Designing Course Level-Appropriate Mentoring for Computing Students

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Abstract

In this research-to-practice full paper, we describe our mentoring initiative, where we incorporated mentoring into a freshman and a sophomore computing course in Spring 2023 and Fall 2022, respectively. Based on our previous work [1], these mentoring initiatives aimed to develop students' sense of belonging, self-efficacy, and computing identity, as research [2, 3] shows sense of belonging and self-efficacy are the two main reasons for low enrollment and retaining underrepresented computing students. First-year retention in STEM programs is always challenging. Data shows that underrepresented students' first-year retention rate is even lower than most students [4]. Research [2, 3] also indicates that attracting and retaining underrepresented students, including women, is challenging without role models and mentoring. Studies [5] also found that mentoring is the most effective intervention to improve the self-efficacy of underrepresented students. Currently, mentoring is applied successfully in many works. However, they did not explore whether we need course-level specific mentoring for computing students to retain them and help them succeed. In this work, to find out "Do we need course-level specific mentoring?" research questions we used:

1. Do we need to design different mentoring activities for the freshman vs. sophomore course?
2. Is there any difference in students' perceptions towards mentoring between the freshman and sophomore courses?

We conducted literature and pre-course surveys to answer our first research question. Based on our survey outputs, we designed course-specific mentoring objectives. For the Freshman course, our main objectives were assisting students to i) explore computing career opportunities, ii) build a sense of belongingness, self-efficacy, and computing identity, and iii) transition to computing. On the other hand, for our sophomore course, our main objectives were assisting students to i) strengthen belongingness, self-efficacy, and computing identity, ii) develop strategies to be successful in computing, and iii) develop career plans and explore resources. To achieve these objectives, we designed a set of course-specific mentoring activities. In our initiative, we formed a group of mentors composed of successful alumni, graduate students, senior students, industrial personnel, and faculty of different races, genders, and ethnicities.

We performed anonymous surveys, interviews, and reflections to answer our second research question. We also analyzed students' course performance. Results show that mentoring improves the sense of belonging and confidence for both groups of students. Data also indicates first-year students prefer mentoring to succeed academically (e.g., learning programming). On the other hand, sophomores like mentoring to get career advice. Both groups expressed positive opinions toward mentoring. For the freshman course, the class average final grade performance was higher compared to the control groups. Our research describes how to design course-level-appropriate mentoring for computing students. We believe that our mentoring efforts should benefit not only

our underrepresented students but also those majority of students who may be hesitant to pursue a computing program or require enhanced self-efficacy for future success.

1. Introduction

Underrepresented students often do not consider computing disciplines a viable field to pursue and struggle to see the relevance of these disciplines in helping their communities address problems that they often encounter in their communities. These students' low sense of belonging and self-efficacy are critical factors for not choosing computing as a career path and retaining computing disciplines [3, 6, 7, 8]. Research [2, 3] also indicates that attracting and retaining underrepresented students, including women, is challenging without role models and mentoring. Studies [5] also found that mentoring is the most effective intervention to improve the self-efficacy of underrepresented students, leading to their commitment to pursue computing careers. Our previous work [1] also found that mentoring helps improve students' sense of belonging, self-efficacy, and computing identity. In this study, we investigate whether course-level-specific mentoring is needed for computing courses to improve the retraining and success of underrepresented students. We incorporate mentoring into a freshman and a sophomore computing course guided by the following two research questions:

1. Do we need to design different mentoring activities for the freshman vs. sophomore course?
2. Is there any difference in students' perceptions towards mentoring between the freshman and sophomore courses?

In our mentoring initiatives, we designed mentorship practices within our computer information technology (CIT) program to build and establish motivating environments for students to express their challenges, interests, and plans by fostering relationships with successful alumni, faculty, graduate students, industry personnel, and others. In our approach, first, we devised course-specific mentoring objectives through literature surveys and pre-course surveys. To achieve these objectives, we created a set of mentoring activities. We also designed evaluation metrics to assess whether there are any changes in students' perceptions toward computing programs and perceived impacts on students' self-efficacy and sense of belonging over time. Through these analyses, we tried to measure whether we need to design course-level-specific mentoring to help our underrepresented students attain their computing careers. We believe our mentoring should help our underrepresented and predominantly major students who may hesitate to pursue a computing program or require enhanced self-efficacy for future success. Our approach could be replicable in other STEM domains.

2. Background and Related Work

STEM jobs are the fastest-growing occupational category, and in the near future, 65% of all jobs in the U.S. will require a post-secondary degree with STEM literacy skills [9]. However, according to the U.S. Department of Education, less than 25% of college students pursuing bachelor's degrees will be specializing in STEM fields [10]. In addition, the current STEM workforce is predominantly male and white or Asian [11]. A study conducted in 2017 based on census data shows that Black, Latino, and Native Americans constituted 31% of science and engineering professionals [12]. Meanwhile, Black, Latino, and Native Americans only represented 21% of the total bachelor's degree recipients in science and engineering. Women are also significantly underrepresented in STEM fields in the USA. Women are filling only a quarter of positions in STEM jobs [13, 14]. The representation of women of color is even less, where Hispanic, Asian,

and African American women each are receiving less than 5% of STEM bachelor's degrees in the USA [14, 15, 16]. Every segment of the U.S. population must be engaged in successful STEM education [10, 17] to meet the growing global demand for a STEM workforce. According to NSF's 2019 data, 88% of STEM professionals are White and Asian [18], thus highlighting the need to diversify the field. The same underrepresentation of women and other minority groups is seen in computing. Our program has a similar underrepresentation of women, Hispanic, and African students [1].

Additionally, many students of color express that they seek to pursue a career in STEM to be better equipped to aid their communities [23]. However, STEM is rarely taught or presented to students, highlighting possible ways these STEM-oriented disciplines may help improve communities, specifically communities like those of these students. This further emphasizes the importance and need of these students of color and women to be supported and represented in STEM fields. The demand for diversity in STEM has been known for many years, and the disparity in representation in STEM has been an issue tackled across many institutions. For decades, private and government entities have sought to attract and retain more students of color in STEM [23, 24].

Researchers found "poor education," "less encouragement," and "lack of Black Hispanic role models" have been seen as the top reasons why so few blacks and Hispanics work in STEM fields [19]. Researchers pointed out that several situational factors typical in STEM, especially in pSTEM (physical science, technology, engineering, and mathematics), lead underrepresented students, including women, to feel less belonging in the field [19, 20]. Most obviously, the absence of role models and peers of the same race, ethnicity, and gender in STEM settings makes underrepresented students think they don't belong there [3, 21, 22]. Researchers have also asserted that these students may be underrepresented in STEM because these learners lack role models from their communities or persons of similar backgrounds who have completed and pursued STEM from academia into a career [23]. Studies [5] found that mentoring is the most effective intervention to improve the self-efficacy of underrepresented students. Also, according to the National Academies report, mentoring has long been found essential in developing science, technology, engineering, mathematics, and medicine (STEMM) professionals [28].

The implementation of mentorship programs has been successfully utilized in various research studies [25, 26, 27] focused on developing and succeeding mentoring relationships, specifically within STEM and computing, to improve underrepresented students' sense of belonging and self-efficacy. Although researchers have emphasized the need for effective mentoring relationships to aid underrepresented learners' success, research needs to be done on defining and developing an effective mentorship program for underrepresented learners. Based on the literature, there is no systematic guideline for developing effective mentorship programs in different settings [25]. To fill the gap, in our previous work [1], we incorporated multiple sources of mentorship to enable students to build relations with mentors in the industry, senior/graduate students, and faculty members. The developed mentorship practices can be transformative to other computing and STEM programs. In this study, we explore the necessity for mentoring tailored to specific courses to enhance student retention and improve success rates within the computing program. We incorporated mentoring in a freshman and a sophomore course and compared their similarities and differences.

3. Our Approach

In our research, we designed and implemented pre-survey, mentoring intervention, and post-survey to answer our research questions. The part of the pre-survey was specifically designed to answer research question 1 - whether freshmen and sophomore students have different preferences in mentoring activities. Based on the pre-survey results, we developed mentoring activities and implemented them on two groups of students who took the freshman and sophomore courses. At the end of the implementation, we utilized the post-survey to answer our research question 2. The mentoring for the freshman course (n=21) was implemented in Spring 2023, while the sophomore course (n=30) was implemented in Fall 2022 at Indiana University - Purdue University Indianapolis (IUPUI). For our mentoring interventions, we choose the freshman course CIT 12000 (Quantitative Analysis I – a course focusing on programming logic and design) and the sophomore course CIT 21400 (Intro to Data Management – a course on introduction to Data Management), which are the core foundational required courses for our technology major undergraduate students in our Computer and Information Technology (CIT) department. These two courses are prerequisites for many of our higher-level programming courses, and programming courses are required for all our undergraduate career pathways. As a result, CIT 12000 and CIT 21400 have immense impacts on the pathways to higher-level courses and student success & retention in computing career pathways. One of the biggest impediments for many computing students is their programming skills. Often, beginner computing students do not continue in the field because of their low performance in programming courses. Another reason for choosing the first-year programming course CIT 12000 was to improve the student's confidence in programming and increase the retention rate of first-year computing students. In addition, many students not majoring in computing also enroll in this course. We expect these courses with mentorship practice will encourage students who have yet to select their majors to choose computing programs, specifically CIT, as their major. On the other hand, these courses will give students already in the CIT program a good experience to continue with the program. In the following sections, we provide details of our mentoring interventions.

3.1 Development of Mentoring Practices for CIT 12000 and CIT 21400

In our mentoring initiative, we designed effective mentorship networks within the computing programs, thus building and establishing a safe and comfortable environment for students to express their views, interests, and culture by fostering relationships with successful alumni, graduate students, T.A.s, industry persons, faculty, etc. In this process, we provided students with a structured, collaborative learning environment and activities to help them explore computing career opportunities, improve mentees' sense of belonging in the computing field, successfully transition to computing, and navigate challenges to reach goals. Mentors shared their personal experiences and views about computing careers with mentees in the mentoring sessions, provided encouragement, and worked as role models. They also shared strategies and resources with mentees to complete their degree programs in computing.

Tables 1 and 2 show mentoring goals and activities for CIT 12000 and CIT 21400 courses. To design course-specific mentoring, we conducted a literature survey and pre-course surveys to identify students' mentoring preferences and interests (see section 4.1). We also believe that if students can develop good computational thinking, they will become more confident in computing work and thus help develop a sense of belonging in the field. That is why, in our mentoring sessions, we tried to improve students' computational thinking via various activities, e.g.,

programming. In the mentoring sessions, we also assisted students in identifying the important resources to be successful in computing careers and making plans to develop critical skills. To implement these activities, we organized six in-person mentoring sessions during the course class time for both courses. Each session was about one hour. Table 3 shows the mentor and mentees' demographic for both courses. Mentors are our senior students or alumni working full-time in the I.T. industry. For CIT 12000 and CIT 21400, we divided the class into five and six groups, respectively. For both courses, each group has an assigned mentor. All students also have access to all the mentors.

Table 1: Mentoring Objective and Activities for Freshman Course (CIT 12000)

CIT 12000 Mentoring Objectives	**CIT 12000 Mentoring Activities**
i) learn computing career opportunities and required skillsets ii) build a sense of belongingness, self-efficacy, and computing identity iii) transition to computing iv) develop problem-solving Skills v) build the mindset and resources to improve programming skill vi) increase the confidence in programming vii) enhance learning experiences	<u>Mentoring Session 1 - Introducing and Bonding:</u> Mentors introduced themselves and shared their journey to their computing careers, including influential factors, inspirations, barriers, and strategies to overcome obstacles. Then, the mentees introduced themselves. In this session, mentors also provided resources on various marginal groups and activities to support first-year students' transition to the program and encourage them to reach out to help them build a community. At the end of this session, mentors also arranged community-building activities to facilitate students to get to know their fellow students. (Focus: objective ii & iii) <u>Session 2 - Learning Mentors' Programming Learning Experience & How do you see computing as a career?:</u> Through a panel discussion, mentors shared their programming learning experience, focusing on challenges they faced, resources used, the mindset required, and other relevant topics. The resources were not limited to online sites, on-campus resources, and departmental resources that could be utilized for programming assistance. The mentors also encouraged freshmen students to use strategies to identify valuable resources. Mentors also shared personal stories to inspire mentees to overcome challenges so that mentors act as role models to motivate students to conquer their learning challenges. In this session, mentees also shared their answers to the following three questions: Question 1: What do you know about the computing career, including programming? Question 2: How do you see computing as a career? Question 3: What do you want to know about a "computing career"? (Focus: objective i, ii, iii, v, vii) <u>Session 3 - Sense of Belonging in Computing:</u> Through a panel discussion, mentors shared their experiences (and/or stories) and struggles related to belongingness and computing identities (and other barriers). Mentors also shared strategies and resources (e.g., support groups) they utilized (or know) to overcome their obstacles. They also talked about the importance of self-efficacy (or self-confidence) and shared resources on self-efficacy. They also discussed why engagement and motivation are essential to be prosperous and shared strategies and resources to stay motivated—shared other resources (university resources and outside) to succeed academically. They also recommended treating failures as a learning experience (with personal experiences and examples). (Focus: objective ii) <u>Session 4 – Algorithm Design:</u> Students often struggle to formulate algorithms (problem-solving steps) in programming. To help students improve their problem-solving skills, mentors worked with students in a group setting where the class was divided into groups, and each group worked with a mentor. In this group activity,

through sharing strategies and resources	mentors worked with students on a set of problem-solving tasks and guided them to develop algorithms. In this process, mentors also shared strategies for solving common challenges toward algorithm design. (Focus: objective iv to vii) Session 5 and 6 – Programming Workshop: These two sessions were working sessions where junior and senior computing students worked as mentors where a set of programming tasks on core programming concepts such as input-output processing, basic computation, logic structure, and loops were given to the mentees. In these sessions, mentors guided students in solving these tasks. Mentors also tried identifying individual students' struggles and recommended the necessary programming guidance. Based on the needs, mentors arranged peer programming with students to provide personalized assistance. We believe these sessions allowed mentees to get senior students' perspectives and approaches to developing programming skills. (Focus: objective iv to vii)

Table 2: Mentoring Objective and Activities for Sophomore Course (CIT 214000)

CIT 21400 Mentoring Objectives	**CIT 21400 Mentoring Activities**
i) strengthen belongingness, self-efficacy, and computing identity ii) being aware of the importance of diversity, equity, and inclusion in computing iii) develop strategies to be successful in computing iv) develop career plans and explore resources. v)learn and identify career goals and required skillsets & mindset. Also, identify experience,	Mentoring Session 1 - Introducing and Bonding: Through a panel discussion, mentors introduced themselves and shared their journey to their computing careers, including influential factors, inspirations, barriers, and strategies to overcome the obstacles. In this session, mentors also provided resources on various marginal groups and activities to support students' adapting to the program. At the end of this session, mentors also arranged community-building activities to help students get to know their fellow students. (Focus: objective i) Mentoring Session 2 - What do you want to know about a "computing career"?: In this Q&A session, mentees were encouraged to ask questions about computing career pathways, including the available career opportunities, skillsets required, internship tips, and other related topics. Mentors shared their experience and their opinions on these topics. (Focus: objective v) Mentoring Session 3 - Develop strategies to overcome barriers to reach goals: This was a Q&A session as well where mentees were able to ask questions related to their perceived obstacles in computing careers, such as low sense of belonging & self-efficacy, preparedness, academic struggle including programming skills, engagement & motivation. Mentors shared their strategies, experiences, and resources to inspire mentees to develop plans to overcome their perceived barriers and reach their future goals. Many of our mentees' questions were related to their challenges in attaining programming competency. Mentors shared their programming learning experience, focusing on their challenges, resources used, the mindset required, and other relevant topics. The resources were not limited to online sites; on-campus and departmental resources could be utilized for programming assistance. (Focus: objective vi) Mentoring Session 4 - Being aware of the importance of diversity, equity, and inclusion in computing: Through a panel discussion, our mentors shared their views on the importance of diversity, equity, and inclusion in computing. Mentors also shared their academic and industry experiences, initiatives, and recommendations. Mentors also discussed the importance of understanding ourselves & others being open-minded, neutral, and non-judgmental at school and work. (Focus: objective ii)

strategies, and resources to reach goals vi) develop strategies to overcome perceived barriers to reach goals.	Mentoring Session 5 - Industry Professional Visit: Two industry professionals with more than 15 years of experience in the I.T. industry were invited. Before this session, we collected questions and topics on which students were interested in getting expert opinions. Then, we categorized students' questions by themes. Three main themes were found: career pathways (including employers' expectations, continuous growth, and work-life balance), internships, and job interviews. The industry professionals shared their opinions and recommendations on those topics. The industry experts also shared career pathway options related to our computing programs, including Data science and management, Web development, and Cybersecurity. These professionals also shared the preparation needed, including academic knowledge and soft skills for a future career in these fields. Mentors also shared their views and experiences. (Focus: objective iii to v) Mentoring Session 6 - Identify career goals and required skillsets: In this working session, mentees were encouraged to identify their career goals. They were also encouraged to identify the skillsets and experiences needed to reach their goals. We also encouraged them to identify perceived barriers to their goals, develop strategies, and identify resources to overcome those with the help of mentors. To guide students, we posed them with a set of questions. Each student wrote down answers to "Where am I now?" "Where do I want to go?" and "Who do I want to become?" (Focus: objective iii to vi)

Table 3: Mentor-Mentee Demographics

Demographics of CIT 12000						**Demographics of CIT 21400**					
Gender		Ethnicity				Gender		Ethnicity			
Male	Female	African	Hispanic	Asian	White	Male	Female	African	Hispanic	Asian	White
Demographics of Mentees						Demographics of Mentees					
15	6	3	3	4	11	21	9	5	4	6	15
Demographics of Mentors						Demographics of Mentors					
4	1	1	1	1	2	4	2	2	2	1	1

4. Results & Discussion

We conducted pre-course surveys to assess students' course-level-specific mentoring needs. After implementing the mentoring sessions, we conducted post-course surveys to evaluate the changes in their perceptions toward computing programs and their impact on their self-efficacy and sense of belonging over time. We also analyzed students' course performance.

4.1 Pre-course Survey Results

In the pre-course survey, to evaluate our research question 1, "Do we need to design different mentoring activities for the freshman vs. sophomore course?", we asked students the following question: "Any topic you want to be included/addressed in future mentoring sessions?". Students' mentoring preferences and interests for freshman and sophomore courses are shown in Table 4. Students' mentoring preferences are evaluated qualitatively. In Spring 2023, for the CIT 12000 course, 18 out of 21 students participated. Twelve male and six female students participated; three were Hispanic and two African American. About 63% of the participants were already in CIT. At the beginning of Fall 2022, for CIT 21400, we conducted an anonymous pre-course survey. A total of 28 students out of 30 students participated in the survey. Twenty of the participants were male. In this survey, four of the participants were Hispanic, and five of them were African American.

Approximately 75% of the participants are currently in computing majors. Table 4 shows the significant findings from the pre-course surveys:

Table 4: Pre-course Survey Results Comparison between Freshman and Sophomore Courses

Topics	**CIT 12000**	**CIT 21400**
Mentoring Preferences and Interests	14 out of 18 students prefer to work with the same mentors. Students expressed they are interested to know about: a) What are the most important skills (set) outside of programming for your career? b) Advice on how to improve coding skills. c) What is your daily job routine and your mood on average after you get home? d) What jobs can you get with a computing career?	24 students out of 28 participants prefer to work with the same mentor. Students expressed interest in knowing: a) How do you apply for internships? b) How do you prepare for the interview? c) Career path and opportunity, and d) How to deal with stress and impostor syndrome.
Which factors contributed to your decision to pursue a major in the Computing field?	Top Ranked answers by participants: • *I liked Computing T.V. shows, ...* • *I wanted to have a Computing …*	Top Ranked answers by participants: • *I liked Computing T.V. shows, ...* • *I wanted to have a Computing ...*
Computing Identity	Many students strongly <u>disagreed</u> with the following statements: • *Computing careers " are hard"* • *"feel like I identify as a computing personal."*	Many students strongly <u>disagreed</u> with the following statements: • *"they are part of the computing community."* • *"feel like I identify as a computing personal."*
Sense of Belonging	Students strongly <u>disagreed</u> with the following statements: • *"Other people I know see me as a Computing person."* • "I feel comfortable/welcomed in my Computing program."	Students strongly <u>disagreed</u> with the following statements: • *"I feel that I am a member of my computing program." and* • *"I feel like I 'belong' in my Computing program."*
Self-Efficacy	Students strongly <u>disagreed</u> with the following statements: • *"Computing careers are too hard."* Students strongly <u>agreed</u> with the following statements: • *"I am confident that I can complete my undergraduate degree."*	Students strongly <u>agreed</u> with the following statements: • "I am confident that I can complete my undergraduate degree"; • "With the right amount of effort/dedication, anyone can become a top computing scholar"; • "Even when things are tough, I can perform quite well."
Academic Engagement	Students strongly <u>agreed</u> with the following statements: • "I use feedback on my work to help me improve what I do."	Students strongly <u>agreed</u> with the following statements: • "I use feedback on my work to help me improve what I do."

	• "When I realize/d I need help, I seek/sought assistance."	• "I am motivated toward my studies."; • "I put a lot of effort into the work."
Persistence Intention ***Question:*** *"Since declaring or planning to declare your computing major, have you seriously considered changing to a noncompeting major?"*	Two students responded, "Yes."	Three students responded, "Yes." As a reason, they mentioned low performance in computing courses. This gave us the idea that in mentoring, we need to share academic resources and strategies to help students improve their academic performance.
Findings related to non-computing students For students who are currently not in computing programs, we asked them the following **question:** *"Do you consider computing as a major in the future?"*	28% of non-CIT majors want to join CIT, and the rest are uninterested. As a follow-up question, we asked them, *"Do you perceive any barriers?"* Here are students' top preceded barriers: • "not as smart as others." • "Being treated differently because of my race/ethnicity."	100% of students responded, "yes." As a follow-up question, we asked them, *"Do you perceive any barriers?"* Here are students' top preceded barriers: • ". . . Not having enough confidence"; • ". . . Not being as smart as other students", • ". . . Not being prepared enough (e.g., missing prerequisite)."

The pre-course survey results also show that students need help building a sense of belonging and computing identity for both courses. These findings guided us in designing our mentoring activities. The survey results also show that students in both courses are confident. It is worth noting that the majority of participants were computing major students.

4.2 Mentee Post-course Survey Results

After the mentoring intervention, we conducted a post-course survey for both courses. In the post-mentoring study, we targeted to assess the following:

(1) After participating in the mentoring intervention, is there any improvement or change in students' perspective toward computing identity and sense of belongingness?
(2) How do mentees perceive mentoring initiatives?
(3) Do students have any recommendations for mentoring?

For the CIT 12000 survey, 17 students participated; for CIT 21400, 26 students participated. Students' demographics were comparable to the pre-course surveys for both courses.

Change in Perceptions

To evaluate students' change in perceptions toward their computing identity, sense of belonging, and self-efficacy through mentoring, we compared pre-course and post-course survey results. Please note that our evaluation compared pre- and post-course survey data within a specific cohort. We did not compare freshmen with sophomore students as they were two different groups of

students, and their mentoring activities differed. Tables 5 and 6 show pre-course and post-course survey comparison results for CIT 12000 and CIT 21400, respectively.

These comparisons are also shown in Figure 1. The survey results show that mentees' perspectives toward their computing identity, sense of belonging in the computing field, and self-efficacy improved after our mentoring interventions for both courses. For the freshman course, the improvement was significant in a two-tailed T-test with a p-value of 0.43541. However, the improvement for the sophomore course was not significant in a two-tailed T-test.

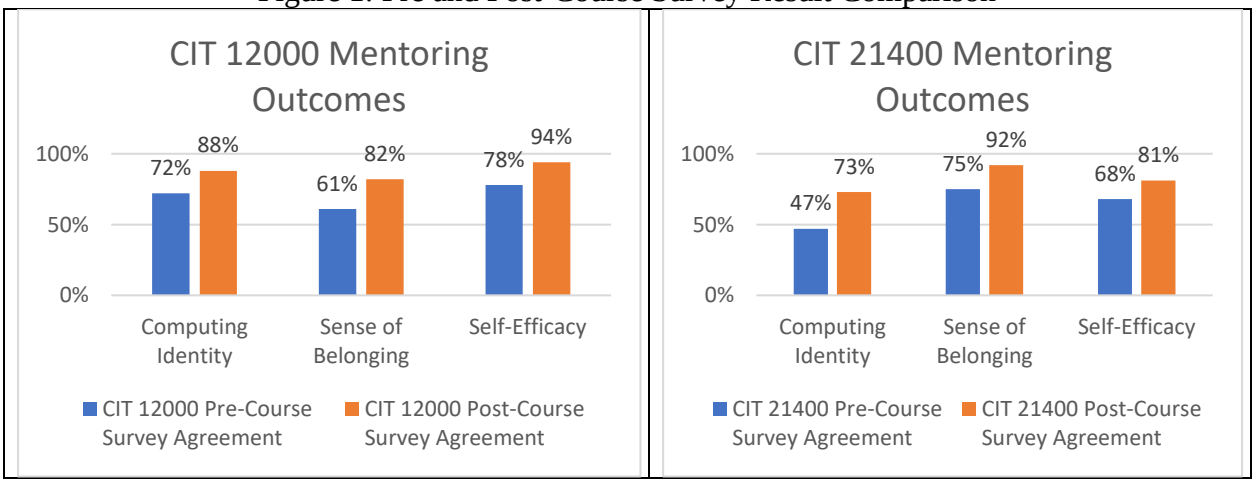
Table 5: Pre and Post-course Survey Comparison for Freshman Course

Category	**Statement**	**Pre-survey**	**Post-survey**	**Improvement**
Computing Identity	I feel like I am part of a Computing Community.	72%	88%	16%
Sense of Belonging	I feel like I 'belong' in my Computing program.	61%	82%	21%
Self-Efficacy	I am confident that I can complete my undergraduate degree.	78%	94%	16%

Table 6: Pre and Post-course Survey Comparison for Sophomore Course

Category	**Statement**	**Pre-survey**	**Post-survey**	**Improvement**
Computing Identity	I feel like I am part of a Computing Community.	47%	73%	26%
Sense of Belonging	I feel like I 'belong' in my Computing program.	75%	92%	17%
Self-Efficacy	I am confident that I can complete my undergraduate degree.	68%	81%	13%

Figure 1: Pre and Post-Course Survey Result Comparison



Mentoring Experience

This survey also assessed students' perceptions of various aspects of our mentoring initiative. Data (shown in Figure 2) shows that for both courses, approximately 82% of the students expressed

positive opinions, and the rest of the participants were neutral in most cases. Table 7 shows a few excerpts from the surveys.

Figure 2: Mentoring Perceptions

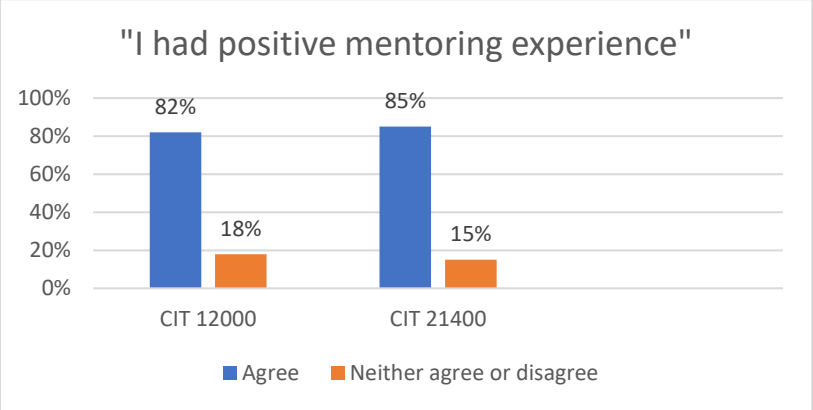


Table 7: Perceptions of Mentees towards Mentoring

CIT 12000	**CIT 21400**
The mentors gave me the sense that s/he and I shared similarities in the background.	*The mentors modeled how to overcome challenges and reach personal goals.*
The mentors helped me explore resources to succeed academically.	*The mentors showed me how to treat failed attempts as a learning experience.*

Students were satisfied with the mentoring initiatives for both courses, and most had no recommendations. However, some students made some recommendations, as shown in Table 8.

Table 8: Mentoring Recommendations

CIT 12000 Recommendation:	**CIT 21400 Recommendation**
Having mentors in CIT 12000 or any computing class is so important because it creates a welcoming environment where they want to succeed and help you. Their personal experience with the program helped so much.	A few students recommended expanding mentoring over multiple courses. Students also appreciate industry experts' visits and recommend more of those. Here are a few excerpts from the survey: 1) "It was helpful learning about the Mentors' experiences. More of that could be great"; 2) "Should be expanded. as a small part of an otherwise larger class, it was limited, but as a service for students, or a course itself, or spread across multiple courses, it could be more meaningful."; 3) "Having guest speakers was helpful, and incorporating more of them from leaders in the city would be a great opportunity."

4.3 Mentor Survey Results

We also conducted anonymous surveys to collect mentors' perceptions about our mentoring for both courses. For CIT 12000, 3 out of 4 (75%) mentors, and for CIT 21400, 4 out of 6 (66.7%) mentors agreed it was a very positive experience and valuable for their future careers. For both courses, mentors recommended accommodating more mentees' participation through conversations and question-answering sessions in the future. Here is a direct quote, *"Have more time for mentees to voice their experiences and questions."*

4.4 Student Performance

In Spring 2023, for CIT 12000, we implemented our mentoring for this introductory course. For the introductory class, overall student performance data shows that the average final course grades improved from a 'C+' to a 'B-' compared to the Fall 2022 lecture-based implementation of the same course taught by the same instructor. Course average scores were computed using seven homework, seven quizzes, one assignment, and two exam scores. Students' performance improvement from 78.1% to 83.7% was not significant in a two-tailed T-test.

5. Conclusion & Future Work

In this work, based on the literature survey and pre-course survey outcomes, we designed course-level-specific mentoring and evaluated the effectiveness of our mentoring initiatives. Our evaluation results show that both freshman and sophomore students found mentoring compelling, and for both groups, mentoring helped improve their sense of belonging and computing identity. Freshmen need more mentoring to succeed academically (e.g., a learning program …). Sophomores need mentoring to achieve in their careers. Both groups show positive opinions on mentoring. Based on our outcomes, we recommend course-level-specific mentoring. Part of our implementation is published in a previous publication [1]. All details of implementation and survey for mentoring are published at Github [29].

In the future, we will assess the enrollment and retention rate improvement by comparing enrollment and retention rates over two years of periods, respectively. In the future, we also plan to develop a more holistic approach to measuring the change in students' perceptions toward their computing identity, sense of belonging, and self-confidence. To implement that, we plan to expand our mentoring initiatives over several computing courses and compare data over a longer period of time to assess a student's change in perceptions upon receiving mentoring in a series of courses. In the future, we also plan to adopt our mentoring for a larger classroom. For scaling, we plan to hire more mentors to ensure each group will have an assigned mentor. We will divide the classroom into smaller groups with a maximum of 5 to 6 mentees. Even though each group will have an assigned mentor, all groups will have access to all mentors.

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