A Tale of Two Majors: When Information Technology is Embedded within a Department of Computer Science

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ABSTRACT

Student success is one of the most widely discussed topics in the higher education literature. One understudied factor that may have a significant impact on student success is the effect of co-locating two different undergraduate programs – specifically, Computer Science (CS) and Information Technology (IT) – in the same department. In this paper, we examine student data from the IT and CS undergraduate programs at a large, public university to identify and compare the paths of IT and CS students, who started the program in Fall 2008 and dropped out, changed their major, or successfully completed the program by Summer 2013. We also conducted an open-ended survey of 165 IT and CS students to determine their perceptions of the two programs. Our results suggest a tiered relationship between the two programs, where CS appears to be a more volatile and rigorous of a major in terms of student pathways and perceptions. We conclude that social comparisons that occur due to the way these programs were established at the target university contribute to this imbalance. Based on our analyses, we propose measures to mitigate negative social comparisons between the two programs and make IT a standalone program contributing to student success.

CCS Concepts

• Social and professional topics ~ Computing education programs • Social and professional topics ~ Information technology education

Keywords

Information Technology, Student Success, Retention, Graduation rates, Program improvement, Social comparisons, Student transitions, Data analytics.

1. INTRODUCTION

Higher educational institutions have been undertaking new initiatives, following successful practices and using various innovative applications, such as predictive analytics, data mining to improve student success [6]. Student success is one of the most important metrics in higher education institutions and research communities around the world. Student success is measured in terms of time to degree, as well as retention and graduation rates of programs [6]. Due to increasing student enrollment in Science, Technology, Engineering, and Mathematics (STEM) programs, it is crucial for institutions to satisfy the needs of each program by taking appropriate measures to improve student success.

One way to meet the demand of the growing need to support more STEM majors is to create new degree programs, such as those in the field of Information Technology (IT). IT programs are relatively new at many degree-granting educational institutions and educators are still in the process of determining how to measure student success. Some universities (e.g., Purdue University [17]) have multiple IT-related programs, while others have IT programs housed within stand-alone schools (e.g., University of Cincinnati's School of IT [21]). Unlike these universities, the case study presented in this paper involves an institution in which a single IT major is housed within a Computer Science (CS) department in a college of Engineering and CS. It is important to understand whether and how this unique situation affects student outcomes. Therefore, we examine the following research questions:

RQ1: *Are there any significant differences in the student pathways between IT and CS?*

RQ2: *What are IT and CS students' perceptions regarding the differences between the two majors?*

RQ3: *What are the implications based on these differences for improving IT student success?*

To do this, we analyzed: (i) institutional-level data to determine significant differences and similarities in the IT and CS student pathways; and (ii) student perceptions to understand the differences between CS and IT majors. Based on these analyses, we discuss the underlying implications for IT student success and program improvements. The major takeaways from this study are: (i) CS and IT students' flow in their program differs significantly; (ii) social comparisons exists between CS and IT majors at the targeted university and this hinders students' interest in completing the major; and (iii) the IT program is unique, and social comparisons between programs has a negative implication on student success. Based on these results, we propose measures to improve the quality of the IT program at the targeted university, such as making IT as a standalone major and increasing the resource allocation, such as the number of professors, tenure-track professors, and instructors supporting the IT program.

2. BACKGROUND

2.1 Student Success, Retention, Graduation

There have been numerous studies on the factors affecting student success in higher education institutions. As per Tinto [2], institutional experiences contribute to students' success which means students' who were satisfied with their college experience graduate at a higher rate compared to those who were not. Many studies have identified that learning centers, satisfactory first-year programs, undergraduate research, dorms facilities, financial aid, etc. account for students' success [3]. Jaeger's and Hinz's [4] study found that the high school GPA, total credits hours in the first year,

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gender, and SAT scores significantly predicted retention. In addition to these factors, Wigdahl et al. [5] showed the effects of program curricula and the number of credit hours accumulated in the degree program on the graduation rates. But according to Akbas et al. [6], the design of curriculums in the universities has not been studied extensively. Thus, they created a curriculum planning system to assist CS and IT programs using historical data analyses. Thus, institutions have been using data analytics to address issues that were causing barriers for students to succeed.

Overall, graduation and retention rates are two factors that are consistently used by universities to measure student success [1]. Low graduation rates and high attrition rates represent a failure to accomplish institutional purpose and an institution's inability to meet students' needs and expectations. Therefore, higher education institutions have been trying to improve the graduation and retention rates of their programs, and hence, increase student success. However, these metrics define student success by college-level metrics only, ignoring student perceptions of success. We build upon this work by taking into account both college-level metrics and student-level perceptions of the CS and IT programs.

2.2 Student Perceptions

There are studies in the literature that focus on understanding needs from student perspectives. A study carried out at the University of Guelph analyzed course perceptions of both instructors and students to categorize courses according to resources and course structure [12]. Their analysis helped to change resource allocation and teaching structure. Student perceptions have also been useful in determining course success indicators in learning [18]. Students believe that adequate instructional design, organized teaching, and direct instruction are factors that influence their success in learning [18]. Also, student perceptions were analyzed to find the correlation between course completion and 'Community of Inquiry'(COI) (social, cognitive, and teaching) presences in a community college [19]. With relation to COI indicators and demographic variables, there is no significant differences between students who completed a course and those who did not [19]. While many studies have focused on analyzing students' perceptions of instruction, our goal is instead to understand IT and CS students' perceptions of their majors, and in particular, their assessment of the strengths and weaknesses when comparing between the IT and CS majors.

2.3 Social Comparison Theory

The thereotical lens we used to frame our research questions comes from social comparison theory [20], which explains how individuals evaluate their own opinions, ideas, and abilities by comparing with others. Social comparisons can undermine an individual's uniqueness [13] and can also affect an individual's ability to objectively self-evaluate one's own strengths and weaknesses. For instance, students have high self-evaluation in the presence of upward and downward comparisons, which means students assess themselves based on comparison with those who believe that they are better or worse than themselves [13]. A study by Dijkstra et al. [14] shows that either upward or downward comparisons between students in a classroom resulted in evoking negative affect and lower academic self-concept. One of the typical effects of social comparisons is its differential impact on the selection of subject interests, grades, and self-concepts [15]. Thus, social comparisons can negatively affect students' perceptions, learning outcomes, and potentially their overall success.

In the next section, we describe why social comparison is an applicable theory when studying student success at a large, public university, where the IT undergraduate major is housed in a CS department.

2.4 The Target University

The University of Central Florida (UCF) is one of the largest universities in the United States in terms of student enrollment. The Department of Computer Science, in which both the CS and IT undergraduate programs are housed, is among the top five largest departments within the university. Both the CS and IT undergraduate programs at this university are accredited by Accreditation Board for Engineering and Technology (ABET). However, the CS program was accredited in the 1980's, whereas the IT program recently received accreditation in the last couple of years. Consequently, the program resource allocation, such as the number of faculty members, graduate teaching assistants, and student support for the CS program is relatively higher compared to IT. Students are typically admitted to IT and CS programs in their first year based on standardized test scores, such as Scholastic Assessment Test (SAT) and the Grade Point Average (GPA), achieved at a previous institution or high school. It is important to note that only the CS program requires students to pass a 'qualifying test' to proceed with upper-division coursework; the IT program does not share this requirement.

Some believe that the IT program was set up as a catch-all for retaining CS students who would have otherwise dropped out of the university or changed their major to another college. Even though the number of students enrolled in the IT program has consistently been significantly lower than in the CS program, the number of degrees awarded in IT has been nearly equivalent to CS over the last decade (Figure 1). The data shows that around 50% of students who failed the CS qualifying test changed their major to IT, and 70% of these students succeeded in getting their degrees in IT.

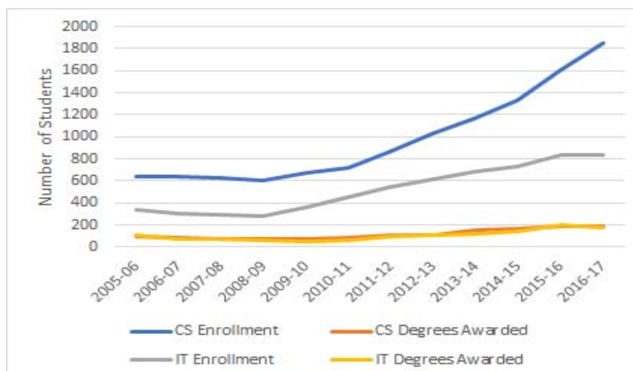

Figure 1: IT vs. CS Enrollment and Degrees Awarded

3. METHODS

We analyzed: (i) institutional data of undergraduate students who enrolled as IT and CS majors at UCF to determine their degree paths and track their degree progress; and (ii) student perceptions to understand what students' thought of their programs.

3.1 Analyzing Student Pathways

Higher education institutions have been using student cohorts to study the underlying factors that influence student success. One way of visualizing student cohorts is through Sankey visualizations [10]. It has been shown that these visualizations are easy to understand student flows between majors, term wise [10]. Also, Sankey visualizations can be used to understand various aspects of institutional effectiveness and for the quality improvement of programs [11]. We create such visualizations to examine student pathways for IT and CS.

This analysis was conducted on student data across twenty-four semesters (Fall 2008 to Summer 2013). The dataset includes all students who selected their academic program as IT and CS in Fall 2008. We consider students' data who started in Fall 2008 semester in this study because of the following reasons: (i) we have a complete cohort of students who started in Fall 2008, and (ii) graduation rates of programs are measured in terms of four or six year periods [16]. The dataset consisted of information on students' start and admit terms, term by term enrollment information (such as academic program, academic load), information on program completion term, and the program in which they graduated.

The specific factors analyzed were (i) program-start-term to program-dropout-term: The term when students drop out from the program after declaring their major as IT (or CS). It is expressed as the number of terms between the term when a student started the program and the term when that student dropped out. (ii) program-start-term to program-graduation-term: The term when students graduated from the program after declaring as IT (or CS) majors, which is expressed as the number of terms between the term when the student started the program and the term when the student graduated. We used these factors for CS and IT programs to determine the dropout and graduation trends of students.

3.2 Understanding Student Perceptions

In Spring 2016, we surveyed 165 undergraduate students from the IT and CS undergraduate programs to understand their perceptions of the two programs. We asked students: (i) their chosen major; (ii) the difference between these two programs; and (iii) the strengths and weaknesses of both programs. Data was collected in the form of open-ended responses, so that students could freely provide their opinions about the two programs without any influence from the researchers. We conducted a qualitative, thematic analysis on the open-ended responses and use illustrative quotes from students to supplement the results from our student pathways analysis.

4. RESULTS

In this section, we describe the results of both our quantitative and qualitative data analyses. First, we provide some descriptive statistics to characterize the student population. Then, we present our data visualizations and describe the results of our qualitative data analysis of student perceptions.

4.1.1 IT and CS Student Characteristics

During Fall 2008, the cohorts under examination included 30 declared IT majors and 101 CS majors. The student population consisted of both international and domestic students. The transfer student population was larger than the freshmen population in both the IT and CS cohorts. Additionally, both the IT and CS programs had a high percentage of part-time enrolled students, and many students worked either part-time or full-time.

4.1.2 Data Visualizations

We visualized institutional data in the form of Sankey diagrams [9, 10,11] as shown in Figure 2 for IT and Figure 3 for CS. The columns represent terms (or semesters) starting from Fall 2008 to Summer 2013. We ordered columns by term starting from Fall, Spring, and Summer semester (e.g., Fall 2008, Spring 2009, Summer 2009). The links between columns denote student transitions such as (i) student changed a major, (ii) dropped out, or (iii) still in the current program. The rows in the diagram denote programs. For example, concerning Figure 2, the first column (or first term), only has one row which indicates the IT program, and in the second column there are four rows which indicates four different programs (IT, engineering and CS, arts and humanities, and business administration).

The width of the rows represents the number of students. If there is a link passing from a row in one column to a row of a different color in another column then it means that those students either changed the program, dropped out, or graduated (refer to column labels). For example, in Figure 2, there is a link from Fall 2008 (Column-1) to arts and humanities (Column-2), which means some students changed their major from IT to arts and humanities. If a link exists from any row (or program) to a graduation node that means a student graduated from that program. For example, in Figure 2, the link from Fall 2011 to the Spring 2012 graduation row means a percentage of IT majors graduated in Spring 2012. The number of students is determined by the width of the link.

4.1.3 Student Success Metrics

Among the 30 students who declared IT as their major in Fall 2008, by Summer 2013: (i) 37% graduated as IT majors; (ii) 17% graduated from a different program; (iii) 40% of the students dropped out of the university, not completing any major (most of the students dropping out in the third term after joining the program); and (iv) the remaining 7% were still in the program or not registered as having dropped out. In contrast, among the 101 students who declared CS as their major in Fall 2008, by Summer 2013: (i) 35% graduated as CS majors; (ii) 16% graduated from different programs; (iii) 34% of the students dropped out of the university, not completing any major; and (iv) the remaining 15% were still in the program or not registered as having dropped out. A chi-square test was conducted, but no statistical difference was found regarding the student success metrics between the IT and CS student pathways. Based on these results, one might conclude that IT majors and CS majors in the same cohort experienced similar levels of student success. In the following sections, we provide more details regarding IT and CS student pathways.

4.1.4 IT Student Pathways

IT students began graduating by the end of their fifth term (Spring 2010). In terms of students who dropped out, about 20% of the IT students dropped out by their fourth term (Fall 2009). Around 25% of the students started dropping out of the IT program at higher rates after the fourth term (i.e., program-start-term to program-dropout-term is equal to four). The highest program-start-term to program-graduation-term for IT majors was the eleventh term (Spring 2012), which means students started graduating at a higher rate in the eleventh term after starting their major. Overall, 23% of the IT students (7 students) changed their majors to: arts and humanities (4 students), business administration (1), sciences (1), and CS (1). By the end of Summer 2013, all of these students, except two arts and humanities students had graduated.

4.1.5 CS Student Pathways

In contrast, CS students began graduating at the end of their ninth term (Summer 2011). Around 18% and 24% of students dropped out by their fourth and sixth terms respectively. Additionally, 29% of the CS students (29 students) changed their major to: IT (7 students), arts and humanities (6 students), business administration (3), engineering (3), computer engineering (2), medicine (2), health and public affairs (1), sciences (5). By the end of Summer 2013, 16% of these students had graduated, but most (84%) were either still enrolled or not reported as having dropped out.

4.1.6 Comparing IT and CS Pathways

Overall, CS students tended to have a longer path to graduation than IT students; CS students were also more likely to switch majors to IT than IT majors were to change their major to CS. It is also important to note that CS students who changed their major to other programs took longer to graduate (i.e., number of terms) than IT students who changed their major. Further, there is a significant difference in the dropout patterns of IT and CS majors. Around 20% of IT majors dropped out in third term and around 13% of IT majors dropped out after staying longer in the program whereas,

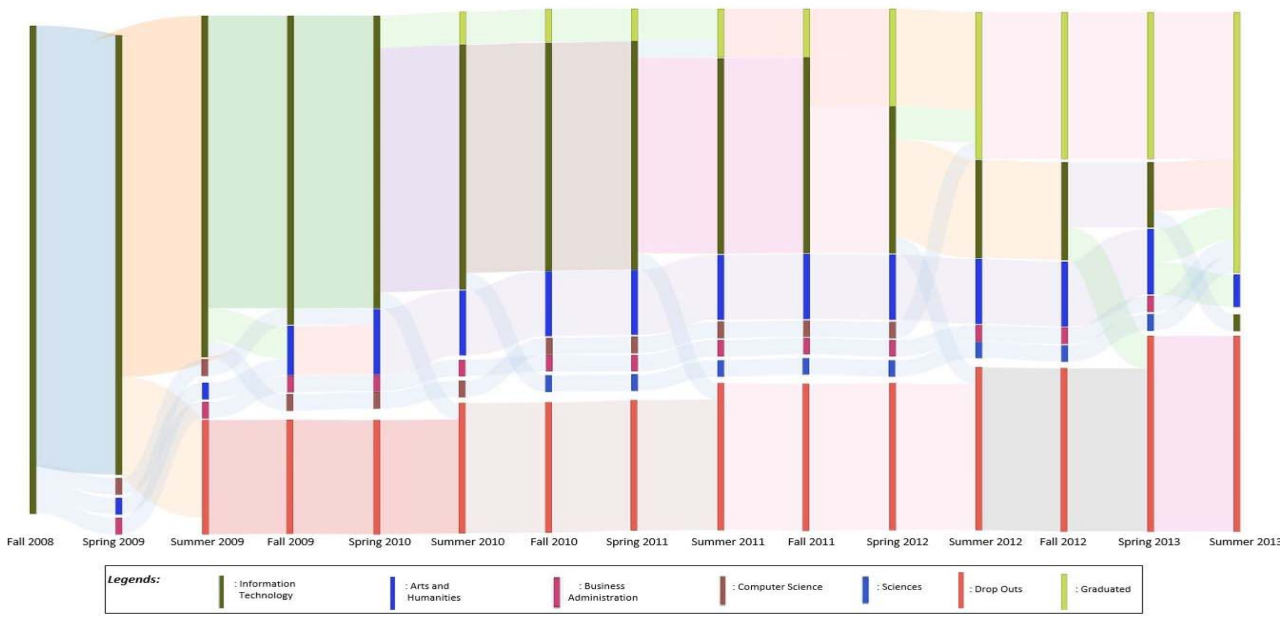

Figure 2: Sankey Visualization of IT Student Pathways

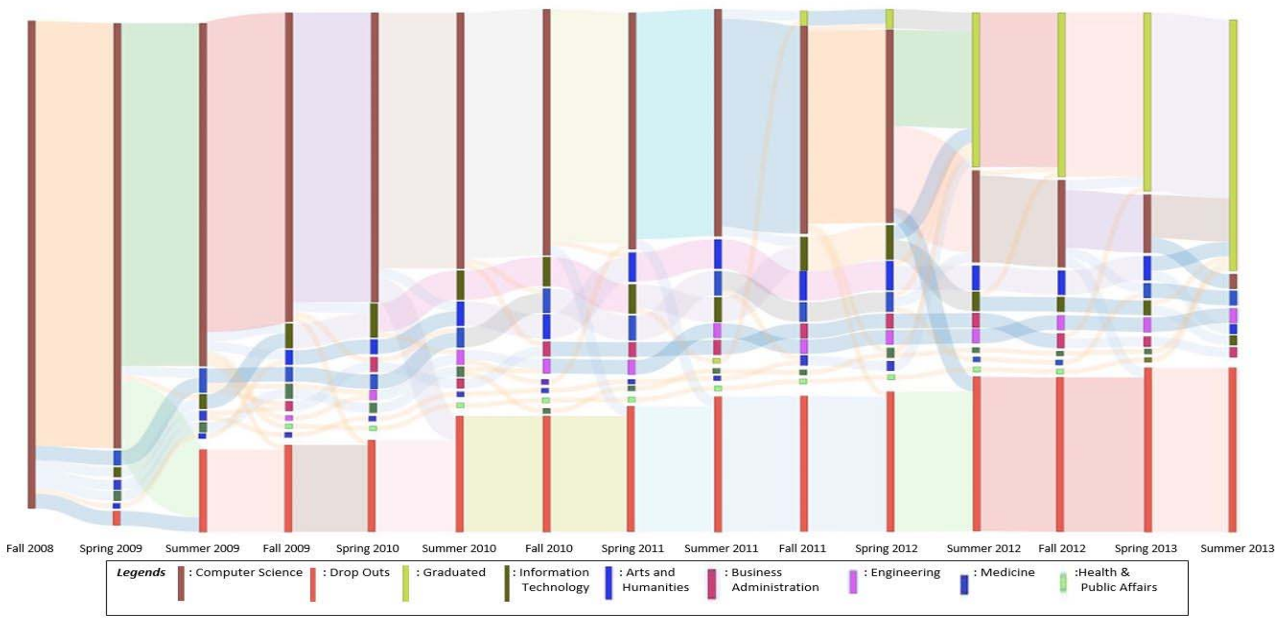

Figure 3: Sankey Visualization of CS Student Pathways

most CS dropouts happened after attempting the qualifying test. A number of IT students ended up dropping out at the end of the program, whereas the majority of CS dropouts happened in the first few terms. We also compared the curriculum rigidities [5] of both programs and found that the curriculum of the CS program (1.34) is more rigid than that of the IT program (0.96).

4.1.7 Student Perceptions

To supplement our quantitative analysis, we also conducted a qualitative analysis of students' perceptions regarding the IT and CS programs. Overall, we saw a stark contrast, where most IT students (77%) described their major based on its deficits (e.g., not having a qualifying test), instead of emphasizing its strengths. They focused more on highlighting the strengths of the CS program rather than their own program's strengths. For example, students said that CS was better at "*programming and mathematical theory*," while IT students are "*not required to study upper-level mathematics, and thus miss out on the benefits of higher-level discrete mathematics.*" (P118, IT major). Such social comparisons often led IT students to feel that CS students had much more computational skills, such as programming. They also considered their major to be "*a lighter degree*" compared to CS, which they considered a more "*honorable degree*" due to the qualifying test.

"In practical terms, the CS degree is more difficult to attain. It requires more difficult classes and has a barrier of entry being the qualifying test." -P58, IT major.

These students characterized their degree as providing "*a 'jack-of-all-trades' education.*" If a student was still undecided on their career path, then they should choose IT as it would provide them an overview of numerous careers in the technology. CS was for those who already had a set career path in development.

"It seems that if someone knows that they were to go into software development, they should choose Comp Sci. If someone knows that they really want to have a career in Technology but not exactly sure what specific area, they should choose IT" -P39, IT major.

Only 22% percent of IT students characterized IT based on its strengths. Unlike those who found the broadness of the degree to be a weakness, these students found it to be a strength. The wide scope of subjects and areas helped students be "*well rounded*," tailor their degree program, and have more job opportunities.

"The IT major is more broad and teaches more of an overall and basics of technology, and students likely have more options of what they want to get into other than code." -P59, IT major.

Though these students valued their major, they felt that others devalued it. One student commented that they felt offended, because, to them, the difference between IT and CS is not in performance, but in their perspectives to solving problems.

"…I have heard of other students in CS say that IT students are less knowledgeable then them. Which to me as an IT student offends me knowing I can preform [sic] better than some of the CS students and can problem solve situation from a different angel then them." P5, IT major.

In contrast, 93% of CS students described their major based on its strengths. They thought their program was more difficult, because of the qualifying test and the numerous computational courses focused on mathematics, programming, and algorithms.

"Computer Science is more heavily math-based and leads toward an in-depth understanding of the theory and implementation involved in computing." -P28, CS major.

This perspective was instilled even before entering the program. One student said that an advisor described CS as "*all about programming*."

"I went to career office once. The adviser told me CS major is all about programming, and as a cs student, I found out that this is true." -P53, CS major.

Only a few students (5%) described their major by its deficiencies. These students felt that the CS program lacked courses in design and usability (more IT-related courses). They felt that their program relies heavily on the theory, overlooking the practical applications.

"…the department doesn't put enough emphasis on the importance of design within the tech world. The department is really good at teaching programming at a deeper level than front end. However, the importance of designing for usability isn't well emphasized because programmers like to assume that it is easy or that they won't need to know it. Honestly, I think this course should be required." -P36, CS major.

Overall, both IT and CS students described their major with a higher emphasis on the strengths of the CS program. According to many of these students, CS was the better, more prestigious degree program that equated to higher levels of student success.

4.2 DISCUSSION

Though we did not find a statistical difference in our data-driven analysis (**RQ1**), it did show that visual differences exist between the IT and CS programs in regard to student flow through the programs (shown in Figure 2 and Figure 3). The CS program experienced more volatility in terms of students changing majors and dropping out, compared to the IT program. To some extent, this implies a higher level of rigor in the program but does not indicate whether student outcomes were truly improved due to this rigor. On the other hand, it is a customary practice in post-secondary institutions for students to change majors, if they are not happy with the current (or previous) program [23]. This practice is prevalent at UCF, particularly within the CS major. We also found the CS program to be more rigid in its curriculum, this suggests that the greater number of CS program prerequisites may be delaying CS student graduation. As mentioned earlier, the qualifying test has been causing barriers for CS students to continue in the program and graduate, which has also been explored in other published works [24]. Recently, the department has taken measures to reduce the failure rate of the qualifying test, but we are not yet aware of how these measures have impacted student success.

4.2.1 Reflecting on the Meaning of Student Success

Based purely on the college-level success metrics, the IT program appeared to demonstrate a similar level of student success as CS in terms of graduation and retention rates. However, it was clear from the qualitative data that social comparisons negatively affected students' mindset about their program of choice and had a serious implication on their perceived success (**RQ2**). IT students more often emphasized their deficits (e.g., lack of math and programming skills) instead of their strengths (e.g., solving real-world problems, strong leadership, or interpersonal skills) when justifying their chosen major. We argue that this emphasis on deficits may occur, in part, because IT students see explicit cues within the program that favor CS over IT. For example, the IT major is embedded within a CS department. Both IT and CS majors have to take CS gateway courses, but the inverse is untrue; CS students are not required to take IT coursework. Further, CS students must pass a qualifying test, while IT students do not have a similar qualifying process to show that they have mastered their chosen field.

Social comparisons are very common in organizations where there are multiple programs that lend themselves to forced comparisons [15, 22]. It has been shown that the social comparisons influence decision making which results in taking risky decisions [12]. Another concern with the students' perceptions that CS is better than IT, is that IT students may not be graduating with a sense of accomplishment or possibly even the skills needed to be successful after graduation. The problem of social comparisons is prevalent in the CS department at the targeted university and it is necessary to address it to avoid risky-decision making in taking measures to improve student success. Therefore, we urge institutions to reflect on the metrics they use to measure student success and consider including more subjective measures that take into account the perceptions of the students within the respective programs.

4.2.2 Recommendations on Moving Forward

Even though CS and IT are the only two majors within the CS department, the undergraduate CS program benefits from stronger support and resources, including more advisors, graduate teaching assistants, and tenure-track or tenured professors (**RQ3**). In other words, CS has been top priority for the CS department, placing the IT program and IT students at a significant disadvantage. We recommend that the CS department reflect on this choice and how it may negatively impact students within the IT program.

Both the IT and CS programs are unique with their own strengths. It is important to take measures that are individually applicable for each program to improve student success. Based on this study, we propose the following recommendations to improve student success of the IT program. First, the department should create a gateway course that helps students choose which major they would like to pursue prior to declaring their major as CS or IT. Students would enter the program undeclared, and after taking this gateway course, they would choose the major that best aligns with their strengths and interests. Also, the department could consider removing the qualifying exam for CS or implementing a similar qualifying procedure for IT. The central idea would be to force equivalencies in the two programs that explicitly signal to IT students that their major is equally important to CS.

A more transformative recommendation would be changing the department from being one for CS to a School of Computing. This new title and structure would incorporate all types of computing fields and reduce any unintentional preferences towards CS. Increasing the number of tenure-track IT professors and administrative staff would also provide maximum support for students and allow them more experiential opportunities in the field of IT. Finally, dropout rates could be improved for both programs by providing students with personalized advising and support on appropriate course selection and progress through their respective programs. This support could include summer boot camps or after hour workshop sessions on difficult content. By implementing these recommendations, negative social comparisons between IT and CS may be reduced and contribute to higher levels of student success. We urge higher education institutions to carefully consider how inherent imbalances between similar undergraduate programs (such as IT and CS) may unintentionally hinder to student success.

5. CONCLUSION

We presented a case study on an institution in which a single IT program is housed within a CS department to understand whether and how this unique situation affects student outcomes. Based on institutional data and student perceptions, we determined that (i) CS and IT students' flow through their program differs visually, even though we found no significant differences in traditional student success measures; (ii) social comparisons exists between CS and IT majors at UCF and this hinders IT students interest in completing the major; and (iii) social comparisons between IT and CS programs has a negative influence on student success. To preserve the uniqueness of the IT program and improve the quality of this program, we proposed several recommendations regarding curriculum changes, as well as additional department resources. A possible limitation of this study is that we chose to analyze data for a cohort that graduated prior to the IT program's ABET accreditation. Our intent is to replicate this study once the first cohort of the newly ABET accredited IT program graduates to see if accreditation itself improves student success metrics and perceptions about the IT program. More broadly, we contribute to the IT education literature by (i) critically reflecting on the meaning of student success and (ii) showing how social comparisons can play a role in student perceptions of success.

6. ACKNOWLEDGMENTS

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