Professional Identity Formation in a joint Engineering/Engineering Technology Capstone Course

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Introduction

Among STEM disciplines, there is an emerging need for, and a growing body of work that investigates professional identity development [1-2]. Although engineering education experts have identified identity formation as an educational imperative [1-3], resources remain limited for practitioners, and curricula still tend to focus only on imparting skill sets, neglecting students' mindsets and their development. An individual's identity is complex, multi-faceted, and changes over time [2-3]. Individuals can embody multiple identities based on various personal and social factors [3-4]. Identity theories are a recognized lens for analyzing perceptions, motivations, efficacy, attitudes, roles, and emotional commitment in educational and social inquiry and educational research [5].

This study focused on professional identity status in an undergraduate capstone course that enrolls both mechanical engineering technology (MET) and mechanical engineering (ME) students. The students work for 2 semesters on projects to design, build, and test novel products and processes within static teams of 3 to 5 individuals. Little to no credence is given to individuals' majors during team formation, so in any given semester, there are many teams of mixed composition, as well as some with only one major or the other (though ME enrollment being 2 to 3 times that of MET drives the composition of many teams to have more MEs than METs). However, a few recent studies [6-7] have adapted the *Professional Identity Status Questionnaire - 5 Dimensions* (PISQ-5d) instrument for ET students in a capstone course of a 4-year program. The present study has adapted the instrument for this particular use case—to be administered at one time near the end of a semester to ME and MET students enrolled in both the first- and second-semester sections of a 2-semester capstone course. Additional questions were added to determine the student's major (ME or MET), which majors were represented by other members of the student's team, whether the student had a leadership position or any participation in a co-curricular student engineering club, and if the student had taken or had a reported result on the Fundamentals of Engineering Exam (FE). Both ME and MET majors at Montana State University (MSU) must take the same version of the FE (the "FE mechanical" version). The goal of this study was to begin categorizing students' professional identity status, noting any differences between MEs and METs, and examining any correlation with capstone group composition by major, co-curricular activity, or taking the FE examination or its result.

Background

Engineering vs. Engineering Technology

At universities in the United States, college-level programs for students interested in mechanical engineering are offered in both mechanical engineering and mechanical engineering technology. While MET degrees are limited to associate and bachelor's degrees, ME degrees range from bachelor's, master's, to doctorate. ABET's Engineering Accreditation Commission (EAC) accredits mechanical engineering degrees at the bachelor's and master's levels. ABET's

Engineering Technology Accreditation Commission (ETAC) accredits MET associate degrees (2-year) and bachelor's degrees (4-year).

The American Society of Mechanical Engineers (ASME) [8] describes the difference between an ME graduate and an MET graduate as follows: while the ME graduate can "develop new procedures to advance the state of the art," an MET graduate can "apply established procedures which utilize the state of the art." Lucietto et al. described the engineer as the playwright while the engineering technologists are the actors [9]. While ME graduates in all states may take the FE as a step towards professional licensure, not all states allow MET graduates to follow this path. This may lead MET graduates to feel like second-class citizens in the engineering world, or to view engineering technology as a separate field with a lower professional ceiling.

One major difference between ME graduates and MET graduates is their aggregate performance on the FE Mechanical Computer-Based Test (CBT). For ME Programs, the ABET pass rate for examinees varies across time periods but has been around 70% over the past 5 years, while the corresponding rate for MET programs is more variable, with an average closer to 35%. Therefore, the psychological effect of requiring an exam attempt might be much different for an ME student who expects, on average, to pass than for an MET student who, on average, should not expect to pass. However, passing the exam might feel like a much greater accomplishment for an MET student who puts great effort into preparing for and succeeding on it than for an ME student. There is clearly a different risk/reward profile between the two majors.

It should be noted, according to the National Council of Examiners for Engineering and Surveying (NCEES), which creates and administers the test, the FE Mechanical exam is "developed to measure minimum technical competence...as the first step in the professional licensing of engineers [10]. As such, the discrepancy between ME student results and MET student results should not be surprising. ME curricula are more often designed to prepare students for professional licensure than corresponding MET curricula. For instance, the FE may contain questions on ordinary differential equations, linear algebra, numerical methods, particle kinematics, free and forced vibrations, and other topics [10] that may not be required in a 4-year MET degree. Also, if an MET student is required to take the exam but believes that further steps in licensing are not required for their chosen career path or are not allowed in the state where they work, full effort may not be given to maximizing their test performance.

Professional Identity Formation

Marcia's [11] framework identified four identity statuses determined by the presence of exploration and commitment. *Achievement* refers to individuals who have navigated a period of crisis to establish firm professional and ideological goals, while *Foreclosure* describes those who commit to roles without undergoing such exploration. Conversely, *Moratorium* involves an ongoing crisis with vague commitments, and *a complete lack of vocational decision-making or concern marks Diffusion*. Later scholars have suggested that other dimensions also contributed to PIS [12-14]. These include *Reconsideration of Commitment* (doubting one's career choice) and *Affirmation* (feeling confident in one's career choice). Identity researchers have proposed a fifth status, *searching moratorium*, which they described as being in the process of revising statuses, with a strong emphasis on reconsideration [12-14]. Recent studies have used the 5-dimensional

Professional Identity Status Questionnaire (PISQ-5d) with undergraduates, particularly STEM majors. Mancini et al. [12] suggested that the use of these and similar tools is a valuable means of understanding how university students develop their professional identities. Because identity development is closely linked to academic confidence and career readiness, using this scale allows educators to better support a student's self-esteem and job-search strategies, as well as inform aspects of educational practice and pedagogy. Ultimately, evaluating one's professional identity helps graduates make more informed career decisions and maintain a more positive outlook on their future work. The rest of this section provides a brief overview of cases from the recent literature.

Pastoor [15] studied the career behaviors and intentions of STEM students (including those in engineering and engineering technology majors), finding that searching moratorium, foreclosure, and diffusion appeared as the most common statuses. They found that a high percentage of students in the searching moratorium status, indicating that many STEM students are highly committed to their field but are also actively exploring alternative roles or specializations.

Kelly et al. [16] examined STEM identity formation among undergraduate students and practicing professionals and found that neither group possesses a predominantly achieved professional identity. The findings indicate that many participants reside in a foreclosed status, suggesting that professional identity is a fluid, ongoing project throughout the lifespan rather than a fixed state reached in early adulthood. These results challenge traditional career guidance models and suggest that STEM education should embrace a more porous, less fragmented understanding of professional disciplines to better support long-term career persistence.

Kostermans [17] investigated the professional identity development of STEM students in Dutch higher vocational education, specifically focusing on how different identity statuses correlate with student characteristics and career choices. They found that STEM students in higher vocational education primarily occupy the diffusion and foreclosure identity statuses, reflecting a general deficiency in active professional exploration despite varying levels of commitment. A significant developmental progression occurs between the first and third academic years; first-year students tend to rely on external authorities for self-definition, while third-year students demonstrate significantly higher levels of professional identification, behavioral practice, and internalized self-definition. This advancement is positively associated with internship experience, which serves as a critical catalyst for accelerating professional identity formation and fostering a deeper sense of vocational belonging.

Research on the development of professional identity in engineering education remains scarce but is increasingly important. This work aims to provide new insights and future directions for scholars and practitioners interested in engineering (technology) education-related professional identity formation. In a previous study, [6] examined a cross-section of 47 engineering technology (ET) undergraduates and found that year in school was a significant predictor of professional identity status. This led the author to a subsequent study of ET capstone students, which, through a pre-post test, found that Affirmation was the highest-rated dimension among students at both the start and end of the term. There were shifts in student status, including a net increase of three students in the Foreclosure status. During the same period, the number of participants classified as Achieved and Diffusion decreased. However, paired samples T-tests indicated that the observed changes in identity dimensions over the semester were not significant [7]. Additionally, it was concluded that small sample sizes and the lack of comparison between ET and conventional engineering students have been significant limitations, thereby providing the impetus for this study.

Methods

This non-experimental study was conducted within a joint capstone course in Mechanical Engineering (ME) and Mechanical Engineering Technology (MET) at MSU and offered to 117 ME and 45 MET students as an online survey at the end of the semester. To maintain consistency in evaluation, surveys with incomplete responses were excluded from analysis. 53 surveys (41 ME and 12 MET; 45%) were completed. All students were seniors in their final two semesters of a four-year bachelor's degree program. Additional questions were added to gain insights based on their interaction with the Fundamentals of Engineering (FE) exam and their engagement in extracurricular activities related to their major. The questions that guided this study were:

RQ1: How do ME and MET students compare in terms of their professional identity development at the culmination of their undergraduate programs?

RQ2: How does a professional milestone like the Fundamentals of Engineering (FE) Exam impact MET students' perception of becoming an engineering professional compared to their ME peers?

Students provided self-reported ratings to indicators measuring five dimensions of professional identity formation. Based on these results, a professional identity status was suggested by grouping students into one of five professional identity statuses using K-Means clustering and correlational analysis. A descriptive univariate analysis of the *PISQ-5d* was conducted by item. The data was found to be normally distributed. Next, items were summarized and standardized according to the corresponding dimensions of professional identity to identify clusters of participants (groups) that reflected the traits of a particular professional identity status. This was achieved using K-Means clustering, which resulted in the categorization of professional identity statuses observed in a similar population of ET undergraduates [6-7]. Clusters were graphed using standardized scores for enhanced clarity and readability. The relationships among the identity statuses of Engineering and Engineering Technology students were then examined in terms of engagement with the FE and extracurricular activities. The following section describes the results of this study in order of the research questions.

Results

Affirmation was rated highest overall and similarly by both groups. High levels of *Affirmation* were previously found to be a significant correlate of recognizing oneself as becoming an engineering professional [6] and were slightly higher in MET students in this study.
The highest-rated item in this dimension for both groups was "I am proud of becoming an engineer."

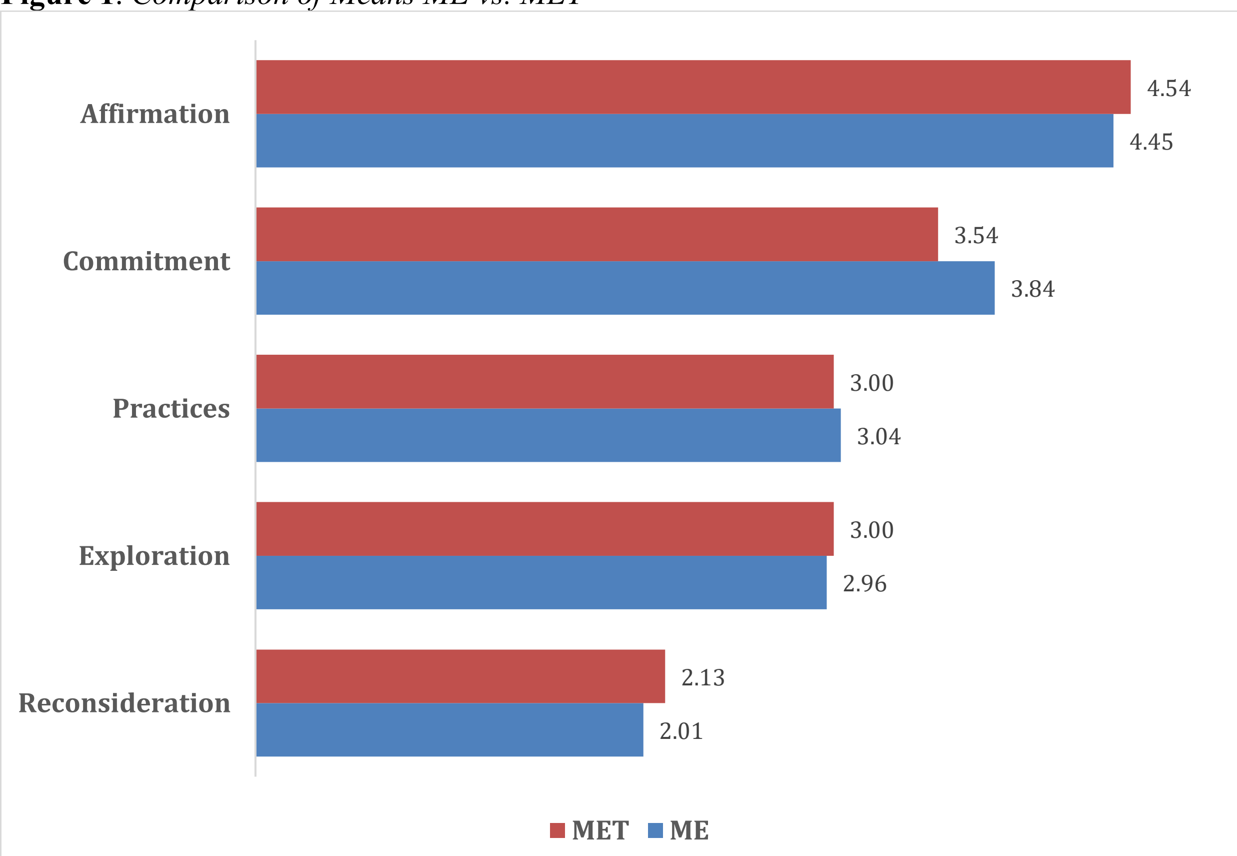
Identification with commitment was the second-highest-rated dimension for both groups and was slightly higher among ME students. "Thinking of myself as an engineer helps me understand who I am" was the highest-rated item for both groups, suggesting that a majority of students are deeply connected to their major/professional pathway.

Practices resulted in similar ratings between groups. ME students rated this dimension slightly higher. Item results varied between groups in this dimension, suggesting that ME and MET students may engage with their professional goals differently, which may lead to significant differences in resulting PIS. For example, the highest levels of *practice* were found among students in the Achieved status, while the lowest were among those in the Diffusion status.

In-depth exploration was also similar between groups, and slightly higher among MET students. Results from these dimensions varied in terms of PIS clustering. Higher levels of exploration were found in both Achieved and Moratorium statuses, while lower levels were found in Foreclosure and Diffusion.

Reconsideration of commitment was rated lowest overall, and slightly higher among MET students. Students who rated themselves higher on this dimension were often found to be in a Moratorium status, meaning they are actively revising their professional identity. Figure 1 shows the mean differences in the dimensions of professional identity status when comparing ME and MET students.

Figure 1. *Comparison of Means ME vs. MET*



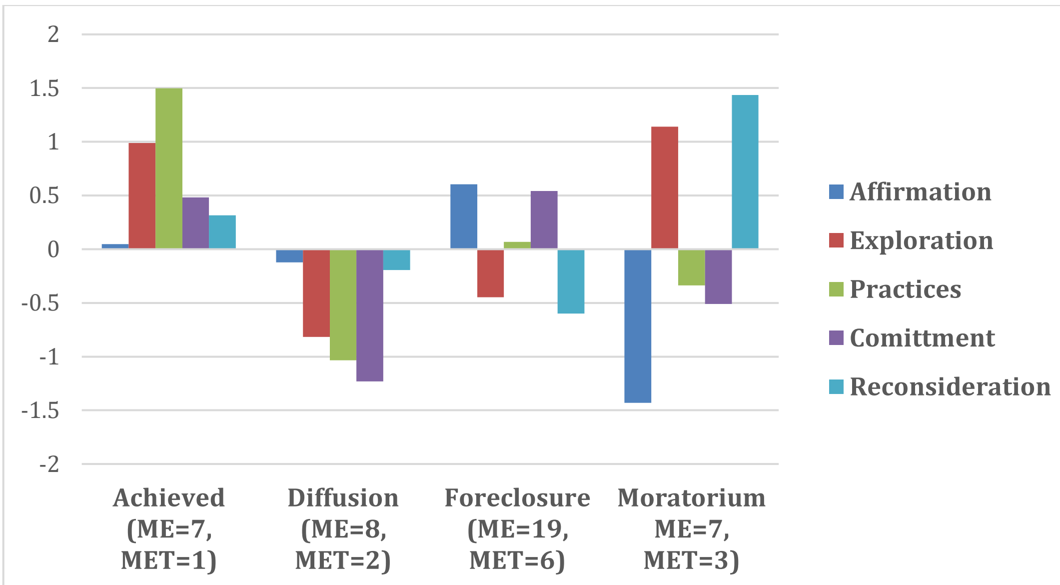
Descriptive results of the PISQ5-d instrument items are summarized in Table 1.

Table 1. *Itemized Results of PISQ5-d*

PISQ5-d (engineering) Items	**ME**		**MET**		**ALL**	
	M	*SD*	*M*	*SD*	*M*	*SD*
Affirmation	**4.45**	**0.441**	**4.54**	**0.393**	**4.47**	**0.430**
It is important for me to become an engineer.	4.71	0.461	4.67	0.492	4.70	0.463
I feel confident at this moment in time as a future engineer.	4.10	1.068	4.17	0.937	4.11	1.031
I am looking forward to becoming an engineer.	4.27	1.049	4.58	0.515	4.34	0.960
I am proud of becoming an engineer.	4.73	0.501	4.75	0.622	4.74	0.524
In-Depth Exploration	**2.96**	**0.807**	**3.00**	**0.744**	**2.97**	**0.793**
Becoming an engineer is a concern for me.	2.66	1.277	3.17	1.697	2.77	1.382
Do you ever think about the advantages and disadvantages associated with becoming an engineer?	3.39	1.137	3.42	1.621	3.40	1.246
Do you pay attention to what other people think or say about engineers?	2.88	1.187	2.67	1.231	2.83	1.189
Do you ever wonder whether if a profession in engineering/ engineering technology is the most suitable for you?	2.93	1.330	2.75	1.712	2.89	1.410
Practices	**3.04**	**0.973**	**3.00**	**1.111**	**3.03**	**1.004**
Do you ever watch videos or read books and/or articles written by engineers?	3.56	1.163	3.50	1.243	3.55	1.170
Do you ever seek information about the different job options that a degree in engineering technology may offer?	3.39	1.202	3.67	1.155	3.45	1.186
Do you ever seek information about the trends, innovations, an/or concerns of the engineering profession?	3.32	1.234	2.92	1.084	3.23	1.203
Do you ever participate in meetings and/or conferences where engineers speak?	1.88	0.927	1.92	1.165	1.89	0.974
Identification with commitment	**3.84**	**0.472**	**3.54**	**0.540**	**3.77**	**0.488**
Thinking of myself as an engineer helps me understand who I am.	3.78	1.061	3.50	1.000	3.72	1.045
Thinking of myself as an engineer makes me feel secure in my life.	3.76	1.135	3.50	1.087	3.70	1.119
Thinking of myself as an engineer makes me feel self-confident.	3.78	1.037	3.25	0.965	3.66	1.037
Thinking of myself as an engineer makes me feel confident about the future.	4.02	1.012	3.92	0.793	4.00	0.961
Reconsideration of commitment	**2.01**	**0.573**	**2.13**	**0.420**	**2.04**	**0.538**
If I could change my choice of becoming an engineer, I would.	2.10	1.136	2.33	1.371	2.15	1.183
Do you ever think that choosing a different profession would make your life more interesting?	2.37	1.220	2.42	1.311	2.38	1.228
Do you ever think that it would be better to prepare yourself for another profession?	1.98	1.172	1.92	1.084	1.96	1.143
I am considering the possibility of changing my university major to be able to practice another profession in the future.	1.61	0.891	1.83	1.193	1.66	0.960

Figure 2 illustrates the PIS clustering results, defined by the distances from the mean to the cluster centers.

Figure 2. *ME and MET PIS Clusters*



Students self-reported their status with the FE and involvement in major-related student organizations. Of the 53 participants, 11 had taken the FE. At the time of this survey, 7 (ME = 6, MET = 1) passed the exam, 2 (ME = 0, MET = 2) did not pass, and 2 (ME = 2, MET = 0) were awaiting results. A Chi-Square test for independence was conducted to determine whether there was a significant association between the FE results and PIS. No significance was found. However, it was observed that in cases where students had passed the FE, all cases were in Moratorium or Foreclosure statuses.

When considering how student leadership roles, such as leading or being a member of an ME or MET student organization was potentially connected to PIS, it was found that 10 (ME = 9, MET = 1) were in leadership roles and 11 (ME = 9, MET = 2) additional students were in membership roles. A Chi-Square test for independence was conducted to determine whether there was a significant difference in the groups' involvement. No significance was found. However, it was observed that students who held leadership positions were also more consistently found in the Foreclosure and Moratorium statuses.

Conclusion, Recommendations, and Future Work

Identity is an ever-changing concept, so although this cross-sectional study sought to explore identity at a given moment in time, drawing on events or features of students' undergraduate experiences, a true longitudinal study may better illustrate the development of students' (professional) identities over their undergraduate career. This study should be taken as only the first step in identifying groupings of student identities at a moment in time near the end of their undergraduate studies; further research is needed to determine if it is necessary to design interventions to guide the development of students' identities throughout their time at the institution. Future work could help develop an understanding of not just the capstone experience of MEs and METs, but perhaps aid in internal assessment of the respective programs and curricula—hopefully answering not only "do students have the skillsets for success in the profession?" but also "have they built the identity necessary to be successful in the profession?"

Institutions can use the results of the FE Examination as an outcomes assessment tool to support ABET accreditation [10]. A broader goal of this study was to begin investigating whether the effects of preparing for, taking, and passing (or failing) the exam can have on the graduating student population, beyond a superficial comparison to an ABET-provided comparator on exam passing rate or average performance index across broad subject matter areas. It may also be possible to discern if professional identity status in general is predictive of test results (giving the institution a way to target interventions to a student sub-population before the exam) or if the exam result is influential in creating the students' professional identity (giving the institution motivation to assist students in preparing for the exam). The results of this study do not indicate a relationship between the professional milestone of taking (or passing) the FE and students' perceptions of becoming an engineering professional. However, these results should not be considered fully conclusive and generalizable. Further investigation is needed in this area.

The authors of this study were surprised to find that relatively few students reported having taken the FE exam. The survey was administered near the end of the fall semester, and students at MSU are now being encouraged to take the FE in their penultimate semester, which usually coincides with enrollment in the first semester of the capstone course. Response to the survey in this study was neither required nor incentivized. Still, there may not be feasible incentives to achieve a high response rate among final-semester seniors. In the fall semester, a larger cohort of students is enrolled in the first-semester capstone than in the second-semester capstone, by about a 3:1 ratio. It was thus expected that all respondents from the second semester would have already completed the FE, resulting in at least 25% of survey respondents having taken the FE. It would then only take 1/3 of the first-semester students who have taken the FE to push the total to 50%. This was clearly not the case in the results. A longitudinal study with surveys administered at the beginning of the first semester, end of the first semester, and end of the second semester would be able to capture results pre- and post- test better, but this strategy might exacerbate the survey fatigue already demonstrated by the second semester (students in the final semester of their undergraduate degree).

References

[1] J. Morelock, "A systematic literature review of engineering identity: definitions, factors, and interventions affecting development, and means of measurement," *European Journal of Engineering Education*, vol. 42, pp. 1–23, Feb. 2017, doi: 10.1080/03043797.2017.1287664.

[2] A. Patrick and M. Borrego, "A review of the literature relevant to engineering identity," in *2016 ASEE Annual Conference & Exposition Proceedings*, New Orleans, Louisiana: ASEE Conferences, Jun. 2016, p. 26428. doi: 10.18260/p.26428.

[3] A. Kaplan and H. Flum, “Identity formation in educational settings: A critical focus for education in the 21st century,” *Contemporary Educational Psychology*, vol. 37, no. 3, pp. 171–175, Jul. 2012, doi: 10.1016/j.cedpsych.2012.01.005.

[4] B. Scheuringer, “Multiple Identities: A theoretical and an empirical approach,” *European Review*, vol. 24, no. 3, pp. 397–404, Jul. 2016, doi: 10.1017/S1062798716000120.

[5] J. P. Gee, “Identity as an analytic lens for research in education,” *Review of Research in Education*, vol. 25, pp. 99–125, 2001, doi: 10.2307/1167322.

[6] J. Williams, “Examining the Identities of Engineering Technology Students,” EdD, Illinois State University, 2024. doi: 10.30707/ETD.1763755357.519611.

[7] J. Williams, “Professional Identity Formation in an ET Capstone Course,” presented at the 2025 ASEE Annual Conference & Exposition, Jun. 2025. Accessed: Mar. 30, 2026. [Online]. Available: https://peer.asee.org/professional-identity-formation-in-an-et-capstone-course

[8] *Mechanical Engineering & Mechanical Engineering Technology: Which Path Will You Take?* ASME International, Fairfield, NJ, 2003

[9] A. M. Lucietto, “Who is the engineering technology graduate and where do they go?,” *2021 IEEE Frontiers in Education Conference (FIE)*, pp. 1–7, Oct. 2016, doi: https://doi.org/10.1109/fie.2016.7757652.

[10] B.G., Crawford, J.W. Steadman, D. L. Whitman, D. L., & R. K. Young, R. K. (2024). Using the Fundamentals of Engineering (FE) Examination as an Outcomes Assessment Tool. White Paper. Seneca, SC: *National Council of Examiners for Engineering and Surveying (NCEES).* Available: https://ncees.org/wp-content/uploads/2025/05/FEOAT-white-paper-2025.pdf.

[11] J. E. Marcia, “Development and validation of ego-identity status,” *Journal of Personality and Social Psychology*, vol. 3, no. 5, pp. 551–558, 1966, doi: 10.1037/h0023281.

[12] T. Mancini, L. Caricati, C. Panari, and A. Tonarelli, “Personal and social aspects of professional identity.: An extension of Marcia’s identity status model applied to a sample of university students,” *Journal of Vocational Behavior*, vol. 89, pp. 140–150, Aug. 2015, doi: 10.1016/j.jvb.2015.06.002.

[13] E. Crocetti, M. Rubini, and W. Meeus, “Capturing the dynamics of identity formation in various ethnic groups: development and validation of a three-dimensional model,” *J Adolesc*, vol. 31, no. 2, pp. 207–222, Apr. 2008, doi: 10.1016/j.adolescence.2007.09.002.

[14] E. Crocetti, L. Avanzi, S. Hawk, F. Fraccaroli, and W. Meeus, “Personal and social facets of job identity: a person-centered approach,” *Journal of Business and Psychology*, vol. 29, Jun. 2013, doi: 10.1007/s10869-013-9313-x.

[15] G. H. Pastoor, “Examining the effectiveness and impact of providing feedback to develop the professional identity of (future) stem professionals.” Accessed: Jan. 18, 2024. [Online]. Available: https://essay.utwente.nl/89349/

[16] R. Kelly, O. M. Garr, K. Leahy, and M. Goos, “An investigation of university students and professionals’ professional stem identity status,” *J Sci Educ Technol*, vol. 29, no. 4, pp. 536–546, Aug. 2020, doi: 10.1007/s10956-020-09834-8.

[17] A. Kostermans, “The professional identity development of STEM- students; identity status and development phase”.