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# INFORMATION SYSTEMS EDUCATION JOURNAL

## Editors

# Empathy-Driven Student Transformations: Bridging the Gap in Software Development for Inclusive User Experiences

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## Abstract

Developing empathy skills is crucial for software developers to create user-centric solutions and design exceptional user experiences addressing the diverse needs of customers. This paper presents the findings of a quasi-experimental study that aimed to enhance empathy among computer science students through the exposure of two interventions utilizing teaching accessibility design. The study included 15 participants from a computer science course. Qualitative data analysis of participants' reflections highlighted the transformative impact of the interventions, as participants expressed changes in their views towards people with impairments and reported the development of technical and soft skills, as well as enhanced empathy. The interventions also motivated participants to make changes to their team website designs, prioritize accessibility, and apply their learnings in their professional lives. A second measure assessed in this study was an expert website review which provided valuable feedback for improvement and yielded a high average score for screen reader accessibility. By equipping future computer scientists with these skills, we can ensure that technology meets the diverse needs of all users, promoting inclusivity and enhancing user experiences.

**Keywords:** Accessibility, Empathy, Career Readiness, Software Development, Inclusive Design, UX Design

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## 1. INTRODUCTION

Developing empathy is arguably one of the most vital skills a computer scientist can cultivate in today's educational and professional setting (Gunatilake et al., 2023; Karimi & Pina, 2021). Empathy offers a gateway to self-awareness, navigating interpersonal relationships, and is essential for software developers to create more relevant products. To be successful as a software developer a professional must be able to interact with a diverse group of colleagues, clients, stakeholders, and leaders. Due to the complexities of software development, teams of professionals must work closely together, putting a premium on teamwork, problem solving and communication skills (Singh et al., 2012).

Brené Brown (2018) defines empathy as a proactive, judgment-free approach to use perspective-taking to understand and resolve problems. Empathy enables developers to build better software that truly meets the needs and expectations of its users. Having empathy skills is essential for software developers because it enables them to understand and connect with the end users of their products. By empathizing with users, developers can gain valuable insights into their needs, challenges, and preferences, which in turn allows them to design and develop software that effectively addresses those requirements. Empathy also plays a central role in enhancing communication within development teams and with stakeholders, fostering collaboration and building trust (Rivas, Husein, 2022). Furthermore, empathy is a key component of user experience (UX) design, helping developers create intuitive interfaces and workflows that enhance user satisfaction. Finally, empathy promotes continuous improvement, as developers who empathize with users seek feedback and make iterative enhancements to their software. Overall, empathy skills empower software developers to create user-centered solutions, enhance communication, design exceptional user experiences, and successfully collaborate with others (Blanco, López-Forniés, and Zarazaga-Soria, 2017; Lariza Laura de Oliveira., 2020).

There are many definitions of empathy available to the scientific community. Most of the definitions characterize empathy as a multidimensional variable encompassing two major factors: cognitive empathy and affective empathy (Cuff et al., 2016). Cognitive empathy is defined as the ability to deduce and recognize the emotions of others, while affective empathy indicates one's ability to experience other individuals' emotions by observing their behaviors (Riess, 2017). It implies that people with higher levels of empathy can recognize the emotions of others and experience these emotions.

According to the World Health Organization (WHO, 2023), 16% of the population or 1.3 billion people have a disability. This includes visual, auditory, physical, speech, cognitive, language, learning, and neurological disabilities. It is crucial for computer science students, the engineers of future technology, to comprehend and empathically experience the usage of the technology they develop from the perspective of individuals with disabilities. This understanding is not just about accessibility; it's about deeply appreciating the challenges and barriers faced by people with disabilities. Such an experience can profoundly influence how these future experts design and innovate, ensuring their creations are inclusive, accessible, and truly serve the diverse needs of all users (Lay-Flurrie, 2021; Walther et al., 2017; Wolberger, 2023). Such technology will often require the implementation of special products such as screen magnification software, screen readers, speech recognition software, special keyboards for communication, and more. Moreover, these skills are rarely taught as part of computer science education (El-Glaly et al., 2020; Ferati & Vogel, 2020).

Empathy plays a pivotal role in the design of accessible software, ensuring it delivers robust solutions for its users (Paananen, Visuri, van Berkel & Hosio, 2023). When software developers empathize with individuals who have different

abilities, they gain a profound understanding of the challenges and obstacles they face when using technology. This empathetic approach empowers designers to proactively identify and address accessibility issues, creating inclusive software that can effectively cater to a wide range of individuals, including those with disabilities. By incorporating accessible features, intuitive navigation, clear interfaces, and alternative input methods, empathetic designers enable users with disabilities to access and engage with software effectively. Furthermore, empathy fosters an inclusive mindset that goes beyond mere compliance with accessibility standards, aiming to provide a meaningful and enjoyable experience for all users. By embracing empathy, software designers become catalysts for breaking down barriers and promoting universal access to technology, ultimately enhancing the lives of individuals with disabilities and fostering a more inclusive digital landscape.

The Empathy Lab experience utilized in this study consisted of two interventions designed to allow students to have an immersive experience from the perspective of a person with a disability using a variety of assistive technologies. Students were instructed to develop a website for a young elite triathlete. In the first intervention, students were informed that their client is blind. They learn firsthand about her lived experiences and how she engages in daily activities familiar to them such as taking notes in class, buying clothes at the bookstore and reading textbooks. After gaining insights regarding their client, students are offered the chance to use a screen reader while blindfolded per their client's suggestion. The second intervention focuses on five hands-on activities such as writing appropriate alt tags, understanding WCAG compliance requirements, hearing and physical ability simulations and developing accessible code. This is in alignment with studies reporting frustrations experienced by blind users (Lazar, Allen, Kleinman and Malarkey, 2007).

Students discover that designing technology with empathy for a diverse range of users can lead to a final product that is not only more enjoyable but also easier to use for everyone, not just the initial target audience. By focusing on inclusivity, particularly for those with disabilities, we inadvertently enhance the overall user experience for all. (Steere, 2008; Norman, 2013).

## 2. LITERATURE REVIEW

Empathy is increasingly recognized as a cornerstone of effective computer science education. Blanco, López-Forniés, and Zarazaga-Soria (2017) argue that empathy is a foundational skill for informatics students, crucial for fostering teamwork competences. This is further supported by Lariza Laura de Oliveira (2020), who explores the student perspective on empathy in the computer science classroom, offering valuable insights into its importance. The emphasis on empathy extends to accessibility education, where Baker, El-Glaly, and Shinohara (2020) highlight its significance for understanding the needs of users with disabilities.

In the realm of software development, the application of empathy has shown to be of paramount importance. Levy (2018) emphasizes the integration of empathy into software engineering courses to deepen students' understanding of user needs. This is echoed in the work of Levy and Hadar (2018), who stress empathy's critical role in privacy requirements analysis, designing systems that respect user privacy concerns. Lundström, Åberg, and Blomkvist (2015) highlight how empathy fosters effective collaboration between developers and designers, enhancing mutual understanding. For mobile applications, Papoutsi and Drigas (2017) demonstrate that empathy is crucial for user-centric app design.

Empathy enhancement through innovative methods has also been explored. Kletenik and Adler (2022) creatively utilize games to instill empathy and promote accessibility awareness. The potential of virtual reality to strengthen empathy and mastery learning is investigated by Abadia, Calvert, and Dasika (2019), with support from Zhongxiang's (2023) meta-analysis, which suggests that virtual reality can effectively enhance empathy. Additionally, gamification techniques have been shown to foster empathy, especially for individuals with invisible disabilities, as illustrated by Gonzalez, George, Miteva, and Singh (2023). The Accessibility Learning Labs (ALL) developed by a team from RIT exemplify the application of empathy in educational settings. These labs use an experiential learning approach to educate participants on creating accessible software, demonstrating the importance of accessibility across various topics such as colorblindness, hearing, blindness, and dexterity (Shi, Malachowsky, El-Glaly, Yu & Krutz,

2020; Moses, Thazin, Nalachowsky & Krutz, 2023). This initiative underscores the need for empathy in designing accessible technology and educational materials.

Industry has also embraced empathy-centric design principles. Drouet, Sleeswijk Visser, and Lallemand (2023) showcase real-world applications of empathy-centric design. Their work highlights a series of case studies and examples where empathy is at the core of the design process, demonstrating its critical role in understanding and meeting user needs.

The literature reviewed underscores the growing recognition of empathy's significance across various domains of computer science education and software development. Empathy fosters effective collaboration, user-centric design, and a more inclusive digital world. Innovative methods to enhance empathy, such as virtual reality and gamification, alongside empathy-centric design in industry and educational settings, demonstrate the multifaceted approach required to cultivate empathy in the field of computer science.

## 3. METHODOLOGY

Our study included a sample of participants who had voluntarily registered for a software engineering II course offered in the Spring of 2023 semester. The institutional review board conducted an expedited review of this study, and their approval was received.

**TABLE 1**

*Sample Distribution*

| Intervention | Client Reveal | Empathy Lab |
|---|---|---|
| Total number of participants | 14 | 15 |
| Gender - female | 21% | 20% |
| Gender - male | 79% | 80% |

This study used qualitative methods approach along with an accessibility expert review. The qualitative research was based on the reflections collected after each of the two interventions: the reveal of the client's condition and the immersive Empathy Lab intervention in the software engineering II class. Reflective questions are listed in Appendix A. All students in the sample were seniors and the assignments were required and graded part of the class. However, students had to opt into the study for the authors to use their reflections. As shown in Table 1, not all students who gave permission completed the assignment for the first reflection.

Both conditions included six identical questions about the students' views on people with impairments, skills they developed, potential modifications of their project deliverables, views on future design and development of technology, application of key learning, and feedback on the effectiveness of the interventions. The reflections were typed and managed anonymously. Qualitative data interpretation was organized in four stages: 1. the researchers developed a codebook (appendix B & C), 2. researchers coded the data and 3. validity was established through interrater reliability and 4. data was analyzed and interpreted. The code book was developed using three distinct methods. The first method utilized traditional coding, the second was implemented through AI-assisted coding, and the third method employed the NVivo software. The NVivo software helped organize, analyze and discover insights for non-numerical or unstructured data. During the process of manual coding the researchers used inductive reasoning and identified major themes along with the codes for each response organized into a database. In the process of AI-assisted coding, prompts were fed to ChatGPT for refinement of the extraction. ChatGPT produced a list of key findings along with the corresponding quotes. The manual coding provided the frequency of codes along with deeper interpretations (appendix D). The AI-generated content was then integrated into the output produced by the manual coding. Finally, the responses input into NVivo for further refinement.

A final measurement in this study was an expert analysis the websites the student teams designed provided by the blind elite triathlete. The sites were reviewed twice during the semester with feedback for improvement. A final grade was assigned based on the "readability" of each of the sites. The user accessibility rating contributed to the assignment grade.

## 4. RESULTS

### 4.1 Qualitative Results

**Intervention #1: Client Reveal**

After coding, the researchers quantified the responses within each category. This involved counting how many responses fell into each predetermined category or theme. The final step was to calculate the percentages based on the

quantified data.

**Question 1**:
To the question inquiring as to whether the participants' view about people with impairments changed after revealing the client's condition, 71% claimed it changed, 7% reported an unchanged view and 21% remained neutral. Respondents whose view changed after the intervention noted the respect for people with impairments when it comes to navigating the website, spending time on making technology work for them, and running screen readers and narrators. Some respondents expressed how seemingly frustrating it could be for people with visual impairment to run "something you work with daily", empathy for spending "some time in their shoes."

**Question 2:**
Participants were asked if they developed any new skills during the workshop. All fourteen participants were positive about developing certain skills. And these skills were linked to navigating websites with the help of a screen reader (71%) and using a keyboard (7%). Of respondents, 22% claimed they developed their empathy skills: "I think my empathy skills developed some more. Getting to work with it and understanding the difficulty helps me see things from the point of view of others who may need this technology". Some respondents started to think how the experience might impact their future: "From now on I'll be more conscious of these things" and "I will take my time in everything I do from a perspective of an impaired person." Incorporating and testing accessibility might be a key element from this experience: "I learned how important it is to incorporate accessibility into our websites."

**Question 3:**
All fourteen respondents agreed to make changes to their existing website to "appeal to the clients" and to include "the basic accessibility features". They envisioned doing these with the help of divs (7%), better headers (14%), more efficient use of screen readers (21%), and more descriptive alt tags (50%). All students stated they need to make various changes: "will make many changes to our website after going through this workshop" to make the website "easier to navigate", "less cluttered", and to "include assurances that our images will be able to be read out in descriptive fashions".

**Question 4:**
The next question considered changes to designing and developing technology in the future. Of the respondents, 71% were positive about taking steps towards more accessible technology in the future while 28% found they would make changes if they are relevant Fifty-eight percent expressed their plans to help accommodate diverse needs and make everything they produce more accessible:

> "I will improve on what I know and create all my future technologies to be accessible to people with impairments and for them to easily navigate them and to have the ability to reach their goals at the same time as someone who does not have impairments."

**Question 5:**
The question enquired about how participants could apply the key learnings of the workshop in their professional life. Of the participants, 93% had a clear view on how to apply their key learnings, while the remaining 7% was unsure. Twenty-eight percent noted that the employers' expectations might play a role in how they utilize their newly acquired skills. They also found that possessing the skills and mindset of inclusivity might aid them when looking for jobs: "Some companies really care about this, so if I am applying for a job at that company".

These might be useful when already working for an organization: "The best companies and government websites put a large emphasis on things like accessibility so ( … ) having empathy for others will be a good thing to have and show to my employers". These skills might prove useful: "I will make it an effort ( … ) to always include accessibility settings to help people with impairments easily navigate through the product". The efforts to "make pages simpler and easy and short" and to create a good layout with "attention ( … ) to the way a site will be read from someone using a screen reader" were also considered by the participants. Fifty percent found that generally thinking of inclusive application would be a key requirement of developing any piece of technology. Of participants, 21% wished to be "informing others about using techniques that help with accessibility".

**Question 6:**
As far as the content and delivery of the workshop went, participants were asked to provide their feedback and 93% found the workshop useful. Participants especially emphasized "many problems with trying to use the screen reader",

the "format of the workshop", "the contrast between navigating through the website with the navigator when not blindfolded", and the overall "understanding how the [client] uses technology". Participants expressed their wishes to demonstrate "using the screen reader with other aspects of the computer such as desktop applications". They would have also wished to see real-life presentation from the client: "Something that would be helpful would be to see how [the client] uses a website herself in depth, so we get an even better understanding". However, the practical nature was highlighted: "with learning anything it is better to do it with practice and that is what this workshop has done so it was very helpful in helping us get a better understanding of the concept".

**Intervention #2: Empathy Lab**

The second intervention was the Empathy Lab after which students reflected on the same set of questions as the one after the first intervention.

**Question 1:**

To the question on the view about people with impairments 93% of the participants noted that their view has changed after the intervention while 7% remained neutral out of the total of 15 responses. Participants referred to empathy (64%) as the main factor that has changed after the intervention. Some views expressed milder sentiments: "Getting into their shoes, and actually feeling what they might makes me feel even more empathy for them". Others have shared stronger sentiments on the topic: "To pass judgment onto someone just because they're different from you is fairly obdurate and quite frankly inhuman".

Participants agreed that understanding the challenges faced by individuals with specific impairments is imperative in their personal and professional life: "Putting myself in their situation with the exercises has shown me how important it is to be able to make it easier for them". And this might contribute to changes in the way they complete tasks in the future: "The lab showed me how to create a more engaging software that will be able for people of all kinds of disabilities to use without any hitches".

**Question 2:**

The second question was enquiring about any new skills that students have developed as part of the exercises. Of the responses, 71% included mentions to different applications such as those related to images: "I improved my skill of being able to better explain a picture without ( … ) making the description too complex." Similarly, "I had to find creative and descriptive ways to explain a picture.", the use of alt tags: "I developed the ability to create more meaningful alt tags to make images more accessible", or more effective color selection: "One new skill I learned is finding more accessible colors.". Designing with accessibility was the main finding for them: "I feel I've gained the ability to better design things to fit people from all walks of life, not just for people like me". However, the findings were not only referring to technical skills but those of soft skills. As one participant claimed he "also learned how to apply teamwork to help with getting through a challenge caused by an impairment". Of the responses, 50% of the responses indicated the development of these soft skills as a result of the intervention: "Experiences like these are important to refining one's sense of empathy, especially for those that one may never consciously think of".

**Question 3:**

To the question of whether students were going to make changes on their teamwork website, all responses indicated unanimous agreement for the need for practical considerations inspired by the content of the workshops. Participants were looking at ways of redefining alt tags: "revising the alt tags for images to be better tailored to blind people.", color selection: "Our color scheme is lacking contrast between the text and different background colors.", and turning the content more concise: "In terms of length, it should be short and concise, with a lot of detail on colors". One participant even considered "testing every feature to make sure it works correctly and for everyone no matter the disability".

**Question 4:**

The next question looked at potential change participants could make to their way of designing technology in the future. All the 15 responses expressed the wish to do so; people-specific changes surfaced in 43% of the responses, while 64% of responses mentioned tech-specific ideas. Awareness and education were considered to be useful when planning for accessibility in the future with one participant referring to advocacy ("will apply to my professional life because I can advocate for more awareness for people with disabilities and impairments.") and another to education ("probably educate people on practical programming and design with these thoughts already in mind."). User experience was another highlight in future-proofing design ideas: "I also want to make sure that any technology I work on is not only usable, but enjoyable for all people to

use". In addition, "I will definitely adjust how I develop tech as a result of this workshop. ( … ) the simpler and more logical way they're designed and made to be used for, the easier it is for the average user to figure out."
Participants highlighted several technical considerations, such as easy navigability (21%), testing screen readers (14%), efficient use of alt tags (21%), clearer application of colors (28%), and overall design ideas (14%). It was apparent from the responses that students were not only thinking of what to change but also of how to change them:

> "I have made it a goal to study accessibility features and how to implement them in the best way possible…That includes alt texts, organizing the sections to make it easier for the navigation system, and making the color, font, and style much more visible and easier to look at."

**Question 5:**
The next question sought students' ideas on how they might apply the key learnings from the project in their professional life. Of the responses, 93% indicated firm ideas about future application of the learnings on accessibility and inclusion. One participant thought of testing their product: "Going forward I would make changes to my designs and be sure to have them thoroughly tested for usability". Others were thinking of what to do with the newly acquired skills: "I'm going to take the skills that I learned from this project and make sure to apply them daily whether I am a developer or have another job". And considerations of career prospects were introduced, too: "I want to be in the front-end developing career path which means I will need to pay attention to this". Some participants looked at the employers' perspectives: "change the ways they implement their products to meet the needs of impaired individuals". And someone already thought of what values to look for when applying for jobs:

> "There's a few values I want to see in companies when I apply for positions... I will advocate for accessibility development when I have a job."

This tied in with another response highlighting empathy as the key take-away from this project:

> "I can apply this workshop by showing stronger levels of empathy with the impaired, whether it's a client or teammate… I can also make sure the way I carry myself is more in line with peoples' disabilities so for situations where I'm with someone in person, I'm more empathetic."

**Question 6:**
The last question was asking for feedback on the delivery of the Empathy Lab workshop. Most participants found it useful (78%), only 7% was indifferent as they already claimed to have enough awareness on accessibility features. Of the responses, 43% indicated that students would have loved to spend more time on the activities. Participants also stated "the only thing that I would think would be useful in the future is more time at each station" and "something that can be addressed is the tools for those who can't type or touch the screen and would have to talk to make a command". Participants indicated that:

> "It was good to highlight the different disabilities that exist in a safe, learning environment... it was good to simulate some of these as it allowed us to properly gain insight into what people experience so that we may be more considerate when designing our future applications."

**The Expert Website Review:**
The client provided feedback throughout the lab after her blind condition was revealed. She remarked on her "readability" of the web sites and offered direct feedback for improvements. Some comments addressed screen reader "readability", poorly labeled images and links, and the heading structure. At the end of the semester, she provided a final rating from 1-10 on a screen reader accessibility: 1 being unusable and 10 being excellent. The four teams were rated between 5-10, with an average score of 7.6.

Acknowledging the absence of baseline measurements for the Expert Review, it is important to emphasize the qualitative benchmark it establishes for website accessibility post-intervention. Feedback from an individual adept in using screen readers due to visual impairment offers critical insights into the "readability" and usability of websites, insights that quantitative analysis alone may overlook. Such expert evaluations not only offer specific areas needing improvement—like screen reader compatibility, image labeling, and structural organization—but also provide actionable guidance for future development endeavors. Furthermore, this process holds significant educational value for participants, offering a direct perspective from an end-user that enhances their understanding of web accessibility challenges and solutions.

## 5. DISCUSSION

The qualitative reflections generated rich discussions on the topics in question. The responses of the reflection exercise indicated the overall success of both interventions - especially the Empathy Lab. The notion of increased awareness and increased respect of people with accessibility challenges was mentioned in all the responses. Participants claimed that the workshops increased the level of respect they feel towards people with impairments. The interventions helped them with understanding the challenges and frustrations of working with technology, especially when accessibility is not a priority in design. Furthermore, participants reported that they developed technical skills, soft skills, and, notably, empathy skills for employment. They claimed that these skills may help them in applying for their future jobs and reported gaining a general sense of direction in their career. Participants also demonstrated a high level of adaptability in making changes to the original website design. Finally, the reflections assessing the quality of interventions indicated that the workshops were meaningful and life changing.

## 6. LIMITATIONS & FUTURE WORK

Despite promising results and the representativeness of our sample, making it generalizable to other computer science classes in similar university systems, further research is necessary to evaluate its generalizability beyond this specific academic context. Future studies should encompass larger sample sizes and incorporate participants from a diverse range of universities and professional environments, extending not only within the United States but also internationally.

Additionally, issues related to various types of accessibility impairments need to be examined. These could include speech, language, and hearing, as well as physical limitations like impaired motor skills, dexterity, and mobility.

To confirm these preliminary findings, more rigorously controlled studies should be conducted. These experiments should address potential ceiling effects and examine the effect sizes. Additional controlled experiments are essential for empirical validation to provide more conclusive evidence for our initial observations.

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## APPENDIX A

### Reflection questions after both interventions

1. Did your view about people with impairments change? If it did, how did it change?
2. Did you develop any new skills during this workshop? If so, what are they?
3. Will you make any changes to your team's website design as a result of this workshop?
4. Will you make any changes to the way you design and develop technology now and in the future as a result of this workshop?
5. How can you apply what you learnt from this project in your professional life?
6. Is there anything that could be changed in the delivery of this workshop to provide a better learning experience? For example, what did you find the most useful and what else could be addressed in this workshop?

**APPENDIX B**

**Themes, codes and comments – Intervention 1 (Client Reveal)**

| Q | Themes | Codes | Comments |
|---|---|---|---|
| 1 | challenges | difficulty to navigate<br>time consuming | changed view: in 10 responses; neutral: in 1; slightly changed: in 1 response |
| | tools | screen reader<br>narrator<br>alt tags | |
| 2 | developed skills | keyboard<br>narrator<br>navigating web page<br>screen reader | all 14 responses were positive in developing certain skills |
| | developed empathy | developing empathy | |
| 3 | accessibility in general<br>functionalities | general accessibility<br>appeal<br>divs<br>headers<br>screen reader<br>alt tags | all 14 responses were positive on making changes |
| 4 | making changes | making change for diverse needs<br>making change if relevant<br>testing | 10 responses were positive in making changes; 4 responses were tentative |
| 5 | employment | accessibility as per employers' expectations<br>accessibility as per students' own discretion | 13 had a view on how to apply the key learnings; 1 was not sure |
| | research | gather more information | |
| | advocacy | informing others of accessibility issues | |
| | being inclusive | Inclusive application | |
| | design | simplicity<br>layout | |
| 6 | workshop | order of tasks<br>more explanation<br>understanding and empathizing | 5 responses on usefulness without suggestions; 1 response did not find the workshop useful but made suggestion; 8 responses found it useful and made suggestions |
| | tools | application of screen readers<br>more on accessibility features | |

**APPENDIX C**

**Themes, codes and comments – Intervention 2 (Empathy Lab)**

| Q | Themes | Codes | Comments |
|---|---|---|---|
| 1 | empathy<br>application | application<br>hard application<br>soft application | 13 changed their view; 1 neutral; 1 not changed |
| 2 | empathy<br>application | empathy skills<br>soft skills<br>images<br>software | 11 responses were positive in getting new skills; 3x were neutral |
| 3 | inspiration<br>practical consideration | ideas for accessibility<br>alt tags<br>colors | all 15 responses were positive on changes |
| 4 | people specific<br>tech-specific | awareness and education<br>legality and fairness<br>user experience<br>easy navigability<br>screen reader<br>alt tags<br>color<br>design | all 15 responses were positive on making changes in the future |
| 5 | take-away thought | think for inclusion<br>think for usability<br>empathize | all 15 responses had hints about accessibility |
| 6 | time spent on activities<br>tools and resources<br>skills | more time needed<br>less time needed<br>more tools and resources are required<br>more skills required | 12 responses found it useful (7 provided suggestions); 1 did not find it useful (provided suggestions); 2 did not address usefulness (1 provided suggestion). |

**APPENDIX D**

**Frequencies in qualitative analysis**

| Codes | Frequencies Intervention 1 | Frequencies Intervention 2 |
|---|---|---|
| alt tags | 50% | 67% |
| color | 21% | 53% |
| keyboard | 7% | 0 |
| layout | 14% | 20% |
| screen reader | 64% | 33% |
| testing | 14% | 27% |
| advocacy | 14% | 67% |
| developing empathy and respect | 50% | 60% |
| do research | 14% | 13% |
| employment-related considerations | 36% | 40% |
| inclusion | 71% | 47% |
| adding specific examples to workshop | 7% | 7% |
| application of screen reader in workshop | 29% | 0 |
| application of worksheet in workshop | 0 | 7% |
| comprehensive workshop | 7% | 27% |
| duration of workshop | 0 | 47% |
| teamwork skills | 0 | 13% |