Assessing the Fidelity of STEM Professional Identity Statuses using Cut-Off Scores for Small Populations

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Abstract

This study utilized a cross-sectional research study design to compare identity status assignments based on the Professional Identity Status Questionnaire (PISQ-5d) categories scores for affirmation, in-depth exploration, practices, commitment, and reconsideration of commitment via both cluster analysis and cutoff scores with respect to the two-factor, three-factor, or five-factor identity status models proposed by Marcia, Crocetti, and Kelly, respectively. The purpose of this study was to determine if cutoff scores could be utilized in lieu of cluster analysis for smaller populations. It was found that cut-off scores aligned with Marcia's framework were aligned with more robust statistical cluster analysis.

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The Science, Technology, Engineering, and Mathematics (STEM) workforce is a crucial component of a nation's innovative capacity, contributing to improving living standards, economic growth, and global competitiveness (Okrent et al., 2021). Concern for the shortage of skilled STEM professionals persists (Waite & McDonald, 2019), despite the US focus on STEM innovation and development. It is projected that there will be 3.5 million STEM jobs in the US by 2025, yet 2 million of those jobs are projected to be unfilled (Red Pen Content Creation, 2023). Previously, it was believed that 99% of STEM employment required a postsecondary degree (Fayer et al., 2017). Although this value may have shifted slightly since it was reported in 2017, institutions of higher education remain in a pivotal role for STEM workforce development.

One area of focus in addressing this shortage and a key challenge for institutions of higher education has been on the retention of STEM majors (Olson & Riordan, 2012). The literature indicates that students from historically marginalized groups (Hispanic, Black, American Indian and Alaskan Native) and females have been historically underrepresented in the STEM disciplines, partly due to lower retention rates (Chang et al., 2014; Cooper, 1983; Hill et al., 1990; Levine, 1985). In the 18-34 age range in the U.S., 37% of the population were from historically marginalized groups, yet, they only accounted for 26% of bachelor degree recipients in a cohort of science and engineering students in 2020 (National Science Foundation [NSF], 2023). Furthermore, the National Science Foundation (NSF, 2009) reported that despite Latino and African American undergraduates being just as likely as their Caucasian counterparts to enter college with the intention to major in STEM, they were much less likely to earn a degree in those majors. According to the National Center for Educational Statistics, less than 8% of the STEM degrees conferred in 2022 went to black students (Institute of Education Sciences National Center for Education Statistics, 2022). Attracting historically marginalized populations to STEM is not the primary concern as it has been shown that underrepresented students in STEM declare their interest in STEM at the same rate as other students (National Academies of Science, Engineering, and Medicine, 2022). Therefore, the focus must be on the retention of these individuals, and in fact all individuals who declare a STEM major.

Numerous factors have been identified to impact the retention of STEM majors. Over time the research has shifted its focus from understanding cognitive factors to affective factors (such as self-efficacy, motivation, and more recently STEM identity) and their effect on retention in STEM majors. This paper focuses on STEM identity as it is influenced by numerous affective characteristics. STEM identity is defined as one's self-recognition or recognition by others as a STEM person (Carlone & Johnson, 2007) and often correlates with participation in specific practices affiliated with that affinity group or community of practice (Carlone & Johnson, 2007; Gee, 2000). Someone with a strong STEM identity feels that they fit in within the STEM field whereby they see themselves as STEM learners and contributing to the STEM field (Center for the Advancement of Informal Science Education, 2018). Unfortunately, literature indicates that many ethnic minority youths are not exposed to the same science experiences or STEM-related hobbies outside of school as their Caucasian classmates, so they enter college with less science capital (Jones et al. 2021)STEM

Experiences, and Tool Access. Furthermore, lack of STEM role models who look like them can diminish the development of STEM identity (Marx et al., 2009; Starr et al., 2020)classroom experiences (felt recognition as a scientist and perceived classroom climate. In the same vein, professional identity is defined by Mancini et. al (2015) as, "one's identification with the groups and social categories to which one belongs by virtue of one's job." Research has shown that the development of a strong STEM identity results in greater persistence and retention in STEM majors (Chemers et al., 2011; Martin-Hansen, 2018; Perez et al., 2014; Simpson & Bouhafa, 2020) positive science, technology, engineering, and mathematics (STEM. Simply put, if one is not able to envision themselves in a STEM role, they will not continue to pursue a STEM career. Therefore, by understanding and employing teaching practices that foster the development of a strong STEM identity, we may slow or stop the leaking of the STEM professional pipeline by increasing the retention of STEM majors.

Current practices that have been reported to impact the development of a student's STEM (professional) identity have focused on the need for diverse role models and career development activities (Buunk et al., 2007; Marx & Ko, 2012). A long-term goal the authors seek to understand is how various teaching practices that are employed within STEM content courses impact a student's STEM identity. There are several instruments that exist in the literature that measure STEM identity (Hazari et al., 2013; Waite & McDonald, 2019; Young et al., 2013), however the Professional Identity Status Questionnaire (PSIQ-5d) includes a unique set of five factors (*affirmation, in-depth exploration, practices, identification with commitment, and reconsideration of commitment*). Each factor, defined in Table 1, has the potential to inform which teaching practices may most impact students. Collectively, identity practices are mapped onto identity statuses, the method of which has evolved over time and is discussed in greater depth in the Theoretical Framework section. The current downside of using the PISQ-5d is that the assignment of a student's STEM identity status had been determined by using cluster analysis. To date, the use of the instrument separate from utilization in a cluster analysis, particularly the instruments' application to smaller populations has not yet been reported. Therefore, the goal of the present research is to understand if a simplified method of assigning identity statuses can be used for smaller populations.

Table 1

Definitions of Practices That Contribute to Identity Formation

Identity Practice	Definition
Affirmation	The value an individual places on being part of the profession.
In-depth exploration	The active questioning and weighing of various identity alternatives before making decisions about the values, beliefs, and goals that one will pursue.
Practices	The behaviors a person may exhibit when engaging in a career.
Identification with commitment	Making a relatively firm choice in an identity domain and engaging in significant activities oriented toward the implementation of that choice.
Reconsideration of commitment	The comparison of present commitments with alternative commitments because the current ones are no longer satisfactory.

Theoretical Framework

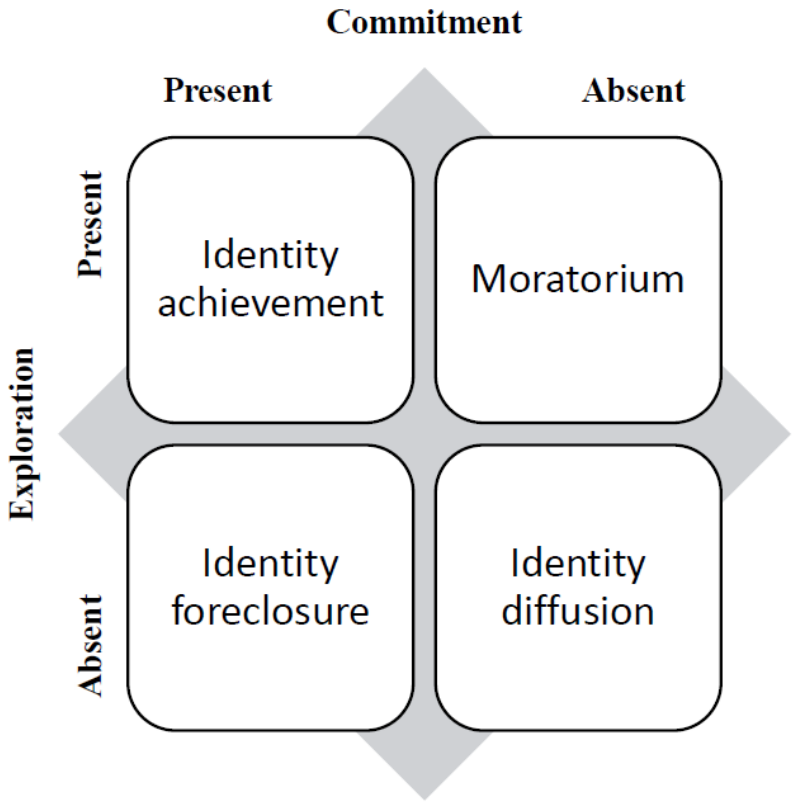
The most recent literature related to STEM identity has focused on the strength of one's identity as measured by instruments that evaluate factors that contribute to the development of their identity. However, the authors of this paper have sought to focus on professional identity status research and the related

theoretical frameworks to shape this current research study. This approach allows students to be classified by identity status which allows an instructor to understand an individual's commitment to a future profession and how these could be further shaped by instruction, advising, or other educational interventions. This section will summarize the iterative research process that has contributed to the most recent framework for identity statuses.

Identity status research is situated on the seminal research of James Marcia (1966). His research sought to elaborate further on what Erickson (1950) posited regarding the pivotal transition from childhood to adulthood during a stage of ego identity formation. Based on empirical evidence, Marcia (1966) proposed a framework, as shown in Figure 1, that describes an individual's identity status relative to two dimensions: *exploration and commitment*.

Figure 1

Marcia's Identity Status Model



Exploration is described as active questioning and consideration of alternative identities before adopting an identity will be taken on to guide an individual's values, beliefs, and goals. *Commitment* is described as making a firm choice about an identity domain which would guide the activities in which a person would choose to become involved. Thereafter, participation in activities and practices affiliated with that identity domain would serve and enhance the confidence of the individual within that chosen identity domain. Along these two dimensions emerges four identity status. The strongest identity status is *achievement*, whereby individuals have made a strong commitment to an identity status following a period of exploration. Opposing this is *diffusion* where there is much uncertainty regarding a specific identity domain and as a result there has been a lack of exploration and no commitment to an identity domain. The *foreclosure* identity status is used to characterize individuals who have made a strong commitment to an identity domain with little or no prior exploration. Lastly, the *moratorium* status describes individuals who have not made a commitment to an identity domain but are actively exploring multiple identity domains (Figure 1). A summary of each of the professional identity statuses as they align with the identity practices is provided in Table 2.

Table 2

Comparison of Identity Status Criteria

		Affirmation	In-Depth Exploration	Practices	Commitment	Reconsideration of Commitment
Marcia	Achievement		High		High	
	Foreclosure		Low		High	
	Moratorium		High		Low	
	Diffusion		Low		Low	
Crocetti	Achievement		High		High	Low
	Foreclosure		Low		High	Low
	Moratorium		Low		Low	High
	Diffusion		Low		Low	Low
	Searching moratorium		High		High	High
Kelly	Achievement	High	High	High	High	Low
	Foreclosure	High	Low	Low	High	Low
	Moratorium	Low	Low	Low	Low	High
	Diffusion	Low	Low	Low	Low	
	Searching moratorium	High	High	High	High	High

Since the development of Marcia's identity status framework, numerous researchers (Bosma,1985; Luyckx et al., 2006; Meeus, 1996; Meeus et al., 1999) have explored the various types of commitment and exploration that contribute to one's identity status. Collectively this research served to demonstrate the social natures of identity formation and most importantly the malleability of one's identity. As a result, Crocetti and coworkers (Crocetti et al., 2010) 975 have proposed a revision to Marcia's model to incorporate a third dimension: *reconsideration of commitment*. This dimension describes the degree to which an individual is comparing the identity domain that they are currently committed to alternatives, since the current domain is no longer fulfilling.

Table 2 depicts how each identity status would be defined using the three dimensions. Due to the addition of this third dimension, *exploration* is reclassified as *in-depth exploration* to describe only the process of reflecting on the current identity domain one is committed to and seeking out information for this current identity domain. The introduction of a third dimension has led to further refinement of the *moratorium* identity status. The previous definition focused on individuals who had not committed to an identity domain and demonstrated a need to introduce a fifth identity status, *searching moratorium*. *Searching moratorium* is defined as an individual who has high commitment to an identity domain following a period of extensive *in-depth exploration* but is actively reconsidering their commitment to the identity domain to a great extent. Individuals with this identity status are best described as fluctuating between the *achievement* and *moratorium statuses* (Stephen et al., 1992) (Figure 1).

As the identity status frameworks have evolved over time, the focus has been on personal attributes that shape one's identity status. However, Social Identity Theory (Tajfel, 1981) highlights the significant role that interactions an individual has with the group members shape their self-concept and directly impact their

identity development. As a result, the dimensions used to identify one's identity status have been expanded. The new framework included five dimensions with the addition of *affirmation* and *practices*. *Affirmation* is defined as the importance one places on being a part of a professional group and the sense of pride it brings to oneself which originates from intergroup interaction (Mancini et al., 2015). The practices dimension also highlights the interaction one has with a professional category by measuring the degree to which one engages in activities that are characteristic to that profession. The new practice is differentiated from *in-depth exploration* in that the individual is actively engaged in the exploration process, while *in-depth exploration* can be passive exploration such as watching videos of what a person in the profession does or reading reports published by professionals in the field. Table 2 summarizes how the five dimensions are used to assign the five identity statuses previously described.

The research presented herein steps through each of these frameworks for defining an individual's identity status to determine the most appropriate framework for assigning identity statuses. Therefore, this paper seeks to propose a new method of assigning a student's STEM professional identity status based on the use of cut-off scores by answering the following research questions:

1. How does professional identity status assignment based on cutoff scores compare to cluster analysis results for smaller populations?
2. Do the demographic characteristics of the participants from the various identity statuses provide evidence for criterion validity based on previous literature?

Methods

This study administered the Professional STEM Identity Status Questionnaire (PISQ-5D), along with some additional demographic questions, to a sample of two cohorts via Qualtrics Survey Solutions Online Survey Software. This research was approved by the Institutional Review Boards of both Kennesaw State University (KSU) and Oakland City University (OCU). Participants from each university were recruited verbally by instructors of their STEM courses and granted informed consent before completing the online questionnaire. The sample included 360 undergraduate students. A total of 203 females and 124 males participated from KSU, while a total of 24 females and 9 males participated from OCU. The sample consisted of students from Science (279), Technology (10), Engineering (39), Mathematics (1), and other (29) majors.

Questionnaire

The Professional Identity Status Questionnaire (PISQ-5d) was developed and validated by Mancini et al (2015) to measure the process of psychologists' professional identity status construction. Kelly (2020) adapted the PISQ-5d to measure the process of undergraduate STEM students' professional identity construction by replacing the word psychologist with the term STEM professional in each item. The instrument includes twenty items, with four items pertaining to each of five categories: *affirmation, in-depth exploration, practices, identification with commitment, and reconsideration of commitment*. The participants utilized a Likert-scale range to report how important each item was to them (1 = Not at all through 5 = Very much).

Data Collection Procedures

Participants from both institutions completed the online questionnaire at the end of the fall term. The responses were downloaded from Qualtrics into an Excel spreadsheet and cleaned in the following manner: (1) any duplicate questionnaire responses from a single participant were removed, keeping the first completed questionnaire; (2) participants younger than 18 were removed; (3) incomplete questionnaires were removed; (4) text-based responses (i.e. class standing) were assigned nominal variables; and (5) the education earned by parents/guardians question was translated into First-generation college student or not First-generation college student.

Data Analysis Procedures

Additional columns were added to the Excel spreadsheet to tally the five category scores. Each category score was then translated to a dichotomous value of "high" or "low" relative to an identified cut-off score. The "high" or "low" values for each category, were then compared, using if/then formulas in Excel, to the literature reported definitions for each of the three identity status models (Marcia, Kelly, and Crocetti) as per Table 2 to assign each participant an identity status. Any participant whose High/Low category scores did not correspond to an identity status definition were left blank.

Results

Sample Demographics

A chi-square test of independence was performed to compare the genders of the participants from the two institutions. The relation between these variables was not significant, indicating that the proportion of males to females at Kennesaw State University and Oakland City University were comparable (124:203 at KSU versus 9:24 at OCU). A chi-square test of independence was performed to compare the ages of the participants from the two institutions. The relation between these variables was significant, $\chi 2$ (12, N= 360) = 49.614, p< 0.05. Older students (25+ years old) were more likely to attend Kennesaw State University than Oakland City University (2% versus 0%). A chi-square test of independence was performed to compare the races of the participants from the two institutions. The relation between these variables was significant, $\chi 2$ (5, N = 360)= 20.116, p < 0.05. Participants from Kennesaw State University (7% Asian, 22% Black/African American, 44% White, 17% Hispanic/Latino, 8% Multiracial, 2% Other/Preferred not to say) were more diverse than those from Oakland City University (0% Asian, 18% Black/African American, 82% White, 0% Hispanic/Latino, 0% Multiracial, 0% Other/Preferred not to say). A chi-square test of independence was performed to compare the ethnicities of the participants from the two institutions. The relation between these variables was not significant, indicating that the proportion of Hispanic/Latino participants to Not Hispanic/Latino participants at Kennesaw State University and Oakland City University were comparable. A chi-square test of independence was performed to compare first generation college student status of the participants. The relation between these variables was significant, $\chi 2$ (2, N = 360) = 25.507, p < 0.05. Participants from Kennesaw State University were more likely to be first generation college students than those from Oakland City University (39% versus 85%).

A chi-square test of independence was performed to compare the majors of the participants from the two institutions. The relation between these variables was not significant. The highest percentage of participants by major from Oakland City University were Biology and Psychology (50% and 10%), while the highest percentages of participants by major from Kennesaw State University were Biology and Engineering (48% and 12%, respectively). (Note: Oakland City University does not offer Chemistry, Computer Game, Cybersecurity, or Nursing majors.) The study population was predominantly comprised of first-year students (65%), with 23% sophomore, 7% juniors, and 5% seniors. A chi-square test of independence was performed to compare the living arrangements of the participants from the two institutions, which indicated that the relation between these variables was not significant, indicating that the proportions of participants at Kennesaw State University and Oakland City University living off campus alone or with friends (22% versus 15%), living off-campus with family (41% versus 27%), or living on campus (37% versus 58%) were comparable.

A Mann-Whitney U test was performed to evaluate whether the PISQ-5d dimensional scores differed by institution (Table 3). The results indicated that there was no significant difference between the dimensional scores of the participants from Kennesaw State University and Oakland City University. Therefore, the participants PISQ-5d dimensional scores were pooled as a single sample for further analyses.

Table 3

Professional Identity Status (PISQ-5d) Dimensional Scores

	KSU N= 327		OCU N= 33		Total N= 360	
	Mean	**St. Dev.**	**Mean**	**St. Dev.**	**Mean**	**St. Dev.**
Affirmation Total	16.17	3.448	15.27	3.394	16.09	3.448
In depth exporation Total	14.40	3.162	13.12	2.997	14.29	3.165
Practices Total	12.04	3.546	11.88	3.324	12.03	3.522
Identification with commitment Total	14.69	4.171	14.48	3.554	14.67	4.114
Reconsideration of commitment Total	10.59	3.995	9.73	2.625	10.51	3.895

Research Question #1:

The use of cut-off scores to assign an identity status improves upon the practicality of the PISQ-5d instrument, since it reduces the need for statistical software to assign the STEM professional identity to individuals. In addition, the criteria for each cluster do not change for each unique sample that may be analyzed. Cut-off scores that ranged from 13-18 were explored, so that anything above the cut-off score would be considered high for the identity practice. Thirteen was chosen as the minimum score to explore since this would correspond to selecting a 4 on at least one prompt and 3, or neutral, on the remaining three prompts for identity practice.

Upon assigning the identity statuses using Kelly's definition using cut-off scores between 13 and 18, as shown in Table 4, there was a sizable portion of the sample (ranging between 59.9% and 32.3%) in which an identity status could not be defined. This phenomenon occurred because the number of permeations for five categories with two variables exceeds the number of defined identity statuses. Therefore, the original method of utilizing the results of the PISQ-5d instrument to assign identity statuses based on cut-off scores had to be abandoned. It did, however, cause the researchers to explore the results for each category more closely.

Table 4

Composition of Sample Based on Identity Status Using Cut-off Scores and Kelly's Definition

	Cut-off Score					
Identity Status	**13**	**14**	**15**	**16**	**17**	**18**
Achievement	84 (23.3%)	63 (17.6%)	40 (11.1%)	24 (6.7%)	9 (2.5%)	5 (1.4%)
Moratorium	10 (2.8%)	11 (3.1%)	9 (2.5%)	12 (3.3%)	12 (3.3%)	9 (2.5%)
Searching moratorium	29 (8.1%)	18 (5.0%)	8 (2.2%)	3 (0.8%)	1 (0.28%)	1 (0.3%)
Foreclosure	18 (5.0%)	28 (7.8%)	47 (13.1%)	51 (14.1%)	62 (17.3%)	51 (14.2%)
Diffuse	16 (4.4%)	24 (6.7%)	42 (11.7%)	70 (19.4%)	114 (31.8%)	177 (49.3)
Unassigned (Blank)	203 (56.4%)	215 (59.9%)	214 (59.4%)	200 (55.6%)	161 (44.9%)	116 (32.3%)

The mean and standard deviation of the overall student responses for each identity practice were *affirmation* (M = 16.1, SD = 3.4); *in-depth exploration* (M = 14.3, SD = 3.2); *practices* (M = 12.0, SD = 3.5); *identification with commitment* (M = 14.7, SD = 4.1); reconsideration of commitment (M = 10.5, SD = 3.9). *Affirmation* scores were severely skewed, with 87.9% of students ranked as high for *affirmation* when a cut- off score of 13 is used. *Affirmation* as it relates to the PISQ-5d may be described as one's sense of pride for the profession or the value one places on being a part of a profession. It is believed that these high scores for *affirmation* may be a residual effect from the importance and value society has placed on STEM professions. As a result, this may be interpreted that the first-year students in this sample lacked knowledge of what it means to be a professional in their desired field and therefore overestimated the personal value towards being a part of the profession.

Due to the skewed results for *affirmation* scores, the researchers considered how the data from the PISQ-d could be applied to past frameworks for defining one's professional identity status. Prior to Kelly's definition for each STEM professional identity status based on the five identity practices explored above, Crocetti defined the same five professional identity statuses using three constructs, including: *in-depth exploration, identification with commitment, and reconsideration of commitment*. Table 5 displays the professional identity status assignments for the sample using only those factors from the PISQ-5d responses that corresponded to Crocetti et al definition. It became apparent that the reduction in identity practices from five to three improved the assignment, however a large portion of individuals still had no professional identity status assigned.

Table 5

Composition of Sample Based on Identity Status Using cut-off Scores and Crocetti's Definition

	Cut- Off Score					
Identity Status	**13**	**14**	**15**	**16**	**17**	**18**
Achievement	165 (45.8%)	145 (40.3%)	119 (33.1%)	87 (24.2%)	45 (12.5%)	24 (6.7%)
Moratorium	19 (5.3%)	16 (4.4%)	11 (3.1%)	15 (4.2%)	14 (3.9%)	12 (3.3%)
Searching moratorium	56 (15.6%)	36 (10.0%)	21 (5.8%)	10 (2.8%)	6 (1.7%)	4 (1.1%)
Foreclosure	37 (10.3%)	55 (15.3%)	69 (19.2%)	73 (20.3%)	81 (22.5%)	69 (19.2%)
Diffuse	36 (10.0%)	57 (15.8%)	83 (23.1%)	122 (33.4%)	173 (48.1%)	228 (63.3%)
Unassigned (Blank)	47 (13.1%)	51 (14.2%)	57 (15.8%)	53 (14.7%)	41 (11.4%)	23 (6.4%)

Upon consideration, the data presented in Table 5, depicts a much more effective assignment of professional identity statuses when the Crocetti model for professional identity statuses was used. However, when a two-step cluster analysis was also performed to compare the results obtained using the cut-off method, five distinct identity status could not be found. Full cluster results are reported in the Supplemental Material.

Due to the poor agreement between the cut-off assignments and the cluster analysis assignments, the researchers returned to the original framework to define professional identity statuses proposed by Marcia. The Marcia identity status model defined four professional identity statuses (*achievement, foreclosure, moratorium,* and *diffuse*) based on only two constructs: *identification with commitment* and *in-depth exploration*. Using the same PISQ-5d responses for these two identity practices and the cut-off score method,

all students were assigned a professional identity status. The composition of the sample in which identity statuses for each cut-off score are shown in Table 6.

Table 6

Composition of Sample Based on Identity Status Using cut-off Scores and Marcia's Definition

	Cut-Off Score					
Identity Status	**13**	**14**	**15**	**16**	**17**	**18**
Achievement	221 (61.4%)	181 (50.3%)	140 (38.8%)	97 (26.9%)	51 (14.2%)	28 (7.8%)
Moratorium	44 (12.2%)	49 (13.6%)	51 (14.2%)	51 (14.2%)	39 (10.8%)	22 (6.1%)
Foreclosure	40 (11.1%)	57 (15.8%)	75 (20.8%)	75 (20.8%)	83 (23.1%)	70 (19.4%)
Diffuse	55 (15.3%)	73 (20.3%)	94 (26.1%)	137 (38.1%)	187 (51.9%)	240 (66.7%)

The two-step cluster analysis also produced improved results as shown in Figure 2. To determine which cut-off score was optimal, a comparison of the cut-off score assignment and the cluster analysis assignment was made. The percent agreement for each cut-off score is shown in Table 7. It was concluded that using a cut- off score of 15 for each identity practice produced the greatest alignment with cluster analysis assignments.

Figure 2

Composition of Participants by Class Standing

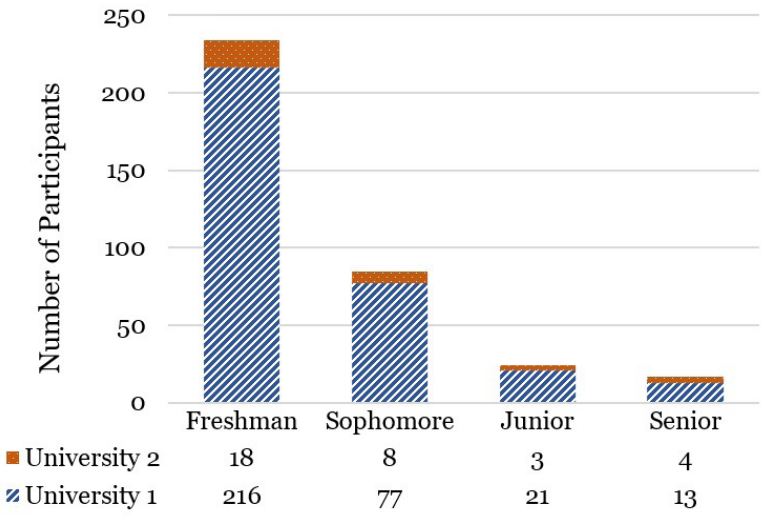


Table 7

Agreement Between cut-off Assignments and Cluster Analysis Results

Cut-off Score	% Agreement
13	66.6
14	76.7
15	83.6
16	73.6
17	49.7
18	34.4

Research Question #2:

The proportion of assigned identity statuses were then analyzed with respect to nine demographic variables, including: gender, age, race, ethnicity, first-generation status, major, discipline category, and class standing. A multiple linear regression was calculated to predict identity status based on gender, age, race, ethnicity, first-generation status, and major. A significant regression equation was found ($F(6,351)= 2.261$, $p<0.05$), with an R^2 of .037). Participants' predicted identity status is equal to

2.020 -.348 (gender) + 0.60 (race) – .003 (ethnicity) - .196 (First-generation status) + 0.036 (age) - .005 (major), where the only significant independent variable is the participants' gender ($p<0.05$).

The largest differences in proportion of identity status category by gender were the *achievement* and *diffuse* identity statuses (see figure 3). Namely, 46.6% of female participants versus 34.4% of male participants were categorized in the *achievement* identity status, while 24.0% of female participants were categorized in the *diffuse* identity status versus 35.2% of male participants.

Figure 3

Identity Status by Gender

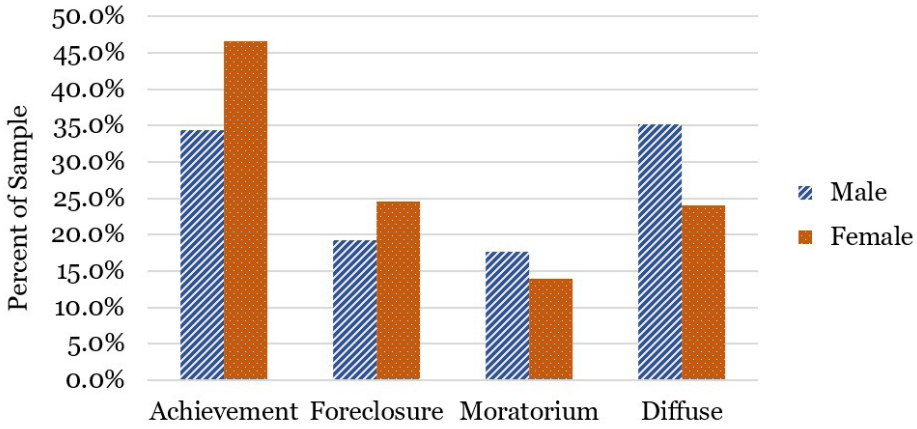
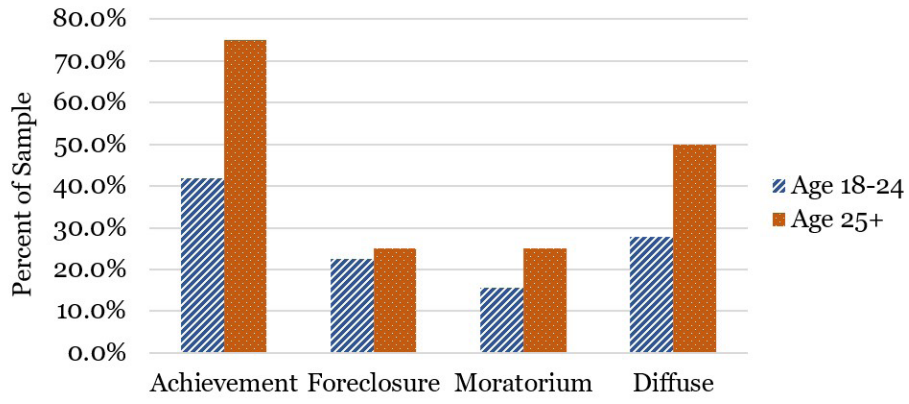


Figure 4

Identity Status by Age



When the participants were categorized by age group (see figure 4), the percentages of participants 18-24 years of age categorized in the *achievement* identity status was slightly lower than those 25 years and older. The reverse is observed for the *foreclosure* status in which case a slightly larger number of 18-25 years of age make up this status when compared to those who are 25 years of age or older. The two groups were comparable with respect to *moratorium* and *diffuse* identity statuses.

Figure 5 indicates that the proportion of the four identity statuses were comparable for Black/African American, White, Multiracial and Unknown race categories, while the participants who identified as Hispanic were more often classified in moratorium and less often categorized as *diffuse*. Likewise, the participants who identified as Asian had notably higher proportions of *achievement* and *foreclosure*, minimal *diffuse*, and *no moratorium* identity statuses. As shown in Figure 6, First-Generation students were categorized in the achievement, foreclosure, and moratorium identity statuses in higher proportions than their Not First-Generation counterparts, who were more likely to identify in the *diffuse* identity status.

Participants in Science, Technology, or Engineering majors were classified in the *achievement* identity status in comparable proportions (see figure 7), although the proportion of *foreclosure* identity status participants was much higher among the Engineering majors than Science or Technology majors. Furthermore, Engineering majors were classified as *diffuse* less than half as often than the Science or Technology majors. The researchers refrain from comparing the proportions of each identity status for the one Math major participant. The 29 participants listed as "Other" in Figure 7 identified as pursuing a variety of major focuses, including architecture, criminal justice, elementary education, interdisciplinary, and undeclared. It is not surprising to find a larger proportion of *diffuse* students in the "Other" category, since the sampling of students in the study occurred within lab-based STEM coursework.

Figure 5

Distribution of Identity Status by Race and Ethnicity

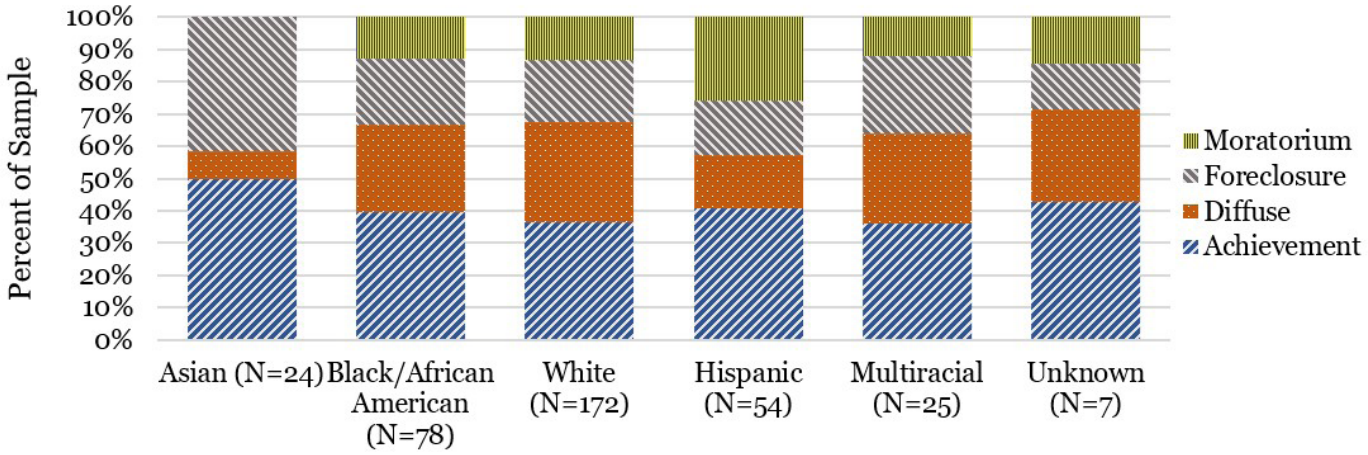


Figure 6

Identity Status by Generational Status

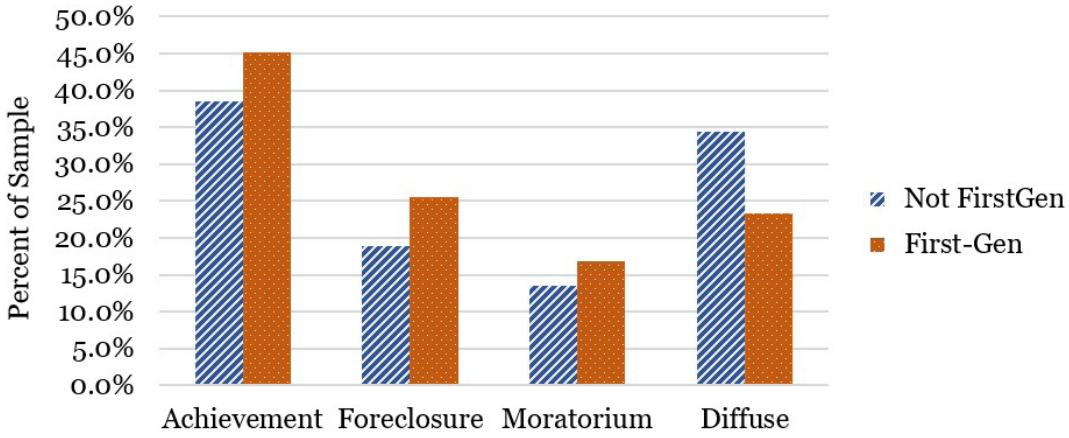
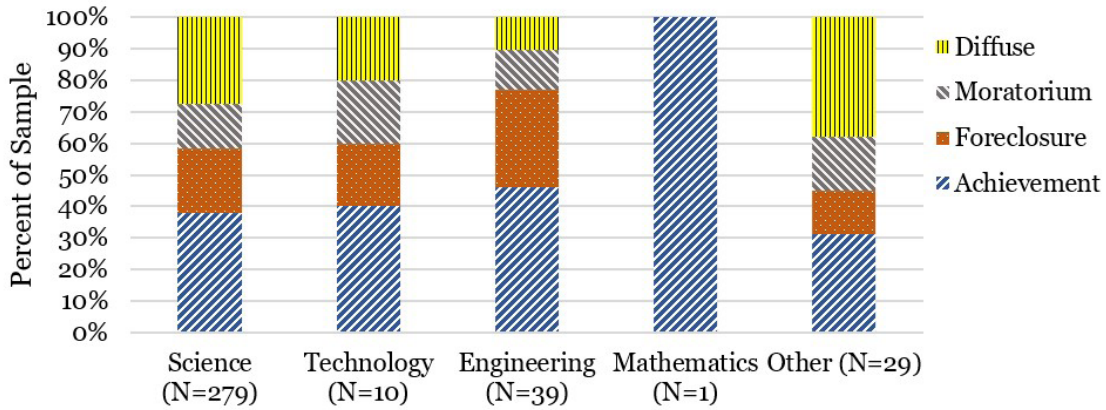


Figure 7

Identity Status by Discipline Category



Summary of Main Findings

- The use of a cut-off score of 15 for i*dentification with commitment* and *in-depth exploration* questions from the PISQ-5d instrument aligns with two-step cluster analysis results to assign the four professional identity statuses (*achievement, foreclosure, moratorium, and diffuse*) proposed in the Marcia identity status model.
- There was a significant difference in the proportion of males and females assigned to each identity status, with females being higher in *achievement* and *foreclosure* and males being higher in *moratorium* and *diffuse*.
- Participants who identified as Black/African American, White, Multiracial, or unknown race has a comparable proportion of the four identity statuses (~40% *achievement*; ~25% *diffuse*; ~20% *foreclosure*; ~15% *moratorium*). Participants who identified as Hispanic were more often classified as *moratorium* and less often categorized as *diffuse* than their Black/African American, White, or Multiracial counterparts. Participants who identified as Asian had notably higher proportions of *achievement* and *foreclosure*, minimal *diffuse*, and no *moratorium* identity statuses.
- First-Generation students were categorized in the *achievement*, *foreclosure*, and *moratorium* identity statuses in higher proportions than their Nor First-Generation counterparts, who were more likely to identify in the *diffuse* identity status.
- Participants in Science, Technology, or Engineering majors were classified in the *achievement* identity status in comparable proportions, although the proportion of *foreclosure* identity status participants was much higher among the Engineering majors than Science or Technology majors. Furthermore, Engineering majors were classified as *diffuse* less than half as often than the Science or Technology majors.

Discussion and Implications

In planning this research, the authors envisaged that the five-factor PISQ-5d instrument would enable the assignment of participants' STEM identity status among five identity statuses (*achievement, foreclosure, moratorium, searching moratorium, or diffuse*), but the percentages of unassigned identity statuses were unacceptably high when either the five-factor Kelly definition or three-factor Crocetti definitions of identity status models were utilized. Furthermore, the participants' *affirmation* question scores from the PISQ-5d instrument were skewed to such a degree that the authors became skeptical that these undergraduate students, most of whom were first-year students, were prepared to reflect on their identity as STEM professional yet. Thus, we narrowed the identity status definitions to include only the two constructs from the original identity status model by Marcia (1966): *identification with commitment* and *in-depth exploration*. Then, not only were all the participants assigned an identity status, but there was also good agreement (83.6%) between the assignment of identity status by two-step cluster analysis and by use of the *identification with commitment* and *in-depth exploration* cut-off scores of 15. Thus, the researchers have demonstrated that a simplified version of the PISQ-5d with cut-off scores of 15 for *identification with commitment* and *in-depth exploration* sections can be utilized to assign undergraduate students' identity statuses.

These findings, therefore, suggest that academic advisors can utilize the abbreviated PISQ-5d instrument to identify the current identity status of undergraduate STEM majors, then respond with appropriate interventions to support the next stage in the development of each student. For example, a students' classification in the *diffuse* identity status could prompt the enrollment of the student in a career counseling initiative in which the student would take a skills, talents, and interest assessment, learn about careers in a variety of disciplines, and participate in internships or job shadowing. Similarly, students' classification in the *foreclosure* identity status could prompt the arrangement of internships, undergraduate research, and job shadowing to help them transition from being certain without investigation (*foreclosure*) to more certain of their career trajectory (*achievement*). Lastly, students' classification of *moratorium* could initiate students' participation in more purposeful guided inquiry about careers in fields of interest.

Furthermore, administering the abbreviated PISQ-5d instrument annually to each student would enable academic advisors to assess and intervene as necessary to ensure students are career-ready by graduation.

Our findings indicated that there were comparable proportions of the four identity statuses among Black/African American, White, and Multiracial participants suggests that identity status is not a useful classification to determine whether or not a student is likely a retention risk. Instead, other cognitive, affective, or socioeconomic factors should be considered. In contrast, our finding that Asian participants were rarely categorized in the *diffuse* identity status and not categorized in the *moratorium* identity status aligns with previous literature that various cultural factors such as "ethnic identity, internalization of Asian American stereotypes, Asian values, parental influences, and perceived barriers" (Kantamneni et al., 2017:649) and honoring "parental expectations of narrowly defined acceptable academic and career achievement" (Dundee et al., 2009:135) seem to be powerful motivators to select and retain a specific STEM career choice. Therefore, academic advising of Asian students would benefit from the inclusion of an array of STEM career information, typical salary ranges, and available graduate research opportunities that can be shared with both parents and students.

Interestingly, our findings indicated that non-first-generation students were more likely to be categorized in the *diffuse* identity status, which contradicts earlier research that reported that "being a first-generation college student…predicted lower levels of certainty of career choice" (Pulliam et al., 2017:89). The authors suggest that our finding is an indication that in this environment of falling college enrollment, individuals from families who have not attended college may have a higher hurdle to enroll in college than the historical expectation of high school graduates (Choy, 2001).

Based on our findings that the two-factor PISQ-5d questionnaire responses could be categorized into four identity statues that aligned with literature definitions via both cluster analysis and cut-off score approaches, we suggest that the PISQ-5d survey be abbreviated when utilized for undergraduate student populations for the purpose of assigning STEM professional identity statuses. This suggestion can also be explained as necessary since the PISQ-5d was designed for use with advanced professional individuals, not novices exploring their identity and career choice. The remaining factors of the PISQ-5d that are not used to assign identity status may still provide value to instructors and advisors to better understand an individual's experiences and self-concept. For example, it would be useful to know the extent to which an individual may be exploring other profession (*reconsideration of commitment*), the degree that one has engaged in practices of the profession, or how they perceive interactions with others to help them validate their career choice (*affirmation*).

Conclusion

Overall, when looking at the results across both research questions and using the STEM professional identities generated using the cut-off scores the expected outcomes, based on previous literature reports, were obtained for various demographic groups. This demonstrates criterion validity, thereby making a modified PISQ-5d survey a much more practical tool for practitioners to utilize to inform their classroom practices. Although the PISQ-5d was reduced to using only two of the five factors (*identification with commitment* and *in-depth exploration*), collecting student data from the remaining three factors (*affirmation*, *practices*, and *reconsideration of commitment*) may be valuable in determining other attributes related to a student's involvement in their career exploration. The results of this paper open many avenues for scholarship of teaching and learning for instructors to better grasp how their specific practices may influence the way student's see themselves in a profession or have engaged in building an understanding for what job responsibilities and job culture are like for a desired profession.

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