Improving Computer Science Curriculum through Cooperative Education

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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ABSTRACT

The CS industry is constantly changing and the CS curriculum at the University of Virginia (UVA) often fails to prepare students for their future careers or to meet the needs of employers. To address the technical shortcomings, I propose the development of a cooperative education program, or "co-op," which would combine classroom-based education with practical work experience, allowing students to learn by using academic knowledge in practical settings. A successful program would acknowledge the difficulties of onboarding at a new job and provide support for students of varying experience levels. Due to the diverse background of students, I recommend a mandatory co-op preparation course that covers essential topics such as resume workshops, career exploration, interviewing skills, and professional conduct in the workplace. To optimize the program, employers and administrators would need to communicate throughout, outlining expectations and evaluating progress, as well.

1. INTRODUCTION

As the world evolves technologically, computer science careers are in high demand. According to the U.S. Bureau of Labor Statistics (2023), computer and information technology employment is projected to grow 25% between 2021 and 2031. Following this trend, more students are choosing to earn CS degrees. Growing 12.1% from 2019, more than 53,000 CS degrees were awarded in 2020 alone (Data USA, n.d.)

Traditionally, the task of managing the transition between universities and the CS industry falls largely on students. While colleges and universities may attempt to create a CS curriculum with courses that provide students with the necessary algorithms and knowledge, the workplace for the CS industry is constantly changing and the skills provided by these classes fail to aid students in preparing for their future careers because they do not always meet the needs of their current and future employers.

The goal of the proposed program and course changes would be to create a co-op program which can be adopted by the CS program at UVA, better preparing students for the workplace by providing them with more experience. This would allow them to be aware of the expectations and experience of beginning a new software engineer job.

2. RELATED WORKS

Existing research provides insight on the gaps in knowledge that new graduates of computer science programs are left with. Numerous existing co-op programs that have documented the benefits and challenges associated with all parties involved (i.e. the students, educators, and employers). Using information from these related works, I propose the design of a new

program and associated course at the University of Virginia that addresses challenges mentioned to create a more comprehensive co-op program.

2.1 Employers' Expectations

Although new graduates typically have proficient coding skills and are taught programming languages and algorithms extensively in their curriculum, Stepanova, et al. (2021) found that new hires' technical skills, such as testing, debugging, and revision control system, are often lacking. Students found that their CS programs did not adequately prepare them for their employment, especially in the area of practical skills, such as user experience design and interface design principles.

Soft skills are a common theme that new hires from CS programs appeared to struggle with, including the ability to communicate effectively both orally and in writing. Published evidence on employers and students alike reports that CS undergraduate education often does not foster soft and practical skills. These skills can be developed by real-world projects and internships, which provide experience in critical areas like working on a team, collaborating, managing a project, developing the ability to think critically, and solve complex problems.

2.2 Benefits and Challenges

A theoretical study of cooperative education opportunities among CS programs conducted by Huggins (2010) posed an array of student benefits and challenges, as shown in Figure 1 below:

Benefits	Challenges
Applicability of Learned Principles	Managing Relationships
Relevancy of Classroom Education	Employer Expectations
(independent of educators)	
Suitability of Career Field	Student Expectations not Aligning
Employability and Competitive Advantage	Calendar / Timeline of Program
Interdisciplinary Experience	

Figure 1: Benefits and Challenges
of Co-op Programs

The challenges of the co-op programs, while relating to technical problems, actually seem to be more soft skill-related, with communication being an important issue that should be emphasized in the course and program.

3. PROPOSED DESIGN

The following proposed design is under the assumption that the UVA CS program has fostered relationships with tech companies that would be interested in partnering with the co-op program and hiring students. The program will be designed with requirements for the employers, administration and students to ensure coordination between all parties involved. It will be broken down into 3 parts: pre-placement, during, and post-placement, inspired by Penn State Smeal College of Business (n.d.).

3.1 Pre-Placement Phase

The pre-placement phase is meant to help the student and employer prepare for the co-op.

3.1.1 Student Course

The course was designed to include an outline of a syllabus that covers the 12-week duration of the course, meant to meet once a week for 75 minutes. The class, taught by the co-op faculty, will facilitate career exploration, practice interviews with students, and teach

them the necessary soft skills required by employers.

The course material will be taught in two 6-week halves: the first half will focus on the application and hiring process, and the second half on professional conduct in the workplace.

In the first half of the course, students will learn about the general hiring process. The co-op faculty will host resume workshops to provide feedback to students on what recruiters are looking for and practice technical and behavioral interviews with students so they know what to expect.

During the second half of the course, co-op faculty will cover employer expectations and employee conduct in the workplace. This course material is meant to make students more comfortable when beginning work at a new workplace. It should go over important communication skills and scenarios to prepare students for situations they might find themselves in when they are struggling or when they need to interact with their supervisor or colleagues.

3.1.2 Work Arrangements

The co-op program would require employers to create a structured learning plan before hiring students. This plan would allow students to make the most of their time by having specific workplace tasks and learning objectives for the students to complete during the work term. There should be a specific overarching project assigned to the student, allowing them to apply things they may have learned in class and giving them a sense of ownership in their work.

Once the co-op program design and learning plan has been created and the company is ready to recruit students, a job description can be created. The job description should include the basics, including the following: the name of the company, position title, clear start and end date, location, compensation and benefits, expectations & description of position, requirements (software skills and languages), mentor information, and application deadline

Once applications are submitted, the employers can arrange interviews, select students, and offer positions directly with students.

3.2 During-Placement Phase

The during-placement phase is where the student begins work and tracks the student's process throughout the term.

3.2.1 Onboarding

Prior to beginning work, students should undergo onboarding. This is essential to a smooth transition into work for the students. Employers should send a welcome letter containing information about the workplace policies (including dress code), program goals and expectations, where and when to report to work, supervisor/mentor contact information, directions to the office, etc. (Penn State Smeal College of Business, n.d.). An additional task employers must do is prepare internally and brief employees about the incoming student and set up all necessary office supplies and computer passwords. This ensures the student can just begin work immediately and there is no unnecessary holdup.

3.2.2 Orientation

On the first day of work, an orientation session should be held to introduce the student to the workplace, including their supervisor/manager and mentor. During this orientation, the student should also receive the following:
- overview of the company
- organization chart with the line
  of communication and reporting
- industry jargon explained
- specific company terms explained
- work standards and procedures

- code of conduct and professional ethics
- tour of the workplace

While these things are not necessary, this is a good practice to ensure there is no confusion. This also allows the student to learn about the company and its practices.

During this first day, the student should also meet with their supervisor to discuss goals and expectations. The supervisor should explain the learning plan and project to the student, including a timeline and how the student will be evaluated. The student is encouraged to ask questions and assist in revising the plan to reach a consensus with the supervisor. This mutual process ensures the student has a feasible project that can be completed based on the work term and the students' background.

3.2.3 On-the-job evaluation and feedback

Once the work term begins, it is essential there are multiple lines of communication between all parties. In order to ensure good progress is being made, the supervisor and the student should arrange informal weekly check-in meetings where the student can ask questions and the supervisor can provide feedback based on the student's performance. This is crucial for the student's learning and professional development, as it allows students to evaluate their performance and whether or not it meets the company's expectations. The administration should continuously touch base with the employer and student, as well.

In addition to the informal meetings, there should be a mid-point and a final evaluation that is more focused on summative assessment of the student's performance. This is less interactive with the student and is more focused on providing them formal feedback.

3.2.4. End of work term

At the end of the work term, the company should allow the student to create a capstone presentation about the work they have accomplished, so they have a tangible representation of the work they did.

3.3 Post-Placement Phase

In order to prove the value of the program and to get feedback about what works well and does not work well, an exit interview should be conducted following the end of the work term. It goes two ways, as the company can get feedback from the students about the work arrangements, and the company can provide the student with feedback about their strengths and weaknesses.

4. ANTICIPATED RESULTS

The anticipated result of the co-op program would be either a chance to return to the company for another work term or, for graduating students, a full-time return offer of employment for students and a continuing relationship with the companies. The student will have gained valuable work skills and the company will have gotten work done and found a potential recruit.

5. CONCLUSION

The CS program at UVA would benefit from the creation of a co-op program and mandatory co-op classes. It is necessary to integrate soft skills into CS curricula, allowing CS programs to provide and encourage experiential learning opportunities to teach students to connect and collaborate with others. The classes, taught by the co-op faculty, will prepare students for interviews, facilitate career exploration, practice interviews with students, and teach them the necessary soft skills required by employers.

6. FUTURE WORK

Outside of the proposed concept of the program, a lot of administrative work needs to be done to ensure the success of the program. Relationships need to be built with companies in order to have positions to offers students.

Consultations from other universities with existing co-op programs would also be helpful. Finally, a chair should be elected to be in charge of the co-op program.

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