Winter 2024

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Recommended Citation
Peterson, Abigayle and Elglaly, Yasmine, "Implementing Impact: A Lesson on mySQL Databases and Accessibility" (2024). WWU Honors College Senior Projects. 776.
https://cedar.wwu.edu/wwu_honors/776

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Implementing Impact: a Lesson on mySQL Databases and Accessibility

Intro

Computer Science (CS) degree programs at academic institutions across the United States offer a holistic education with technical courses ranging from data structures to artificial intelligence. As such, they offer courses to ensure their graduates are prepared with the necessary skills to build software that impacts billions of people across the world. In particular, CS curricula includes database management systems (DBMS) courses as part of its core curricula. Western Washington University (WWU), and other academic institutions with DBMS classes focus on using programming languages like mySQL (https://www.w3schools.com/mysql/default.asp) to create, manage, and design software databases. WWU’s DBMS class denoted as CSCI 330 guides students through a set of learning objectives on DBMS to ensure students meet the expectations of the technology industry. The goal of implementing innovative products at high-caliber companies like Google, Microsoft, Uber, and more underscores the importance of including a DBMS at CS programs. Indeed, the WWU CS program requires CSCI 330 because approximately 1 billion websites exist across the Internet and most require a scalable, secure database that holds important info, further highlighting the sheer relevancy and in-demand nature of holding a CS degree.

Motivation

A CS degree can lead to lucrative and impactful job prospects where graduates have the opportunity to build software and hardware impacting billions of people globally. However, there exists a huge gap in the technology industry. Out of the 7 billion people living on Earth, 15% have a disability. This could prevent them from accessing websites with important information like medical patient portals, banking websites, etc. In fact, “a 2023 study by Nucleus Research discovered that over 70% of websites contain major accessibility issues” (Bureau of Internet Accessibility) reports Bureau of Internet Accessibility blog. Consequently, these companies lost approximately $6.9 billion from competitors who have accessible sites. Digital accessibility, the purposeful design of creating user-friendly experiences for people with disabilities, addresses these challenges. Despite this, traditional CS degree programs currently fail to teach digital accessibility concepts as part of their core curricula. Classes focused on the design of accessible software, at best, surface as an afterthought, such as in optional electives. This results in CS graduates having little to no skills on building accessible software. Essentially, these graduates lack knowledge on how to build technology that helps people with disabilities have equal access to technology, furthering systematic inequalities that people with disabilities face. Even worse, a lack of knowledge on accessibility can snowball into legal ramifications.
According to the Accessibility Works blog, the researchers found that the UsableNet 2023 Year End Report received 3,086 federal lawsuits and 1,519 state lawsuits, for a grand total of 4,605 related to the Americans with Disabilities Act (ADA). The ADA protects against discrimination of people with disabilities. Through the enactment of ADA, the gap towards equal opportunity for people with disabilities shrinks. But given the amount of disability lawsuits still occurring in 2023, there is still much work to be done.

Goal

Our research seeks to accomplish the ultimate goal of digital accessibility knowledge included as a core learning objective in CS degree program curricula. By integrating these topics at the forefront of CS education, people with disabilities can have access to online information and services. This enables people to experience the world equally and helps the design of technology stay ethical. Other researchers have also started to think critically about including accessibility in CS education.

Related Work

Prior research work uncovered the gap between CS education and accessibility knowledge. Beyond HCI: The Need for Accessibility Across the CS Curriculum, makes the case for accessibility in CS education. They also find the lack of accessibility education being taught in CS programs produces CS graduates that cannot meet growing industry demands of building accessible software. “Recent industry research found a disparity between needs and employee competencies, specifically that there is a significant disconnect between understanding accessibility standards and creation of content that actually adheres to them” (Teach Access, qtd. in Elglaly, Ross, Baker, Sinohara 2). To bridge the gap, the authors proposed a concept called the Accessibility Knowledge Area, representations of competency for providing guidance towards teaching accessibility concepts within CS curricula. These Accessibility Knowledge Areas contain must-know information about accessibility and fall under pedagogical topics referred to as Knowledge Units. “We began by delineating five fundamental accessibility knowledge units: Disability Awareness, Accessibility Design, Accessibility Implementation, Accessibility Evaluation, and Accessibility Profession and Continuous Learning. These knowledge units represent clusters of competencies sought after in the technology industry” (Martin, Baker, Sinohara, Elglaly 1-4, qtd in Elglaly, Ross, Baker, Sinohara 3). Overall, Beyond HCI: The Need for Accessibility Across the CS Curriculum, effectively uncovers the critical importance of integrating accessibility in CS education in order to create successful engineers in the industry. Besides modifying teaching pedagogy to guide decisions in the design of CS curricula, another research paper explores infusing accessibility in programming assignments.

Infusing Accessibility into Programming Courses experiments with a new method of accessibility integration. “Few have included accessibility in programming courses as an add-on
topic. We studied assignments that infuse accessibility into programming topics without impacting the core computing learning objectives.” (Jia, Baker, Elglaly, Sinohara 1). The researchers “included accessibility content in programming assignments in four course offerings: Programming in C (CS1) at Rochester Institute of Technology in Spring 2018 and Spring 2019, and Object Oriented Programming (CS2) at Creighton University in Fall 2018 and Spring 2019” (Jia, Baker, Elglaly, Sinohara 2). In CS1, students learned about C pointers (https://www.geeksforgeeks.org/c-pointers/) and C arrays (https://www.geeksforgeeks.org/c-arrays/?ref=header_search) in order to convert ASCII (https://www.britannica.com/topic/ASCII) text to Braille output. In CS2, students learned about how to read accessibility test results through using Java programming language to read a file and loop through a list of data. After grading the assignment, the researchers used surveys and follow up interviews to help understand student’s newfound perspectives on accessibility. The pre and post survey results for their Sympathy factor, a benchmark for measuring attitude towards accessibility, exhibited significant variance. Additionally, “the Fear factor (pre = 0, post = -2) indicated a positive change, notably, that students perhaps felt more sympathy and less fear towards people with disabilities after the course.” (Jia, Baker, Elglaly, Sinohara 1). The survey results further exhibit the positive impact on infusing accessibility in programming assignments. Furthermore, my programming assignment formerly known as, Implementing Impact: a Lesson on mySQL Databases and Accessibility, takes the learnings of these two research papers into one programming assignment for classes teaching database management, like WWU’s CSCI 330.

Method

Database Creation

The database contains 125,000 unique records of disability facts and statistics in order to educate CS students on digital accessibility knowledge. To create this database, I created a boilerplate in Excel to start collecting resources. I used text taken from credible sources such as the United Nations - Department of Economics and Social Affairs, Law Office of Lainey Feingold, and Pew Research Center to name a few. Find the comprehensive list here (https://docs.google.com/spreadsheets/d/16zePPChgGe11feV45EDaFSCBU0tfV1ZzYuA5bUDe n4s/edit?usp=sharing). All of these sources fall under a column in each table called SourceTitle and Source_URL. After researching using the aforementioned sources of these 125,000 resources, I divided the information into groups of 50 records and implemented it into 3 different categories of information for accessibility: ethical, legal, and business cases. I divided these based on the learning outcomes from research paper Beyond HCI: The Need for Accessibility Across the CS Curriculum for including accessibility knowledge in CS programs: Motivations Behind Accessibility (Elglaly, Ross, Baker, Sinohara 3)
I needed to manually research and check against the learning objectives of the assignment. To ensure credibility, I collaborated with my research group for any misinformation. Additionally, I also included the title and url of the original resource. Because of the copious amounts of data each containing a large amount of information, I cleaned the database. To clean, I clarified the meaning of each acronym and removed extra information for brevity. After containerizing the database in an Excel file, I transferred the database boilerplate into a real database using mySQL. This required thousands of lines of code using mySQL commands like CREATE, ALTER TABLE, and INSERT INTO to name a few.

Assignment Design

This assignment aims to provide Computer Science students the complete picture behind the motivations of including accessibility and fundamentals of the mySQL programming language. Students must download a database with 250 records containing different facts and cases on disabilities. The database organized the records into three tables called Human_and_Ethical_Cases_Table, Legal_Cases_Table, and Business_Cases_Table. The Human_and_Ethical_Cases_Table sheds light on the experiences of people with disabilities. The Legal_Cases_Table shares various laws, like ADA, across the globe on accessibility, further necessitating the importance of having digital accessibility. The Business_Cases_Table provides data on how the workforce and other businesses approach digital accessibility. This table also reports on the unacknowledged contributions people with disabilities make to the industry as well.

Databases learning objectives

Students will learn how to perform basic mySQL commands that aligns with industry standards of competency. In particular, students need to learn the following commands to complete the assignment successfully: SELECT, INNER JOIN, EXISTS, COUNT, WHERE, AND, NOT, REGEXP, and AS. They need to perform queries using these commands in order to answer the fourteen carefully selected questions. To learn more, check out this website on mySQL: https://www.w3schools.com/mysql/default.asp.

Accessibility learning objectives

Beyond learning mySQL programming, the higher purpose of this assignment remains: equipping students with sufficient disability knowledge to build inclusive technology in the industry. As such, students takeaway the following learning objectives on accessibility:

1. Understanding of the experiences of people with disabilities
2. Awareness that current poorly designed software can cost businesses millions of dollars in fines
3. Recognition towards the benefits accessibility brings for people with disabilities
These objectives map to the cases and facts inside the aforementioned tables above. For instance, the Human_and_Ethical_Cases_Table maps to the first point and so on so forth.

**Assignment Description**

The assignment positions the student as a software engineer at an imaginary tech company, simulating the real-world experience of building accessible software. The description also defines terms to ensure everyone agrees with the standard definitions. You can read the assignment description itself below:

“Imagine you are a software engineer at a software company that wants to build technology that is inclusive and accessible. In this programming assignment, you will learn about important cases and statistics around people with disabilities. In order to help you succeed in this assignment, let’s understand critical definitions that will be mentioned throughout this assignment. There are two definitions of disability. There is the medical definition and then there is the social model definition of disability.

**Medical Disability:** “a disability is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions). These include, but not limited to: vision, mental health, social relationships, and more” (CDC). This medical model, however, focuses on the individual rather than the environment around them.

**Social model of disability:** This model conceptualizes disability as a result of environmental and social barriers rather than a limitation within the individual. Suppose a person with a visual impairment is trying to access a website on a computer. On that computer, there is no screen reader installed. A screen reader helps individuals that are blind or have low vision read the text on a screen. As such, this is the fault of the technology, not the person. Consequently, people with disabilities can feel isolated, excluded, pitied, and undervalued. As a collective society, we must create inclusive environments that promote equal access.

**Disability inclusion:** This concept encompasses the idea of equal access. In short, disability inclusion is “making sure everybody has the same opportunities to participate in every aspect of life to the best of their abilities and desires” (CDC).

**Digital Accessibility:** In light of the example above, “refers to the inclusive practice of removing barriers that prevent interaction with, or access to websites, digital tools and technologies, by people with disabilities” (Georgetown Law).

Additionally, the database records contains sources from credible websites like the World Health Organization (WHO), U.S Department of Labor, Pew Research Center, and more. In the tables,
you will see links to the sources in the last column. By learning about these facts, you will better understand the importance of inclusivity for different groups of people.”

Discussion

How can the assignment be used by Database instructors?

CS professors who plan on teaching a course on DBMS can integrate this assignment to build recognition of people with disabilities and fundamental understanding of MySQL commands. One component of the assignment involves an advanced topic, i.e., table joining. Hence, we recommend assigning this exercise later in the semester or quarter. After students understand the syntax of the basic SQL commands, they will have enough preparation to adequately complete this assignment. To support students’ learning, instructors can direct students to the command hints and external documentation as resources located in the assignment description itself.

Conclusion

CS instructors who desire to prepare students for building inclusive technology that ensures equal access to online information need to consider teaching accessibility. This assignment is an example for how accessibility can be integrated into a DBMS course. This will lead to recognition of people with disabilities and a more prepared future workforce of technologists. We implore both instructors and students to understand the gap between CS education and digital accessibility knowledge. The cost of not understanding has led to inequalities for the 1 billion people with disabilities. CS instructors have an important role as they are the beacons of knowledge to the next generation of technology. Bridging the accessibility gap stands out as an effective means of fulfilling this responsibility.

References

Works Cited


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