Educational Institutions Can Learn from CodeVA

With CodeVa, while there might be smaller activities within the week, the main focus is almost always around the greater project directly. The activities related to the lectures for HCI require the students to read through a sample scenario and create a model, analysis, or new design based on the specifics of the activity. These activities and their scenarios can easily be replaced by the students' own project which would create a closer coupling of the lecture and project. By having students work on their project immediately after new material is taught to them, they will already be in the appropriate mindset for testing and experimenting.

Like CodeVa, this will also provide an environment where the students can directly ask TAs and the teacher questions for their project instead of a made-up scenario. The TAs and teachers can then read student's body language to figure out why they are struggling in trying to relate the lectures to their projects. The teacher is the most important component in making a proper creative space. Aside from knowing the material, an effective teacher is a role model for students.

Learning does not happen passively. Students internalize new information far better when they are engaged with the subject material and educational systems should be constructed to reflect this. Lecture-centered teaching persists in college to accommodate for the amount of content courses need to cover, but this does not ensure that students are learning from it. Human Computer Interactions takes an important step in the right direction with its project-based learning.

The class detracts from its efficacy, however, by separating the teacher and lectures in-class from the group work on the projects out of class. The separation does not allow for an effective creative space within the classroom as the class structure discourages students

from connecting the lecture with their projects. Apostolellis also removes himself from the students' creative process by having them work on the project outside of class. He is unable to interact with students while they are working in the way a teacher would at CodeVa.

Students who go through programs like CodeVa learn a lot about problem-solving, working with technology, and have an enjoyable experience making projects they are proud to take home. If the goal of courses like HCI is not only to teach students, but to instill a passion for the subject material, then the class should be entirely invested in the students' experience and instilling passion for their creations throughout the course.

4. RESULTS

Some of the concerns that Simpson and Solms bring up with open-ended projects is that some students may find the ambiguity frustrating; and some groups may have a tougher time working together than others. However, CodeVA teaches students from K-12. If CodeVA's teaching model were integrated into the traditional classroom at all age groups, students will work on the skills required for open-ended projects throughout their academic career. These same concerns will likely be mitigated by the time students reach higher level courses, as they have been continuously working on their problem-solving and team working skills.

Part of the reason Chris Dovi, the executive director of CodeVA, started CodeVA is to prepare students for a job market in Virginia which is in high demand for computer science-related jobs (The New Virginia Economy, 2017). Taking their educational model and integrating it into the traditional educational system will help students be adequately prepared for the jobs by providing them with experiential skills relevant to what is expected from jobs in the real world.

5. CONCLUSION

In shifting the educational focus from lectures to projects, students can learn valuable skills that are vital to entering the workforce. In addition to applying technical skills to a complex system, open-ended projects give students a chance to practice creative problem-solving and project management, along with the communication and collaborative skills that are required for working with a team. The skills and information learned through project-based learning are necessarily grounded in real world applications and mimic many of the situations that students will find themselves in once they enter the job market (Simpson and Solms, 2018, pg. 16). The end result is students better equipped for industry jobs with technical and soft skills.

6. FUTURE WORK

CodeVA now trains computer science teachers for middle and high schools in Virginia. To continue with the research outlined in this paper, it would be important to understand how CodeVA trains its teachers with its teaching principles in mind. It would also be inciteful to look into the students that have been through CodeVA's camps to see how prepared they are for college courses and jobs. Finally, it will also be important to examine other organizations similar to CodeVA that utilize project based learning to understand different ways it can be implemented.

REFERENCES

About Us CodeVA (n.d.). *CodeVA.* Retrieved from https://www.codevirginia.org/about/

Apostolellis, P. (2021). Welcome to CS 3205 for Fall 2021. *University of Virginia*. Retrieved from https://collab.its.virginia.edu/portal/site/5e418c23-c98a-41e2-beb2-6c6e69f2a471/tool/1584d275-18bd-455e-ad4b-2c3fb1913cc3/main

Author, Zach Simpson (n.d.). *SAGE Publishing*. Retrieved from http://us.sagepub.com/en-us/nam/author/zach-simpson

IEEE Xplore, Author: Sune Von Solms (n.d.). *IEEE*. Retrieved from https://ieeexplore.ieee.org/author/37953333200

Lang, D. (2017, September). Making more Makers. In Zero to Maker, 2nd Edition. *Make: Community*. Retrieved from https://learning.oreilly.com

Simpson, Z., & Solms, S. (2018). Project Based Learning. In Projects as Socio-Technical Systems in Engineering Education. *CRC Press*, 1, 17-19.

The New Virginia Economy with Mike Hamlar (2017, February 6). *New Virginia Economy Interview with CodeVA (5 minutes).* Youtube. Retrieved from https://www.scribbr.com/apa-examples/interview/