A Longitudinal Evaluation of the Impact of a Graduate Student Accessibility Training on Student Learning Outcomes

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ABSTRACT

This paper describes a training program designed to increase accessibility competencies in graduate students of interdisciplinary backgrounds, including those in computing education, and presents a longitudinal study that examined the program's effectiveness. We surveyed two graduate student cohorts in the program at multiple periods over eight months ($N = 14$). Students reported their level of program engagement, empathy, technical knowledge, and career interests in accessibility. We found that participants' physical engagement and empathy increased over time at a marginal significance level. Students reported high medians on other measurements, which imply the program successfully maintained their engagement, technical knowledge, and career interests. We offer recommendations to enhance the quality of accessibility education to graduate students in computing.

CCS CONCEPTS

• **Social and professional topics** → Professional topics; Computing education; Student assessment.

KEYWORDS

Accessibility training, Longitudinal study, Graduate students, Learning outcomes

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1 INTRODUCTION

Accessibility refers to the design of products, services, or environments for all intended audiences, including persons with disabilities [3]. Teaching accessibility to students in computing is important because these students will occupy positions in influencing the design or development of services and environments that impact daily life, ultimately holding the key to removing barriers that prevent people with disabilities from participating in the community as anybody else. When students do not develop accessibility competencies, there will be a continual marginalization of people with disabilities who cannot use many products and services [9]. For instance, in the analysis of 5753 free Android apps, 45.9% of apps have at least 90% of their image-based buttons missing labels, making a screen reader ineffective [11]. Teaching accessibility is one necessary means through which to cultivate ethical citizens.

Presently, there are no formal curriculum requirements for accessibility in computing education that are reinforced by major accreditation organizations, which can be a significant barrier to teaching accessibility [13]. Lewthwaite and Sloan [8] emphasized the pressing need to build a pedagogical culture—a collective repository of learning theories and teaching and evaluation approaches—to improve the quality of accessibility education. When such a culture is established, educators have resources to effectively overcome department-, instructor-, and student-level hurdles that can discourage the implementation of accessibility courses [7, 13]. Collectively moving towards building the pedagogical culture, more and more researchers have actively shared their teaching approaches and corresponding assessment of their approaches. In this paper, we report 1) a graduate training program called the Research and Education in Accessibility, Design, and Innovation (READi) and 2) a longitudinal assessment of the effectiveness of the program with two student cohorts ($N = 14$). We contribute towards building the accessibility pedagogical culture for graduate students in computing and offer a reference point where other educators can adopt some of the program's components.

2 RELATED WORK

There are many approaches to teaching accessibility to undergraduate students in computing disciplines. Shinohara et al. [12] introduced a 10-week design thinking course in which Information

Technology (IT) and Software Engineering (SE) students learned about the human-centered design process for diverse user groups and collaborated on a design project with a person with a disability (expert users). The researchers analyzed students' course outputs and reported qualitative evidence suggesting students showed increased accessibility awareness in designing technologies and improved their skill in translating the needs of expert users into the final design of prototypes. Most importantly, some students changed their attitude towards disability (e.g., no longer fearful of interacting with people with disabilities). Zhao et al. [16] described four accessibility educational interventions for undergraduates in IT and SE: 1) a one-week lecture on accessibility, 2) a team project in which students considered accessibility in designing technologies, 3) a team project in which students interacted with someone who uses accessible technologies, and 4) a team project in which students collaborated with a team member who had a disability.

Similarly, Palan et al. [10] reported that a one-week exposure to accessibility topics could result in positive learning gains. Within a week, the researchers introduced lectures on accessibility topics to IT and SE undergraduate students. They found that students reported enhanced accessibility awareness (i.e., being more aware of people with specific disabilities) and increased knowledge of accessible web design and development.

Students can also learn about accessibility systematically throughout four years. Waller et al. [14] described a structured 4-year curriculum for undergraduates in computing. In the first and second year, students are introduced to courses to build foundational knowledge on accessibility; in the third year, students learn about the inclusive design process and evaluation methods by participating in hands-on projects; and last year, students work on a project that directly involves people with disabilities to practise inclusive software design and development. Other researchers have shared pedagogical approaches targeted to reduce frustrations on computer science (CS) instructors who may lack knowledge on accessibility and time to prepare new lecture contents. Kawas et al. [6] introduced a novel micro-professional development platform (micro-PD); on this platform, CS faculty get quick and efficient web-based instruction and obtain relevant materials to integrate accessibility into their existing courses.

We now describe an accessibility training program geared towards graduate students of interdisciplinary backgrounds, including those from computing disciplines. There is a gap in computing education with respect to accessibility education for graduate students, and our program can be a model to consider for computing educators.

3 RESEARCH AND EDUCATION IN ACCESSIBILITY, DESIGN, AND INNOVATION TRAINING PROGRAM

The Research and Education in Accessibility, Design, and Innovation (READi) is a graduate training program led by three institutions in collaboration. It trains an interdisciplinary group of students spanning the department and schools ranging from computing disciplines, including CS to computer engineering and IT and students outside of computing disciplines, including History and Cultural Mediations. READi students typically start the program in the Fall semester and conclude training in the subsequent Fall semester. READi has five major training components: (1) a graduate course on accessibility and inclusive design, (2) an Action Team Project (ATP), (3) a Retreat, (4) Workshops, and (5) a Symposium. By the end of the program, students should be able to (1) apply inclusive design principles to ideate and create products, services, and environments accessible to people of all ages, gender, and abilities; (2) employ a human-centered design process to advance the current state of accessible design standards and principles; (3) interact with people of all ages, gender, and abilities in their research; (4) recognize and empathize with people with disabilities; and (5) discuss accessibility from multiple perspectives (e.g., technical, social). We briefly describe each component, and a detailed description of components can be found in [5].

3.1 A Graduate Course on Accessibility and Inclusive Design

READi students take a graduate course in the Fall academic term. This course is also open to non-READi students and provides students with foundational knowledge on accessible, inclusive, and human-centered design principles. There are four learning objectives in this course: (1) students will understand inclusive and accessible design principles crucial to create inclusive products and services; (2) students will develop empathy and appreciation for diversity; (3) students will become proficient in conducting qualitative and quantitative human-centered design research; and (4) students will be able to define different models of accessibility.

3.2 Action Team Project (ATP)

This is the flagship component of READi and offers students the theory-practice link. The ATP is inspired by the premise of community-engaged pedagogy, which involves students applying their skills to learn about the needs of local community organizations and generate ideas in partnership [15]. Students form Action Teams (~3 to 4 members) and engage in an 8-month interdisciplinary learning experience. The intention is that student groups' ideas and concepts will help 'move the needle forward.' At the end of the project, students offer community partners tangible insights for future studies and improvement. READi community partners come from diverse backgrounds, such as not-for-profit organizations that are dedicated to building inclusive community space for children and youth; and organizations that create customized assistive devices to support people with disabilities.

Below describes the ATP completed by five student groups who completed the READi in 2020-2021 and 2021-2022. Some of them were also participants in the present study.

Group 1. The group collaborated with a non-profit organization that supports artists with developmental disabilities and identified what these artists would like to see in a shared artist hub.

Group 2. The group collaborated with community partners that provide leisure activities to local citizens, including para-athletes, and the group examined how to make the partners' social media content accessible and engaging to various audiences.

Group 3. The group collaborated with community partners who offer seniors an art program so they are not isolated from the community during the pandemic. In the end, the group identified the strengths of the existing program and new opportunities to be embedded in the program.

Group 4. The group collaborated with community partners who offer a program to support individuals with mental health conditions. The program empowers individuals to engage in artistic self-expression and social opportunities with invited artists. The group identified how the program could improve accessibility for future hybrid delivery.

Group 5. The group collaborated with a non-profit organization that supports individuals with dementia and their caregivers and identified design considerations for the organization's future space and services for their clients.

3.3 Workshops, Retreat, and Symposium

READi has three components that can foster affective learning. Interactive workshops are offered throughout the year, covering various topics, including web and document accessibility; attitudinal barriers to accessibility; and networking with industry and accessibility experts. The Retreat occurs mid-way through the ATP (around May) and provides an intensive learning experience joined together with the ATP community partners and READi faculty members. Formal elements include students' interim ATP progress reports and workshops on leadership and innovation, and a lived experience testimony and discussion. At the Symposium, which occurs in the subsequent Fall semester (October), students present final ATP projects to the ATP community partners and the public.

4 METHOD

4.1 Study Design

We conducted a repeated-measures study in which participants completed a survey two or three times implemented across eight months: January, May, and October. We administered the survey through Qualtrics, which took approximately 20 minutes to complete. Participants were given a 2-week time frame to complete the survey.

4.2 Study Participants

We recruited 14 graduate students from two cohorts, a cohort who completed the program from 2020 to 2021 (cohort 1) and the subsequent cohort who completed the program from 2021 to 2022 (cohort 2). Cohort 1 completed a survey in May and October, whereas cohort 2 completed a survey three times. Ten participants came from cohort 1 (M_{age} = 30.7 years old). Nine were master's students, and one was a doctoral student; 9 participants majored in computing disciplines (e.g., HCI, Engineering) and one majored in Arts. Four participants came from cohort 2 (M_{age} = 24.25 years old). All of them were master's students; one majored in Arts and the rest majored in computing disciplines (e.g., CS). For each cohort, we retained the same group over 8 months. They were compensated with a CAD 40 e-gift card.

4.3 Survey Measurements

Unless otherwise indicated, all measurements used a 7-point Likert scale (1 = Strongly disagree, 7 = Strongly agree).

1. Student Engagement. Participants indicated their emotional engagement with READi (i.e., their enjoyable states of mind) and sample items are "I feel energetic being part of this program" and "I am interested in material I learn in this program" (cohort 1 = Cronbach's α's > .80; cohort 2 = Cronbach's α's > .76). They indicated their physical engagement with READi (i.e., the degree to which a student puts effort in working on assignments.), and sample items are "I exert my full efforts towards this program" and "I devote a lot of energy towards this program" (cohort 1 = Cronbach's α's > .75; cohort 2 = Cronbach's α's >.53). Lastly, they indicated their cognitive engagement with READi and sample items are "my mind is always focused on project discussions" and "I pay a lot of attention to project discussions and tasks" [1] (cohort 1 = Cronbach's α's > .88; cohort 2 = Cronbach's α's > .59).

2. Career interests in accessibility. Participants indicated the degree to which they were interested in pursuing a career where they could apply accessibility knowledge. Sample items are "I want to explore career options where I can apply accessibility-related knowledge" and "I am not interested in learning what accessibility-related career opportunities are available" (cohort 1 = Cronbach's α's > .70; cohort 2 = Cronbach's α's > .70).

3. Empathy. Participants indicated the degree to which they felt empathy towards the specific community for whom their ATP will directly impact. The stem of the question was "When I think about the specific community of my ATP project . . ." and items include "compassionate," "moved," "sympathetic," and "warm" [4] (cohort 1 = Cronbach's α's > .80; cohort 2 = Cronbach's α's > .76).

4. Cognitive learning. Participants indicated their general understanding of accessibility and sample items are "I can identify benefits of accessibility" and "I can define the purpose of the Accessible Canada Act" [7] (cohort 1 = Cronbach's α's > .87; cohort 2 = Cronbach's α's > .76).

5 RESULTS

We conducted the Skillings-Mack test and Figure 1 and Figure 2 succinctly present the results.

1. Cognitive engagement. For both cohorts, their level of cognitive engagement did not statistically differ between different time points (Skillings-Mack Statistic = 0.90, p = 0.34; Skillings-Mack Statistic = 2.10, p-value = 0.35).

2. Physical engagement. For cohort 1, there was a marginal significance, such that participants reported a higher level of physical engagement in October than in May (Skillings-Mack Statistic = 3.60, p = 0.06). For cohort 2, their level of physical engagement did not statistically differ between time points (Skillings-Mack Statistic = 4.68, p = 0.10).

3. Emotional engagement. For both cohorts, their level of emotional engagement did not statistically differ between time points (Skillings-Mack Statistic = 0.40, p = 0.53; Skillings-Mack Statistic = 2.95, p = 0.23).

4. Empathy. For cohort 1, there was a marginal significance, such that participants reported higher empathy in October than in May (Skillings-Mack Statistic = 3.60, p = 0.06). For cohort 2, there was no statistical difference between different times (Skillings-Mack Statistic = 0.23, p = 0.89).

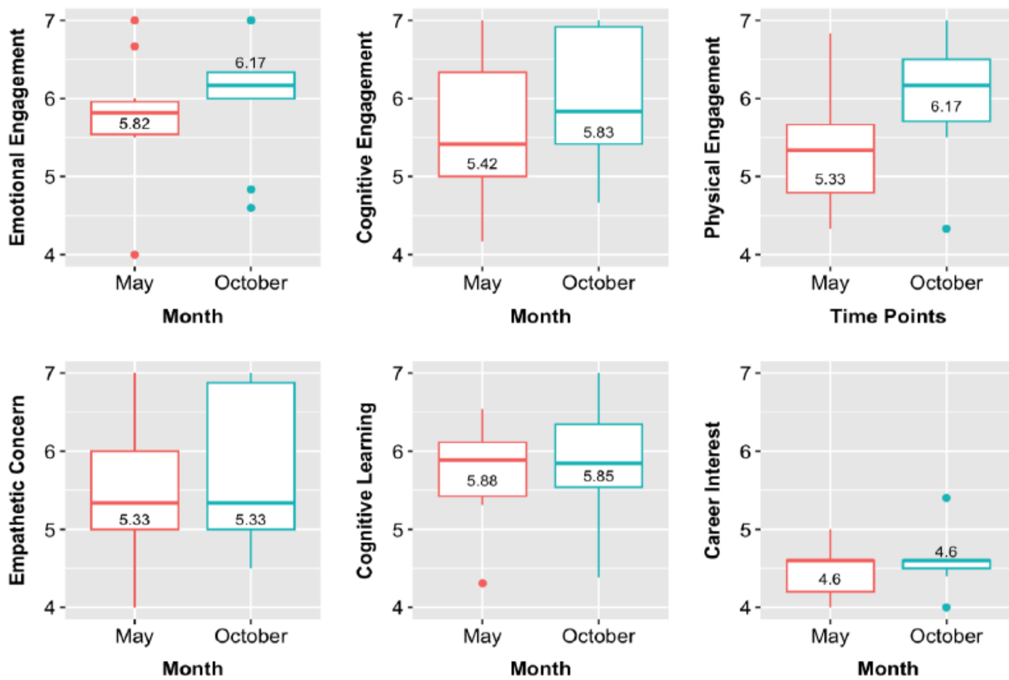

Figure 1: The program's effect on student learning outcomes (cohort 1), and medians are reported.

5. Cognitive learning. For both cohorts, their technical knowledge did not statistically differ between different time points (Skillings-Mack Statistic = 1.60, p = 0.21; Skillings-Mack Statistic = 2.85, p = 0.24).

6. Career interests. Both cohorts' career interests did not statistically differ between time points (Skillings-Mack Statistic = 1.50, p = 0.47; Skillings-Mack Statistic = 1.50, p = 0.47).

6 DISCUSSION

While we did not find significant changes in most dependent variables, it is essential to note that participants' medians on these variables were consistently high over three (cohort 1) or eight months (cohort 2), which were above the midpoint on a 7-point Likert scale. One interpretive lens of these non-significant findings is that READi successfully maintained students' knowledge and engagement. Many READi students join the program because they are already interested in or know about accessibility (e.g., through their supervisors). Such prior involvement can explain participants' high starting points. It is essential to reflect upon the READi's program elements that could have supported participants' consistent high medians on all measurements during the study duration. We can speculate on several sources in relation to prior work. Conn et al. [2] found mentorships in accessibility and the opportunity to interact with people with a disability are important motivators for students to continuously learn accessibility.

Both factors are present in READi. Regarding mentorship, students receive support from various sources, including READi faculty and coordinator, peers in the program, READi Ph.D. mentors who completed the program one year before students and ATP community partners. Also, students are given ample social interaction opportunities with people with disabilities. When working on the ATP, students brainstorm and collect data from interacting with people with disabilities. They meet people with disabilities who are frequently invited to share their lived experiences and expertise at workshops, the retreat, and the symposium. In addition to these two factors, we speculate that each program element worked in concert to reinforce students' knowledge of and engagement with accessibility continuously. In a study by Zhao et al. [16], many undergraduate students who went through accessibility education interventions did not retain their accessibility knowledge after 18 to 24 months, supposedly due to the absence of reinforcers of accessibility knowledge in a computing curriculum at the school. In READi, reinforcers were systematically embedded and presented throughout students' participation in the program (i.e., the graduate course in the first Fall semester, followed by the ATP from January to October, the Retreat in May, and the Symposium in October) and we recommend other educators to implement reinforcers for long-term knowledge retention.

The ATP is different from hands-on accessibility research projects given to undergraduate students in terms of project duration (e.g., a semester-long vs. 8-month long), the breadth and the depth of interactions with the accessibility community (e.g., one person with a disability vs. the community partners and people with disabilities involved in the community) and the depth of mentorship and peer support (e.g., main mentorship from a course instructor vs. mentorship from senior Ph.D. student and other peers). As undergraduate and graduate students can differ in cognitive needs,

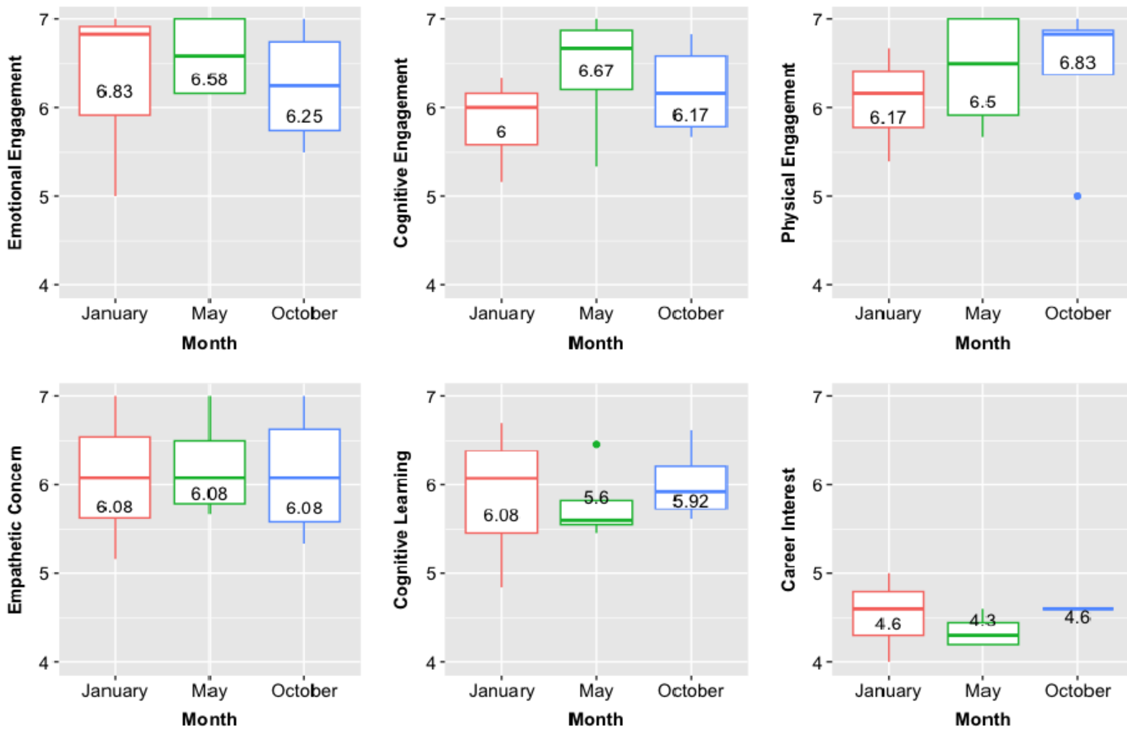

Figure 2: The program's effect on student learning outcomes (cohort 2), and medians are reported.

career trajectory, and prior interest and involvement with accessibility, educators can use the ATP as a reference point to design accessibility research projects specifically for computing graduate students.

7 LIMITATIONS & CONCLUSIONS

Our study has its caveats. First, participants from each cohort self-selected to participate in the survey, and there are potential differences between those who participated versus those who did not. Our results may only characterize graduate students of particular characteristics. Second, we tracked students' learning during their ATP participation, and we acknowledge that participants' high medians on all measurements can be attributed to many factors, including their outside-of-the-program activities. We caution other researchers from considering students' ATP participation as the causal factor of the observed marginal significance and non-significance findings.

Despite these caveats, our study contributes towards building the pedagogical culture for accessibility education for graduate students in computing and other backgrounds. With a gap in computing education with accessibility education focused on undergraduate students, the READi can serve as a model to consider for computing educators.

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