Exploration on Integrating Accessibility into an AI course

Chia-En Tseng
tsengc2@wwu.edu
Western Washington University
Bellingham, Washington, USA

Seoung Ho Jung
jungs7@wwu.edu
Western Washington University
Bellingham, Washington, USA

Yasmine N. Elglaly
elglaly@wwu.edu
Western Washington University
Bellingham, Washington, USA

Yudong Liu
liuy2@wwu.edu
Western Washington University
Bellingham, Washington, USA

Stephanie Ludi
stephanie.ludi@unt.edu
University of North Texas
Denton, TX, USA

ABSTRACT

Understanding accessibility and how it relates to artificial intelligence (AI)-based technology is an imperative skill for computing students from both an ethical and employment standpoint. Unfortunately, AI courses do not typically cover accessibility. When teaching ethics in AI, discussions on bias and fairness cover user diversity in terms of gender and race, but *not* disability. To address the lack of teaching accessibility in AI courses, we conducted a pilot study to explore what and how accessibility topics can be integrated into an AI course, titled Natural Language Processing (NLP). We added to the NLP course some general and quick accessibility topics through means such as a short guest lecture, a programming assignment and a final project that connect accessibility and AI. We gathered student feedback through a pre-survey, a post-survey and interviews with five students. The course we looked at took place synchronously in an online setting using Zoom. In this context, we observed how implementing accessibility topics remotely into the course affected students in their knowledge of accessibility and disability.

The results did not show significant improvement on students' understanding on accessibility after completing the course. We discussed the limitations of our work, and our plans to continue the exploration on how AI courses can cover accessibility topics, so that computing students become better equipped and more aware about inclusive AI-technology development.

CCS CONCEPTS

• **Human-centered computing** → **Accessibility**; • **Social and professional topics** → **Computing education**.

KEYWORDS

accessibility, artificial intelligence, computing education

SIGCSE 2022, March 3–5, 2022, Providence, RI, USA

ACM ISBN 978-1-4503-9070-5/22/03…$15.00
https://doi.org/10.1145/3478431.3499399

ACM Reference Format:
Chia-En Tseng, Seoung Ho Jung, Yasmine N. Elglaly, Yudong Liu, and Stephanie Ludi. 2022. Exploration on Integrating Accessibility into an AI course. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2022), March 3–5, 2022, Providence, RI, USA*. ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3478431.3499399

1 INTRODUCTION

In response to the rising need for computing professionals that can build smart systems, many colleges and universities added Artificial Intelligence (AI), Machine Learning (ML), and Data Science courses to their curriculum. Unfortunately, many of these courses do not cover ethics [9, 14]. While smart systems have the potential to support people with disabilities, several mainstream smart systems are almost obsolete to people with disabilities [15]. This is because accessibility is usually an afterthought in software development in general [27], and in AI-systems in particular [32].

Accessibility has been taught in several computing courses [4], such as programming courses [11, 19], and design courses [24]. Other researchers created a whole course on accessible computing [10]. However, AI courses did not receive such an attention on incorporating accessibility into their curriculum despite the extensive research on teaching ethics in AI courses [17]. Ethical considerations in AI usually look at the diversity of users in terms of gender and race, but not disability [25, 32], and so teaching ethics in AI followed the same pattern of excluding accessibility from the discussion [6, 17]. Hence, we are seeking to establish accessibility teaching materials for AI courses and to increase student awareness on accessibility topics in the realm of AI and machine learning.

The research was conducted in the Natural Language Processing (NLP) course which is an elective course in the computer science program at Western Washington University. The teaching methods that were found effective in teaching accessibility included lectures, projects, and interaction with individuals with disabilities [33]. Hence, we incorporated a guest lecture, a programming assignment, and a final project that cover AI topics with emphasis on accessibility to improve students' learning of accessibility. The guest lecture introduced not only the basic concepts of accessibility, but also examples of AI systems that are used as assistive technology, and an example of a non-inclusive AI system that demonstrated the importance of accessibility. The assignment and the final project were designed to contain accessibility features while keeping the integrity of the NLP learning objectives.

We collected students' feedback using pre- and post-survey, in addition to follow-up interview after the end of the course. Our findings indicated that our interventions had small impact on students' knowledge on accessibility. With the qualitative analysis of the interviews, we were able to plan for further improving the interventions in future offerings of the course. The contributions of this work are: (1) Presentation of an AI assignment and a list of AI projects that cover accessibility and do not require extra preparation from the AI instructor. (2) Empirical findings on the effectiveness of our approach, and discussion on improvement plan of the teaching materials.

2 RELATED WORK

2.1 Teaching Accessibility in Computing

Teaching accessibility in engineering and design courses has been a growing topic of discussion both within academia and beyond, as schools and companies realize the need to assist students in not only acquiring technical skills but also human-centred ones. There is an increasing need in awareness for worldwide accessibility standards of technology, and an increased demand for engineers and designers who understand diverse social and ethical responsibilities pertaining to technology innovation.

Though there is such a need in industry, recent papers have reported a lack of cohesive accessibility teaching methods in higher-educational institutions for computer science courses, where focus mainly centres towards courses on human-computer interaction or on web development as opposed to AI-specific courses [7, 8, 20]. There have been longitudinal and short-term studies that documented accessibility teaching interventions such as lectures, project-based learning, working with individuals who have disabilities, and media-based learning such as videos and movies [24, 28, 33]. In our study, we employed similar teaching interventions, i.e., lecture and assignments, but in an AI course.

2.2 Teaching Ethics in AI Courses

Studies have been conducted on the teaching of ethics to students in computer science courses, including ethics in relation to the fields of AI and machine learning [6, 16, 30]. However, though studies mentioned developing courses to teach students about ethical reasoning, ethical design, and ethical implementation, they do not seem to mention ethics in terms of accessibility or universal design.

From previous literature we see that there have been studies conducted on teaching accessibility in mainly HCI or web-development courses with various teaching methods. In addition, we also see that ethics within AI or machine learning courses are being discussed, but often not within the context of accessibility. Thus, through this research we address the gap of specifically incorporating accessibility teaching interventions into AI courses.

2.3 Bringing Accessibility to Students Attention

Studies show that accessibility related interventions result in an increase of students' awareness and knowledge on the topic [7, 8, 24]. In order to encourage students to reflect more on accessibility, it is required to have them exposed to accessibility related topics. Increasing awareness would motivate students to consider accessibility measures in the future which could also increase their level of knowledge and empathy [21]. Higher motivation may provoke students' desire to voluntarily acquire knowledge [19] and would be able to develop their sense of empathy. We may increase the motivation by focusing on students' personal interest [1] or by creating a concrete connection between accessibility related topics and industry-related skills [22]. Since the main course objectives for AI courses often do not cover accessibility, we studied how to include accessibility topics in an AI course through multiple interventions.

3 METHOD

We implemented three interventions to cover accessibility in the Natural Language Processing (NLP) course, taught in Spring 2021. This is a 4-credit, 10-week, elective course in a quarter-based system offered for students in the computer science major. The course was taught synchronously on Zoom due to COVID-19. The enrollment capacity was 35 and the class stayed full throughout the quarter. Fundamental concepts, algorithms and applications regarding natural language processing are covered in this class. Programming assignments and projects are introduced for students to gain hands-on experience on text processing. Throughout the quarter, we implemented three interventions: a guest lecture, an accessibility related assignment, and a final project that offers the opportunity for students to choose an accessibility related topic. The teaching materials can be found on github[1].

We collected students' feedback using pre- and post- surveys, and follow-up interviews. The study was approved by the Internal Review Board (IRB). In the following, we will give a detailed description on each of the three interventions aforementioned.

3.1 Guest Lecture on Accessibility

A guest lecture was given by a faculty member as a domain expert other than the course instructor during the third week of the quarter. Through an approximately 15-minute-long presentation, students were introduced to the basic concepts and the importance of accessibility in computing. The presentation highlighted examples for how AI and ML can be used in developing accessible technologies for people with disabilities. Discussed examples included automated captions, contrast analysis of an image, and text simplification. The presentation also included examples for serious and fatal problems that can occur if ML models and datasets excluded people with disabilities [32]. The deck of slides containing the presentation, references, and suggested readings, was shared with the students afterwards.

3.2 Accessibility-related Assignment

As the programming assignment one (Assignment zero is a small warm-up programming assignment that focused on the introductions of the NLP toolkits including NLTK [5] and spaCy [18], and the development environment Google Colab[2]), it was introduced in late of week 2 and made due in the middle of week 4. The description of the assignment goes as follows:

- *Title*: Text Classification

[1] https://github.com/Teaching-Accessibility/Accessibility-AI
[2] https://colab.research.google.com/

- *Description*: For this assignment, we'll be building a text classifier. The goal of our text classifier will be to distinguish between words that are simple and words that are complex. Example simple words are *heard*, *sat*, *feet*, *shops*, and *town*, and example complex words are *abdicate*, *detained*, *liaison*, and *vintners*. Distinguishing between simple and complex words is the first step in a larger NLP task called *text simplification*, which aims to replace complex words with simpler synonyms. Text simplification is potentially useful for rewriting texts so that they can be more easily understood by younger readers, people learning English as a second language, or people with learning disabilities [13, 23, 26].
- *Data and Assessment:* Students were provided with training and development data that has been manually labeled. Students were also given a test set without labels. Students were tasked to build a classifier to predict the labels on the test set.
- *Deliverables:*
  - Implementations for the functions in the skeleton code.
  - Model's output for the test set

A more detailed description on the complex word identification task was given along with the specific data examples and the data format explanation in the subsequent sections in the assignment release. Students were asked to follow the instructions to implement and evaluate three non-ML based baseline models, two ML models and one ML model of their own with the requirement of outperforming the baseline models. Error Analysis on the built models was offered as a bonus question in the end.

3.3 Final Project

The final project was in a larger scale and had a wider scope than the programming assignments and accounted for almost one third of the final grade. It was introduced later in the course. Students were allowed to work in pairs, and had four weeks to complete the project. Unlike the aforementioned programming assignment on text classification, students were given a list of topics for their final project and they can select the one they prefer. They were also allowed to propose one not in the list.

The list of projects was compiled in such a way that that every project had an equivalent level of difficulty with respect to NLP skills and knowledge. We also tried to keep the applied domain of the projects to be diverse, e.g., some projects were related to news, others were related to music, etc. We wanted to observe how many groups would choose accessibility related topics over non accessibility related topics. The final project topics that students chose go as follows (projects with bold font are accessibility related):

- Tweet clustering and topic modeling
- Haiku generator
- Toxic comment classification
- **Text complexity assessment on Shakespeare plays** - Automatic classification of a text according to its level of complexity can enable suitable recommendations and selections of materials to a learner. This can particularly help children with dyslexia.
- Question answering system using BERT
- **An autocomplete system for the Scottish Gaelic language** - An autocomplete tool can make it easier to type text by providing suggestions based on the characters already typed. This particularly helps people who find typing difficult and people who may be susceptible to spelling mistakes.
- Sentiment analysis on vaccinations over the course of the pandemic
- Neural language models for song lyrics generator
- News generator that simulates the local student newspaper
- Neural language models for children's stories generator
- **News article summarization** - Summarization is the task of producing a shorter version of one or several documents that preserves most of the input's meaning. This could potentially help people with reading disabilities.
- **A summarization system of BBC political news articles** - Same as above.
- Language model-based Poem Generation
- Click-bait detection from news headline
- **Automatic image caption generator** - Automatic image captioning is the task where, given a photograph, the system generates a caption that describes the contents of the image. One of its important applications is creating alt-text for images which is a particularly important for screen reader users.
- **Aspect-based opinion mining from movie reviews** - A system that automatically extracts or highlights important and relevant information for targets (or aspects of targets) can help improve comprehension for people with dyslexia or people who are deaf and hard of hearing.
- Fine-Tuning DialoGPT with movie dialogue data
- Topic extraction and sentiment analysis of tweets on the pandemic and Native American communities
- **Text simplification on climate change related articles** - Text Simplification is the task of reducing the complexity of the vocabulary and sentence structure of text while retaining its original meaning, with the goal of improving readability and understanding. Simplification has a variety of important societal applications, for example increasing accessibility for those with cognitive disabilities such as aphasia, dyslexia, and autism, or for non-native speakers and children with reading difficulties
- MCU (Marvel Cinematic Universe) story analysis project
- Lyrics-based genre classification on Indie music

Among the 21 project topics that students ended up presenting, 7 of them (marked in bold) were systems that can be useful for people with disabilities. These seven projects were either text simplification, text complexity prediction, or information extraction projects. We note here that automated text simplification systems are used as reading assistance tools that were shown to be helpful for people with various disabilities, e.g., people with dyslexia [13, 29] and deaf and hard of hearing individuals [2]. Similarly, text summarization can be used as a substitute for skimming, and it was shown to be helpful for blind people [31], and people with dyslexia among other groups of users with disability [12].

3.4 Survey

A pre-survey and a post-survey were implemented to compare students' knowledge and awareness on accessibility prior to the interventions and after the interventions. The questions were designed to determine the participants' perception and existing knowledge on accessibility similar to [24]. The survey consisted of two open-ended questions asking students about accessibility and disability, and 4 yes/no questions about students' experiences on accessibility education and interacting with people with disabilities. The survey also included 8 questions on students' knowledge of technical challenges faced by the various groups of people with disabilities, such as people with visual impairment, people with learning disabilities, and people with motor impairments.

The pre-survey was administered during the third week of the quarter, and was closed before the guest lecture. The post survey was administered during the last week of classes.

3.4.1 Participants. Twenty-six students (19 male, 6 female, 1 genderqueer) completed the pre-survey and 15 students (10 male, 4 female, 1 genderqueer) completed the post-survey. We had a total of 12 students (8 male, 3 female, 1 genderqueer), of an average age of 21.7 (σ= 1.886) completed both the pre- and post- survey. The class standing among these 12 students is senior status.

3.5 Interview

After the end of the course, we conducted a semi-structured interview to further understand students' perspective on their accessibility learning in the NLP course. The interview included questions on students' learning experience taking the natural language processing course, their knowledge regarding accessibility technologies, and their interest in further accessibility education in the future.

Interview sessions were all conducted remotely using the Zoom video-conferencing application. On average, the interview lasted for thirty minutes. Each interview was audio-recorded and transcribed for analysis. Each participant in this study was able to enter a raffle for the chance to receive a $50 electronic gift-card.

3.5.1 Participants. Among the students who participated in the post-survey, 5 of the students volunteered to participate in the follow-up interview which provided more detailed information on students' learning experience. Three of the interviewees were male, two were female, of an average age of 21.4 (σ= 1.356) and all were in the computer science major registered in the NLP class during the Spring quarter of 2021. Four students were computer science Senior students, while one was a computer science Junior student.

4 RESULTS

4.1 Survey Results

For the combined survey data, we coded the students' responses to the survey questions and analyzed the data using Wilcoxon Signed-Rank Test. In addition, we qualitatively coded the responses to the survey open-ended questions.

Using the Wilcoxon Signed-Rank Test, we did not find a significant difference between pre- and post- results on most questions. However, we did find a significant difference in students' self-reported learning on technology challenges faced by blind people (p = 0.049), and by older individuals (p = 0.023).

Ten students out of the 12 who responded to the pre- and post-survey reported that they had interacted with people with disabilities, mostly as colleagues or family members. Seven students reported in the pre-survey that they had some education on accessibility. From the responses to the open-ended we received in both the pre- and post-survey, students mentioned that disability is something that makes it challenging for an individual to accomplish certain tasks. We also noticed a tendency of students defining disability and those who have one as a subject that needs comparison with those who do not. For example, a student said:

> "Disability [is] something that someone has which impacts everyday tasks... there are things [people with disabilities] might not be able to do quite as well as others". (Student 5)

Students often described accessibility as creating something that is usable for everyone, regardless of whether someone has a disability or not. For instance, a student described accessibility as:

> "Accommodation for [people] with disabilities, often benefiting everyone in the long run". (Student 6)

By comparing the pre- and post-survey responses, we found that students answered very similarly in both instances.

4.2 Interview Findings

Two researchers qualitatively analyzed the interviews responses using inductive coding. Four themes were identified in the students responses: Accessibility Education, Self-learning Accessibility, Personal Relationships with People with Disabilities, and Personal Interests.

1. Accessibility Education

Students did not see a strong focus on accessibility topics within the current computer science curriculum, but are willing to learn more on the subject. One student gave suggestions on how accessibility topics can be incorporated into the general computer science curriculum.

A student mentioned that in general, they did not see accessibility topics as a topic strongly focused on within the computer science program. They mentioned the possibility for implementing accessibility topics throughout the core computer science curriculum as a way for students to deepen their exposure and knowledge on the subject. In addition, they also mentioned how knowing accessibility topics can assist them in technology development during the student's computer science senior project.

> "I think in general, we don't really touch on accessibility at all. It's kind of something we put on the back-burner... I think accessibility topics need to be sprinkled in throughout ... [so] you're getting kind of a general sense. I think once you get into more senior projects, then we definitely should have had something about accessibility." (Student 2)

Another student mentioned how computer science courses directly related to accessibility are often elective courses. They would be interested to register for an elective on accessibility but they would choose to finish up their core courses first.

> "I am not registered in [accessibility courses] right now. There are some other core major courses that

> I think I need to take earlier on. However, I would be interested in taking [accessibility courses] in the future." (Student 4)

In general, students responded positively when asked if they would consider taking accessibility courses in the future, but they also remarked that accessibility topics are not currently a strong focus within computer science courses.

2. Self-Learning Accessibility

Students reported on self-learning accessibility topics. Students spoke about encountering and self-learning accessibility topics through various means such as self-driven research on accessible technology and summer coding programs.

One student remarked learning about iOS development, browsing through iOS documentation, and working on iOS development as a way to learn more deeply about current usability and accessibility topics.

> "I first learned about accessibility through iOS development. I've been interested in Apple, iOS documentation, and iOS development for a long time. Apple really has this big focus on accessibility... and so I learned a lot about accessibility technology just from diving deep and looking into Apple's design and developed systems." (Student 3)

Another student mentioned learning about accessibility from a high school summer program. They mentioned much of their knowledge of accessibility came from that program.

> "I think what I know about accessibility mostly came from my experience with a summer program in high school called Cohesive Code."(Student 5)

3. Personal Relationships with People with Disabilities

Some students reported on knowing people with disabilities in their own personal lives. Students mentioned how knowing close friends or family members can challenge them to think more about disability and accessibility.

A student who knew of close friends and family members who are blind, hard of hearing, or deaf tends to focus on those disabilities more when thinking about topics that are accessibility-related.

> "Some of the people closest to me with disabilities are blind or hard of hearing or deaf. So I tend to focus a little bit more on those disabilities when thinking about accessibility." (Student 1)

A student mentioned having a parent who has a medical condition that prompts them to use more accessible technology. The student remarks that they are uncertain if they would classify their parent as having a disability even though their parent uses assistive technology.

> "I do not personally have a disability. I wear glasses, but I can see up close, so it's not an issue. However, my parents have bad eyesight and so my mom always uses really big text, but I don't know if I would classify that as an actual disability." (Student 2)

4. Personal Interests

Students comment on choosing final project topics based on interest regardless of whether a topic was accessibility-related. Students were found to have chosen topics for their final project based on personal interest that may or may not connect with topics of accessibility.

A student mentioned selecting a poem generator as their final project choice. When we asked why they chose the particular topic, they mentioned how it seemed like an interesting project to do and that they did not give particular thought about whether to choose an accessibility related or non-accessibility related final project.

> "Our final project was basically trying to generate poems given a whole big dataset. For me personally, I didn't think about accessibility at all... I think we were just going after what sounds cool and what would be a cool thing to do." (Student 2)

Another student mentioned working on an accessibility related auto-complete and auto-correct tool for typing Gaelic. They mentioned that they chose this topic because they were interested in the language. Despite not focusing too much on explicitly picking an accessibility-related topic for the final project topic, they ended up choosing this topic which connects well to language accessibility.

> "I've been learning Scottish Gaelic. [Gaelic] is extremely hard to type, so if it's extremely hard to type, it means that the language will be used less online... I wouldn't say it's like a super obvious connection with disability [and] accessibility, but I'd say it's definitely accessibility in the sense of making technology more accessible to those who speak a different language." (Student 3)

5 DISCUSSION

5.1 Teaching Accessibility Resources for AI

While keeping the learning objectives of the NLP course seamless, it was also required to keep the interventions explicit enough to help students remember and solidify accessibility topics within their consciousness. As NLP is a very broad sub-field of AI and only ten weeks were given to cover a wide range of topics, the NLP course in question focused solely on the data in text format and aimed to cover the core NLP techniques and algorithms. The reason that we focused on natural language processing in text format only is twofold: 1. It is a common practice in the discipline; and 2. Students are not expected to have prior knowledge on Signal Processing or Computer Vision. As most of the current accessibility related applications that use NLP techniques involve speech processing including a screen reader, or image alt-text generation that has the image recognition as an integral part of the task, most students are not technically ready to take on such a task when they are in the NLP course. The assignment and the final project were focused on text-based topics since non-text-based topics require prior knowledge on more sophisticated tools, such as signal processing or computer vision, which are not prerequisites for the NLP course. Finding relevant materials and applications that can directly combine the NLP topics covered in class and accessibility topics seamlessly was one of the major challenges faced. Resources that we found inspiring include a Workshop on NLP [3] for Improving Text Accessibility and Text Simplification [3].

[3] https://aclanthology.org/volumes/W13-15/

We note that only the guest lecture was delivered by a Human Computer Interaction professor, while the assignment and the final project were carried out by an AI professor. This implies that with the creation of "Accessibility for AI" teaching materials, AI professors can find it easy to integrate accessibility into their teaching.

5.2 Effectiveness of the Accessibility Interventions

The survey and interview results showed that the interventions had little impact on students' knowledge on accessibility. The Wilcoxon Signed-Rank Test on the combined pre- and post-survey data reported only one factor, i.e., knowledge on technology barriers, that showed a significant difference. The interviews revealed that students were looking for more opportunities to learn about accessibility. In general, the interventions did not significantly affect students' education on accessibility.

Similar to previous work, we found that students overlooked the connection between assistive technology and accessibility, such as Braille in [19], and reading assistance in our work. This may indicate that there is an actual need to integrate human-centered perspective in non-design computing courses, so use cases become a natural thought to students when working on their different programming assignments.

Based on our findings, we suggest the following to improve the integration of accessibility into AI courses:

- Make the connection between AI topics and accessibility more explicit.
- Reinforce learning through repetition and consistency of presented accessibility materials.
- Encourage students' engagement with AI-accessibility topics by involving students in discussions and reflective writing.
- Mix accessibility assignments and projects with topics that are more appealing to students or trend-adjusting, such as social media and gaming.

5.3 Drawing Student Interest

Students tend to show higher motivation towards topics that are closely related to their personal interests [1] or that will acquire them advantages for their future careers. First of all, implementing accessibility to trend following topics would be able to draw higher motivation. From the final projects, we learned that 5 student groups chose topics that mainly concerns social media and 3 groups chose topics that are related to pop culture. Similarly, the interview results showed that students with an interest in the accessibility field are willing to take future courses that mainly covers accessibility. Secondly, two students from the interview mentioned that they would not take accessibility classes because it does not seem to be related to the career that they are pursuing in the future. In other words, if they could find an advantage in learning accessibility for their career, they would more likely be interested in the topic. In order to achieve this objective, we may provide the students with resources that demonstrate the importance of accessibility in the technology industry and motivate them to reconsider the leverage of accessibility.

5.4 Limitations of the Work

We acknowledge that small sample size and a single iteration of the course brought limitations to our research. Twelve out of 35 students participated in both the pre- and post-survey, and 5 students participated in the interview. Especially, there was a significant decrease of student participation in the post-survey (15 students) compared to the pre-survey (26 students). Conducting the research over multiple iterations of the course would provide comparable data, allowing us to better identify determining factors for students' accessibility learning.

6 CONCLUSION AND FUTURE WORK

Presenting accessibility in AI courses provides computing students with ethical point of view which is more and more demanded in the current society, especially with the increase in AI-systems that exclude people with disabilities [32]. We emphasize that teaching ethics in AI courses should cover user diversity in terms of disability as well as the other axes of diversity, e.g., race and gender. In this study, we incorporated accessibility topics into an NLP course while keeping the original course material seamless. We created teaching materials that tie together AI topics and accessibility. We identified a list of AI-accessibility projects that are of moderate difficulty for students, and do not require extra preparation work for AI instructors. Despite the fact that we did not observe a statistically significant change in students' knowledge on accessibility, multiple students showed interest in learning more about accessibility and were aware of the importance of this topic. More work is needed in order to improve the effectiveness of our presented teaching materials. We plan on improving the current materials by making the connection to accessibility more clear and the project topics more engaging. In the future, we will explore how accessibility can be covered in other AI courses, such as computer vision and signal processing.

REFERENCES

[1] Mary Ainley and John Ainley. 2011. Student engagement with science in early adolescence: The contribution of enjoyment to students' continuing interest in learning about science. *Contemporary Educational Psychology* 36, 1 (2011), 4–12.

[2] Oliver Alonzo, Matthew Seita, Abraham Glasser, and Matt Huenerfauth. 2020. Automatic Text Simplification Tools for Deaf and Hard of Hearing Adults: Benefits of Lexical Simplification and Providing Users with Autonomy. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–13.

[3] Oliver Alonzo, Jessica Trussell, Becca Dingman, and Matt Huenerfauth. 2021. *Comparison of Methods for Evaluating Complexity of Simplified Texts among Deaf and Hard-of-Hearing Adults at Different Literacy Levels.* Association for Computing Machinery, New York, NY, USA. https://doi.org/10.1145/3411764.3445038

[4] Catherine M Baker, Yasmine N Elglaly, and Kristen Shinohara. 2020. A systematic analysis of accessibility in computing education research. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*. 107–113.

[5] Steven Bird, Ewan Klein, and Edward Loper. 2009. *Natural language processing with Python: analyzing text with the natural language toolkit.* " O'Reilly Media, Inc.".

[6] Emanuelle Burton, Judy Goldsmith, Sven Koenig, Benjamin Kuipers, Nicholas Mattei, and Toby Walsh. 2017. Ethical considerations in artificial intelligence courses. *AI magazine* 38, 2 (2017), 22–34.

[7] Paula Conn. 2019. *A Systematic Analysis of Accessibility Education Within Computing Disciplines.* Rochester Institute of Technology.

[8] Paula Conn, Taylor Gotfrid, Qiwen Zhao, Rachel Celestine, Vaishnavi Mande, Kristen Shinohara, Stephanie Ludi, and Matt Huenerfauth. 2020. Understanding the motivations of final-year computing undergraduates for considering accessibility. *ACM Transactions on Computing Education (TOCE)* 20, 2 (2020), 1–22.

[9] Eric Eaton, Sven Koenig, Claudia Schulz, Francesco Maurelli, John Lee, Joshua Eckroth, Mark Crowley, Richard G Freedman, Rogelio E Cardona-Rivera, Tiago Machado, et al. 2018. Blue sky ideas in artificial intelligence education from the EAAI 2017 new and future AI educator program. *AI Matters* 3, 4 (2018), 23–31.

[10] Yasmine N Elglaly. 2020. Teaching Accessibility to Software Engineering Students. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*. 121–127.

[11] Yasmine N Elglaly, Weishi Shi, Samuel Malachowsky, Qi Yu, and Daniel E Krutz. 2020. Presenting and evaluating the impact of experiential learning in computing accessibility education. In *2020 IEEE/ACM 42nd International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET)*. IEEE, 49–60.

[12] Richard Foulds and Cynthia Camacho. 2003. Text summarization contributions to universal access. *Technology and Disability* 15, 4 (2003), 223–229.

[13] Núria Gala and Johannes Ziegler. 2016. Reducing lexical complexity as a tool to increase text accessibility for children with dyslexia. In *Proceedings of the Workshop on Computational Linguistics for Linguistic Complexity (CL4LC)*. 59–66.

[14] Natalie Garrett, Nathan Beard, and Casey Fiesler. 2020. More Than" If Time Allows" The Role of Ethics in AI Education. In *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society*. 272–278.

[15] Abraham Glasser, Kesavan Kushalnagar, and Raja Kushalnagar. 2017. Deaf, hard of hearing, and hearing perspectives on using automatic speech recognition in conversation. In *Proceedings of the 19th International ACM SIGACCESS Conference on Computers and Accessibility*. 427–432.

[16] Judy Goldsmith and Emanuelle Burton. 2017. Why teaching ethics to AI practitioners is important. In *Workshops at the Thirty-First AAAI Conference on Artificial Intelligence*.

[17] Thilo Hagendorff. 2020. The ethics of AI ethics: An evaluation of guidelines. *Minds and Machines* 30, 1 (2020), 99–120.

[18] Matthew Honnibal, Ines Montani, Sofie Van Landeghem, and Adriane Boyd. 2020. *spaCy: Industrial-strength Natural Language Processing in Python*. https://doi.org/10.5281/zenodo.1212303

[19] Lin Jia, Yasmine N Elglaly, Catherine M Baker, and Kristen Shinohara. 2021. Infusing Accessibility into Programming Courses. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–6.

[20] Saba Kawas, Laura Vonessen, and Andrew J Ko. 2019. Teaching accessibility: A design exploration of faculty professional development at scale. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*. 983–989.

[21] Claire Kearney-Volpe, Devorah Kletenik, Kate Sonka, Deborah Sturm, and Amy Hurst. 2019. Evaluating instructor strategy and student learning through digital accessibility course enhancements. In *The 21st International ACM SIGACCESS Conference on Computers and Accessibility*. 377–388.

[22] Megan Lawrence and Mary Bellard. 2017. Teach Access: Preparing Computing Students for Industry. In *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education*. 700–700.

[23] John SY Lee and Chak Yan Yeung. 2018. Personalizing lexical simplification. In *Proceedings of the 27th International Conference on Computational Linguistics*. 224–232.

[24] Stephanie Ludi, Matt Huenerfauth, Vicki Hanson, Nidhi Rajendra Palan, and Paula Garcia. 2018. Teaching inclusive thinking to undergraduate students in computing programs. In *Proceedings of the 49th ACM Technical Symposium on Computer Science Education*. 717–722.

[25] Ninareh Mehrabi, Fred Morstatter, Nripsuta Saxena, Kristina Lerman, and Aram Galstyan. 2021. A survey on bias and fairness in machine learning. *ACM Computing Surveys (CSUR)* 54, 6 (2021), 1–35.

[26] Gustavo H Paetzold and Lucia Specia. 2017. A survey on lexical simplification. *Journal of Artificial Intelligence Research* 60 (2017), 549–593.

[27] Rohan Patel, Pedro Breton, Catherine M Baker, Yasmine N Elglaly, and Kristen Shinohara. 2020. Why Software is Not Accessible: Technology Professionals' Perspectives and Challenges. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–9.

[28] Cynthia Putnam, Maria Dahman, Emma Rose, Jinghui Cheng, and Glenn Bradford. 2016. Best practices for teaching accessibility in university classrooms: cultivating awareness, understanding, and appreciation for diverse users. *ACM Transactions on Accessible Computing (TACCESS)* 8, 4 (2016), 1–26.

[29] Luz Rello, Ricardo Baeza-Yates, Stefan Bott, and Horacio Saggion. 2013. Simplify or help? Text simplification strategies for people with dyslexia. In *Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility*. 1–10.

[30] Jeffrey Saltz, Michael Skirpan, Casey Fiesler, Micha Gorelick, Tom Yeh, Robert Heckman, Neil Dewar, and Nathan Beard. 2019. Integrating ethics within machine learning courses. *ACM Transactions on Computing Education (TOCE)* 19, 4 (2019), 1–26.

[31] K Mona Teja, S Mohan Sai, PV Sai Kushagra, et al. 2018. Smart Summarizer for Blind People. In *2018 3rd International Conference on Inventive Computation Technologies (ICICT)*. IEEE, 15–18.

[32] Meredith Whittaker, Meryl Alper, Cynthia L Bennett, Sara Hendren, Liz Kaziunas, Mara Mills, Meredith Ringel Morris, Joy Rankin, Emily Rogers, Marcel Salas, et al. 2019. Disability, bias, and AI. *AI Now Institute* (2019).

[33] Qiwen Zhao, Vaishnavi Mande, Paula Conn, Sedeeq Al-khazraji, Kristen Shinohara, Stephanie Ludi, and Matt Huenerfauth. 2020. Comparison of methods for teaching accessibility in university computing courses. In *The 22nd International ACM SIGACCESS Conference on Computers and Accessibility*. 1–12.