Work-in-Progress: An Application of Social Cognitive Career Theory (SCCT) to AE/C Education

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Abstract

This work-in-progress (WIP) introduces Social Cognitive Career Theory (SCCT) as a framework for examining undergraduate students' interest and major choice goals in an Architectural Engineering and Construction (AE/C) program. Retention and sustained interest in engineering programs remain ongoing challenges, as many students enter these programs with uncertainty about their academic and career decisions or experience declining interest after initial exposure. Understanding how personal, environmental, and behavioral factors relate to students' interest development and academic goals in AE/C is therefore critical for informing interventions aimed at building competency level interest. According to SCCT, students' interests in a field are shaped by their self-efficacy beliefs, defined as confidence in their ability to succeed, and by their outcome expectations, defined as beliefs about the anticipated benefits of pursuing a particular career path. These interests subsequently influence students' major choice goals. SCCT further recognizes that self-efficacy and outcome expectations are influenced by contextual supports and barriers, as well as by students' demographic characteristics, backgrounds, prior discipline-related experiences, and initial levels of interest and understanding of AE/C subdisciplines. The purpose of this study is to examine the extent to which first-year AE/C students' data fit the SCCT model. This WIP focuses on study design, including SCCT-based measurement scales, their theoretical alignment, and psychometric properties of the scales. Preliminary results draw on data from first-year students enrolled in introductory AE/C courses at a large R1 Midwestern university, R2 Southeast HBCU, and an R1 Southeast institution. Findings are intended to inform future modeling and ultimately understanding of the impact of targeted interventions in AE/C pathways.

I. Introduction

Student retention and persistence remain central challenges in engineering in general and architectural engineering and construction (AE/C) programs specifically. Although engineering programs often demonstrate comparatively strong persistence patterns relative to other STEM pathways, attrition remains substantial and is disproportionately concentrated during the first two years of study, when students are most vulnerable to leaving or switching majors [1], [2]. Seminal qualitative and quantitative studies have shown that many students who leave engineering do so not because of insufficient ability, but due to misaligned expectations, limited early exposure to professional practice, and difficulties navigating program demands and learning environments [3], [4]. These findings suggest that early program experiences play a critical role in shaping students' decisions to persist or reconsider their major choice. Importantly, workforce demand for engineering and related architecture occupations is projected to continue growing, reinforcing the need for AE/C programs to strengthen early supports and promote persistence during the initial years of study [5].

Evidence further indicates that program-level structures and support significantly influence student persistence in engineering. Large-scale analyses have demonstrated that circular design, availability of academic and social support, and opportunities for early engagement with authentic engineering work are associated with higher retention rates, particularly in the early years of study [1], [5]. For students in AE/C programs, uncertainty about the nature of professional practice and limited contextualization of coursework may exacerbate these challenges. In parallel, labor market projections indicate that employment in architecture and engineering occupations is expected to grow faster than the average for all occupations in the United States [6]. Together, this evidence highlights the need for engineering and AE/C programs to implement targeted, theory-informed interventions that support early student engagement, confidence development, and persistence through graduation.

Social Cognitive Career Theory (SCCT) [7] provides a well-established framework for examining how program-level experiences shape students' academic and career-related decisions. SCCT proposes that students' interests in a field develop through their self-efficacy beliefs, which reflect their confidence in their ability to succeed, as well as through their outcome expectations, defined as beliefs about the anticipated value of pursuing a particular academic pathway. These interests subsequently inform students' major-choice goals and intentions. SCCT emphasizes the role of contextual support and barriers, including curricular structure, instructional practices, and learning environments, in shaping students' self-efficacy, outcome expectations, and academic goals [8].

Prior research in STEM and engineering education, grounded in Social Cognitive Career Theory (SCCT), indicates that students' self-efficacy, outcome expectations, and perceived contextual supports are consistently associated with interest development, persistence intentions, and major-choice goals across engineering pathways [9], [7], [10]. In an engineering-specific test of SCCT, [11] showed that social-cognitive variables (e.g., self-efficacy and outcome expectations) significantly predicted engineering students' persistence intentions, satisfaction, and engagement, reinforcing the relevance of SCCT mechanisms in engineering contexts. More recently, focusing on first-year engineering students, [12] examined within-person changes in core SCCT constructs and demonstrated that shifts in these beliefs over time are meaningfully linked to persistence intentions, highlighting how early experiences and evolving perceptions can shape students' continuation decisions. Studies with first-year engineering populations further suggest that early academic experiences and support perceptions play a critical role in shaping persistence-related outcomes [13], [14]. Together, this body of work supports using SCCT to examine how motivational beliefs and contextual influences relate to engineering students' interest and persistence outcomes.

However, comparatively fewer studies have examined Social Cognitive Career Theory (SCCT) specifically within AE/C programs, despite the hybrid nature of these curricula and the likelihood that distinctive learning and industry-facing experiences shape students' intentions and continuation decisions. Evidence from the broader built-environment literature nevertheless supports SCCT as an appropriate framework in these contexts. For example, [15] showed that socio-cultural and contextual conditions are meaningfully related to career-choice outcomes and appear to operate through SCCT-consistent social-cognitive processes, underscoring the need to measure both motivational beliefs (e.g., self-efficacy and outcome expectations) and contextual supports and barriers. Consistent with engineering-focused SCCT findings more broadly [11], this gap in AE/C-specific applications motivates the present study's focus on first-year AE/C students and the psychometric evaluation of the adapted measures (factor structure and internal consistency) prior to testing structural relations among SCCT constructs.

The purpose of this study is to examine the extent to which first-year AE/C students' data align with the Social Cognitive Career Theory (SCCT) model. This work-in-progress (WIP) focuses on the measurement aspects of the study, including the development of SCCT-based scales, the examination of their psychometric properties, and the investigation of initial patterns of relationships among variables. To establish a baseline understanding of students' interests, self-efficacy, outcome expectations, support, and barriers prior to exposure to instructional interventions, exploratory factor analysis of related scales was conducted using the combined Fall 2023 and Fall 2024 datasets. Preliminary results were drawn from students enrolled in introductory AE/C courses at a large R1 Midwestern university, R2 Southeast HBCU, and an R1 Southeast institution. By establishing the validity evidence of these measures and the baseline relationships among SCCT constructs, this study aims to prepare the groundwork for examining the effectiveness of future interventions designed to improve student interest and major-choice goals in AE/C programs. Future work will involve structural equation modeling using mid-semester and end-of-semester measurements to examine the stability of students' perceptions over time.

II. Background

Social Cognitive Career Theory (SCCT) offers a framework for understanding how individuals develop academic interests, form major-choice goals, and engage in persistence-related behaviors. Originally articulated by [7] and grounded in Bandura's social cognitive theory [16], SCCT emphasizes the reciprocal interplay among personal attributes, learning experiences, contextual influences, and behavioral outcomes. Within SCCT, students' academic and career pathways are shaped by how self-efficacy beliefs and outcome expectations develop from prior learning experiences and how these beliefs interact with perceived supports and barriers in the environment, ultimately influencing interests and choice-related goals [7]. Figure 1 presents the adapted SCCT model used as the conceptual basis for this work. The white and gray boxes represent the original model proposed by [7], whereas the colored boxes indicate the constructs operationalized and measured in the present AE/C study.

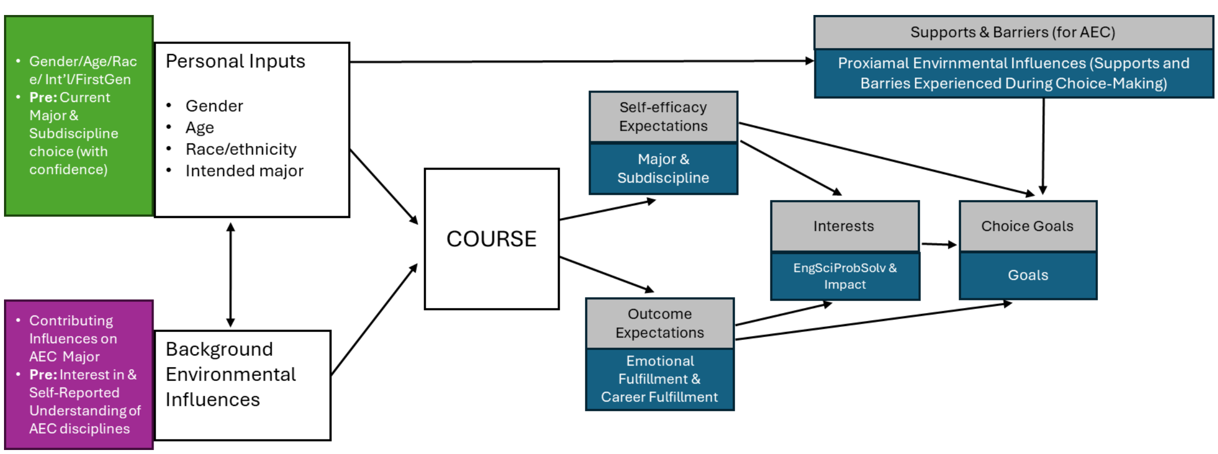

Figure 1. Social Cognitive Career Theory model as a conceptual framework. **(Adapted from [7])**

According to SCCT, students' academic and career paths are shaped by three core variables: self-efficacy expectations, outcome expectations, and interests. Self-efficacy refers to individuals' beliefs in their capability to perform tasks required for success in a particular domain. Outcome expectations reflect beliefs about the consequences and value of pursuing activities in that domain, such as expected satisfaction, financial benefits, or alignment with personal goals. When students believe they can succeed and expect desirable outcomes, they are more likely to develop interests in the field. These interests subsequently influence major-choice goals, which guide academic decisions and behaviors such as course enrollment, degree persistence, and engagement with discipline-specific opportunities.

SCCT also highlights the role of contextual factors. Background contextual influences include socialization patterns, cultural norms, and prior exposure to disciplinary content. More immediate influences, referred to as proximal environmental influences, include support and barriers encountered during major-choice processes. Supports may include encouragement from faculty, mentoring, or access to resources, while barriers may involve financial constraints, lack of representation, or limited prior experience. These environmental conditions shape self-efficacy and outcome expectations, either facilitating or constraining students' confidence and academic choices.

Learning experiences play a central role in SCCT. Prior success, feedback, observational learning, and task exposure provide the foundation upon which students build efficacy beliefs and expectations about potential outcomes. In engineering and related fields, hands-on projects, early technical experiences, and positive interactions with instructors are examples of learning experiences that can strengthen students' academic self-efficacy and disciplinary interest. The full SCCT model integrates person inputs, background contextual influences, learning experiences, self-efficacy, outcome expectations, interests, choice goals, choice actions, and performance outcomes (Figure 1). The model has been widely applied to STEM fields and has demonstrated utility in explaining differences in interest and persistence among various student populations, including women and underrepresented racial and ethnic groups [17], [7], [10]. Research conducted at Historically Black Colleges and Universities has shown that SCCT variables predict engineering students' interests and goals across university types and demographic groups [10], indicating the generalizability of the model in diverse educational contexts.

Given its strong empirical foundation, SCCT provides a relevant framework for studying how students in Architectural Engineering and Construction programs form academic intentions, evaluate potential pathways, and navigate early choices. Understanding how SCCT variables operate among first-year AE/C students can help educators identify factors that promote student engagement and persistence and can inform the development of interventions aimed at supporting students during critical phases of their academic trajectory.

III. Research Questions

The overall work will address the research question: How does Social Cognitive Career Theory explain the factors that influence first-year students' interest and major-choice decisions in Architectural Engineering and Construction? In preparation for answering this question, this WIP focuses on the question: What are the psychometric properties of the SCCT scales (i.e., self-efficacy, outcome expectations, interests, supports and barriers, choice goals) adapted for AE/C program settings?

IV. Methods

A. Setting & Participants

This study was conducted at a large R1 Midwestern university, an R2 Southeast HBCU, and an R1 Southeast institution that offers undergraduate programs in AE/C. Data were collected from students enrolled in one of three major-specific first-year courses in architectural engineering, construction engineering, and construction management during the Fall 2022, Fall 2023, and Fall 2024 semesters. In Fall 2022, approximately 178 students were enrolled in the first-year course offered at the R1 Midwestern university. Across Fall 2023 and Fall 2024, participants enrolled in the first-year course offerings at the three institutions were approximately 356, 54, and 36, respectively. Scale development and the gathering of validity evidence for the study measures used the combined Fall 2023 and Fall 2024 datasets, whereas the SCCT modeling analyses will focus on the Fall 2022 R1 Midwestern university cohort, a cohort for whom no interest-targeted interventions were implemented.

Table 1 shows the larger scale psychometrics sample from 2023–2024 and the SCCT study sample from 2022. After exclusion criteria (Section IV.D) were applied, the scale psychometrics dataset included 373 students and SCCT dataset included 65 first-year AE/C students. Across both samples, students identifying as male comprised the majority, and gender distributions were similar across cohorts. Racial and ethnic patterns were also comparable, with most students identifying as White, followed by Hispanic or Latino and Black or African American.

Differences in declared majors reflected typical cohort variation: architectural engineering students represented a larger proportion of the 2022 sample, while construction-related majors were more frequently reported in 2023–2024. Both samples were predominantly composed of students under 20 years of age, consistent with participants' first-year status. Overall, the demographic similarities between the 2023–2024 psychometrics and the 2022 SCCT datasets support the comparability of the two datasets and provide justification for using the larger dataset to establish scale properties while interpreting SCCT results within a comparable sample.

B. Instruments for SCCT

A multi-scale instrument was developed by adapting items from SCCT measures that have demonstrated strong validity evidence and have been widely used in STEM and engineering education research. SCCT emphasizes the importance of theoretical alignment and construct validity when assessing self-efficacy, outcome expectations, interests, and contextual influences [7], [8]. Accordingly, each construct was operationalized using items drawn from or informed by existing instruments with established validity evidence, including those previously employed in engineering education contexts [10] [18] [19].

Table 1. Self-reported Demographics

Category	Subgroup	Scale Psychometrics 2023 & 2024	SCCT Study 2022
Number of students (n =)		373	65
Gender[a]	Male	286	46
	Female	84	19
	Other	4	-
Race/ethnicity[b]	Black or African American	61	5
	Hispanic or Latino	59	13
	White	252	49
	Asian	19	2
	Other [c]	9	5
Institution	R1 Midwestern institution	300	65
	R2 Southeast HBCU	43	-
	R1 Southeast institution	30	-
Intended Major	Architectural Engineering	133	39
	Construction	228	23
	Other	9	-
	Undeclared	3	3
Age (years)	≤20	327	58
	>20	46	7

[a] Counts > sample size when students selected more than one gender option
[b] Counts > sample size when students selected more than one race/ethnicity option
[c] Other is a combination of Counts < 5

Self-Efficacy. Self-efficacy refers to students' confidence in their capability to successfully complete tasks required to attain desired academic outcomes [16], [7]. In [10], self-efficacy was assessed with an 11-item instrument that combined academic milestone efficacy (4 adapted items) and barrier-coping efficacy (7 items), rated on a 0 to 9 confidence scale; the authors reported adequate internal consistency for the milestone component in earlier work ($\alpha = .89$) and for coping efficacy ($\alpha = .89$), and the combined 11-item scale showed strong reliability in their 2005 sample ($\alpha = .91$). Building on this approach, the present study adapted the self-efficacy content to the AE/C context and created parallel items for general or major-level confidence and for task-specific or subdiscipline confidence. The final self-efficacy measure was reduced from 11 original items to 8 adapted items, with four items at the at the major level and four at the subdiscipline level. Participants responded using a 6-point confidence scale ranging from 1 (Not at all confident) to 6 (Completely confident), with higher scores indicating stronger self-efficacy.

Outcomes Expectations. Outcome expectations are students' beliefs about the benefits and consequences they anticipate from pursuing goals, including both personally meaningful rewards and career-related outcomes. In engineering contexts, [10] measured outcome expectations with a 10-item scale of positive outcomes and reported adequate internal consistency in prior work ($\alpha = .91$) as well as theory-consistent relations with task and coping efficacy, interests, and major choice goals. In their 2005 sample, the scale also demonstrated strong reliability ($\alpha = .89$) [10]. For the present study, item content was adapted from the original measure to reflect AE/C-relevant outcomes while preserving the theoretical intent of SCCT, resulting in a 12-item scale organized into two subscales, Emotional Fulfillment and Career Fulfillment, with six items each. Students responded on a 6-point agreement scale ranging from 1 (Strongly Disagree) to 6 (Strongly Agree), and mean scores were computed so that higher values indicated more positive outcome expectations. The same 12 items and two-subscale structure were used across cohorts, with only minor terminology adjustments to align with course language without changing item meaning.

Interests. Interests reflect students' enjoyment, curiosity, and desire to engage in career related activities and learning experiences. In engineering contexts, [10] assessed technical interests using a 7-item measure of interest in engineering related activities (rated on a 5 point interest scale), and they reported prior evidence of internal consistency ($\alpha = .83$) and theory-consistent relations with self-efficacy, outcome expectations, and major choice goals. Reliability in their 2005 sample was also acceptable ($\alpha = .80$) [10]. Building on this approach, the present study adapted the original interest measure by tailoring item wording to introductory AE/C coursework and by reducing the instrument from 7 items to 6 items, while retaining a coherent structure aligned with SCCT. The adapted scale was organized into two subscales with three items each (i.e., Core Interest and Broader Interest). Students responded on a 6-point interest scale anchored from 1 (No interest) to 6 (Very high interest).

Support and Barriers. Evidence for the internal structure of the Supports and Barriers measures has evolved across studies, reflecting increasing psychometric rigor and refinement of the item pool. Building on the SCCT distinction between contextual supports and barriers [8], [20] developed a revised instrument for engineering majors with 15 support items and 23 barrier items rated on a 5-point scale. They reported strong internal consistency for both scales ($\alpha = .92$ for Supports; $\alpha = .94$ for Barriers), supporting their alignment with the intended constructs. The present study adapted the measures to introductory AE/C settings by selecting and tailoring items most relevant to first-year decision making. The resulting instrument included nine items organized into two subscales: Support and Belonging in AE/C (five items) and Barriers and Negative Social Influences (four items), rated on a 6-point likelihood scale from 1 (Not at all likely) to 6 (Extremely likely).

Major-Choice Goals. Major-choice goals capture students' intentions to persist in a major and pursue related academic and career pathways. In engineering contexts, [10] operationalized choice goals with a 4-item measure assessing students' academic intentions to remain in engineering (5-point agreement scale). In prior work, this measure demonstrated strong internal consistency ($\alpha = .95$) and was strongly predictive of future persistence in engineering [20]. Reliability in the [10] sample was excellent ($\alpha = .93$). Building on this SCCT-aligned approach, the present study adapted goal item wording to the introductory AE/C context while retaining a concise 4-item format and broadening content to reflect first-year intentions across both academic and career pathways. The resulting instrument comprised two 2-item subscales (i.e., Academic Goals and Career Goals) and used a 6-point agreement scale (1 = Strongly Disagree to 6 = Strongly Agree), with mean scores computed such that higher values indicate stronger AE/C major-choice goals.

C. Data Collection

All students in each of the three cohorts completed three surveys, administered at the beginning, mid-semester, and near the end of the term as part of regular course activities. Participation in the research component was voluntary, and analyses were conducted only with data from students who provided consent. Surveys were administered in Qualtrics. Survey A established a baseline prior to substantive engagement with AE/C course content and included Personal Input (PI), Education Background and Current Program (EBC), demographic characteristics, and Contributing Influences on AE/C Major (including prior casual contact, social influence, and intentional contact with engineering and AE/C). Survey B retained PI and EBC variables for longitudinal consistency and added core SCCT constructs, including interest in and understanding of AE/C subdisciplines, subdiscipline choice and confidence, self-efficacy at the major and subdiscipline levels, outcome expectations, interest in engineering problem solving, major choice goals, and perceived supports and barriers. Survey C repeated the SCCT constructs from Survey B to examine stability and change over time.

D. Data Analysis

Prior to psychometric analyses, Fall 2023–2024 survey B responses were screened to ensure data quality and meaningful engagement with the instrument. Responses with substantial missingness were removed (e.g., cases with a large portion of a scale left incomplete). A response-quality check was then applied to identify potentially inattentive responding: students were flagged for exclusion when they selected the same response option for at least 80% of the items within a scale (e.g., 8 of 9 items answered identically). As a result, the final sample size varies slightly across scales depending on item-level missingness. After these screening steps, the remaining records were retained for analysis in RStudio. Finally, reverse-scoring was required for the Barrier items in the Support and Barriers scale due to negative wording. No reverse-scoring was needed for items on the other scales.

Data analysis for this WIP focused on evaluating the measurement quality of the adapted scales. Consistent with prior SCCT research, exploratory factor analysis (EFA) was used as an initial step to examine dimensionality and identify item groupings aligned with SCCT constructs [19] For each scale, factorability was evaluated using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. EFAs were estimated using principal axis factoring with oblimin rotation to allow correlated factors, consistent with expected relations among SCCT variables. Factor retention decisions were informed by parallel analysis, eigenvalues, scree plots, and interpretability of the solution.

Reliability was assessed using Cronbach's alpha to evaluate internal consistency [21], and item-level and scale-level descriptive statistics were computed for the 2023–2024 data. This analytic sequence was applied consistently across scales, and scale-specific screening statistics, EFA results, reliability estimates, and descriptive statistics are reported in the Preliminary Results (Section V) for each construct.

Future work will entail confirmatory factor analysis (CFA) to test measurement models and evaluate construct validity using fit indices such as CFI, TLI, RMSEA, and SRMR [22]. Structural equation modeling (SEM) will then be used to test the SCCT relationships among self-efficacy, outcome expectations, interests, supports, barriers, and major-choice goals. SEM is widely used in SCCT research because it evaluates both direct and indirect pathways and provides a comprehensive test of theoretical alignment [10], [15]. Two SEM models will be estimated: one using mid-semester data and one using end-of-semester data. Comparisons between these models will allow examination of developmental shifts in SCCT cognitions as students' progress through the courses.

V. Preliminary Results (from Scale Analysis)

Because the study is ongoing, only preliminary scale analyses are reported here. Each SCCT construct was examined using exploratory factor analysis (EFA) to evaluate dimensionality and to assess whether the adapted items performed in a theoretically coherent manner in the 2023 to 2024 dataset. EFAs were conducted using principal axis factoring with oblimin rotation to allow correlated factors, which are consistent with the expected relations among SCCT constructs. Tables 2 to 6 report factor level Cronbach's alpha coefficients with the salient factor loadings at or above 0.40. Loading (F1/PA1) indicates how strongly each item relates to Factor 1, and Loading (F2/PA2) indicates how strongly each item relates to Factor 2. Item level means and standard deviations are also provided as an initial check of internal consistency and score distributions prior to confirmatory modeling and subsequent structural analyses.

Self-Efficacy. Self-efficacy data (2023–2024; n = 191) were screened to confirm suitability for factor analysis (overall KMO = 0.73; Bartlett's test $\chi^2(28) = 807.51$, $p < .001$). Table 2 summarizes internal consistency, factor loadings, and descriptive statistics for the two-factor solution. Parallel analysis suggested more than two factors; however, a theory-driven two-factor solution was retained to align with the intended distinction between general (major-level) confidence and task-specific (subdiscipline) confidence. The two factors were moderately correlated (r = 0.58). The general/major-level self-efficacy factor (the "confidence" items) showed acceptable internal consistency (α = .82). In the two-factor EFA, loadings for these items ranged from .53 to .88 on Factor 1 and from −.07 to .13 on Factor 2, indicating that general confidence items loaded more strongly on the first factor. Item means for this set were in the upper-mid range (M = 4.48–4.74; SD = 0.91–1.06). The task-specific/subdiscipline self-efficacy factor (the "top confidence" items) showed acceptable internal consistency (α = .83). In the two-factor EFA, loadings for these items ranged from −.08 to .14 on Factor 1 and from .57 to .79 on Factor 2, indicating that task-specific items loaded more strongly on the second factor. Item means for this set were in the upper-mid range (M = 4.37–4.68; SD = 0.87–1.02).

Table 2. Self-efficacy internal consistency, EFA loadings, and descriptive statistics for Falls 2023 & 2024 (*n* = 191).

Construct / Factor	Cronbach's α	Item Confidence …	Loading (F1/PA1)	Loading (F2/PA2)	*M*	*SD*
F1: General / Major-Level	0.82	to achieve my AE/C major goals	0.73	-0.07	4.48	0.91
		that AE/C fits me	0.73	0.11	4.53	1.06
		AE/C matches my interests	0.88	-0.03	4.74	0.92
		my abilities match AE/C	0.53	0.13	4.66	0.94
F2: Task-Specific / Subdiscipline	0.83	to achieve my subdiscipline goals	0.14	0.57	4.37	0.87
		that this subdiscipline fits me	0.06	0.76	4.52	1.02
		this subdiscipline matches my interests	0.00	0.79	4.68	0.94
		my abilities match this subdiscipline	-0.08	0.79	4.62	0.98
Overall	*0.86*	*Overall score (mean of 8 items)*	—	—	*4.57*	*0.68*

Note. *Factor loadings ≥ .40 were considered salient.*

Outcomes Expectations. Outcome expectations data (2023–2024; $n = 259$) were screened to confirm suitability for factor analysis (overall KMO = 0.89; Bartlett's test $\chi^2(66) = 1159.55$, $p < .001$). Table 3 summarizes internal consistency, factor loadings, and descriptive statistics for the retained solution. Parallel analysis supported a two-factor structure, with the factors moderately correlated ($r = 0.56$), suggesting related but distinct dimensions. The first factor, Fulfillment/Satisfaction, demonstrated acceptable internal consistency ($\alpha = .83$) and included items reflecting intrinsic and personal outcomes associated with AE/C, with primary loadings on Factor 1 and minimal cross-loadings. The second factor, Career/External Outcomes, also showed acceptable internal consistency ($\alpha = .80$) and captured extrinsic and socially oriented expectations, with stronger loadings on Factor 2. Reliability for the overall 12-item scale was high ($\alpha = .87$; $M = 5.06$, $SD = 0.54$). Subscale means were similarly elevated (Fulfillment/Satisfaction: $M = 5.01$, $SD = 0.65$; Career/External Outcomes: $M = 5.10$, $SD = 0.56$), indicating generally positive outcome expectations. Overall, these results support the use of both the total outcome expectations score and the two subscale scores in subsequent analyses.

Table 3. Outcome Expectation internal consistency, EFA loadings, and descriptive statistics for Falls 2023 & 2024 (*n* = 259).

Construct / Factor	**Cronbach's α**	**Item Expect …**	**Loading (F1/PA1)**	**Loading (F2/PA2)**	***M***	***SD***
F1: Fulfillment / Satisfaction	0.83	to be successful in AE/C	0.44	0.36	5.12	0.84
		good work life balance	0.54	0.02	4.51	1.01
		satisfaction from AE/C work	0.91	-0.08	5.08	0.85
		my abilities will be valued	0.61	0.19	5.04	0.77
		AE/C work to be exciting	0.73	0.00	5.09	0.86
		to make a difference through AE/C	0.49	0.13	5.21	0.92
F2: Career / External Outcomes	0.80	strong job opportunities	0.08	0.64	5.35	0.70
		respect in an AE/C career	-0.13	0.67	4.87	0.79
		increased self worth	-0.02	0.63	4.71	0.99
		my family will value this path	0.02	0.63	5.33	0.79
		to build a strong network	0.04	0.69	5.20	0.73
		supportive colleagues	0.23	0.43	5.15	0.78
Overall	*0.87*	*Overall score (mean of 12 items)*	—	—	*5.06*	*0.54*

Note. *Factor loadings ≥ .40 were considered salient.*

Interests. Interests data (2023–2024; $n = 243$) were screened to confirm suitability for factor analysis (overall KMO = 0.78; Bartlett's test $\chi^2(15) = 462.06$, $p < .001$). Table 4 summarizes internal consistency, factor loadings, and descriptive statistics for the retained solution. Parallel analysis supported a two-factor structure, with the factors moderately correlated ($r = 0.46$), suggesting related but distinct dimensions of interest. The first factor, Core Interest, demonstrated acceptable internal consistency ($\alpha = .78$) and included items reflecting interest in core engineering activities, such as AE/C projects, engineering problem solving, and solving AE/C problems. The second factor, Broader Interest, also showed acceptable internal consistency ($\alpha = .74$) and captured interest in broader contextual themes, including health and safety topics, real-world AE/C applications, and global and societal impact. Reliability for the overall six-item scale was acceptable ($\alpha = .80$; $M = 4.54$, $SD = 0.70$). Item means were in the upper-mid range ($M = 4.40$–4.70; $SD = 0.82$–1.09), indicating moderate-to-high interest across both factors. Overall, these results support the use of both the total interest score and the two subscale scores in subsequent analyses.

Table 4. Interest internal consistency, EFA loadings, and descriptive statistics for Falls 2023 & 2024 (n = 243).

Construct / Factor	Cronbach's α	Item Interest in …	Loading (F1/PA1)	Loading (F2/PA2)	*M*	*SD*
F1: Core Interest	0.78	solving AE/C problems	0.57	0.15	4.55	0.82
		in AE/C projects	0.91	-0.05	4.47	0.99
		engineering problem solving	0.65	0.04	4.53	1.00
F2: Broader Interest	0.74	health and safety topics	-0.08	0.69	4.70	0.96
		real world AE/C applications	0.35	0.51	4.40	1.09
		global and societal impact	0.00	0.80	4.56	1.06
Overall	*0.80*	*Overall score (mean of 6 items)*	—	—	*4.54*	*0.70*

Note. *Factor loadings ≥ .40 were considered salient.*

Support & Barriers. Support and barriers data (2023–2024; n = 354) were screened to confirm suitability for factor analysis (overall KMO = 0.74; Bartlett's test $\chi^2(36) = 1533.47$, $p < .001$). Table 5 summarizes internal consistency, factor loadings, and descriptive statistics for the retained solution. Parallel analysis suggested up to three factors; however, for interpretability and alignment with SCCT, a two-factor solution was retained. The factors were weakly correlated (r = .09), indicating largely distinct dimensions. The Support factor demonstrated strong internal consistency (α = .86), with items reflecting social and contextual resources (e.g., role models, mentoring, peer and family support, and sense of belonging) loading strongly on Factor 1 (.59–.85) and showing minimal cross-loadings. The Barriers factor showed acceptable internal consistency (α = .80) and captured perceived obstacles and negative social influences, with primary loadings on Factor 2 (.45–.92). One item ("I do not fit") showed modest cross-loading but was retained with the Barriers factor due to its stronger loading on Factor 2. Reliability for the overall scale was acceptable (α = .79). Subscale means indicated relatively high perceived support (M = 4.54, SD = 1.01) and high reversed barrier scores (M = 5.23, SD = 0.92). Because barrier items were reverse-scored, higher scores indicate fewer perceived barriers, suggesting that students generally reported relatively low levels of barriers or negative social influences. Overall, results support the use of both subscale scores in subsequent analyses.

Table 5. Support & Barriers internal consistency, EFA loadings, and descriptive statistics for Falls 2023 & 2024 (n = 354).

Construct / Factor	Cronbach's α	Item Likelihood of …	Loading (F1/PA1)	Loading (F2/PA2)	*M*	*SD*
F1: Support	0.86	having AE/C role models	0.85	-0.11	4.32	1.32
		having an AE/C mentor	0.85	-0.04	4.34	1.35
		support from friends	0.74	0.05	4.62	1.23
		support from family	0.62	0.21	4.93	1.14
		feeling I belong in AE/C	0.59	0.09	4.50	1.31
F2: Barriers	0.80	negative influence from friends	-0.06	0.77	5.25	1.17
		negative influence from family	0.00	0.92	5.47	1.06
		feeling I do not fit in AE/C	0.23	0.45	4.79	1.30
		pressure not to pursue AE/C	0.02	0.70	5.40	1.13
Overall	*0.79*	*Overall score (mean of 9 items)*	—	—	*4.85*	*0.75*

Note. *Factor loadings ≥ .40 were considered salient.*

Goals. Goals data (2023–2024; $n = 140$) were examined to evaluate measurement quality for the four-item scale. Factorability was limited, with a low KMO value (KMO = 0.45); however, Bartlett's test was significant ($\chi^2(6) = 166.94$, $p < .001$). Table 6 summarizes internal consistency, factor loadings, and descriptive statistics for the retained solution. Guided by SCCT, an exploratory factor analysis using maximum likelihood estimation with oblimin rotation was conducted to examine the expected distinction between Major Goals and Subdiscipline Goals. The solution aligned with the expected pattern: major-level items loaded strongly on Factor 1 (.67–1.00), and subdiscipline items loaded strongly on Factor 2 (.56–1.00), with minimal cross-loadings. The two factors were weakly correlated ($r = 0.13$), indicating that major-level and subdiscipline-level goals are related but distinct constructs. Internal consistency was acceptable for Major Goals ($\alpha = .80$) and Subdiscipline Goals ($\alpha = .71$), whereas the overall composite showed lower reliability ($\alpha = .65$). Descriptive statistics indicated stronger endorsement of major-level intentions than subdiscipline-specific intentions, with higher scores for continuing in the major ($M = 5.49$, $SD = 0.99$) and committing to the major ($M = 5.07$, $SD = 1.23$) compared to intending to pursue a subdiscipline ($M = 4.44$, $SD = 0.77$) and committing to a subdiscipline path ($M = 3.84$, $SD = 1.04$). The overall composite mean was $M = 4.71$ ($SD = 0.71$). Overall, these results support the use of separate subscale scores in subsequent analyses, while the overall composite should be interpreted with caution and used primarily for descriptive purposes.

Table 6. Goals internal consistency, EFA loadings, and descriptive statistics for Falls 2023 & 2024 (*n* = 140).

Construct / Factor	**Cronbach's α**	**Item**	**Loading (F1/PA1)**	**Loading (F2/PA2)**	***M***	***SD***
F1: Major Goals	0.80	Intend to continue in the AE/C major	1.00	-0.06	5.49	0.99
		Commit to completing the AE/C major	0.67	0.23	5.07	1.23
F2: Subdiscipline Goals	0.71	Intend to pursue an AE/C subdiscipline	0.12	0.56	4.44	0.77
		Commit to an AE/C subdiscipline path	-0.02	1.00	3.84	1.04
Overall	*0.65*	*Overall score (mean of 4 items)*	—	—	*4.71*	*0.71*

Note. *Factor loadings ≥ .40 were considered salient.*

Future Work

The psychometric analyses conducted in this study provide initial evidence that the SCCT-aligned scales demonstrate acceptable measurement properties and are suitable for use in modeling relationships among key constructs. Building on these findings, future work will extend the present analyses in two steps. First, confirmatory factor analysis (CFA) will be conducted using a new dataset collected in Fall 2025 to evaluate the measurement model. CFA will be used to assess model fit, confirm the factor structure identified in the exploratory analyses, and refine the instruments as needed. Second, structural equation modeling (SEM) will be applied to test the hypothesized SCCT pathways among self-efficacy, outcome expectations, interests, supports, barriers, and major-choice goals. These analyses will include examination of relationships across multiple time points to better understand how these constructs interact over time. Finally, once the measurement and structural models are established, the SEM framework will be leveraged to examine how specific course experiences and interventions relate to changes in students' SCCT variables over time.

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