Preparing Professionally Competent Computing Graduates: The Role of Work Experiences

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Abstract

The academic preparation of computing graduates ready for successful long-term careers remains challenging due to a variety of factors, with most universities still unable to incorporate competencies into their education. Competencies refer to the knowledge, skills, and professional dispositions expected from these graduates during task performance. This panel presents three different perspectives on how work experiences may be incorporated into the program curriculum to develop the needed competencies.

CCS Concepts

• **Social and professional topics** → **Computing education**; **Computing profession**;

Keywords

Computing competencies, competency-based education, computing profession, computing curricula, work-based experiences.

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1 Background

Misalignment between the competencies (knowledge, skills and dispositions) [3] of computing graduates and the constantly changing demands of industry remains ongoing [6]. In short, although these graduates often have sufficient knowledge derived from their computing studies, they often have little or no experience applying that knowledge in the workplace, let alone the development of associated skills and the professional dispositions, as explored by recent ITiCSE working groups [5, 9].

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A study [8] of the 2023 graduating class in the US showed that less than 15% of computing graduates pursue advanced study, i.e., approximately 85% of computing graduates enter the job market. So the question arises whether these graduates have the capacity to perform competently as *computing professionals* in the workplace, immediately upon employment or later on in their careers?

As Denning points out, this gap is exacerbated by academia's focus on research, which permeates the institutional education mission, while industry practitioners are less involved in education due to the changing employment landscape [4]. Improving the long-term work readiness of computing graduates requires greater practitioner involvement in education via promising solutions, such as work-integrated learning, experiential learning, cooperative education, and multiple entry points into computing degree programs [5, 6]. At the same time, it is not easy for many computing programs to invest in such approaches.

Computing Curricula 2020 (CC2020) defines *competency* as comprising knowledge, skills, and dispositions within the performance of a task [3]. While knowledge is typically included in computing coursework, skills and dispositions are not: knowledge represents the "know what" dimension, skills the "know how" dimension, and dispositions the "know why" and "know yourself" dimension [10]. The *task* construct frames the skilled application of knowledge, making dispositions concrete. Although the CC2020 model of competency was a major advance for computing educators, it is not as helpful when communicating with employers who use industry-driven competency models, e.g., ISO 247773-2019 [7] and SFIA [11].

This panel takes a holistic look at how computing competencies can be developed using work experiences within computing graduates [2]. The panelists will use their experiences with competency-based education to present different perspectives on the role of integrating and harmonizing work placement and work-based learning within the academic program curricula:

- Some aspect of work integrated learning [12] must be incorporated with a focus on developing competencies – Clear
- Work experiences must be a minor component (~20%) – Raj
- Work experiences must be a major component (~80%) – Barr

These perspectives are expanded in Section 2. Table 1 outlines the panel structure and sets aside ample time for audience participation.

2 Position Statements

The panelists' initial perspectives are presented here.

Table 1: Panel Structure

	Description	Duration
1	Introductions	3 minutes
2	Background	6 minutes
3	Panelists' Perspectives	24 minutes
4	Audience Q & A	24 minutes
5	Summary	3 minutes

2.1 Mihaela Sabin (Moderator)

Mihaela Sabin is a Professor of Computer Science at the University of New Hampshire. Her teaching experience includes foundations of programming, data structures, software engineering, artificial intelligence, and capstone projects. Dr. Sabin chaired the Information Technology 2017 task force. She is a member of the ACM Education Board. She is also ACM SIGITE Vice Chair of Education and CSAB Vice President.

Dr. Sabin will present the background on competencies and work experiences, and moderate the panel and the audience Q & A.

2.2 Matthew Barr

Dr. Matthew Barr is head of the Education & Practice section at the University of Glasgow's School of Computing Science, where he is also Program Director for the Graduate Apprenticeship in Software Engineering. Dr. Barr was appointed Director of Education for SICSA (the Scottish Informatics and Computer Science Alliance) in 2021 and serves on several national committees, including the Digital Economy Skills Group and the Apprenticeships Approvals Group. His latest book, an edited collection on work-based learning in higher education, was published with Taylor & Francis in 2024.

Dr. Barr will present an argument in favor of CS programs that fully embrace work-based learning, drawing on his experience of running an apprenticeship program that sees students spend *most* of their time in the workplace [1]. This stance acknowledges that Computer Science and Software Engineering are applied disciplines wherein students must develop a range of skills, competencies, and dispositions that university study alone cannot support.

2.3 Tony Clear

Tony Clear is an Associate Professor in the Department of Computer and Information Sciences and Co-Director of the Software Engineering Group at Auckland University of Technology. An ACM Distinguished Member, he edits a column for ACM Inroads and serves as Associate Editor for three computing education research journals. Among other research and leadership roles, he has recently studied the impact on IT professional competencies of artificial intelligence.

Dr. Clear will discuss his experiences with supervising capstone projects and teaching large practical software engineering courses. His research into competency-based curricula has led to an increasing interest in how to nurture dispositions to ensure that graduates can competently perform in professional settings.

2.4 Rajendra K. Raj

Rajendra K. Raj, a Computer Science Professor at RIT, currently focuses on computing education, cybersecurity, and data science. Interested in improving the computing profession, Dr. Raj has held several leadership positions in ABET's Computing Accreditation Commission, including Commission Chair. He co-chaired the ACM/IEEE-CS/AAAI task force that developed Computer Science Curricula 2023 and led its Security Knowledge Area Subcommittee.

Dr. Raj will assert that around 20% of an undergraduate degree must comprise full-time work where students apply and refine knowledge, skills, and dispositions. This *cooperative education* (co-op) model is used at several universities, including RIT, where students spend one (non-contiguous) year out of five years in multiple practitioner settings, yielding around 95% graduation outcomes. Competency attainment from co-ops is self-reflected upon by students, assessed by managers, and reviewed by faculty.

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