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Barrett Honors Thesis Paper

Topic: A Practical Application of Culturally Responsive Pedagogy in Computer Science

Background

CRP Theory

Based on Gloria Ladson-Billings' 1994 culturally relevant pedagogy framework, culturally responsive teaching refers to an approach to teaching and learning that facilitates the achievement of all students by recognizing that culture is a powerful force in shaping how we see ourselves and the world around us. By including content that is relatable to all cultures, and creating a culturally-supported and learner-centered environment, teachers can build on the students' strengths and cultivate academic success and individual growth in the classroom. According to The British Journal of Educational Technology, Culturally responsive computing theory "is categorized into five tenets: (1) all students are capable of digital innovation; (2) the learning context supports transformational use of technology; (3) learning about oneself along various intersecting sociocultural lines allows for technical innovation; (4) technology should be a vehicle by which students reflect and demon-strate understanding of their intersectional identities; and (5) barometers for technological success should consider who creates, for whom and to what ends rather than who endures a socially and culturally irrelevant curriculum."[2] Adapting teaching methods to align with the cultural backgrounds of ethnically diverse students leads to improved educational results for minority groups that are often underrepresented

(Hollins, 1996; Ladson-Billings, 1994, 1995). This approach considers cultural aspects such as students' ethnic heritage and customs. Factors such as different learning approaches, contributions to society, ways of communicating, and the socialization of gender roles are all shaped by students' cultural influences (Gay, 2000). Accordingly, teachers must adopt a methodology that envisions content through their students' cultural lens (Aguirre & del Rosario Zavala, 2013; Gay, 2000, 2002, 2010), instead of implementing a homogeneous pattern of teaching across students. Through effective implementation of culturally responsive pedagogy, teachers will share content knowledge in meaningful ways, while also creating avenues for students to challenge the systemic issues in society. Ladson-Billings (1994) defined CRP through three prominent tenets for instructional practices: (1) academic achievement: upholding high expectations for all students; (2) cultural competence: guiding students through the development of their cultural competence; and (3) sociopolitical consciousness: fostering a sense of critical sociopolitical and cultural consciousness in students.

Culturally Responsive Pedagogy Tenet I

The first tenet asks instructors to foster an environment that is inclusive of the instructional practices intended to help students master the content. Teachers who were able to effectively teach students of color upheld a sense of responsibility towards preparing students to be academically successful. Ladson-Billings (1994) further explained that the embodiment of CRP ‘‘requires that teachers attend to students' academic needs, not merely make them feel good''. Ladson-Billings (2006) later clarified the term ‘‘academically successful'' so to differentiate from student outcomes on high-stakes standardized tests, ‘‘What I envisioned is more accurately described as ‘student learning' what is that students actually know and are able to do as a result of pedagogical interactions with skilled teachers'." The first principle of culturally responsive teaching emphasizes that education should support student learning by aiding them in achieving mastery of the content, rather than focusing solely on performance in standardized tests.

Culturally Responsive Pedagogy Tenet II

The second tenet of CRP tasks teachers to design learning experiences that celebrate the social, cultural, and linguistic background of their students. Teachers hence view the students' backgrounds and lived experiences as an asset to their learning process. Consequently, teachers who embrace cultural competence affirm and celebrate their students' cultural identities. According to Ladson-Billings (2006) the concept of fostering cultural competence in students is the most challenging component of CRP to convey to educators. Cultural competence does not necessarily mean cultural sensitivity, but rather, ''helping students recognize and honor their own cultural beliefs and practices while acquiring access to the wider culture.'' This second principle emphasizes providing students with opportunities to explore their own culture within the course framework. This approach also opens the door to learning about other cultures, thereby enhancing their cultural competence.

Culturally Responsive Pedagogy Tenet III

The third tenet of CRP aims to develop the sociopolitical and critical consciousness of students. Teachers who integrate CRP in their classrooms cultivate opportunities for students to engage in academic discourse and activities that challenge the power dynamics within their communities. Through this tenet, students are empowered to question the social inequities they may have personally experienced or witnessed, while teachers also develop their own sociopolitical consciousness. This area of CRP was the least evidenced in the teachers' projects and is often less likely to appear in projects designed by teachers who are not well-versed or comfortable with CRP (Gay & Howard, 2000; Young, 2010). Additionally, teachers often struggle with this concept of CRP because they are lacking in their own sociopolitical consciousness (Gay & Howard, 2000). By fostering sociopolitical consciousness, students are given the opportunity to understand the cultural contexts and potential inequities behind the subjects they study. This includes examining how power dynamics, cultural biases, and social injustices have influenced the creation and dissemination of knowledge. Such an approach empowers students to question and critically evaluate the information and narratives they are taught, encouraging them to consider multiple perspectives and the role of culture in shaping our understanding of the world.

Through the three tenets of culturally responsive pedagogy, students are encouraged to leverage their ethnic background and experiences towards academic success and personal growth. By developing a sense of critical socio-political consciousness from a young age, and utilizing an inclusive classroom approach to reflect on their individual experiences, students that receive their education in a culturally responsive classroom are likely to excel academically and grow to become critical thinkers and socially aware adults.

Challenges

The exploration of culturally responsive pedagogy within online STEM classrooms remains a significantly under-researched area, highlighting a crucial gap in the literature that addresses the intersection of technology, education, and diversity. While culturally responsive pedagogy has been recognized as a vital approach in face-to-face educational settings for enhancing the engagement and achievement of diverse student populations, its application and effectiveness in the online environment, especially within STEM disciplines, warrant further investigation. Studies such as those by Gay (2000) and Ladson-Billings (1994, 1995) have laid the groundwork for culturally responsive teaching by emphasizing its importance in traditional classroom settings. There are unique challenges and opportunities presented by online STEM education such as the digital divide, the impersonal nature of online learning, and the specific demands of STEM subjects.

Most research and studies are concentrated on classes and instructors at a primary or secondary level with instructors either teaching in person or live through an online video conferencing platform like Zoom. However this doesn't translate to the deduction that culturally relevant practices cannot be applied in pre-recorded courses. Information about "the culture of the students may help inform the delivery of content and participant structures but the response of the students to the pedagogical approach should ultimately determine the approach used" (Meijas Marlon). A significant obstacle is that much of the existing research recommends adapting teaching methods to make them more culturally relevant, tailored according to student feedback. However, this becomes challenging to execute in a course that enrolls around 750 students, is delivered online, and utilizes pre-recorded lectures. Kumi-Yeboah's study which spoke to instructors teaching online courses and classes mentions that a challenge that instructors faced was "their inability to identify students and categorize them based on ethnicity or race within the online environment" and that in an online environment it was not just hard to make connections with each of the hundreds of students but was impractical to ask and remember their cultural backgrounds. "Connectedness is a crucial component of culturally responsive computing programs, but establishing a sense of community in online learning is a documented challenge in recent prior literature from the CSCW community[12, 38], let alone community in service of advocacy and social change. However, whether chosen out of necessity or for certain conveniences, learners who are in online learning environments face multiple challenges to experiencing a sense of community especially related to social and teaching presence, such as lack of feeling connected to the instructor and establishing peer rapport [46] or feeling isolated often, since there exist few social cues to build on in comparison to in-person learning" (Jaemarie).

To add to our challenge is the fact that we are trying to enhance a STEM based curriculum to be more inclusive but, "While data support that research can be enhanced by the inclusion of theory-to-practice studies of culturally relevant principles (e.g., Adjapong, 2017), the literature on urban STEM teacher learning about these principles is sparse" (Brown Bryan). Studies, like the one of Aronson and Laughter (2016) have shown that to serve diverse student populations effectively, investments need to be made in the training of quality teachers who need to be equipped with the necessary tools to promote student success. "STEM teacher education is often seen in elementary contexts within the novel use of technology such as robots and game design with weak ties to culturally relevant principles (e.g., Kim et al., 2015; Leonard et al., 2017), but the focus is on STEM as a culture of indoctrination rather than the culture of the students' lives as valuable areas of inquiry. These inquiries lack interrogation of students' cultures in STEM teacher education and actively avoid recent calls for embracing cultural relevance (Young, Young, & Paufler, 2017) and social justice–oriented goals (Sondel, et al., 2017) in STEM teacher education."

Though, “Primary and secondary education is a core time for underrepresented learners to become introduced to STEM and computing in a way that impacts their perspectives on their opportunities to make long term contributions to the field”(), culturally responsive pedagogy can be extremely beneficial at the collegiate level. As universities have people coming in from various cultural backgrounds~~,~~ enrolled in a similar set of classes, molding standard curriculum to suit different cultures can promote interest in the subject and also promote retention in STEM majors.

Previous Applications

Exploring how various schools have embraced culturally relevant pedagogy reveals innovative educational strategies that resonate deeply with diverse student populations. CRP is most often found in primary and secondary education, one such example is at Dashawn Holloway School, a STEM charter school for grades K-5, it is a charter school designed to get African American males involved in STEM education. In their study, teachers were interviewed pre and post CRP training. The pre interviews found that teachers have been exposed to culturally relevant pedagogy training in the past but have never learned how to apply it to STEM fields. However the post-training interviews revealed two primary applications of CRE for STEM teaching. “First, when teachers designed their lessons, they used a cognitive apprenticeship approach to apply CRE by focusing on teaching new content in the context of a racially specific phenomenon. Second, teachers readily used CRE in their formative and summative assessments by focusing on racially and culturally specific topics to create relevant contexts for students” (Brown et al.). One teacher Sallie integrated CRE with the Cognitive Apprenticeship approach which defines the following steps: establish a problem, model, coaching, scaffolding. Sallie was teaching a lesson on subtracting two-digit decimals, to introduce the topic she played a video in the context of buying shoes that were appropriate for their families for the students and had them write down rules. Then to model the problem, students were asked to create and exchange their own problems, problem solving in small groups. To practice scaffolding the students were asked to record a video explaining whether it is wise to buy expensive shoes using two digit decimal subtraction (Brown et al.). Another application of CRP in STEM is seen through another teacher, Serrita, and her lesson on sunlight and energy. Serrita tells the students a story about Melanin Man, "One day, I was walking down the hall. I saw two scholars. One scholar was crying [begins to act like she's crying]. It made me sad, because I don't want anyone to cry at our school. So, I went to him and asked him why are you crying? And you know what he told me. He was crying because someone said he had ugly skin. They said he was too black. I didn't understand that because I knew a story about a beautiful black bird. I thought black was beautiful." The lesson created a discussion about what students knew about why people's skin was dark. The actual STEM content was about a " simple lesson about the traveling rays of sunlight, in this particular context, through the value of having higher levels of melanin in ones' skin'" (Brown, et al.). CRP is incredibly important in primary education and just as valuable in post secondary education.

A study at Howard University looks at how they restructured their computer science department to be more culturally responsive. Specifically, the department worked to redesign its "Introduction to Computer Science" course. In this process they discovered that assignments were not scaffolded and there was emphasis on the code itself rather than solving problems

(Mejias, et al.). One of the changes they made was to use Python instead of C++ because of "reduced setup and installation on students' personal computers" (citation). As a teaching assistant for a first year programming class (CSE 205 Object Oriented Programing and Data Structures), undergraduate teaching assistants can attest to the difficulties that arise with complicated set up. While holding office hours, the days with the most students were the first couple of days setting up IDEs for the students and the middle of semester which included installing JavaFX. The setup time and complexities led to a lot of frustration from the students.

Furthermore "the new class curriculum was made more culturally relevant and emphasized computational and algorithmic thinking. It covered primitive data types, logical operators, program flow control, testing and debugging primitives, lists, queues, stacks, tuples, dictionaries, graphs, and Software Version control (GitHub). The content of the class was put into the context of students' everyday experiences and student interaction and input was emphasized. Assignments were scaffolded to include visual elements. The class went from a lecture format to one of facilitation. The first few weeks of the class now focuses on computational thinking" (Mejias, et al.). In addition to curriculum changes, course slides were also redesigned to support a wide array of students: "the first few slides are sufficient for the students who have had programming experience or are global learners, to skip ahead to the questions. For those who are new, the subsequent scaffolded content allows them to jump around to build their understanding" (Mejias, et al.). These changes led to significant success, the university's registrar office has reported "a program retention rate of 94 percent in the academic year 2015-2016, up from 74% in academic year 2014-2015 and 66% percent in the academic year 2013-2014" (Mejias, et al.). In addition to that "the pass rate for the subsequent courses in the curriculum, a C or better, has also increased from approximately 65% (2012-2013) prior to the change to 78% in the second course in the scheme and 87% percent in the third course in the scheme as of 2015-2016 academic year.”

Research Question

Culturally relevant pedagogy, while recognized for its benefits in education, appears to be less prevalent in practice than one might expect. A survey conducted by Educators for Excellence in 2023 revealed that only 26% of educators nationally believe their classroom curriculum is culturally relevant for their student population. (Miller) This suggests that there's a significant gap between the recognition of the importance of culturally relevant education and its actual implementation in classrooms. Our research question is “**Does culturally responsive pedagogy help students learn CSE 110 content better?”** To understand the relationship, we will observe how students score on worksheets crafted in a culturally responsive manner and normal classroom worksheets.

Procedure

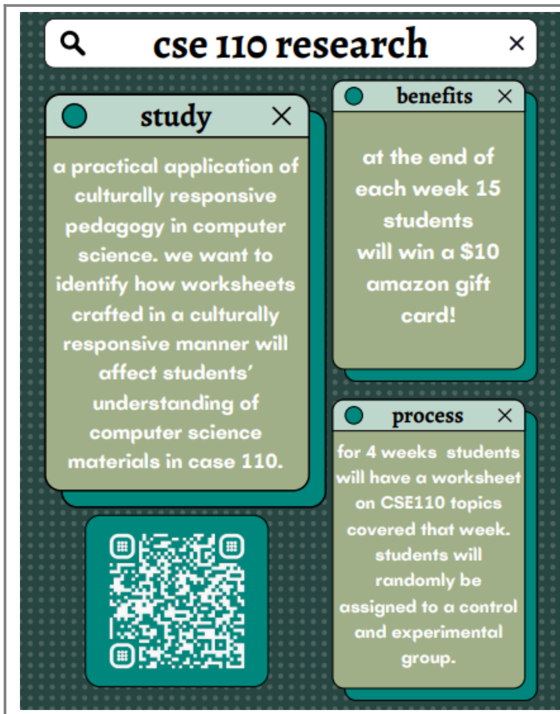
IRB Approval

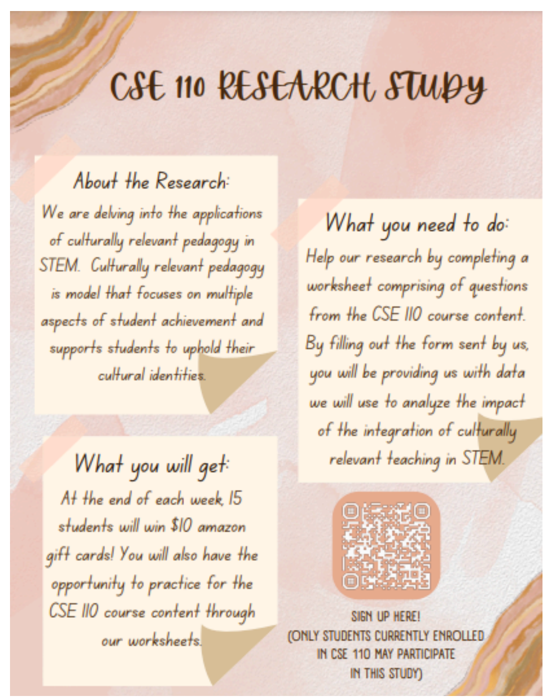
The first step of our research was to seek IRB approval, IRB is the institutional entity charged with providing ethical and regulatory oversight of research involving human subjects. In order to get approved we needed to submit all forms of correspondence with study participants, study materials and procedures. Our first step was to develop a timeline. We decided to start at the beginning of February so that students could ease into the semester and have a little bit of experience with the module before we would be testing them on it. Based on that we developed the following schedule:

Procedure	When (mm/dd/yy)	Who	Where	How Long	How/What Data
Worksheet 1 (Experimental Group) - Students will be given a practice worksheet about topics recently covered in their CSE110 course that employs a culturally relevant approach.	02/05/24 to 02/09/24	Rhea Mane, Isha Sathe, Tejal Tripathi	Online	30 min	Student score, Demographic info, student email (not tied with other data)
Worksheet 1 (Control Group) - Students will be given a worksheet about topics recently covered in their CSE110 course that does not employ a culturally relevant approach.	02/05/24 to 02/09/24	Rhea Mane, Isha Sathe, Tejal Tripathi	Online	30 min	Student score, Demographic info, student email (not tied with other data)
Worksheet 2 (Experiment Group)	02/12/24 to 02/16/24	Rhea Mane, Isha Sathe, Tejal Tripathi	Online	30 min	Student score, Demographic info, student email (not tied with other data)
Worksheet 2 (Control Group)	02/12/24 to 02/16/24	Rhea Mane, Isha Sathe, Tejal Tripathi	Online	30 min	Student score, Demographic info, student email (not tied with other data)
Worksheet 3 (Experiment Group)	02/19/24 to 02/23/24	Rhea Mane, Isha Sathe, Tejal Tripathi	Online	30 min	Student score, Demographic info, student email (not tied with other data)

Worksheet 3 (Control Group)	02/19/24 to 02/23/24	Rhea Mane, Isha Sathe, Tejal Tripathi	Online	30 min	Student score, Demographic info, student email (not tied with other data)
Worksheet 4 (Experiment Group)	02/26/24 to 03/1/24	Rhea Mane, Isha Sathe, Tejal Tripathi	Online	30 min	Student score, Demographic info, student email (not tied with other data)
Worksheet 4 (Control Group)	02/26/24 to 03/1/24	Rhea Mane, Isha Sathe, Tejal Tripathi	Online	30 min	Student score, Demographic info, student email (not tied with other data)

During the approval process we also developed the requirement material we would be using to get students to take our surveys:





In addition, the process required creating consent forms in order to collect responses as well as demographic information from students. Students were asked to sign and date the following consent form:

We are Computer Science Honors students from the Ira A Fulton School of Engineering under the direction of Dr. Tara Nkrumah from the Mary Lou Fulton Teachers College, at Arizona State University. We are conducting research studying the integration of culturally responsive learning in STEM education. We are trying to assess how culturally responsive crafted study material helps students learn CSE 110 concepts.

We are inviting your participation, which will involve completing a ~30 minute worksheet in either a control or experimental group. These worksheets will be aligned to concepts you've learned in CSE 110 that week. We will have 4 weeks of worksheets and you can choose to do however many of these as you'd like. You have the right not to answer any question, and to stop participation at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. At the end of each week you will have a chance to enter a drawing to win a $10 amazon gift card, 15 students will win each week, you can participate in the drawing each week you complete a worksheet. You must be 18 years or older to participate in the study.

No foreseeable direct benefit, there is the potential benefit for students to have extra study material for the CSE110 course and a chance to win a $10 gift card. There are no foreseeable risks or discomforts to your participation.

We will maintain identifying information only as long as it is required, with that information being deleted when it is no longer required to link data to provide compensation. Your responses will be confidential. The results of this study may be used in reports, presentations, or publications but your name will not be used. Results will be shared in aggregate form.

If you have any questions concerning the research study, please contact the research team at: igsathe@asu.edu, ttripat2@asu.edu, rbmane@asu.edu, tara.nkrumah@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788. Please let me know if you wish to be part of the study

By signing below you are agreeing to be part of the study.

One of the final parts of the process was to show proof of funding if any. In order to encourage students to participate we applied for Barrett thesis funding in order to provide students with research incentives. We applied for $600, so that each week we could distribute 15 $10 Amazon gift cards. We were approved for funding and included that in our IRB application.

This process concluded at the end of January and we were set to start survey distribution at the beginning of February.

CSE 110 Course

CSE 110 Principles of Programming is the first programming course in the sequence for students majoring in Computer Science. It is an introductory level course that teaches concepts of problem solving using an object-oriented programming language, algorithm design, structured programming, fundamental algorithms and techniques. The course is taught in Java, online with one weekly in-person lab. Our research focuses on modules 1-4 which focus on the field of computer science and what Java is; basic data types and variables in Java; the Math and Random classes; and the Scanner and String classes respectively. The more fine tuned goals of each module will be further discussed when explaining how questions for each worksheet were developed. The structure of this class is predominantly online with an online textbook and pre-recorded video lecture system, as opposed to the conventional in-person course format.One of the three tenets of culturally responsive pedagogy is cultural competence, which fosters the connection between educators and students through educational activities. This introduced the challenge of implementing culturally relevant practices to an online pre-set course.

Creating The Worksheets

The study done by Howard university quotes Geneva Gay who notes that there are three kinds of curricula (Marlon, et al.). The first is formal plans which are officially sanctioned instructional plans, which have been endorsed by the institution. The second, symbolic curriculum are the images used to convey ideas, such as the type of clipart used in instruction videos or powerpoints. Lastly there is a societal curriculum which includes the historic aspects taught, in computer science this could be the origins of an algorithm or theory. In our study we had limited access to the materials we could adapt, we could not change textbooks or powerpoints. Instead in our worksheets we adapted a section/sections of the students' textbooks into our worksheets. In the control set of worksheets the textbooks snippets were left unchanged. In the experimental worksheets we made adjustments to the snippets to be more accessible. In making these snippets more accessible we wanted to promote meaningful learning, which "suggests that building on prior experiences, knowledge, and perceptions that students possess leads to long-term learning . It enables the student to make deeper, more thorough, connections between information that they possess and new information" (Marlon, et al.). In order to create more meaningful connections to the passages we rewrote them to be analogous to a broader more common experience, such as cooking. This allows students to create a stronger connection to the material they're reading.

Week 1 Worksheet

The Week 1 Worksheet focuses on module one which includes the following goals: describe the field of computer science, describe how computers work, describe the characteristics of an algorithm, describe the characteristics and processes for writing programs and describe the structure of a Java program. With goals in mind we created the following questions:

1. Each statement in a Java program ends with which symbol?
    a. **Semicolon ;**
    b. Colom :

c. Period .

d. None of the above

2. Which statement prints the value of the variable number followed by a new line?

a. System.out.println(number);

b. System.out.print(number);

c. System.out.print(number ln);

d. System.out.println("number");

3. Assume int evenNumber = 2, what is the output of System.out.print(evenNumber + "isEven")?

a. evenNumber is Even

b. 2 is Even

c. 2is Even

d. none of the above

4. Each System.out.print() and System.out. println() statement outputs items to

a. An output file named output.txt

b. The keyboard

c. The console on the screen

5. What will happen if you run the following code:

wage = 20;

int wage;

a. a variable called wage will be assigned the value 20

b. 2 variables called wage will be created where one is an integer and the other will be equal to 20

   c. The code will throw an error

   d. Output will be "wage = 20"

6. What do you use to enclose your main function in Java:

   a. ()

   b. []

   c. {}

   d. <>

7. Given a variable int sum = 9, which of the following statements prints sum?

   a. System.out. print(sum);

   b. System.out.print("sum");

   c. System.out.print('sum');

   d. print(sum)

8. Given a variable personName, holding the value "Sally", what does the following statement print? System.out. print("Hello, my name is "+ personName);

   a. Hello, my name is personName

   b. No output, error exists

   c. Hello, my name is Sally

   d. Hello, my name is + Sally

9. What is the work of a software developer?

   a. Build websites, focusing on the look and feel of the website

   b. Focus on protecting an organization's data

   c. Create, design, and program software

   d. Help an organization use computing knowledge to operate effectively

For this week we excerpted the following passage from the textbook: [CITE TEXTBOOK]

> A computer program consists of instructions executing one at a time. Basic instruction types consist of input, process, and output. An input is where a program gets data, perhaps from a file, keyboard, touchscreen, network, etc. A process is where a program performs computations on that data, such as adding two values like x + y. An output is where a program puts that data somewhere, such as to a file, screen, network, etc. The basic components of a Java program include the following: A program starts in main(), executing the statements within main's braces { }, one at a time. Each statement typically appears alone on a line and ends with a semicolon, as English sentences end with a period. Variables are created in a manner such that an int wage statement creates an integer variable named wage. The wage = 20 statement assigns wage with 20. The print and println statements output various values on the screen, where println prints the statement followed by a new line. Writing code in Java that does not follow Java's rules on how symbols can be combined results in a syntax error being thrown by the code.
>
> There are various jobs in the industry that exist as a result of applications of computer science in the real world. Some of these professions include Software Developers, Web Developers, Computer Programmers, and Computer Systems Analysts. Software developers develop the underlying systems that run applications or devices. Web developers design and create websites. Computer programmers write code to create software programs. Computer systems analysts study an organization's current computer systems and procedures and design information systems solutions. There are multiple more professions that have arised as a direct application of computer science and are a part of a dynamic and thriving industry.

We reconstructed the passage to be more culturally responsive by comparing it to cooking:

> Think of a computer program as a recipe, which is a sequence of steps that need to be followed to prepare a dish. In programming, these steps are instructions that a computer follows one by one. These instructions can be grouped into three main types: input, process, and output.
>
> - 'Input' is like gathering ingredients for your dish. It's how a program receives information, which could come from many places - like a recipe book (a file), an order (keyboard input), a touch (touchscreen), or a phone call (network).
> - 'Process' is akin to cooking, where you mix and cook your ingredients. Here, the program manipulates the data it received, doing things like adding spices (values) together (e.g., x + y).
> - 'Output' is serving the dish. It's how the program presents the end result, which could be displaying it on a plate (screen), storing it in a container (file), or sending it to someone (network).
>
> In Java, a popular programming language used around the world, programs typically start with a 'main()' function. This is like opening the recipe book to the page with the dish you want to cook. The steps (instructions) are written in order, enclosed within curly braces {}. Each step (statement) is like a line in the recipe and ends with a semicolon (;), signaling the end of an instruction.
>
> Creating variables in Java is like naming your pots and pans for different ingredients. For example, 'int wage;' can be seen as labeling a pot for rice (an integer variable named wage). Setting 'wage = 20;' is like measuring 20 cups of rice into the pot. Java's 'print'

and 'println' commands are ways to show the cooking progress on a display, with 'println' also starting a new line, like moving to the next step in the recipe.

Not following Java's recipe (syntax rules) correctly results in a syntax error. It's like missing a step in the cooking process, leading to an unexpected outcome. Each programming language has its own recipe book (syntax), reflecting the rich diversity in how different cultures approach cooking (problem-solving and communication).

The field of computer science has given rise to a diverse array of professions worldwide, reflecting its widespread applications in various cultural and practical contexts. These professions include, but are not limited to, Software Developers, Web Developers, Computer Programmers, and Computer Systems Analysts.

- Software Developers are the creative minds who build the foundational systems for applications or devices, adapting to the needs of different communities and industries.
- Web Developers design and craft websites, which can range from local business pages to global e-commerce platforms, taking into account diverse user experiences and accessibility.
- Computer Programmers write the code that forms the backbone of software programs, a skill that bridges languages and cultures, turning ideas into reality across borders.
- Computer Systems Analysts work to understand and improve existing computer systems and procedures within organizations, tailoring solutions to meet diverse organizational needs and cultural contexts.

These roles, among many others emerging in the field, demonstrate the dynamic and thriving nature of the industry. They highlight the global impact of computer science, as it adapts to and influences a multitude of cultural and societal frameworks.

In the first section the analogy of a recipe makes the concept relatable across cultures. The explanation is non-technical, making it accessible to beginners of any background. The passage acknowledges the global use and diversity of programming languages, analogous to different cuisines and cooking styles around the world. In the second section about the field of computer science we recognize the global impact of these professions and their relevance in various cultural contexts. We emphasize the adaptability and inclusivity of the roles within the computer science industry and use language that acknowledges the diversity of the field and its practitioners.

Week 2 Worksheet

The Week 2 worksheet is based on module two which focused on the following goals: identify the Java Primitive Types, choose the best data type for given data, explain the limitations of int, float and double types, describe the differences between String and char types and numeric types like (int, float, and double), use math operators to construct an expression, identify the precedence of the Java math operators, evaluate a Java math expression, define the term variable, explain the rules and guidelines for naming a variable, describe the syntax of an assignment statement, declare a variable, initialize a variable, store a value in a variable, retrieve a value from a variable. With these goals in mind we created the following questions:

1. Which of the following would be the best data type to store the number of students in a class?
    a. float

b. char

c. string

d. double

e. int

2. Which of the following is not a java primitive type?

a. int

b. char

c. String

d. Double

3. What would be the output of the following code?

```
public static void main(String[ ] args) {
        int x = 10;
        int y = 5;
        x = y + 20;
        x = x + 5;
        System.out.println(x);
}
```

a. 30

b. 20

c. 10

d. 5

4. Which of the following is variable only declaration?

a. “Enter number: “

b. number = 50;

c. int number = 20;

d. int number;

5. What is wrong with the following code snippet?

```
int number1 = 20;

double number2 = 30;

int ans = number1 / number2;

System.out.print("answer: " + ans);
```

a. an integer is being assigned to a double variable

b. a double is being assigned to an integer variable

c. using an undeclared variable

d. using an unitialized variable

6. What is the output of the following code?

```
public static void main(String[] argos) {

        int x = 50;

        int y = 2;

        int z = x / y;

        z = z / y;

        System.out. println(z);

}
```

a. 12

b. 12.5

c. 13

   d. none of the above

7. Every statement in Java must be terminated with

   a. Period

   b. Comma

   c. Semicolon

   d. Quotes

8. These 2 lines of code produce the same output

   System.out.println(12 + 3);

   System.out.println("12 + 3")

   a. True

   b. False

9. What is the output of the following code snippet?

   System.out.print("Hello");

   System.out.println("Good Day!");

   a. Hello Good Day!

   b. HelloGood Day!

   c. Hello

      Good Day!

   d. Hello

      GoodDay!

For this week we excerpted the following passage from the textbook: [CITE TEXTBOOK]

A Data Type is an encoding of a set of values so that the computer can store and manipulate them. Most programming languages, including Java, come with a small number of built-in (primitive) data types. Primitive data types in Java include:

byte: Integers (whole numbers) in the range of -128 to +127

short: Integers in the range of -32,768 to +32,767

int: Integers in the range of -2,147,483,648 to +2,147,483,647

long: Integers in the range of -9,223,372,036,854,775,808 to +9,223,372,036,854,775,807

float: Real numbers in the range of ±3.40282347 x 1038 to 1.40239846 x 10-45

double: Real numbers in the range of ±1.7976931348623157 x 10308 to 4.9406564584124654 x 10-324

char: Any single character

boolean: Only two values: true and false

Java also has a data type for representing textual information. This type is named String. String literals are sequences of characters (zero or more) placed between double quote marks, such as “Hello World”.

The concept of an expression is a fundamental concept in programming. An expression is anything that evaluates to a value. We will want to get the computer to do some computations or operations for us. One way to do this is to use operators. Java had the following operators: Addition (+), Subtraction (-), Multiplication (*), Division (/), and Modulus (%). It is important to remember that in Java, when you divide an int by another int, the result will always be an int, with any fractional component truncated (removed).

We reconstructed the passage to be more culturally responsive by comparing each of the primitive types to real world applications:

> *In computer programming, a 'Data Type' is a way to categorize values so that a computer can efficiently store and work with them. Different programming languages, Java included, offer a variety of built-in basic data types, known as 'primitive' data types. These data types are fundamental and widely used across different cultures and applications.*
>
>> *byte: Handles small integers, ranging from -128 to +127. This type is useful for small-scale calculations, like counting the number of participants in a local event.*
>>
>> *short: Manages integers within -32,768 to +32,767. It's suitable for scenarios that require numbers larger than 'byte' but still relatively small, such as tracking the number of books in a community library.*
>>
>> *int: Designed for integers in the range of -2,147,483,648 to +2,147,483,647. This is a versatile data type for general-purpose calculations, from managing population data in a city to calculating financial transactions.*
>>
>> *long: Handles very large integers, from -9,223,372,036,854,775,808 to +9,223,372,036,854,775,807. It's ideal for applications requiring extensive numerical range, like astronomical calculations.*
>>
>> *float and double: These represent real numbers (with decimal points). 'float' covers a wide range, and 'double' offers even greater precision and range. They're used in various contexts, from scientific research involving small particles to large astronomical measurements.*

char: Represents any single character, like letters, numerals, or symbols from any language or script globally, highlighting the diversity of human communication.

boolean: A simple type with only two values: true and false. This is fundamental in decision-making logic in programs, reflecting the binary choices often faced in various aspects of life and technology.

Understanding these data types is crucial for programmers worldwide, as they form the basis for creating software that addresses a wide range of cultural, economic, and scientific needs.

In Java, a widely-used programming language, there's a special data type for handling textual information called 'String'. A 'String' is a sequence of characters — which can be letters, numbers, symbols, or even spaces — enclosed in double quotes. For instance, “Hello World” is a string. This flexibility allows programmers from all over the world to represent text in multiple languages and scripts, reflecting the rich diversity of human communication.

Another fundamental concept in programming is that of an 'expression'. Simply put, an expression in Java is anything that can be calculated to produce a value. This is akin to solving a math problem in a variety of world cultures, where different symbols and operations come together to give a result.

In Java, basic operations are performed using operators such as Addition (+), Subtraction (-), Multiplication (*), Division (/), and Modulus (%). These operators are universal in mathematics and thus familiar to people from diverse educational backgrounds. A key point to remember in Java is that when you divide one integer (a whole number) by another using the division operator (/), the result is always an integer, with any fractional part removed. This is like dividing a pie into equal parts — if the pie can't be divided evenly, the leftover piece isn't considered in the result.

These features in Java show how programming languages often mirror basic mathematical principles, making them accessible to people with varying levels of expertise and from different cultural and educational backgrounds.

In the first section we provide real-world examples relevant to different cultures and applications. We emphasize the universality and practicality of these data types across various contexts and use language that is inclusive and accessible to a global audience. In the second section the explanation of the String data type highlights its ability to represent diverse languages and scripts. The analogy of solving a math problem makes the concept of expressions relatable across cultures. And the discussion of operators ties programming to universal mathematical principles, emphasizing inclusivity and accessibility.

Week 3 Worksheet

The Week 3 worksheet is based on module three which focused on the following goals: use Math methods to construct expressions, differentiate integer division and floating point division, cast and convert values from one data type to another, use escape sequences to include special characters in a String, explain the causes and effects of operations that result in an integer overflow, differentiate integer and floating point numeric data types, use the Random class to generate pseudo-random numbers, describe and demonstrate basic debugging practices, explain the value of using variables in your code, explain the value of using descriptive names for your variables. With these goals in mind we created the following questions:

1. Which of the following will evaluate to 3.5? (check all that apply)
    a. **7.0 / 2**

   b. 7 / 2
   c. 7 / 2.0
   d. 7.0 / 2.0

2. Which of the following will print “He\\o Wor\d”? (including quotation marks)
   a. System.out.println("\"He\\\\o Wor\\d\"");
   b. System.out.println("\"He\\\o Wor\\d\"");
   c. System.out.println(""He\\o Wor\d"");
   d. System.out.println("\"He\\o Wor\d\"");

3. Select the TRUE choice about integers and floating point numeric data types.
   a. Integers can represent both whole numbers and fractions, while floating-point numbers can only represent whole numbers.
   b. Integers are used for storing whole numbers, while floating-point numbers are used for fractions only
   c. Integers can represent only whole numbers, while floating-point numbers can represent numbers with decimal fractions.
   d. Integers and floating-point numbers are interchangeable and can be used interchangeably in all programming languages.

4. What would be a good name to give to a variable that stores the number of houses a person owns?
   a. houses
   b. numHouses
   c. num
   d. var

5. What does y evaluate to?

   y = Math.pow(2,4)

   a. 16

   b. 8

   c. 2

   d. Error

6. How would you code the following mathematical operation in Java?

   $a^2 = \sqrt{(b^2 - c^2)}$

   a. Math.pow(b,2) - (Math.pow(c,2)

   b. Math.sqrt(b - c)

   c. It is not possible to code the expression in java

   d. Math.sqrt((Math.pow(b,2)) - (Math.pow(c,2)))

7. Which of the following may not be an output to the following code?

   import java.util.Random;

   Random rand = new Random;

   int randomNum = rand.nextInt((30 - 23) + 1) + 23;

   System.out. println(“A random number: “+randomNum);

   a. 22

   b. 26

   c. 30

   d. 25

8. When converting a double to an int in Java, which method can be used to round the double value to the nearest integer?

a. ceil()

b. floor()

c. round()

d. truncate()

9. When converting a higher primitive data type to a lower one, what casting is necessary in Java?

a. Automatic casting

b. Manual casting

c. Explicit casting

d. Implicit casting

For this week we excerpted the following passage from the textbook: [CITE TEXTBOOK]

A method is a list of statements executed by invoking the method's name, such invoking known as a method call. Any method input values, or arguments, appear within ( ), separated by commas if more than one. A programmer must precede the method name with Math. to call a Math class method. Some programs require math operations beyond +, -, *, /, like computing a square root. A standard Math class has about 30 math operations, known as methods. Some examples of the application of methods from the Math class include the following: y2 can be represented as Math.pow(y, 2.0), √x can be represented as Math.sqrt(x, 2.0).

A calculation sometimes must mix integer and floating-point numbers. A type conversion is a conversion of one data type to another, such as an int to a double. The compiler automatically performs several common conversions between int and double types, such automatic conversion known as implicit conversion. A type cast explicitly converts a value of one type to another type. A programmer can precede an expression with (type) to convert the expression's value to the indicated type. Ex: If myIntVar is 7, then (double)myIntVar converts int 7 to double 7.0. An escape sequence: A two-character sequence starting with \ that represents a special character.

\n	newline
\t	tab
\’	single quote
\”	double quote
\\	backslash

We reconstructed the passage to be more culturally responsive by comparing methods to cookbooks and explaining culturally intuitive ways the Java Math class can be used:

> In the world of programming with Java, a 'method' is akin to a recipe in a cookbook. Just as you follow a recipe to create a dish, a method in Java is a collection of instructions that perform a specific task when you 'call' or invoke the method's name. When using a method, any ingredients, or in programming terms, 'arguments', are listed within parentheses ( ), and are separated by commas if there are multiple.
>
> Java’s Math class is like an international cookbook for mathematics, offering a rich assortment of methods that cater to diverse computational needs around the globe. These methods go beyond elementary operations like addition (+), subtraction (-), multiplication (*), and division (/), and are crucial in a variety of cultural contexts.

For example, the Math class provides about 30 advanced operations, reflecting the wide-ranging ways people use mathematics in everyday life and specialized fields. Consider the task of squaring a number, 'y'. In Java, this is done using Math.pow(y, 2.0), similar to saying 'y squared' in common mathematical language. This operation might be used by a farmer in Asia to calculate the area of a field or by a builder in Africa to determine material quantities.

Similarly, to find the square root of 'x', Java offers Math.sqrt(x). This method could be employed by a market analyst in South America to analyze financial trends or by a teacher in Europe to demonstrate geometric concepts.

The Java Math class, with its broad range of methods, serves as a universal tool, enabling people from various cultural and educational backgrounds to solve problems that are locally relevant and globally connected.

In programming, just like in cooking, sometimes you need to mix different types of ingredients to get the desired result. In Java, these 'ingredients' can be data types like integers (whole numbers) and floating-point numbers (numbers with decimal points). When you mix these types in a calculation, Java often performs an automatic type conversion, known as implicit conversion. This is like automatically converting a recipe from using grams to ounces if needed.

Sometimes, though, you need to explicitly convert one data type to another, just as you might specifically choose to use a cup instead of a spoon for measurement. This is known as a type cast. A programmer can do this by placing the desired type in parentheses before the value. For example, if you have an integer variable myIntVar with the value 7, writing (double)myIntVar in Java converts it from the integer 7 to the double 7.0, much like explicitly changing a recipe ingredient from whole to diced.

There's also something in programming called an escape sequence, which is like a special seasoning in cooking that changes the flavor or presentation of a dish. In Java, an escape sequence starts with a backslash () and lets you represent special characters in a string. Some common escape sequences are:

\n for a newline, like starting a new paragraph in a recipe.

\t for a tab, similar to adding an indentation or space in a recipe for clarity.

' for a single quote, like using apostrophes in a word.

" for a double quote, as in quoting a famous chef.

Understanding these concepts in Java is like learning the nuances of a global culinary art, enabling programmers from diverse cultures and backgrounds to precisely and creatively express their ideas in code.

In the first section we use the analogy of a cookbook to make methods more relatable and understandable across cultures. We highlight the universal application of these methods in various real-life scenarios from different parts of the world. And we emphasize the role of Java's Math class as a bridge connecting diverse cultural and professional practices through a common language of computation. In the second section we continue the cooking analogy and make the concepts of type conversion and escape sequences relatable and easy to understand globally. The explanation includes comparisons to everyday practices, making it more accessible to people with different experiences and cultural backgrounds. And the language used is inclusive, emphasizing the universality of these programming concepts.

<u>Week 4 Worksheet</u>

The week 4 worksheet is based on module 4 which covers the following topics: using Scanner nextFloat or nextDouble method to collect user input, using Scanner next and nextLine method to collect user input, differentiating between Scanner next and nextLine methods, outputting to console with System.out.println and System.out.print, differentiating System.out.println and System.out.print, and demonstrate an understanding of String methods: charAt, compareTo, equals, indexOf, length, substring. With these goals in mind we created the following worksheet:

1. How would you use Scanner to ask a user to input a decimal number and store it in a variable?
    a. System.out.println(“Enter a number: “ + scanner.nextFloat());
    b. **System.out.println(“Enter a number: “);**

       double number = scanner.nextDouble();
    c. System.out.println(“Enter a number: “);

       double number = scanner.nextLine();
    d. System.out.println(“Enter a number: “ + scanner.nextInt());

2. What is the difference between System.out.println() and System.out.print()?
    a. System.out.println() and System.out.print() take different parameters
    b. System.out.println()prints longer strings
    c. **System.out.println()prints a string followed by a new line**
    d. There is no difference

3. Which of the following would return true? (check all that apply)
    a. **“random string”.equals(“random string”);**

b. “random string”.equals(“Random String”);

c. “random string”.equals(“randomstring”);

d. none of the above

4. If String text = “banana”, evaluate the expression text.IndexOf(“nas”).

a. 2

b. 4

c. -1

d. None of the above

5. What is the output of the following code snippet?

```
public static void main(String[ ] args) {
        String str = “Computer Science”;
        String str2 = str.substring(1,5);
        System.out.println(str2);
}
```

a. Comp

b. ompu

c. omput

d. Computer

6. Given the following code:

String myStr1 = "flowers";

String myStr2 = "apricots";

System.out.println(myStr1.compareTo(myStr2) > 0);

What is the output?

a. **true**
b. false

7. Assume that x, y, and z are all ints equal to 50, 20, and 6 respectively.

   What is the result of x / y / z in Java?

   a. **0**
   b. 12
   c. 16
   d. A syntax error as this is syntactically invalid
   e. A run-time error because this is a division by 0

8. What does the String method 'compareTo' do?

   a. **Compares two strings lexicographically.**
   b. Concatenates two strings.
   c. Checks if two strings are equal.
   d. Finds the first occurrence of a character in a string.

9. What is the value inside the value variable at the end of the given code snippet?

   public static void main(String[] args) {

   int value = 3;

value = value – 2 * value;

value = value +1;

}

a. 4

b. -1

c. 2

d. -2

For this week we excerpted the following passage from the textbook: [CITE TEXTBOOK]

> The two basic options for outputting text to the console are System.out.print(<expression>), System.out.println(<expression>). The only difference between these two basic options is that println always adds (appends) a newline character ('\n') to whatever (<expression>) you tell it to print out.
>
> We can use the Scanner class to get input from the user. scnr.nextLine() splits the input up along newlines and returns the next line of the input when called. scnr.nextInt() similar to scnr.next() splits the input up along whitespace characters and returns the next integer in the input when called. scnr.nextFloat() similar to scnr.next() splits the input up along whitespace characters and returns the next single precision floating point number in the input when called. scnr.nextDouble() similar to scnr.next() splits the input up along whitespace characters and returns the next double precision floating point number in the input when called.
>
> The String data type comes with several useful methods. One such useful method is the indexOf method. The method call someString.indexOf("me") returns the index where the String "me" is first found in the String someString. If the String "me" is not found in the

> String someString, then someString.indexOf("me") returns -1 to indicate that the String "me" was not found in the String someString. Another method from the String class, substring(startIndex), returns a substring starting at startIndex. substring(startIndex, endIndex) returns substring starting at startIndex and ending at endIndex - 1. The length of the substring is given by endIndex - startIndex. The equals() method compares two strings, and returns true if the strings are equal, and false if not. The compareTo() method compares two strings lexicographically. The comparison is based on the Unicode value of each character in the strings. The method returns 0 if the string is equal to the other string. A value less than 0 is returned if the string is less than the other string (less characters) and a value greater than 0 if the string is greater than the other string (more characters).

We reconstructed the passage to be more culturally responsive by comparing the Scanner class to story telling and the String class to recipes and cooking:

> In Java programming, sharing information is much like telling a story. To 'print' text to the console, which is like sharing a story verbally, Java offers two basic methods: System.out.print(<expression>) and System.out.println(<expression>). The difference between them is akin to the difference between pausing and starting a new paragraph in a story. System.out.print(<expression>) is like pausing — it outputs the text without moving to a new line. System.out.println(<expression>), on the other hand, is like starting a new paragraph — it adds a new line after outputting the text, symbolized by '\n'.

Just as a storyteller gathers information from their audience, programmers can use the Scanner class in Java to receive input. This is like having a conversation where you listen and respond. The Scanner class offers various methods to understand this input:

- scnr.nextLine(): It's like listening to the entire story or sentence until the speaker pauses. This method returns the next line of input, divided by newlines.
- scnr.nextInt(): This is akin to picking out and understanding only the numbers in a conversation. It splits the input by spaces and returns the next integer.
- scnr.nextFloat(): Similar to scnr.nextInt(), but it's like understanding a specific type of number — single precision floating-point numbers, which are numbers with decimals.
- scnr.nextDouble(): Again, like scnr.nextInt() but for double precision floating-point numbers, which are more precise decimal numbers.

These methods in Java allow for a rich, interactive exchange of information, much like engaging in diverse conversations around the world. They enable programmers to create programs that can interact with users in a variety of languages and formats, reflecting the global nature of communication.

Imagine the String data type in Java as a versatile tool, much like a multi-purpose knife used in kitchens around the world. Just as this knife can be used for slicing, dicing, and chopping various ingredients, the String data type comes with several useful methods for handling text in a variety of ways.

- indexOf Method: This method is like searching for a specific spice in a recipe. When you call someString.indexOf("me"), it searches for the 'spice' or substring "me" within the 'recipe' or the String someString. If it finds "me", it tells you where it first appears, just like noting the point in a recipe where a spice is added. If "me" isn't found, it returns -1, indicating that the 'spice' isn't in the 'recipe'.

- substring Method: This is akin to extracting a particular portion of a recipe. substring(startIndex) gives you the part of the String starting from startIndex, much like reading a recipe from a certain step onwards. substring(startIndex, endIndex) is more specific – it's like taking a segment of the recipe from one step to another, ending just before the endIndex.

- equals Method: This method compares two strings to see if they are exactly the same, similar to comparing two recipes to check if they are identical. It returns true if the 'recipes' (strings) match and false otherwise.
- compareTo Method: Think of this like comparing two dishes based on their ingredients (characters in the string). The comparison is based on the Unicode value (akin to the flavor profile) of each ingredient (character). If the dishes (strings) are exactly the same, it returns 0. If one dish (string) has 'less flavor' (less characters or lower Unicode values), a value less than 0 is returned. Conversely, if it has 'more flavor' (more characters or higher Unicode values), it returns a value greater than 0.

These methods make the String data type a highly adaptable and useful tool in Java, much like a multi-functional kitchen tool in the hands of chefs from different culinary traditions. They allow for precise and creative manipulation of text, reflecting the diverse ways in which people from various cultures and backgrounds communicate and express ideas.

In the first section we used the analogy of storytelling and conversation to make the concepts of outputting text and receiving input relatable globally. The explanation included culturally neutral examples, making it more accessible to people with different backgrounds and the language used emphasizes the universal nature of these programming functions and their relevance in diverse cultural contexts. In the second section we used the analogy of cooking and recipes to make the explanation of String methods more relatable and understandable across different cultures. The explanation uses globally understandable concepts like searching for ingredients and comparing recipes and the language and examples used are inclusive, emphasizing the universal nature of these programming functions.

Adding Demographic and Reflection Questions

During our background research, we observed a trend where students from certain racial backgrounds tended to excel academically compared to others. To incorporate these insights into our study, we opted to collect demographic data from the students we surveyed. Arizona State University, being a sizable public institution, offered an ideal setting for our research, particularly within the CSE 110 class—a mandatory course for students across various STEM disciplines, thus providing us with a diverse pool of participants. Our aim was to examine whether culturally relevant testing methods yielded differential outcomes across demographics. To achieve this, we included fields such as Age, Ethnicity, Gender, Household Income, and Languages Spoken, deeming them essential for obtaining a comprehensive understanding of each student's background.

Ladson-Billing's CRP theory outlines three key tenets—Academic Success, Cultural Competence, and Sociopolitical-Critical Consciousness—which serve as the foundation of CRP. Successful implementation of CRP, according to Ladson-Billing, hinges on addressing these tenets. To gauge their presence, we appended three supplementary questions to each worksheet, prompting students to reflect on their experiences with the material and assess its impact on their academic growth, cultural awareness, and critical thinking abilities.

Students were presented with descriptions of the three tenets and were asked to provide feedback on how they perceived the concept's application within the context of our research survey. The questions on the worksheet were framed as follows.

> Academic Success is defined as the students' intellectual growth and moral development, but also their ability to problem-solve and reason.
>
> Do you think this course promotes academic success, if so how?
>
> Cultural competence is defined as skills that support students to affirm and appreciate their culture of origin while developing fluency in at least one other culture.
>
> Do you think this course promotes cultural competence, if so how?
>
> Critical consciousness is defined as the ability to identify, analyze, and solve real-world problems, especially those that result in societal inequalities.
>
> Do you think this course promotes critical consciousness, if so how?

Data Collection

In order to collect data for our research, the research surveys were marketed to CSE 110 students. Through marketing the research, students were provided with the link to the weekly worksheets. Various means were utilized for marketing the surveys, including printing out flyers and QR codes for our survey, and putting them up in the classrooms where CSE 110 labs are usually conducted. Flyers were distributed and put up in each of the classrooms, and QR codes were put up on each of the tables in the classrooms. Furthermore, an announcement was made on the course canvas page elaborating the details of the research and with the link to participate in the survey. The instructors for the CSE 110 labs were also asked to make an announcement about the research and to encourage students to participate in the survey during the labs. We wanted students to be randomly placed in control or experiment groups so we created a website so that each time a student scanned the QR code they would be randomly redirected to one of the two google forms.

```
<!DOCTYPE html>
<html>
<head>
    <title>Chosing Study Group</title>
    <script>
        window.onload = function() {
            // List of websites
            var websites =
['https://forms.gle/W1Dhky7RPznMaxDs8',
'https://forms.gle/abyVCsHKrXEA8Jzd9'];

            // Select a random website
            var randomWebsite =
websites[Math.floor(Math.random() * websites.length)];

            // Redirect to the website
            window.location.href = randomWebsite;
        }
    </script>
</head>
<body>
    <p>Redirecting...</p>
</body>
</html>
```

To incentivise students into filling out the survey, a drawing for Amazon gift cards as a gift prize was conducted each week. Each week, 15 respondents of the survey were selected during the drawing to receive $10 Amazon gift cards. This incentive was heavily marketed along with the research to the CSE 110 students, as the potential to win $10 gift cards was highlighted on the surveys, flyers, and QR codes.

Results and Analysis

We would like to preface our data analysis by making the disclaimer that due to the restricted period of data collection and lack of student participation we do not have enough data to draw any strong conclusions. We are simply making statements on the trends that we see presented in the data. Furthermore before analyzing each week of data we cleaned the data of any responses from students not on the CSE 110 roster.

Week 1

The first week of data collection was the most successful, generating 16 responses. 9 for our non culturally relevant worksheet and 6 for our culturally relevant worksheet. For the non culturally relevant worksheets the range of scores was between 20-90 points, with an average of 63.33 points and a median of 70 points out of 90 total points. For the culturally relevant worksheets the range of scores was between 30-90 points, with an average of 77.14 points and a median of 90 points. The following is a question scoring breakdown:

Question	Non Culturally Relevant	Culturally Relevant
#1	100%	100%
#2	67%	86%
#3	67%	71%
#4	78%	100%
#5	78%	86%
#6	56%	71%

#7	44%	86%
#8	67%	86%
#9	78%	86%

Overall in the culturally relevant worksheet students performed better on every question. Students appear to understand and engage with the material better when the passage they read is culturally relevant, as evidenced by higher scores across all questions.

Week 2

The second week we received 5 responses, 3 for the non culturally relevant worksheets and 2 for the culturally relevant worksheets. For the non culturally relevant worksheets the scores ranged between 70-80 points, with an average of 73.33 points and a median of 70 points out of 90 total points. For the culturally relevant worksheets the scores ranged from 70-80 points as well, an average of 75 points and a median of 70 points out of 90 total points. The following is a question scoring breakdown:

Question	Non Culturally Relevant	Culturally Relevant
#1	100%	100%
#2	100%	50%
#3	100%	100%
#4	100%	100%
#5	33%	0%
#6	0%	100%
#7	100%	100%

#8	100%	100%
#9	100%	100%

Given the lack of data there are no conclusions that we can reasonably draw.

Week 3

In the third week, we received an overall of nine responses, 5 for the culturally relevant worksheet and 4 for the non-culturally relevant worksheet. The turnout for responses was better than week 3 as we had a better participation rate. For the non-culturally responsive worksheet, the scores ranged between 50 - 70 points out of a total of 90 points, with an average of 62.5 points out of 90 and a median of 60 points out of 90. For the culturally relevant worksheet, the scores ranged from 40 - 70 points out of a total of 90 points, with the average being 58 out of 90 points and the median score being a 60 out of the total 90 points. The following table represents a breakdown of the responses per question, comparing the results from the culturally relevant worksheet and the non-culturally relevant worksheet.

Question	Non Culturally Relevant	Culturally Relevant
#1	75%	80%
#2	0%	0%
#3	100%	100%
#4	100%	100%
#5	100%	100%
#6	100%	80%
#7	75%	80%

#8	75%	40%
#9	0%	0%

The results do not indicate a particular trend or pattern.

Week 4

In week 4, we received 2 responses, both of which were for the non-culturally responsive worksheet. We had a poor response rate during this week due to it being midterm week followed by Spring Break. Due to a lack of data acquired for the culturally relevant worksheets, we are unable to analyze results for week 4.

Overall

In total,across 4 weeks and 8 worksheets (a culturally reponsive and a non culturally responsive worksheet) we had 38 responses. Of these 38 responses 6 were considered to be invalid as the students who submitted those responses were not in the class roster. After that, we had 32 valid responses. On further analysis, we deduced that we only had 22 students fill out the surveys, as students could fill out the survey once every week, hence there were students who filled the surveys multiple times over the course of our data collection period.

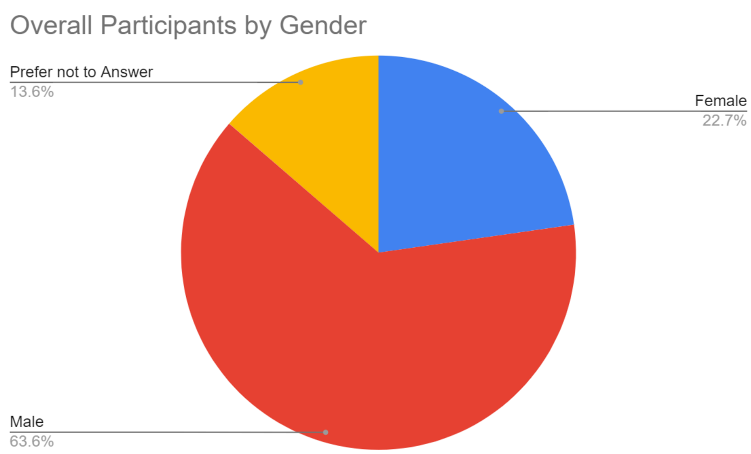
The overall scores of the students were as follows:

20 / 90	1
30 / 90	1
40 / 90	3
50 / 90	2
60 / 90	4
70 / 90	9
80 / 90	6

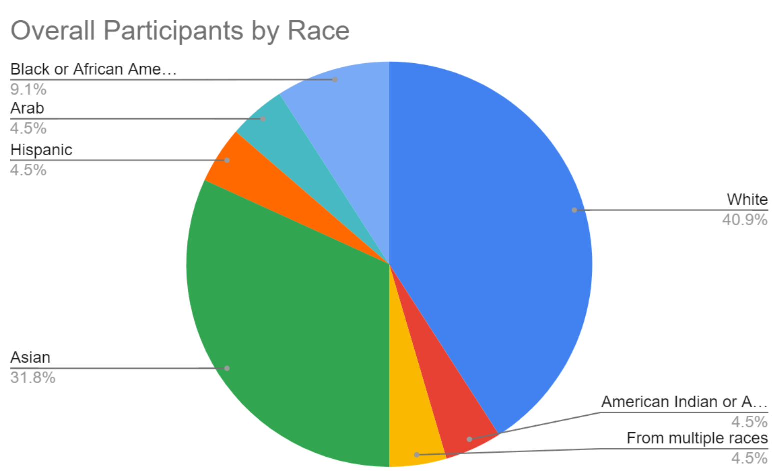
90 / 90	6

The overall average score for the worksheets was 68/90 ~ 75%

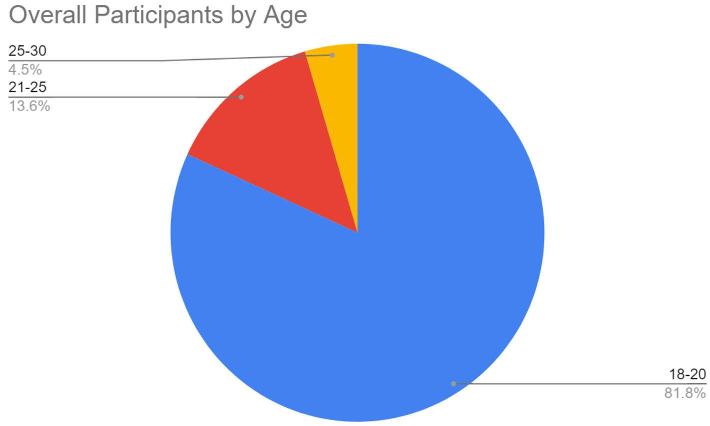
We took the demographic information of our students and decided to chart it out.



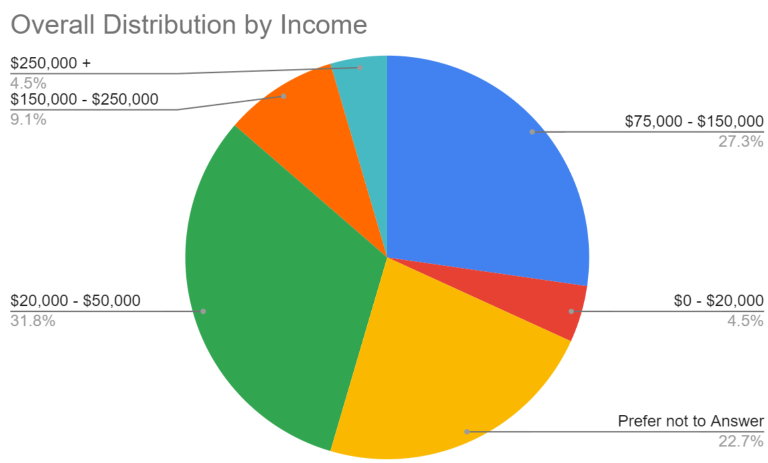
Overall, 5 of our research participants were female, 14 were male and 3 chose not to disclose their gender information



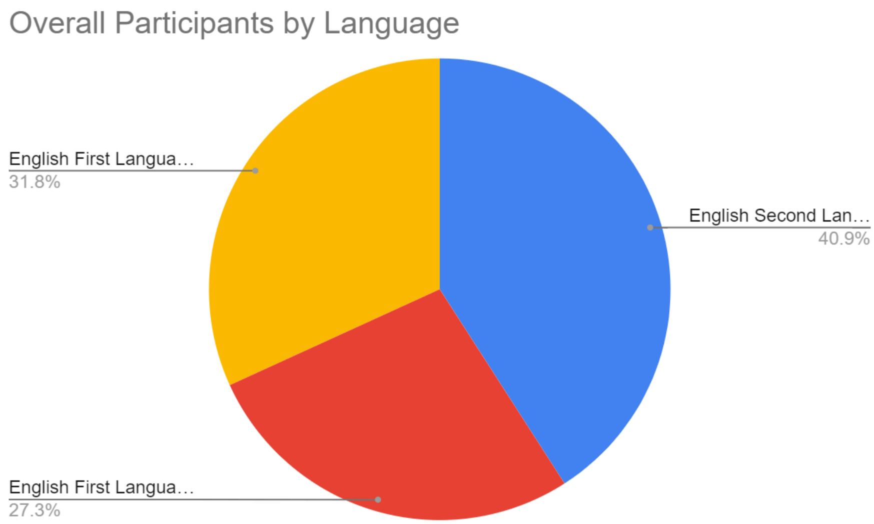
9 were White, 7 were Asian, 2 were African American 1 Hispanic, 1 Arab,
1 Native American and 1 from multiple races



This is a class taken by asu freshmen therefore, 18 of students were between the ages of 18-20, 3 between ages of 21-25 and 1 between the ages of 25-30.



By household income:
0-$20000 : 1
$20000 - $50000 : 7
$75000 - 150000: 6
$150000-$250000: 2
$250000+ : 1



English First Language (Only know English) (Yellow): 7
English First Language (Know other languages) (Red): 6
English Second Language: 9

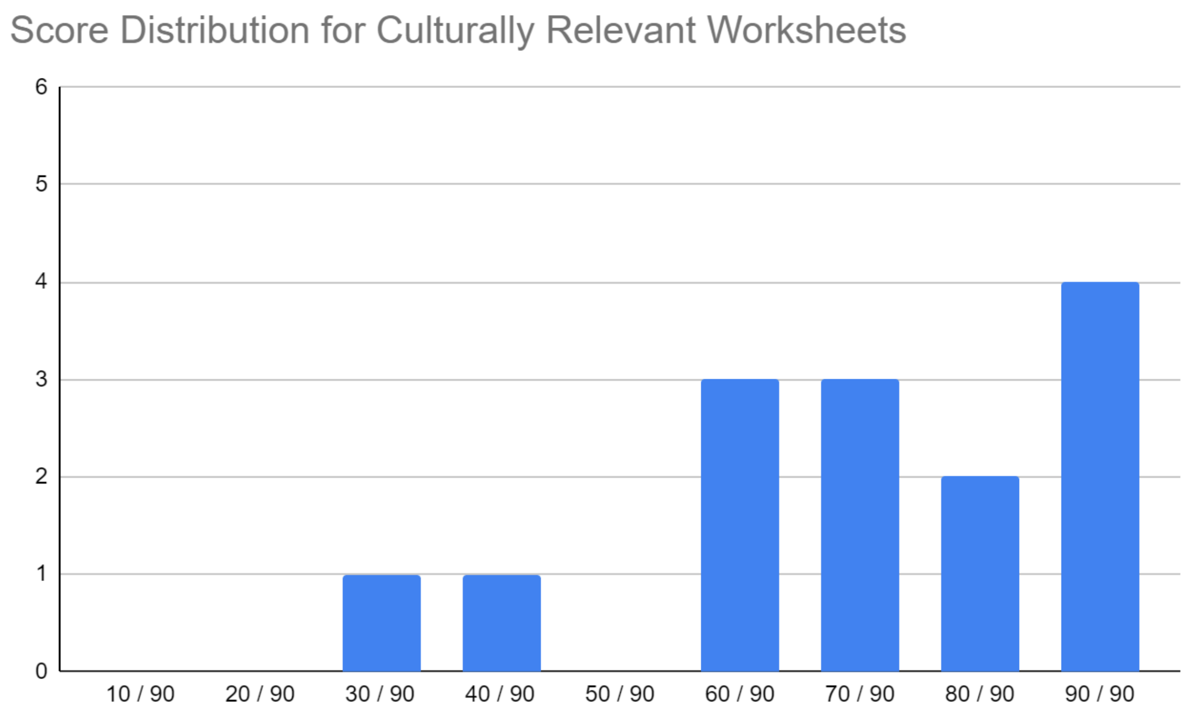
We then move onto the responses received for the culturally and non culturally relevant worksheets over the course of 4 weeks of data collection:

For the worksheets which had the culturally responsive paragraph, we received 17 responses in total, of which 3 were invalid as the students were not in the CSE 110 class roster hence, we ended up with 14 valid responses.

Below is the average score distribution for the culturally relevant worksheets.

10 / 90	0
20 / 90	0
30 / 90	1
40 / 90	1
50 / 90	0
60 / 90	3
70 / 90	3
80 / 90	2

90 / 90	4



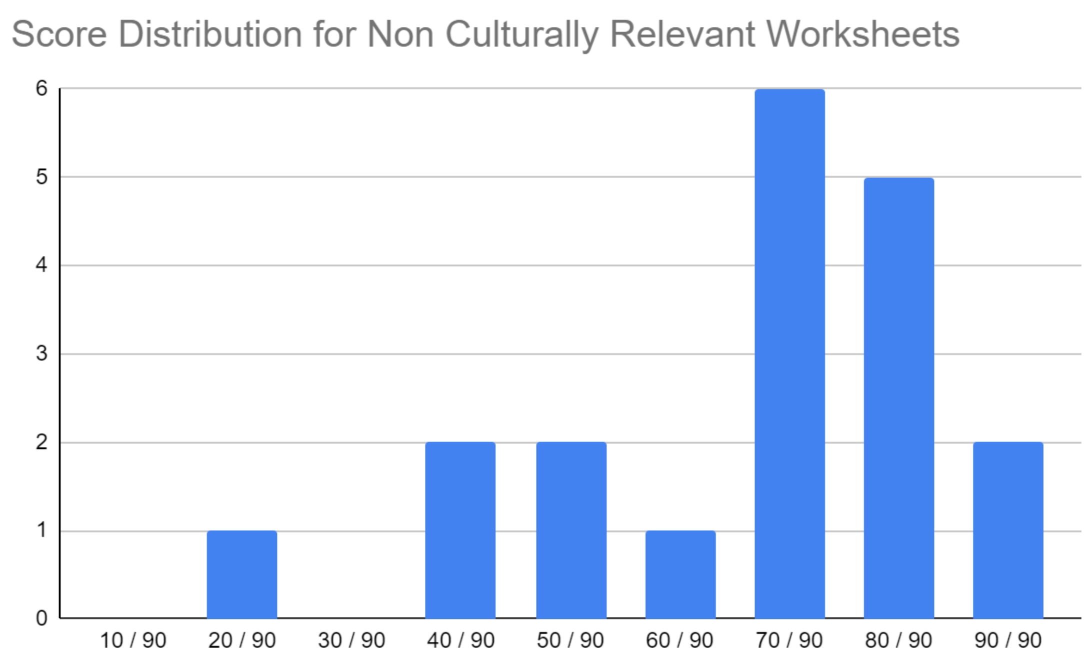
We then analyzed student opinions of the 3 tenets of CRP, academic success, cultural competence and critical consciousness.

When asked if the worksheet promoted academic success, all the 14 students taking this worksheet responded yes. When asked about whether it promotes cultural competence the results were a little more varied with 4 students saying yes, 7 saying no and 3 choosing to be neutral. And while determining whether the worksheet promotes critical consciousness 10 students responded yes and 4 students answered no.

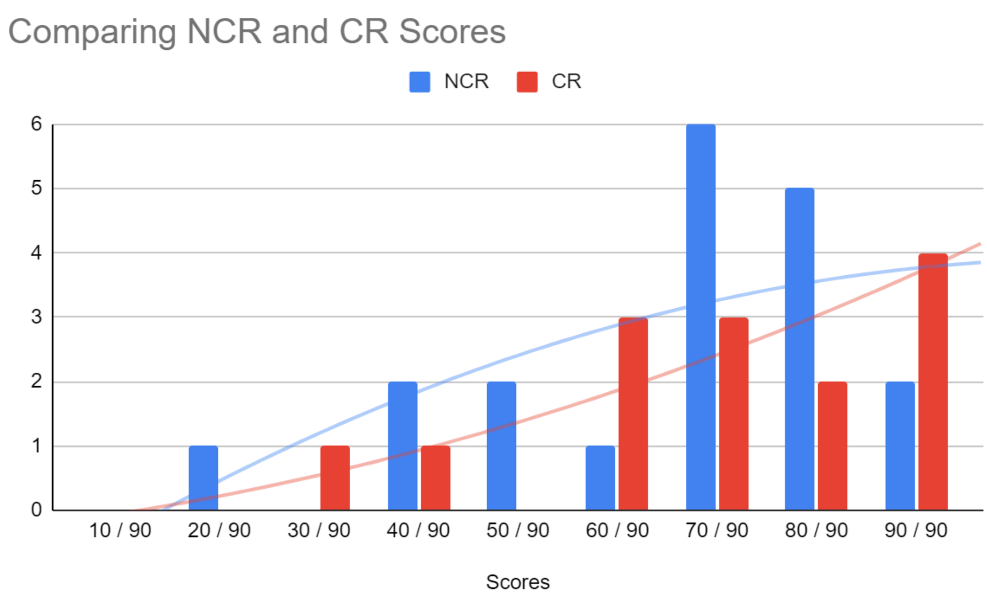
For the Non Culturally Responsive worksheets, we received 22 total responses of which 3 were invalid as they were not in the class roster, which left us with 19 valid responses.

The overall score distribution is as follows:

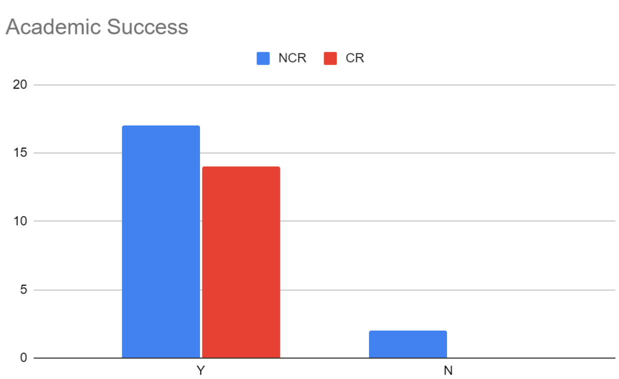
10 / 90	0
20 / 90	1
30 / 90	0
40 / 90	2
50 / 90	2
60 / 90	1
70 / 90	6
80 / 90	5
90 / 90	2



Comparing Scores of both the worksheets, the following graph displays the trendline:



Conducting analysis for the 3 tenets of CRP, when asked about whether the worksheet promoted academic success, 17 students responded yes while 2 responded no. When asked whether cultural competence was promoted, 10 responded yes, 6 said no and 3 chose to stand neutral. And finally when asked about whether the worksheets promoted critical consciousness 14 agreed by saying yes, 3 said no and 2 chose to remain neutral. The following graphs display the opinions of students taking the non culturally responsive and culturally responsive surveys comparatively for the 3 tenets of CRP.



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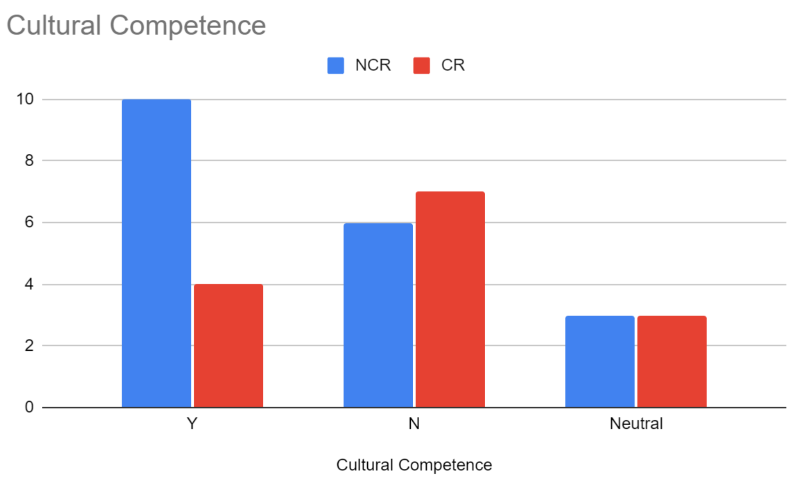
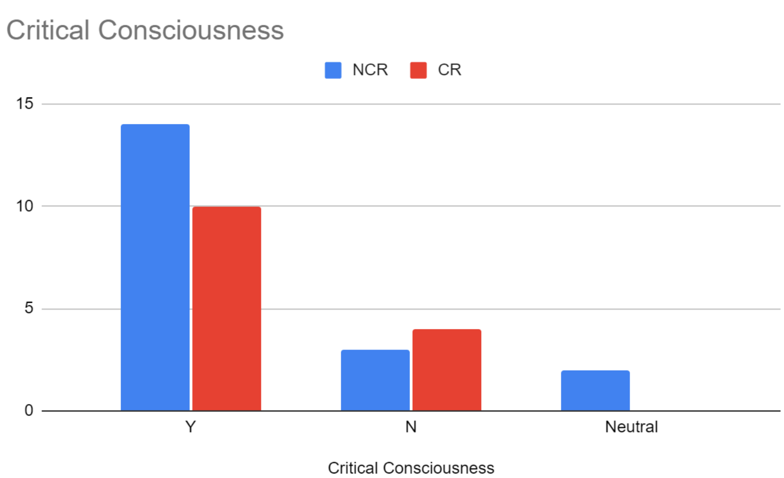

Cultural Competence
NCR
CR
10
8
6
4
2
0
Y
N
Neutral
Cultural Competence


Critical Consciousness
NCR
CR
15
10
5
0
Y
N
Neutral
Critical Consciousness

Conclusion

Limitations and reflecting on the process

As observed in the aforementioned analysis, the response rate over the weeks where we released weeks dwindled down significantly over time. Our best response rate was during week 1 where we received 16 valid responses. The responses during the following weeks were much less, ranging from five responses in week 2, nine responses in week 3, and merely two responses in week 4. As the number of students taking the course is almost 600, we were expecting a much larger number of responses for all of the weeks. We identified a few external factors that may have played into the success of our response rate.

We chose multiple avenues to advertise our research such as physical copies of QR codes linked to our surveys in the classrooms where the labs take place, announcements on the course canvas, and the encouragement of participation in our survey from the Teaching Assistants conducting the labs. Despite the aforementioned activities, many students may have chosen not to participate due to fatigue and a disinterest in participating in extra academic work. The time during which we advertised our surveys did coincide with midterm weeks, especially during week 3 and 4. Students may not have had the motivation to explore an academic survey on top of their preexisting academic workload, especially around halfway through the semester when academic workload is generally fast-paced. Furthermore, even though we incentivized students to take the survey by advertising a drawing that would result in 15 students winning $10 gift cards each week, our chosen incentive may not have been an adequate motivating factor for students. The students were not provided with extra credit opportunities or any academic rewards after completing the survey. The lack of an academic incentive may have led to the students' disinterest in participating in the research.

Reflecting on the process, we have evaluated that the CSE 110 course being primarily online may have been a significant factor in the turnout of students participating in our research. The CSE 110 course is primarily taught online through the medium of the ZyBooks platform. Students attempt weekly readings, watch lectures, and complete assignments through the online learning platform. The only in-person aspect of the course are the weekly 75 minute labs that are conducted by Teaching Assistants. Due to the course being held primarily online, the students generally do not engage with the faculty of the course as they are not required to attend lectures conducted by faculty. As a result, the students' involvement with the course is more self-paced, and they may not feel a sense of connection or familiarity with the faculty or fellow students. Furthermore, as the lab assignments are completed online as well, many students choose to come into the labs very briefly for attendance purposes but choose to leave the labs earlier if they are able to successfully work on the lab assignments themselves. As a result, they may not have focused their attention to the advertisement of our research surveys through the mediums of QR codes, flyers, or announcements during the labs. A sense of connection or personal touch with the faculty may have sparked an interest in students to participate in the research. A lack of the same may have caused the students to find the research study irrelevant to their personal interests.

Due to the online nature of the course, we found ourselves unable to find an effective way to create a personal connection with the students that may have motivated them to participate in our research. Furthermore, we could have taken into consideration the timings during which we were releasing our surveys, and scheduled the surveys earlier in the semester while the average workload for students was light and they may have had more time to participate in extra academic activities. Perhaps advertising our research in a different setting such as student organizations catering to freshman Computer Science students, or utilizing more engaging tactics for our physical form of advertising through flyers and printed QR codes may have positively impacted our response rate.

Next Steps

Although our study has had its limitations we believe in a necessity for continuing our research. Even with our small numbers our data and data from many other studies suggests that culturally relevantly framed course work has the potential to make computer science material more accessible to a wider demographic of people. For future work of this study we suggest that researchers add an additional step to the data collection process and schedule interviews with students who responded to the survey to get additional input on their thoughts of how the course can be improved. The length of the study also needs to be extended so that students have more than a week to complete the survey. It is also important to foster collaborations with educators to ensure that the culturally relevant coursework not only remains aligned with educational objectives but also dynamically evolves based on empirical evidence and student feedback. This will help research be incorporated into classroom activities, for example the survey can be used as an attendance check for labs that can be completed in the last 10-15 minutes or can be used as extra credit or promoted as extra study material for exams, all of which provide students with more of an incentive to participate. Since the CSE 110 course structure is roughly the same every semester the worksheets can be kept the same and reused for each group of students, this way researchers can also test if different semesters bring about different data patterns. One thing to note is that this study was conducted in a spring semester and CSE 110 is primarily a fall semester course, students taking CSE 110 in the spring could be students who are not in a computer science/engineering major or students who are behind, re-conducting this survey in fall could indicate what impacts this has on the findings. Evaluating long-term impacts will be essential in assessing the broader applicability and sustainability of these educational interventions.

Our research embarked on a critical exploration of culturally relevant pedagogy, aiming to understand its impact within the realm of computer science education. By designing and implementing worksheets with culturally relevant material alongside conventional content, we were able to observe and measure the differences in student performance and engagement. The data, while small in quantity, suggest that culturally relevant materials not only enhance students' comprehension and retention but also foster a more inclusive and engaging learning environment. This study underscores the importance of making computer science education accessible and resonant with a diverse student body. It reinforces the idea that educational content that reflects and respects students' cultural backgrounds is not merely beneficial but essential for cultivating a generation of computer scientists who are diverse, innovative, and socially aware. It is imperative that educators and curriculum developers integrate culturally relevant approaches into their teaching strategies. Our research contributes to a growing body of evidence that culturally relevant pedagogy is not just a theoretical ideal but a practical pathway to equitable and effective education.

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