Promoting Diversity in CS via Code as a Liberal Art

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Abstract—We discuss how a minor in Code as a Liberal Art was established through novel approaches to curriculum and pedagogy at a liberal arts college with a strong commitment to progressive interdisciplinary education. Working groups of com-mitted faculty from a range of disciplines, outside of computer science, identified a set of core learning objectives for coding in the liberal arts. Multiple course offerings were developed by faculty with diverse expertise ranging from theater to machine learning to address the core learning objectives within the context of their discipline. This approach suggests a new avenue for broadening participation and increasing equity in computing, especially at institutions without programs in computer science, by addressing well-known challenges such as student prepared-ness and lack of sufficient faculty with appropriate expertise. More importantly, it demonstrates how, by explicitly avoiding a 'one size fits all' model, students from diverse backgrounds can become confident and successful coders within a liberal arts context.

Keywords—liberal arts computer science, Interdisciplinary computer science, computer science minor

I. INTRODUCTION

Reports from the Computer Research Association (CRA) [1] and the National Academies (NA) [2] on broadening participation in computing implicitly focus on institutions with existing programs in computer science (CS) for majors and non-majors. A broadening initiative started at Lang College in Spring 2020 is outside the scope of these reports because the institution lacked a formal program in computing. Lang is representative of other institutions in which access to any computing is severely limited. This report is a road map for implementing a highly interdisciplinary model that respects the significant contributions of faculty outside of CS who both designed and are implementing this program through the application of integrated, cross-disciplinary learning objectives.

II. WHO HAS ACCESS TO COMPUTING

The Code as Liberal Art initiative casts a wide net without one-size fits all requirements. Both CRA and NA reports highlight two recent phenomena that impede progress toward diversifying access to computing education. (1) While significant gains have been made in increasing under-represented groups into CS, classroom demographics remain significantly different from those of the undergraduate population at large; and (2) there is a crisis of resources, particularly of faculty, as overall demand for computing courses has ballooned in the past decade. The reports note distinctions between major and non-major offerings; however the analysis assumes that credentialed CS faculty teach (or co-teach) courses, and that offerings for non-majors and majors are distinct, with the former providing breadth rather than depth.

Small liberal arts colleges, historically black colleges, or associate degree providers are barely represented in the analysis, yet suffer acutely from these problems. They are increasingly the gateway to higher education for under-represented groups and those with insufficient mathematics background [3], [4]. Of equal concern is evidence that for-profit institutions that do not provide a liberal education that includes ethical and social impact of computing make a significant contribution to the recent increased enrollment of students of color, especially women [5]. One solution to proposed by the CRA and NA reports is to promote interdisciplinarity. The challenges are well known, requiring significant changes in academic culture [6], [5] from silos to collaboration by faculty across disciplines.

III. CODE AS A LIBERAL ART

Our new minor was established by a multidisciplinary group of faculty to deepen students' understanding of code and computational thinking in relation to access, equity and social justice. Lang College has a tradition of curricular innovation with strengths in the Arts, Writing, Media Studies and Social Sciences. It does not offer majors in CS or mathematics. It employs an open curriculum (with a single first year general education requirement in writing), and emphasizes interdisciplinary seminars. In 2018, a task force drawn from Culture and Media, the Arts, Anthropology, Philosophy, Music, and Mathematics was charged: "to increase coding literacy, and to foster a new form of civic education in response to the increasing presence of computational systems in contemporary life."

The Task Force sponsored courses across disciplines. The courses embedded coding experiences into disciplinary courses, demonstrating how code is increasingly integrated into research methodologies of academic practice and techniques for artistic expression. The task force sponsored round-tables to develop explicit goals for a minor program and

build interest among faculty at Lang, and the larger university. Code as a Liberal Art received a substantial financial gift to support new curriculum development and now offers courses in Culture and Media Studies, Writing, Natural Science and Mathematics, Politics, and the Arts. Funding enables non CS-trained faculty to incorporate coding modules or assignments in their classes by pairing them with experienced part time faculty to develop curriculum and lab experiences for the classroom. The new minor launched in Spring 2020.

IV. STANDARD LEARNING OBJECTIVES

In four semesters (Fall 2018 - Spring 2020), 14 new minor courses in six disciplines, each met most, if not all, of a common set of learning objectives:

- Use computation as a tool to enhance liberal arts education, to better analyze, communicate, create and learn
- Engage in project-based and collaborative learning utilizing computational/algorithmic thinking
- Gain a broader understanding of the historical and social factors leading to the increasing presence of computing.
- Work through the social and political implications of/embedded within computational technologies and develop an accompanying ethical framework.
- Appreciate the challenges of equity and access posed by increased reliance on computing as well as their potential to reinforce existing inequalities in society.
- Think critically about the ways one interacts with computation including understanding its limits from philosophical, logical, mathematical and public policy perspectives.
- Understand the intrinsic relationship between the physical world, analog environments and digital experiences

The depth of coverage of the objectives, and the breadth of disciplines represented suggests that we are successfully providing increased interdisciplinary computing opportunities.

The exercise of defining these objectives provides guidance both for future curricular planning and to help students learn to code within their educational focus or to broaden their experiences coding. The collaborative articulation of common learning objectives across disciplines helps faculty integrate coding into their offerings, and simultaneously shapes the minor within the liberal arts. Faculty have opportunities to share expertise, leading to pedagogical development, over time.

V. STUDENT ACTIVITIES TO MEET OBJECTIVES

Two courses are summarized briefly to illustrate how a common thread is the balanced inclusion of key concepts computing and the complementary discipline.

Digital Creative Writing is a second year level elective with no coding prerequisite. It is a broad survey of how coding and digital tools can be applied to the written word, from generative text and twitterbots, to memes, interactive fiction and narrative games. Each week students explore a new area of digital written culture, with new coding techniques introduced to create new work. Coding skills are introduced primarily through examples. Students begin by adapting that code,

eventually dramatically restructuring programs to achieve their creative goals. In the final project students integrate new techniques into their existing writing practice, to build an ongoing digital writing practice for future work.

Do Machines Learn? is an elective in Culture and Media that introduces students to theories of human learning and contrasts it with artificial intelligence, including knowledge representation, logic systems, heuristic search, agent theory, and neural-net based machine learning. Students code a small simulation in which their intelligent avatar navigates a world model without human intervention. Through their coding research on human learning, each student answers the question 'do machine learn?'. (Their answers were all 'NO!')

VI. CONCLUSIONS AND RECOMMENDATIONS

Student assessment and course evaluations provide preliminary evidence that learning objectives are being met. Equally significant is that faculty across disciplines are collaborating to share expertise, identify common and consistent approaches and identify resources to expand individual expertise. Next steps and upcoming challenges include: (1) Providing academic support outside the classroom (coding tutors, facilities, equipment) (2) developing a detailed curriculum map that includes identifying specific computing skills and language choice (3) developing advanced courses (4) support for students and faculty to integrate new coding skills beyond the minor's course offerings.

The Code as a Liberal Art approach presents one avenue for broadening participation in computing by overcoming the shortage of computer science faculty – a challenge facing many institutions including those with existing CS programs. Key to its success is the interdisciplinary and collaborative faculty engagement to determine core learning objectives and develop curriculum in computing as well as its social, ethical and intellectual implications.

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