Teaching Inclusive Thinking in Undergraduate Computing

Nidhi Palan
Golisano College of Computing and Information Sciences
Rochester Institute of Technology
Rochester, NY 14623 USA
nxp4195@rit.edu

Vicki Hanson, Matt Huenerfauth
Golisano College of Computing and Information Sciences
Rochester Institute of Technology
Rochester, NY 14623 USA
{vlh, matt.huenerfauth}@rit.edu

Stephanie Ludi
Department of Computer Science and Engineering
University of North Texas
Denton, TX USA
stephanie.ludi@unt.edu

ABSTRACT
With the increasing importance of accessibility awareness and knowledge as both a moral imperative and an employment differentiator, it is incumbent on educational programs to have demonstrated ability to teach these skills. We report on our year-long evaluation of university students' accessibility awareness and knowledge following a week of accessibility lectures as part of courses on Human-Computer Interaction (HCI). We report gains in awareness and knowledge when accessibility lectures were part of the course. We describe the test battery developed to measure these skills, and describe our ongoing longitudinal research to measure the effectiveness of several interventions for teaching inclusive thinking in undergraduate computing courses.

CCS Concepts
• Social and professional topics ~ Professional topics ~ Computing education • Human-centered computing ~ Accessibility

Keywords
Computer science education, accessibility, ethics

1. INTRODUCTION
We report on a study that investigates the efficacy of lectures about accessibility as a means of teaching inclusive thinking. There is a growing awareness among employers of the need to hire developers knowledgeable about accessibility and inclusion [2][6]. Despite calls for more accessibility-aware developers, even recent publications have noted the lack of principled methods for teaching accessibility [3][5]. Several approaches have been reported anecdotally, but there have been few attempts to measure outcomes. Most commonly, degree programs include accessibility content in upper-level undergraduate courses on accessibility, or in courses on related topics, e.g. human-computer interaction (HCI) [1][4][5][7].

2. METHOD
We used pre- and post-tests to measure changes in student attitudes and awareness about disability and creating accessible technology. The study was conducted as part of required courses in Information Technology (IT) and Software Engineering (SE). At Rochester Institute of Technology, students majoring in IT or SE are required to take a course in HCI (a separate course for each major). The HCI courses for both majors contain a semester-long project, in which teams of 4-5 students design a mobile app, website, or desktop application while following a design process and submitting progress reports. Both classes currently provide a week of lectures on: (1) diversity of human sensory abilities, including experiences of people with common visual impairments and who are Deaf/deaf or hard of hearing; (2) human motor system and various movement impairments; (3) diversity in human cognitive or learning abilities; (4) common assistive technologies for accessing computers (e.g. screen readers, magnification, alternative input tools); (5) U.S. legal requirements for technology accessibility; (6) key aspects of website design for accessibility (e.g. alt text, captioned media). In general, our survey questions (described below) are related to this lecture content. The survey began with an IRB approved informed consent statement, indicating that the questionnaire was voluntary and it would not affect the outcome of their course grades.

ASSETS'17, October 29-November 1, 2017, Baltimore, MD, USA

ACM ISBN 978-1-4503-4926-0/17/10…$15.00
DOI: https://doi.org/10.1145/3132525.3134808

2.1 Measurement Instruments
Participants in the pre- and post-tests (beginning and end of semester) completed the following battery of tests:

(1) Scenario: Participants were presented with the voting machine problem scenario from Ludi [4]. The scenario included requirements to design a voting kiosk for state elections. Participants were asked two open-ended questions about the scenario. **Design Question:** The first question asked them to discuss key points that they would keep in mind in the design of the voting system. **Evaluation Question:** The second question asked what potential addressed voters they would test the kiosk prototype with in order to gain feedback on the new design. The scenario did not mention disabilities. The two questions were designed to be unbiased/neutral, so any mentions of accessibility by the students were based on their awareness of accessibility importance in the design and evaluation of software.

(2) Accessibility Survey: This survey first asked about ***accessibility awareness***. Students were asked to indicate whether they either had *knowledge of* or *personal experience with* people with specific disabilities (low vision, blindness, hearing loss, autism, learning disabilities, intellectual disabilities, motor disabilities, or older people). For each, radio button options were used to indicate either a) *knowledge of* or b) *personal experience with* each case.

Second, there were questions about ***accessibility knowledge*** in design and development. Participants were asked to indicate whether they had *read about* (scored as 1 point) or *had done* (scored as 2 points) website development for people with disabilities (8 items with radio button choices).

Next, they were asked if they were *familiar with* (scored as 1 point) or had *taken into account* (scored as 2 points) each of several accessibility issues in web design (e.g., CSS, alternative text, colors, etc.) and if they had accounted for each when designing websites (10 items with radio button choices).

There was a further set of questions in which they were asked whether they were *familiar with* or had *taken into account* each of several accessibility issues in accessible software design (e.g., screen-reader interfaces, avoiding responses that require a fixed time limit, etc.) (6 items with radio button choices).

The final two items were Yes / No questions asking whether they had previously been involved in the design / development of websites or software and, if yes, whether accessibility issues had been taken into account (1 point for each "yes" response).

A SurveyMonkey survey was created with the above instruments, in the order above. Students in participating classes were asked to complete the pre-test during the first 2 weeks of the semester and the post-test during the last two weeks of the 16-week semester.

3. RESULTS

In our two semesters of testing, 49 students completed both the pre- and post-test. Our reported analyses were only on this sample who had completed scores for both.

3.1 Scenario

To evaluate whether students considered accessibility in the voting scenario, we assigned a binary score to participants' responses to each of the two open-ended questions: whether or not their response mentioned accessibility. Thus, for both pre- and post-testing, each student could have a score of 0, 1, or 2 – if they had mentioned accessibility in response to neither, one, or both of the questions.

There were more accessibility mentions at the end of the semester than at the beginning (for both, *Mdn* = 1, *Range* = 0 to 2). This repeated-measures ordinal data was analyzed using the Wilcoxon Signed-Rank test, with the pre- and post-test scores found to be statistically different ($W = -134$, $Z = -2.69$, $p<.01$, two-tailed).

Combining the pre- and post-test scores, accessibility was mentioned in 34% of the participants' responses to the **design question** and in 59% of their responses to the **evaluation question**. This difference in accessibility mentions for the two questions was significant, $X^2(1) = 12.46$, $p<.001$.

3.2 Accessibility Survey

For ***accessibility knowledge***, each student could receive a total score from 0 – 50. A Wilcoxon Signed Rank test ($W = 997$, $Z = 5.44$, $p<.001$, two-tailed) determined that the median accessibility knowledge scores were significantly higher in the post-test (*Mdn* = 32, *Range* = 0 to 35) than the pre-test (*Mdn* = 18, *Range* = 0 to 50).

4. DISCUSSION

Results reported here show gains in undergraduate students' ***accessibility awareness*** and ***accessibility knowledge*** following one week of lectures on people with disabilities and on accessibility in HCI courses. To our knowledge, this is the first such quantitative evidence. Important for future work is the demonstrated effectiveness of our battery in measuring such changes.

The voting scenario test in our battery found clear gains in students' considering users with disabilities in a design task. Using this scenario, Ludi [4] originally examined potential differences in inclusive thinking about software design and evaluation. We found the instrument also sensitive to detecting increased awareness following courses that contained accessibility lectures.

The accessibility survey developed for our research was a sensitive measure of changes in ***accessibility knowledge***. In contrast to no significant changes in ***accessibility awareness***, there were significant self-reported gains in ***accessibility knowledge*** following the week of lectures in HCI courses.

The measures of ***accessibility awareness*** and ***accessibility knowledge*** are broad categories, each with multiple aspects. We believe these categories are useful in considering whether varied teaching interventions promote an understanding of the technical aspects of accessibility and / or whether they promote an awareness of the need to consider accessibility requirements during development.

5. FUTURE WORK

The current work reports on one teaching intervention during the first year of a four-year longitudinal study. Our long-term project goal is to gather information about comparative longitudinal gains regarding of multiple teaching interventions. The full longitudinal study, in progress, examines the effectiveness of interventions involving a team project related to accessibility, a classroom interaction with someone having a disability, and a team project in which a team member has a disability.

6. ACKNOWLEDGMENTS

This material is based upon work supported by the National Science Foundation under award number 1540396. We thank Ashley Miller for her contributions to early phases of this research project.

7. REFERENCES

[1] *Computer Science Curriculum 2013: Curriculum Guidelines for Undergraduate Degree Programs in Computer Science*. 2013. Retrieved 20 April, 2017 from https://www.acm.org/education/CS2013-final-report.pdf.

[2] Ladner, R.E., May, M. 2017. Teaching Accessibility. In *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education* (SIGCSE '17). ACM, New York, NY, USA, 691-692.

[3] Lewthwaite, S., Sloan, D. 2016. Exploring pedagogical culture for accessibility education in computing science. In *Proceedings of the 13th Web for All Conference* (W4A '16). ACM, New York, NY, USA, Article 3, 4 pages.

[4] Ludi, S. 2007. Introducing accessibility requirements through external stakeholder utilization in an undergraduate requirements engineering course. In *Proceedings of the 29th international conference on Software Engineering (ICSE '07).* IEEE Computer Society, Washington, DC, USA, 736-743. DOI=10.1109/ICSE.2007.46

[5] Putnam, C., Dahman, M., Rose, E., Cheng, J., Bradford, G. 2016. Best Practices for Teaching Accessibility in University Classrooms: Cultivating Awareness, Understanding, and Appreciation for Diverse Users. *ACM Trans. Access. Comput.* 8, 4, Article 13 (March 2016), 26 pages. DOI=http://dx.doi.org/10.1145/2831424

[6] Teach Access. 2017. Retrieved April 28, 2017 from http://teachaccess.org

[7] Shinohara, K., Bennett, C. L., Wobbrock. J. O. 2016. How designing for people with and without disabilities shapes student design thinking. In *Proc. 9th international ACM SIGACCESS conference on Computers and accessibility (Assets'16).* ACM, New York, NY, USA, 123-130.