

Understanding Career Identity Development and Preparedness of Freshmen Students to Leverage Convergence in Engineering Education

Victor M. Garcia
Department of Civil Engineering
The University of Texas at El Paso
El Paso, Texas, USA
vmgarcia5@utep.edu

Diane Elisa Golding
Department of Teacher Education
The University of Texas at El Paso
El Paso, Texas, USA
degolding@utep.edu

Irma Torres-Catanach
Department of Electrical and
Computer Engineering
The University of Texas at El Paso
El Paso, Texas, USA
iytorrescatanach@utep.edu

Crystal Cholewa
Department of Teacher Education
The University of Texas at El Paso
El Paso, Texas, USA
clcholewa@utep.edu

Helen Geller
Department of Leadership and
Engineering Education
The University of Texas at El Paso
El Paso, Texas, USA
hegeller@utep.edu

Gilberto Moreno
Prestige Consulting
El Paso, Texas, USA
gmoreno@prestigeconsult.com

Peter Golding
Department of Leadership and
Engineering Education
The University of Texas at El Paso
El Paso, Texas, USA
pgolding@utep.edu

Abstract — This Work in Progress paper reports on the intervention strategies formulated to leverage the career identity development and academic preparedness of freshmen students enrolled in introductory engineering classes at a Hispanic Serving Institution. The interventions were implemented by a newly initiated university program called ‘Yes SHE Can,’ which aims to develop new engagement techniques, mentoring approaches, professional development opportunities, and career pathways for underrepresented minority student groups in STEM academic programs, especially Hispanic female students. The main intervention activity consisted of incorporating the Mentorship Community of the Yes SHE Can program into an online education platform called “EduGuide.” Thirty-two trained mentors coached 53 freshmen students enrolled in two introductory engineering classes during the fall of 2020. Surveys and questionnaires were distributed to the freshmen students to collect information. The strategies implemented to influence career identity development and academic preparedness of freshmen students are elaborated and preliminary insights from the information collected through online surveys and observations are shared.

Keywords— *STEM Identity, Engineering, Career Preparedness Mentoring, Minorities, Resume Building*

I. INTRODUCTION

Career identity development and academic preparedness can positively influence the engagement, persistence, graduation, and success of first-year undergraduate students, especially those in science, technology, engineering, and mathematics (STEM) programs [1]. Post-secondary education significantly contributes to student cognitive growth, career identity development and professional career preparation [2]. However, the process for career identity development and academic preparedness may vary widely as the content knowledge, epistemological paradigms and professional foci are aligned with specific fields [3]. Most explorations of career identity development have focused on personal perceptions related to gender, place in society, confidence, and professional engagement [4] [5] [6]. From the literature, there is still an opportunity to contribute to the knowledge base regarding early

career identity development and academic preparedness of college students in STEM, especially engineering.

Several models have been developed to archetype the career identity development of students (see examples, [1] [3] [7]). Many of these recognized education and intervention models have been mainly focused on graduate students. In contrast, this study focuses on investigating the career identity development and academic preparedness of freshmen students. Maintaining high rates of engagement, retention, persistence, and graduation of first-year students in STEM has been a prevalent challenge for many academic institutions [8]. Historically, it has been reported that 50% of students entering two-year colleges and 29% entering four-year institutions drop from their academic programs by the end of their first academic year [9]. As such, universities have reacted to this challenging situation by providing students with a variety of academic support services that enhance college essential skills such as communication, leadership, teamwork, study methods, and academic performance (see examples, [10] [11] [12]). Students’ learning experiences, interactions, and application of knowledge are some essential factors that significantly influence career identity development [3]. The approach adopted by our study hinges on the participation of students in their own learning process to foster increased learning outcomes, intrinsic student motivation, and significant career identity development.

The use of professional role models to impact the performance of college students has been previously explored by [13] and [14] and reported effective. Our study combined the use of role models as mentors and an online education platform called EduGuide, as suggested by [15], to influence the career identity development and academic preparedness of first-year engineering students. In addition, the career identity development and academic preparedness of freshmen students were assessed through a series of self-reflective open-ended questions distributed through an online survey.

II. OVERVIEW OF YES SHE CAN PROGRAM

The “Yes SHE Can” program was established with support from the U.S. Department of Education to influence the career decision-making of Hispanic female students interested in

STEM. The Yes SHE Can program aims to develop and implement new education models, engagement techniques, mentoring approaches, professional development opportunities, and career pathways through a multi-pronged education intervention. The six main intervention components of this program are 1) STEM Education Workshops, 2) Mentorship Community, 3) Research Component, 4) Recruitment Activities, 5) Professional Networking, and 6) Curricula Development. The ultimate goal of Yes SHE Can is to close the education gap for female students in STEM.

III. STUDY METHODOLOGY

During the fall of 2020, the Yes SHE Can program partnered with a faculty professor of an introductory engineering course to support professional and academic preparation of the first-year students. The Mentorship Community of the Yes SHE Can program interacted academically with the freshmen engineering students through an online educational platform called “EduGuide.” The objective of this intervention was to positively influence the career identity development and academic preparedness of freshmen students in STEM, specifically engineering, at an early stage in their academic careers and degree plans.

A. Student Demographic

Two introductory classes were intervened during the fall of 2020 with a total number of students of 56, although 3 students dropped before starting the semester. Fig. 1 presents the distribution of the freshmen students from the two introductory classes. From Fig. 1a, most of the students are male. In terms of ethnicity/race, most students are from a Hispanic or Latino background, as shown in Fig. 1b. Fig. 1c reports that 21 of the students’ parents have not graduated from college. From Fig. 1d, 32 of the participating students expressed an interest in completing at least a bachelor’s degree. Moreover, 17 students are interested in completing a master’s degree, while 4 students would like to pursue a doctoral degree.

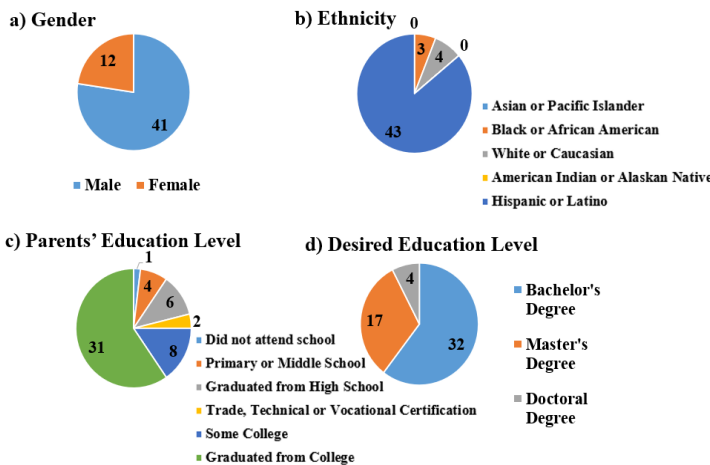


Fig. 1. General information from freshmen students.

B. General Information of Mentors

The Yes SHE Can program trained 32 members who actively coached the freshmen students during the online learning modules. The mentors consisted of workforce

professionals, faculty members, and college students with a wide range of educational backgrounds and demographics. All mentors participated in a training program that discussed topics related to best practices to be effective mentors in STEM. Overall, each mentor was assigned to at least two students.

C. Online Education Technology

The educational lessons and learning modules and the coaching activities from the Mentoring Community, were undertaken through an online educational platform called “EduGuide.” EduGuide is commercially available and its access to the Yes SHE Can program was provided by the faculty professor of the introductory classes who has been evaluating this online educational platform [15]. The learning modules and topics were already pre-defined.

IV. DISCUSSION OF ACTIVITIES

A. Readiness Assessment of Freshmen Students

At the beginning of the semester, the freshmen students were given an online survey with questions formulated to assess the students’ understanding of and readiness to pursue a professional career in STEM, specifically in engineering. The questions were formulated with five possible responses to generate quantifiable measurements of preparedness. Fig. 2 shows the results for four of the questions from the survey. The bar graph represents the count of students’ responses while the dots are the corresponding percentages. The two questions from Fig. 2a and 2b were designed to assess students’ interest in STEM and their understanding of STEM in their professional careers. In Fig. 2a, reports the queried students’ responses as to how exciting it would be for them to pursue a professional career in STEM. It can be observed that 79% and 15% of the students selected the options “strongly agree” and “agree,” respectively, which illustrates the interest level of this student population on a professional career in STEM. When students were asked about STEM concepts in their professional careers, 40% selected the response “always,” and 30% responded with “often,” as seen from Fig. 2b. These results can be interpreted as, freshmen students are interested in and understand the importance of STEM.

The other two questions were designed to complement the readiness assessment for freshmen students to pursue an academic career in STEM. Students were asked if they persist until they accomplish their goals and if new ideas or projects distract them from their goals. Twenty-three percent of the students responded with a “very much like me” or “mostly like me” (Fig. 2c). Similarly, 23% of the student population selected “very much like me” or “mostly like me” for the fourth question (See Fig. 2d). Based on the results of the latter two questions, the readiness level of about 20% of freshmen students in STEM may be considered critically low, considering that an academic career in STEM may take time and present challenges that can distract students from their long-term goals.

B. Supporting Preparedness of Freshmen Students

A strategy used to leverage the career preparedness of freshmen students consisted of using EduGuide, a commercially available online education platform, to engage

students on subjects that complement their academic programs. The topics that were studied included dealing with anxiety, class-taking strategies, community building, personal development, and critical thinking.

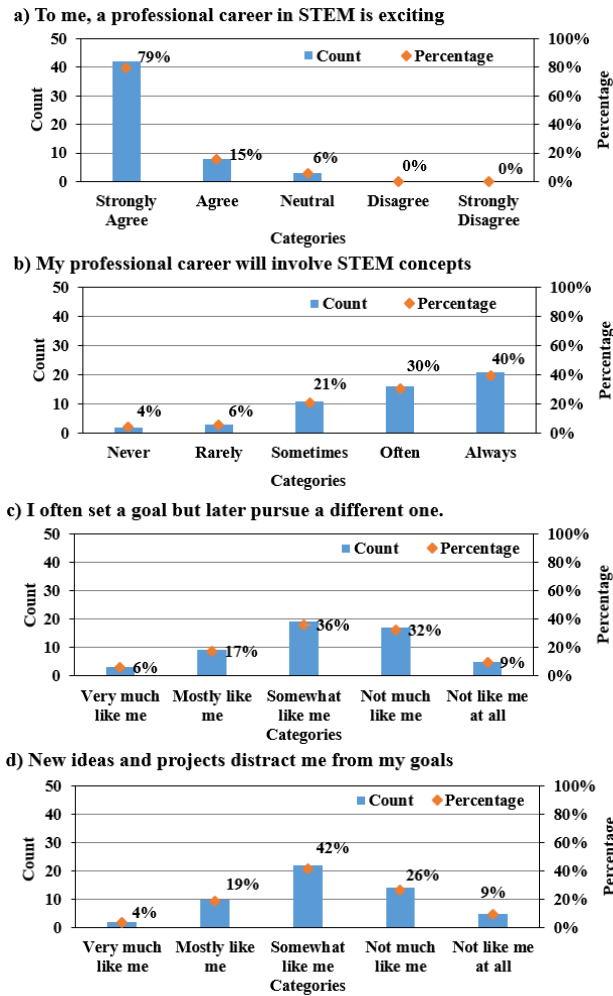


Figure 2. Analysis of Pre-Program Survey for Students

Students were tasked to complete 20 learning modules during the 15 weeks of the fall semester. Three learning modules were review sections. On average, freshmen students completed 15 modules. Only two students did not complete any module, while ten students completed the 20 modules. Table 1 provides a summary of the module titles and the number of students who completed these specific learning modules. Overall, the number of students who completed the modules was between 35 to 50 students, except for the last two modules completed by 9 and 8 students, respectively. Most students completed the first two modules, *Your Path to Growth* and *Your Mind is Like a Muscle*. The next step is to investigate the modules at which the students stopped participating in the online education program.

C. Quantifying Impact of Mentor-Mentee Connectedness

In an effort to strengthen the career preparedness of freshmen students in engineering, mentors were assigned to the participating students while they were completing the online learning modules. In total, mentors provided 1,313 coaching

comments collectively. This means that each participating student received 23 coaching comments on average.

TABLE I. SUMMARY OF MODULES' TITLES AND COMPLETION

| Learning Module | Number of Students |
|--|--------------------|
| Your Path to Growth | 51 |
| Your Mind is Like a Muscle | 51 |
| Your EduGuide | 50 |
| Fixed vs. Growth Mindset | 47 |
| Your Core Purpose | 45 |
| Talking Back to the Fixed Mindset | 43 |
| Finding Your Way Around the Change Curve | 41 |
| Seeing Trauma | 47 |
| Sleeping Through Trauma | 39 |
| Gaining Perspective on Trauma | 36 |
| Finding Meaning in Trauma | 35 |
| Self-Test is Best | 49 |
| Four Times to Build a Self-Testing Habit | 44 |
| Know Your Values | 42 |
| Use it or Lose It | 40 |
| Never Give Up | 9 |
| Moving from Short-Term to Long-Term Memory | 8 |

The distribution of the coaching comments was analyzed as shown in Figure 3. Ten mentors provided less than 20 coaching comments. Nine mentors coached the students with between 20 and 50 comments. While six mentors provided between 51 and 100 coaching comments, seven mentors exceed their coaching responsibility by delivering more than 101 comments. The wide distribution of coaching comments provided by the number of mentors creates an opportunity to investigate further if a correlation exists with the number of modules completed by the students.



Fig. 3. Distribution of coaching comments given by the number of mentors.

In addition, the mentor-mentee connectedness can be assessed by identifying the number of coaching comments that motivated students to continue elaborating their responses to the learning modules. Fig. 4 shows a great example of a mentor-mentee connectedness that influences the preparation of the student. This analysis will also be conducted to delineate if the students' engagement was enhanced indirectly.

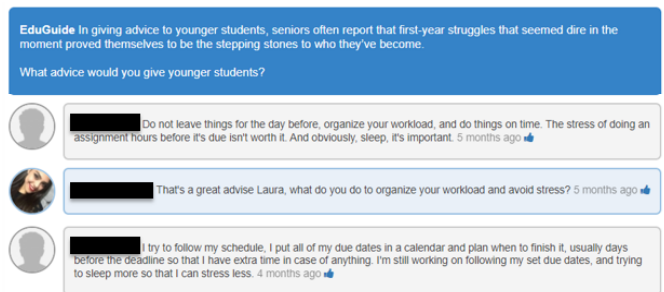


Fig. 4. Example of mentor-mentee connectedness.

D. Assessing Impact of Program Interventions

To complete the semester, freshmen students were asked to complete a survey containing 20 questions to assess the effectiveness of the activities as well as to reflect on their academic growth and preparation. Concerning the topics posed in this paper, four of the questions were formulated to generate relevant information that can reveal the career identity development and preparedness of the freshmen students. The relevant questions to the posed research topics are:

a) *Reviewing your semester as a whole, do you feel a sense of self-empowerment? What factors have contributed to the way you feel?*

b) *Looking back, what will you do differently next semester than you have done this semester to further enhance your success in learning engineering and computer science?*

c) *Did you put in the effort needed to achieve ultimate success all semester long? How can you avoid repeating this behavior pattern next (and in future) semesters?*

d) *When you look at your pathway forward, what concerns do you have, when it comes to being able to complete this "long-distance race?"*

Given the length limitations for this WIP paper, the analysis of these four questions will be provided in a follow up full-length paper version of this study. To improve the drawing of conclusions from these questions, suggestions to select the analysis methods and approaches are welcomed.

V. SUMMARY AND PRELIMINARY OBSERVATIONS

During the fall of 2020, the Yes SHE Can program partnered with a faculty professor of an engineering introductory class to support the professional and academic preparation of freshmen students. The Mentorship Community of the Yes SHE Can program intervened to academically engage and prepare freshmen students through an online educational platform called "EduGuide". Several strategies were formulated to assess the impact of this intervention to the career identity development and academic preparedness of the freshmen students enrolled in the engineering program. The following observations are provided:

- From this study, 95% of freshmen students understand the importance of STEM as a career and in their professional careers.
- In general, 20% of freshmen students are marginally ready to pursue an academic career in STEM given their weakness in setting and achieving their career goals.
- A considerable number of students completed their learning modules through EduGuide, which indirectly reflect their preparation to continue with their academic career in STEM, specifically engineering. On average, students completed 15 learning modules from EduGuide.
- Some learning modules received more responses from students than others. The subjects for these learning modules must be evaluated to identify the interest of freshmen students in engineering programs.

- The role of mentors is crucial to engage and help students during introductory engineering classes. The effect of coaching performance of mentors will be further investigated as well as the influence of mentor-mentee connectedness on the students' performance.

VI. ACKNOWLEDGMENT

This study was carried out as a part of a grant from the Minority Science and Engineering Improvement Program (MSEIP) of the U.S. Department of Education. The authors would like to express their gratitude to Dr. Bernadette Hence of the U.S. Department of Education. The authors would also like to acknowledge all members of the Yes SHE Can program and Mentorship Community who participated in this study.

VII. REFERENCES

- [1] L. S. Nadelson, S. Paterson, K. A. Davis, A. Farid, K. K. Hardy, Y. C. Hsu, U. Kaiser, R. Nagarajan & S. Wang. "Am I a STEM professional? Documenting STEM student professional identity development," *Studies in Higher Education*, 42:4, 701-720, 2017. DOI: [10.1080/03075079.2015.1070819](https://doi.org/10.1080/03075079.2015.1070819)
- [2] National Research Council. "BIO2010: Transforming Undergraduate Education for Future Research Biologists," Washington, DC: National Academies Press, 2002.
- [3] F. Trede, R. Macklin, and D. Bridges. "Professional Identity Development: A Review of the Higher Education Literature." *Studies in Higher Education* 37 (3): 365–84. 2012. DOI: 10.1080/03075079.2010.521237
- [4] S. R. Jones, "Voices of Identity and Difference: A Qualitative Exploration of the Multiple Dimensions of Identity Development in Women College Students," *Journal of College Student Development* 38 (4): 376–86. 1997
- [5] T. F. N. Laird, "College Students' Experiences with Diversity and their Effects on Academic Self-Confidence, Social Agency, and Disposition toward Critical Thinking," *Research in Higher Education* 46 (4): 365–87. 2005. DOI: 10.1007/s11162-005-2966-1
- [6] V. B. Sweitzer, "Towards a theory of Doctoral Student Professional Identity Development: A Developmental Networks Approach," *The Journal of Higher Education* 80 (1): 1–33. 2009 DOI: 10.1353/jhe.0.0034
- [7] Cen, Y. Teaching for developmental growth: learning partnerships and student development in graduate education in China. *Teaching in Higher Education*, 23(1), 30-46. 2018.
- [8] C. A. Amenkhenan, and L. R. Kogan, "Engineering students' perceptions of academic activities and support services: factors that influence their academic performance." *College Student Journal*, vol. 38, no. 4, 2004, p. 523.
- [9] J. B. Berger & J. M. Braxton, "Revising Tinto's internationalist theory of student departure through theory elaboration: Examining the role of organizational attributes in the persistence process," *Research in Higher Education*, 39(2), 103–120. 1998.
- [10] E. J. Seat, R. Parsons & W. A. Poppen, "Enabling engineering performance skills: A program to teach communication, leadership, and teamwork" *Journal of Engineering Education* 90, no. 1: 7-12, 2001.
- [11] Turner, P., & Thompson, E. College retention initiatives meeting the needs of millennial freshman students. *College student journal*, 48(1), 94-104. 2014.
- [12] T. Abdel-Salam, P. Kauffmann and K. Williamson, "A case study: do high school GPA/SAT scores predict the performance of freshmen engineering students?" *Proceedings Frontiers in Education 35th Annual Conference*, 2005, pp. S2E-7, doi: 10.1109/FIE.2005.1612225.
- [13] Chong, Y., & Thi, L. S. University Freshman Mentoring Effectiveness and Scale Enhancement. *Asian Journal of University Education*, 16(4), 181-189. 2020.
- [14] D. E. Gibson, "Role models in career development: New directions for theory and research." *Journal of vocational behavior* 65, no. 1: 134-156. 2004.
- [15] P. Golding, D. E. Golding, A.K. Jimenez Enciso, A. Raj, and M. T. Pitcher, "Lessons Learned from a Summer Bridger Research Partnership between a Community College and a University." In 2020 ASEE Virtual Annual Conference Content Access. 2020.