Enhancing the Program Quality and College-Level Success Metrics of an IT Program at a Large Public University

Prateek Basavaraj, Ivan Garibay
University of Central Florida
Orlando, Florida, USA
prateek_basavaraj@knights.ucf.edu, igaribay@ucf.edu

ABSTRACT

Student success is a widely discussed and studied topic in higher education. Colleges and universities have been using college-level success metrics (time to degree, graduation, and retention rates) to measure student success. There are multiple factors that affect student success. Our previous study found that non-accredited Information Technology (IT) program within the Department of Computer Science and the way IT and Computer Science (CS) programs were established within the department and the resulting social comparisons were one among many factors that had a negative consequence on IT students' success. However, the IT program at the targeted university received accreditation from the Accreditation Board for Engineering and Technology (ABET) in 2013, and since then, many changes were made in the program. In this paper, we examine student data from IT undergraduate program at a large public university to identify who started the program in Spring 2014 and Fall 2014 semesters and dropped out, changed their major or successfully completed the program by Fall 2017. We also conducted a network analysis of the IT program curriculum to determine courses that were causing difficulty for students to continue in the program. Our results suggest that there is no significant improvement in college-level student success metrics since ABET accreditation. We conclude that IT programs in higher education institutions need to take additional program improvement measures that are student-centered to improve students' course passing rate. Based on our analyses, we propose necessary measures to improve both college-level success metrics and program quality.

CCS CONCEPTS

• Social and professional topics ~ Computing education programs

SIGITE '19, October 3–5, 2019, Tacoma, WA, USA

ACM ISBN 978-1-4503-6921-3/19/10…$15.00
http://doi.org/10.1145/3349266.3351418

KEYWORDS

Information Technology, Student success, Program improvement, Analytics, Student transitions.

ACM Reference format:
Prateek Basavaraj, and Ivan Garibay. 2019. Enhancing the Program Quality and College-Level Success Metrics of an IT Program at a Large Public University. In *Proceedings of ACM Special Interest Group for Information Technology Education (SIGITE'19). ACM, Tacoma, WA, USA, 6 pages.* http://doi.org/10.1145/3349266.3351418

1 INTRODUCTION

Higher education institutions have been trying to improve the college level success metrics such as time to degree as well as graduation and retention rates of its programs. These metrics represent student success from an institutional perspective. One of the main reasons educational institutions are trying hard to improve student success is because these metrics represent their commitment to retain and graduate students in a timely manner. There has been a lot of debate on whether these metrics were efficient in measuring the quality of academic programs [1]. In the midst of all these debates, some institutions have been trying to improve the quality of its programs by implementing high-impact practices such as first-year seminars, learning communities, service-learning, undergraduate research, capstone experiences, internships and experiential learning [2]. For example, the IT program at the targeted university provides its students with an opportunity to apply their knowledge of IT core areas such as Human-Computer Interaction and user experience skills, in industry-sponsored projects [3]. However, most computing programs extensively depend on ABET for program evaluation. The ABET evaluates the extent to which program outcomes map onto the program objectives and the feasibility of the specified outcome assessment and continuous improvement process etc. [4]. It is interesting to see how institutions improve both the program's quality and college-level metrics. The study presented in this paper involves an institution in which the IT program received ABET accreditation in 2013. The college-level success metrics before accreditation were relatively low. This may be due to the way IT and other programs were established within the department and the resulting social

comparisons, etc. It is important to understand whether and how this accreditation process affects student outcomes and program quality. Therefore, we examine the following research questions.

RQ1: *Are there any improvements in IT students' college-level success metrics after ABET accreditation?*

RQ2: *What courses in the curriculum were causing a barrier for students to continue in the program?*

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

To do this, we analyzed (i) institutional data to determine if there are any improvements in college-level success metrics after accreditation; and (ii) IT program curriculum to determine what courses were causing difficulty for students to continue in the program. Based on these analyses, we discuss implications for IT student success and program improvement. The major takeaways of this study are (i) there is no significant improvement in college-level success metrics after accreditation; (ii) computing courses such as C-language, Computer Science-1, Databases, and Statistics-1 were causing difficulty for students; (iii) IT program needs to take additional improvement measures to reduce the dropout rates and to improve the course experience for students.

2 LITERATURE REVIEW

2.1 Student Success in Computing Programs

There have been numerous studies on factors affecting student success in computing programs. Studies have shown that several pre-college experiences such as pre-college preparation, test scores, academic experiences in mathematics and science in and before high school, and prior achievement in mathematics affect students' success in computing programs [5, 6]. Also, students' decision to remain enrolled in the computing programs is greatly influenced by their prior experience in mathematics courses and academic aptitude [6]. In addition to these factors, the computing program curricula also influence students' success. The design of the student-centered optimal curriculum is crucial to reduce dropout rates. Muollo et al. [7] used course reviews data to improve the college experience of students in computing programs.

Overall, academic programs measure student success in terms of graduation and retention rates. Low graduation rates represent an institutional failure to meet students' needs and expectations. So, higher education institutions have been trying to improve the graduation and retention rates, and hence student success. However, these metrics provide a measure of institutional success in retaining and graduating students neglecting some specifics related to improving the program quality. We build upon this work by improving both college success metrics and program quality.

2.2 ABET Accreditation

ABET instituted a set of accreditation standards known as Engineering Criteria 2000, which demand institutions to take continuous improvement measures in planning and curriculum development. Regan et al. [8] argue that there were only a few studies that investigated the value and utility of the assessment-based-program improvement since ABET adopted Engineering Criteria 2000. This was due to the following reason: 62% of institutions in the United States experienced faculty climates that were not receptive to the ABET program improvement model **[8]**. Also, 67% of participant institutions reported that ABET program improvement process lacked clarity in the program expectations and places a substantial burden on smaller programs.

Though most programs are accredited, they still lack the necessary resources required for program improvement. This may be due to the non-receptive nature of some faculties within the department to accept the changes needed for the improvement. Because of this, students' pay the price by either dropping out or changing their major as per the theory described below.

2.3 Holland's Theory of Vocational Choice

The theoretical lens we used to frame our research questions comes from Holland's theory of vocational choice [9], which explains how individuals make decisions regarding their careers. Holland states that educational behaviors such as choice, stability, satisfaction, and achievement resemble vocational behaviors [9, 10]. Though the actors in this theory are adults, many education researchers have accepted the fact that this theory holds good for higher education institutions in contributing to student success [10]. Out of three major assumptions of Holland's theory, two of them are the basis for patterns of student success in higher education. First, students' choice of major is an expression of their personality and most people fall under one of these six personality types (Realistic, Investigative, Artistic, Social, Enterprising, Conventional). According to Holland, students who prefer to major in computing programs tend to be more of investigative types because of their critical, intellectual, and reserved characteristics [10]. However, they may fall under one of the other five types. Second, student success is a measure of how well students improve their abilities and interests that are reinforced and rewarded by their chosen program. Thus, the chosen program (or academic environment) plays a vital role and has a greater impact on student success.

Students stay in the program if their academic environment is supportive, encourages their involvement, and aims to increase persistence. Students leave the program when they feel their program does not support their involvement and persistence and they start to find a different place (or program) within the university where they get the support they need [11]. As a solution to decrease the program dropout rates and program transition (change of majors) rates, Reardon and Bullock [11] used Holland's theory as theoretical support for their 'service-delivery model' to assist students in program selection. Thus, Holland's theory is an applicable theory when studying student success of the IT program at a large public university.

2.4 The Target University

The University of Central Florida is one of the largest universities in the country by enrollment. IT program is housed in the Department of Computer Science, which is one of the top five largest departments within the university. IT program was started in 2001 and received ABET accreditation in 2013. IT program

shares the program resource allocation (graduate teaching assistants, faculty, and student support) with the CS program.

3 METHODS

We analyzed: (i) institutional data of IT undergraduate students to determine their degree paths and track their progress in the program; and (ii) program curriculum to understand the course relationships (such as prerequisites and post-requisites) and to determine what courses were causing a barrier for students to progress in the degree.

3.1 Analyzing Student Pathways

Student cohorts are used by higher education institutions to study the factors that influence student success. Sankey diagrams are one way of visualizing student cohorts [12]. Studies have shown that these visualizations are easy to understand student flows between majors, semester-wise [12, 13]. Also, Sankey visualizations can be used to study various aspects of institutional effectiveness and used to provide recommendations to improve the quality of academic programs. We create such visualizations to understand IT student pathways.

The analysis was conducted on student data across ten (Fall 2014 to Fall 2017) and twelve semesters (Spring 2014 to Fall 2017). The dataset analyzed in this study includes all students who selected their major as IT in Spring 2014 and Fall 2014 semesters. We consider students' data who started in Spring 2014 and Fall 2014 semesters in this study because of the following reasons: (i) IT program at the targeted university received accreditation in Fall 2013 and we were interested to evaluate student success metrics after accreditation; (ii) we have a complete cohort of students who started in Spring 2014 and Fall 2014 semesters; (iii) the graduation rates of programs are measured in terms of four- and six- years period [14]. The dataset consisted of information on students admit and start term, term by term enrollment information (such as academic programs), information on program completion term, and the program in which they graduated.

3.2 Curricular Analysis

Some higher education institutions have been using a curricular analytics framework to study program curricula. This framework makes use of complex network analysis and graph theory [15, 16, 17]. The network analysis of courses is used to understand course relationships and prerequisite requirements. Each node in the network represents a course, and a directed edge between two nodes represents a prerequisite requirement. The curricular analysis metric that is studied extensively is the course cruciality. The cruciality of a course represents the importance of a course in relation to other courses and is calculated by multiplying the betweenness centrality of a node with the total path length of a course in the curriculum. As per Wigdahl et al. [18], bottleneck courses are determined by the number of in-degrees and out-degrees of nodes. If a node has an in-degree or out-degree larger than three or a combination is larger than five, then those nodes are classified as bottleneck courses. These metrics provide a tool for higher education administrators to evaluate the efficiency of programs curricula and can be used to assist the curricular reform process [15, 16]. We analyze the IT program curriculum in the form of a network and determine bottleneck courses.

4 RESULTS

This study investigates the cohorts of Spring 2014 and Fall 2014 semesters, which included a total of 86 students (Spring 2014: 39 students, Fall 2014: 47 students).

4.1 Data Visualizations

We visualized student cohorts in the form of Sankey diagrams [12] as shown in Figure 1 and Figure 2 for Spring 2014 and Fall 2014 semesters, respectively. The columns represent semesters starting from Spring 2014 for Spring cohort (Figure 1), and Fall 2014 for Fall cohort (Figure 2) to Fall 2017. The columns were ordered starting from Spring, Summer, Fall semester (e.g., Spring 2014, Summer 2014, Fall 2014) for Spring 2014. For the Fall 2014 semester, the columns were ordered starting from Fall, Spring, and Summer semesters (e.g., Fall 2014, Spring 2015, Summer 2015). The rows in the Sankey diagrams denote different academic programs. The edges (or links) between columns represent student transitions (changed a major (or program), dropped out of college, still in the current program). The thickness of the rows represents the number of students. The width of the link represents the number of students transitioning between same rows or transitioning to new rows. For example, in Figure 1, there exist four links between Summer 2014 and Fall 2014 semesters. A link with the highest width (IT to IT) relatively represents a large number of students compared to other links (IT program to CS; IT to Elementary Education; IT to Marketing; IT to Digital Media). If there exists a link between two same rows, then it means students did not change their previous status (or program). But if a link is between two different rows, then it represents either student changed their major or dropped out of college or graduated.

4.2 Student Success Metrics

4.2.1 Spring 2014: Out of 39 students who started their undergraduate program in IT, (i) 41% graduated as IT majors; (ii) 5% of students graduated from a different program; (iii) 30% of students dropped out of the university, without completing any program; (iv) 23% of students are still in the program.

4.2.2 Fall 2014: Among 47 students who started in IT program, (i) 32% graduated as IT majors; (ii) 4% of students graduated from a different program; (iii) 23% of students dropped out of the university; (iv) 40% of students are still in the program.

A chi-square test was performed, and we found no statistical difference in the student success metrics of Spring 2014 and Fall 2014 semesters. We also conducted a chi-square test of student success metrics for Fall 2008 (from our previous study), and Spring and Fall semesters of 2014. We found that there is no statistical difference in student success metrics between these terms. Based on these results, we might conclude that IT students of cohorts before and after ABET accreditation experienced similar levels of student

success. We provide more details regarding IT student pathways in the following sections.

4. 3 Spring 2014 Student Pathways

IT students began to graduate by the end of Summer 2015, which is their fifth term since starting their major. In terms of dropout rates, two students dropped out of college by the end of their third term (Fall 2014). IT students started dropping out of the IT program at a higher rate after the sixth term (Fall 2015). Around 13% of students changed their major to CS, elementary education, digital media, marketing, criminal justice, nursing, hospitality management, and business. Two students who changed their major from IT to digital media and marketing again changed their major to criminal justice

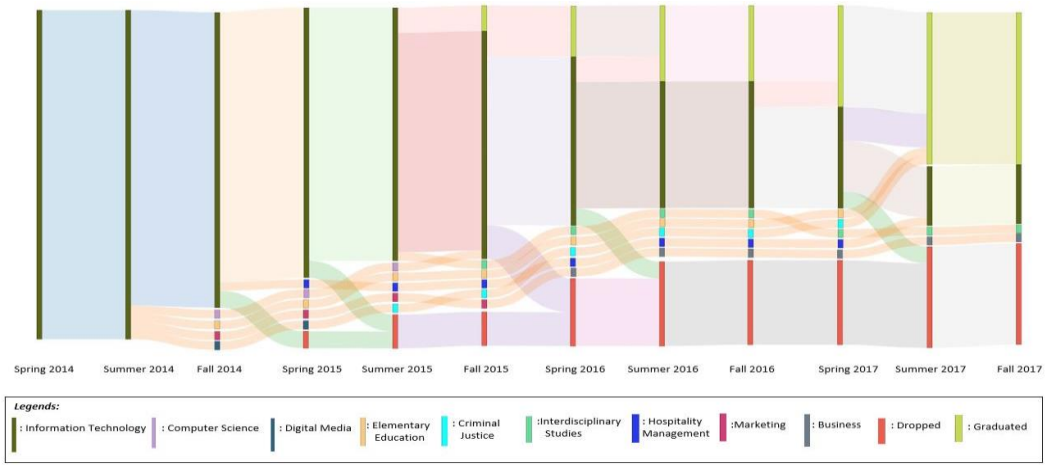

Figure 1: Sankey Visualization of Program Pathways of IT Students, who Started in Spring 2014 Semester

Figure 2: Sankey Visualization of Program Pathways of IT Students, who Started in Fall 2014 Semester

and business, respectively. Out of five students, who changed their majors, only 2 of them graduated by the end of Summer 2017.

4. 4 Fall 2014 Student Pathways

Students began to graduate by the end of the third term (Summer 2015) since starting their major. Around 11% of students (5 students) changed their major to other programs at the end of their first term. Also, students began to drop out after the first term. IT students started dropping out at a higher rate at the end of their second term (Spring 2015). The number of students who dropped out of IT reached a high number at the end of Fall 2016 when five students dropped out after staying in the program for a while. Around 13% of students changed their major to interdisciplinary studies, event management, economics, radio television, finance, health sciences, human communications, and nursing. Two students who changed their major from IT to interdisciplinary studies and economics again changed their major to nursing (later health sciences) and finance respectively. Out of 6 students who changed their majors, only 2 of them graduated by the end of Summer 2017.

4. 5 Comparing Spring 2014 and Fall 2014 Student Pathways

There are many common degree progression characteristics of IT students in Spring 2014 and Fall 2014 cohorts. IT Students begin to drop out early in their degree program. Two students dropped out at the end of their third term (Summer 2014) in case of Spring 2014 cohort, whereas, two students dropped out at the end of their first term (in case of Fall 2014 cohort). It is also important to note that IT

students who stayed in the program for more than six terms ended dropping out of the program. In the case of the Spring 2014 cohort, around 21% of students dropped out after staying in the program for more than six terms, whereas 18% of students dropped out in the case of the Fall 2014 cohort. IT students changed their majors to a variety of programs, out of which most of them are non-computing programs.

4. 6 Curriculum Analysis

We also conducted curriculum analysis of IT program to determine (i) bottleneck (important) courses; (ii) what courses were causing difficulty for students to continue in the program; and (iii) the curriculum rigidity.

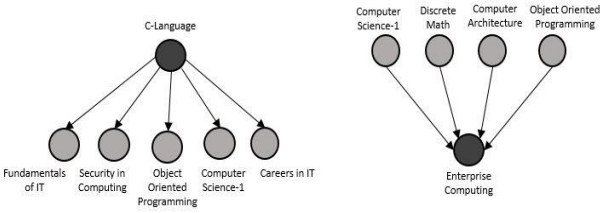

Figure 3: Prerequisites and Post-requisites of Bottleneck Courses

We identified IT bottleneck courses based on the metric proposed by Wigdahl et al. [18]. The bottleneck courses in IT program curriculum at the targeted university are C language, and Enterprise Computing. The prerequisites and post-requisites of bottleneck courses are shown in Figure 3.

To determine what courses were causing a barrier for students to continue in the program, we examined course histories of students' who dropped out of the program. Institutional data shows that these students (i) received grades less than 'C' (< 2.0) in core IT courses; (ii) received withdrawal grades. Some students retook courses more than twice.

Out of 23 students who dropped out in Spring and Fall semesters of 2014, 52% of students (12 students) failed in C-language and Computer Science-1, 57% of students (13 students) failed in databases, 39% of students failed in (9 students) in statistics-1. Around 50% of students received withdrawal grades and dropped out of college. Thus, we identified three courses (Computer Science-1, databases, statistics-1) in addition to two bottleneck courses that were causing a barrier for students to continue in the program.

5 DISCUSSION

Though we did not find any significant statistical difference in college-level success metrics of IT program before and after ABET accreditation (**RQ1**), it did show some improvement in the dropout rates (Fall 2008: 40%; Spring 2014: 30%, Fall 2014: 23%). The IT program experienced some level of arbitrariness in terms of students dropping out and changing majors. There are multiple factors affecting students' dropout. Mostly, students' dropout when they (i) feel that their college is not supportive or (ii) think college degree has no value [19]. With reference to our analyses, we found that bottleneck courses were causing barriers for students to continue in the program due to the presence of a greater number of prerequisites and post-requisites. In other words, if students fail to pass these courses, then they cannot take other succeeding courses. Students' change their majors due to many reasons. More importantly, their personal beliefs play a vital role in decision making [20].

5.1 Reflecting on the Meaning of Student Success

The IT program appeared to demonstrate the same level of student success before and after ABET accreditation based on the analysis of college-level success metrics. Based on course data analyses, we identified three additional courses (Computer Science-1, databases, statistics-1) that were causing difficulty for students to continue in the program. Thus, it was clear from the curriculum and data analyses that IT core courses such as databases, Computer Science-1, C language, Statistics-1 were causing difficulty for students to continue in the program and negatively affected their success (**RQ2**). Around 50% of students who dropped out of college withdraw these courses in their first attempt after enrolling, again retook them for one to two times but failed to pass. Computer Science-1 and C-language are CS core courses as well and IT students are required to take these courses. These courses have been taught by CS faculty. Our historical data analysis shows that even the CS program has a high failure rate in Computer Science-1. Both IT and CS students take these courses together. There may be a sense of downward comparisons among IT students due to the way that these courses are structured. In other words, the course curriculum may be more rigorous and focused extensively on the CS program neglecting the level of proficiency of IT students in prerequisite courses. It is clear from our previous study that social comparisons existed between these two programs within the department and negatively affected perceptions of IT students [13]. Also, the Sankey visualizations show that out of total IT students who changed their major, almost 95% of students changed their major from IT to non-computing (or non-STEM) programs. We argue that the reasons mentioned above cause IT students to either drop out or change major.

Students' college dropout and change of majors between programs are very common in higher education institutions. It has been shown that students leave the program when they feel that their current program does not support their involvement and persistence, and they start to find a different place (or program) within the university where they get the support they need [11]. Another concern with the students' changing majors is that they may take longer than usual to complete the program and sometimes end up dropping out [19]. It is important for institutions to think from a student's perspective. Students need help in deciding their major, and they need maximum institutional support to stay in college. Therefore, we urge institutions to take necessary measures to reduce dropouts and to provide assistance to decide a suitable major.

5.2 Recommendations and Implications

Based on this study, there is a need to take measures to (i) improve the quality of IT program and; (ii) provide additional course support for IT students in CS courses (**RQ3**). In other words, there exists an imbalance in the allocation of resources (academic advisors, tenure-track and tenured professors) for IT program placing the program at a significant disadvantage.

IT program is unique and prepare students for IT related workforce. It is important to take measures that are individually

applicable to IT program to improve student success. Based on this study, we provide the following recommendations to improve IT student success. First, the department should provide additional course support (such as increasing the number of teaching assistants, conducting extra evening sessions) for IT students in databases, Statistics-1, Computer Science-1, and C-language. More preference should be given to CS courses by giving periodical tests once in a month to assess IT students' proficiency in these courses. Second, the department should take additional measures to improve the program quality such as implementing the qualifying (or a similar) exam for IT. This could help students to decide early in their college journey whether IT is the right major for them or not. Also, providing personalized advising and support for students on when to take CS courses could help to reduce the dropout rates. By implementing these recommendations, the dropout rates and the program quality may be improved and contribute to higher levels of IT student success.

6 CONCLUSIONS

We presented a case study of an IT program established within the CS department at a large public university to understand whether accreditation is enough for a program to maintain its quality and achieve higher levels of student success. Based on institutional data and curriculum analysis, we determined that (i) the college level success metrics did not change significantly after a program received accreditation; (ii) CS core courses that are part of IT program curriculum were causing difficulty for students to continue in their program; (iii) imbalances in the allocation of resources for a small-sized program IT has a negative influence on student success. To improve the quality of IT program and college-level success metrics, we proposed several recommendations regarding resource allocation, additional course support. A possible limitation of this study is that we analyze data of Spring 2014 and Fall 2014 semesters till Fall 2017, which consists of respectively ten to twelve terms after accreditation. We intend to replicate this study for 2016 and 2017 cohorts to see if college-level success metrics have improved. We contribute to the IT education literature by (i) showing the importance of ABET's policy on continuous program improvement to enhance both college-level success metrics and program quality; and (ii) critically reflecting on the meaning of student success by providing student-centered recommendations to improve both the program quality and college-level success metrics.

ACKNOWLEDGMENTS

This work is partly funded by the Board of Governors - TEAm Grant: An Urban University Coalition Response to Florida's Computer and Information Technology Workforce Needs.

REFERENCES

[1] D. Bok, "Improving the Quality of Education," INSIDE HIGHER ED, 21 September 2017. [Online]. Available: https://www.insidehighered.com/views/2017/09/21/how-improve-quality-higher-education-essay. [Accessed 22 May 2019].

[2] J. Brownell and L. and Swaner, "High-impact practices: Applying the learning outcomes literature to the development of successful campus programs.," in *Peer Review, 11(2), p.26.*, 2009.

[3] A. Talone, P. Basavaraj and P. and Wisniewski, " Enhancing Human-Computer Interaction and User Experience Education through a Hybrid Approach to Experiential Learning.," in *In Proceedings of the 18th Annual Conference on Information Technology Education (pp. 83-88). ACM.*, 2017.

[4] R. Felder and R. and Brent, "The ABC's of engineering education: ABET, Bloom's taxonomy, cooperative learning, and so on.," in *In Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition (Vol. 1).*, 2004, June. .

[5] W. Tyson, R. Lee, BormanK.M. and M. and Hanson, "Science, technology, engineering, and mathematics (STEM) pathways: High school science and math coursework and postsecondary degree attainment. 12(3), pp.243-270.," *Journal of Education for Students Placed at Risk*, no. 12(3), pp. 243-270, 2007.

[6] A. Astin and H. and Astin, "Undergraduate science education: the impact of different college environments on the educational pipeline in the sciences," Final report., 1992.

[7] K. Muollo, P. Basavaraj and I. and Garibay, "Understanding Students' Online Reviews to Improve College Experience and Graduation Rates of STEM Programs at the Largest Post-Secondary Institution: A Learner-Centered Study," in *In 2018 IEEE Frontiers in Education Conference (FIE) (pp. 1-7). IEEE.*, 2018.

[8] T. Regan, *Applications and outcomes of continuous improvement protocols in civil engineering programs: a perspective of the processes, practices, and pitfalls*, (Doctoral dissertation, Humboldt State University)., 2012.

[9] J. Holland, "A theory of vocational choice," *Journal of counseling psychology*, vol. 1, no. 6, p. 35, 1959.

[10] J. Smart, K. Feldman and C. and Ethington, "Holland's theory and patterns of college student success.," In Commissioned report for the national symposium on postsecondary success: Spearheading a dialogue on student success. Washington DC: The National Postsecondary Education Cooperative., 2006.

[11] R. Reardon and &. B. E. , "Holland's theory and implications for academic advising and career," *NACADA Journal.*, no. 24, pp. 111-122, 2004.

[12] C. Morse, "Visualization of Student Cohort Data With Sankey," 2014.

[13] P. Basavaraj, K. Badillo-Urquiola, I. Garibay and P. and Wisniewski, "A Tale of Two Majors: When Information Technology is Embedded within a Department of Computer Science.," in *In Proceedings of the 19th Annual SIG Conference on Information Technology Education (pp. 32-37). International World Wide Web Conferences Steering Committee.*, 2018.

[14] J. McFarland, B. Hussar, C. de Brey, T. Snyder, X. Wang, S. Wilkinson-Flicker, S. Gebrekristos, J. Zhang, A. Rathbun, A. Barmer and F. and Bullock Mann, "The Condition of Education 2017 (NCES 2017-144), Undergraduate Retention and Graduation Rates.," National Center for Education, 2017.

[15] A. Slim, J. Kozlick, G. Heileman, J. Wigdahl and C. and Abdallah, "Network analysis of university courses.," in *Proceedings of the 23rd International Conference on World Wide Web (pp. 713-718). ACM.*, 2014.

[16] M. Akbaş, P. Basavaraj and M. and Georgiopoulos, "Curriculum GPS: an adaptive curriculum generation and planning system.," in *In Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC).*, 2015.

[17] P. Basavaraj and I. and Garibay, "A Personalized Course Navigator Based on Students' Goal Orientation," in *Proceedings of the 2018 ACM Conference on Supporting Groupwork, ACM.*, 2018.

[18] J. Wigdahl, G. Heileman, A. Slim and C. and Abdallah, "Curricular efficiency: What role does it play in student success," in *In Proceedings of the the 121st ASEE Annual Conference and Exposition. IEEE.*, 2014.

[19] V. Tinto, "Stages of student departure: Reflections on the longitudinal character of student leaving.," *The journal of higher education*, pp. 59(4), pp.438-455., 1988.

[20] J. Edmonds, "Factors influencing choice of college major: what really makes a difference?.," 2012..