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Evaluating the Future Self Continuity Questionnaire for use in Engineering Education Research

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Introduction

Industry's report that recent graduates are not fully prepared for the workforce—framed variously as a "misalignment" of skills, a lack of professional capabilities, and a general "readiness gap"—has been well known for many years [1], [2], [3]. This gap has persisted despite pedagogical and curricular changes, such as PBL, CDIO, capstone courses, and the broader integration of professional skills into engineering education [4], [5], [6] [7], [8]. Additionally, research documents the dissatisfaction of many early career engineers with their careers [1], [9], [10], and their frustrations mirror those of their employers: they did not anticipate the integrated nature of professional skills in modern engineering work. Much of this dissatisfaction, then, can be attributed to not just a "readiness gap" but also to an "expectation gap," meaning that many engineering students have an unclear or mistaken vision of their future work [1], [9], [11], [12]. Despite the increased incorporation of professional skills into engineering education, engineering students consider those skills separate from and secondary to their technical education [13], [14], and hence they ignore them when forming mental models of their professional futures. The expectation gap, then, names the same misalignments described as a "readiness gap," but reframing the issue from students' perspectives shifts the focus from identifying the gap to investigating its origins.

The Future Self Continuity Questionnaire (FSCQ) may offer engineering education researchers a tool to assess the effectiveness of interventions aimed to promote engineering students' successful transition to the workforce. Research in psychology and organizational behavior proposes the concept of the future self, which is one's current perception of how one will be in the future. Future self-continuity extends the concept of future self by considering the psychological connectedness one has to their future self, in essence it is "the sense of persistence of selfhood from the present to the future" [15]. Students have been in school nearly their entire lives: graduation is a dramatic life transition. Although some students may have participated in internships or client-based capstone courses, upon graduation they will shift from a holding a primary identity as a student to developing a primary identity as an engineer; as students, they may anticipate this transition, but they likely have an unclear or incomplete understanding of that future identity [1], [9], [10], [11], [12]. Studies suggest that engineering students may have limited imaginative abilities when considering their life after graduation [12], in particular harboring inaccurate expectations of their future engineering work [1], [2], [3]. In essence, they may have limited understanding and imaginative capacity to envision their future selves.

A scale to measure students' ability to envision their future selves could be useful for engineering education research because it could gauge the effectiveness of interventions aimed at aligning students' work expectations with the realities of professional practice. Additionally, such a scale could assess efforts to enhance students' capacity to imagine themselves in future engineering roles, which may be useful for retention and future career satisfaction. This paper presents data and analysis from a study using such an instrument, the Future Self Continuity Questionnaire (FSCQ), which measures respondents' ability to imagine their future selves overall and across three latent constructs: relatedness (or similarity), vividness (or realism), and positivity [15].

Originally validated in 2020 through multiple studies using Mechanical Turk respondents, the FSCQ requires further evaluation for use with engineering students, who represent a distinct subject population with a shared future career goal. To that end, this paper evaluates the dimensionality and reliability of the FSCQ when used to study engineering students' perceptions for their future selves, and it seeks to answer the following research questions in the context of administering the instrument to engineering students:

1) How do engineering students interpret the FSCQ items?

2) Do the FSCQ's three latent constructs demonstrate internal reliability with engineering students?

3) Do the FSCQ's the three latent constructs fit the data from engineering students?

The following Literature Review describes the future self construct and the FSCQ. Then, the paper presents a qualitative review of the FSCQ and a statistical analysis of FSQC data collected as part of a study aiming to improve students' imaginative capacity to envision salient future selves. A brief Discussion section considers the Research Questions in light of the qualitative review and statistical analysis. Lastly, the Conclusion notes limitations of the study as well as implications and potential future directions for utilizing the FSCQ.

Literature Review

Students' View of the Future

Students' ability to connect their learning to a future purpose, such as work, has been researched using the framework of future time perspective (FTP) within higher education in general [16], and several recent studies demonstrate and the usefulness of considering FTP in the context of engineering education. For instance, the framework of FTP can illuminate engineering students' perceptions of problem solving [17], connect their sense of identity and learning motivation [18], and analyze retention in foundational courses [19]. In these studies and others, FTP provides a persuasive description of many students' motivation and cognitive processes. For instance, an FTP framework can uncover students' perceptions of instrumentality and whether they perceive a task as related to their emerging identity [17], [19], [20]. FTP investigations, then, can provide indirect insight into students' views of their future selves by identifying whether they perceive a task as related to their emerging identity; the FSCQ, on the other hand, questions respondents directly about their views on their future selves.

Future Self Theory

The future self is a person's vision of themselves in the future, and future self theory can be useful for analyzing students' current perceptions of how they expect they will be in the future. Like FTP, this concept has been coupled with motivation: the concept has been used for behavioral modification, to promote certain positive behaviors (for example, saving money [21]) and to reduce certain negative behaviors (such as reducing procrastination [22]). Research shows that "people think about their current selves and their future selves as if they are different people" [23], and multiple reviews of future self scholarship note a consensus that the sense of connectedness between one's present self and one's future self decreases as time distance to the future self increases [21], [23], [24]. In the case of students, the time distance to their future

working self is not great, but an incomplete understanding of the nature of their future work (lack of vividness and relatability in terms of the future self construct) can make it difficult to imagine their future work selves. The concept of a future work self was proposed initially in the context of professionals already in the workplace [25], but applications have evolved. For instance, recent career counseling scholarship considers current undergraduates imagining their future work selves [26], and future work self salience is discussed in the context of career adaptability for graduates struggling to find employment in China [27]. In engineering education research, enhancing students' ability to imagine their future selves has been proposed as a potential mechanism to foster students' general ability to imagine life and work after graduation [12], [28].

The future self model is multi-dimensional and consists of three latent constructs [15], also termed components [29]: *relatedness* (or similarity), *vividness*, and *positivity*, as shown below in Figure 1. These three latent constructs are correlated but independent factors [15], [29].

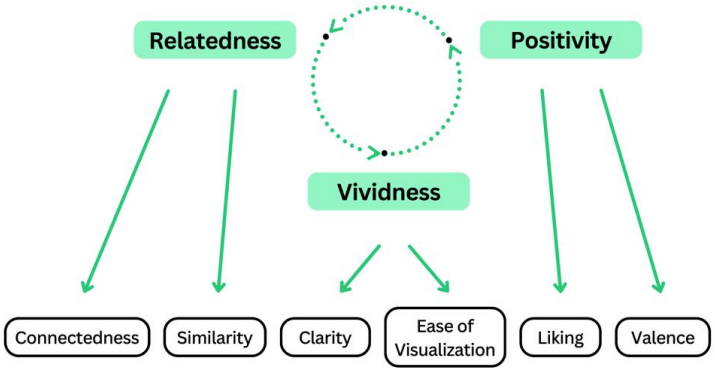

Figure 1: The three latent constructs of the future self model and examples of their qualities. Adapted from [29]

Relatedness speaks to the expected degree of similarity between the present self and the imagined future self. In the case of engineering students, the time distance to graduation is relatively short, but the similarity gap between being a student and being an early career professional is great. Vividness addresses the ability to clearly and easily imagine one's future self. In the case of engineering students, they may be able to clearly imagine a future self that they do not realize is incomplete, and that incomplete vision may be of a rigid and fixed future [12]. Positivity refers to the degree of desirability of a vision of one's future self. While the theory of "possible selves" addresses both negative and positive future outcomes [30], [31], future self theory only considers positively valenced representations, with low positivity ratings indicating negative expectations. Possible selves theory has been a productive framework in engineering education research [32], [33], [34]. However, this paper examines the FSCQ because it specifically addresses the expected continuity between one's present and future self, rather than a broader range of potential positive and negative potential selves. This narrower scope makes the FSCQ easier to administer and analyze, allowing it to function as either a stand-alone instrument or a component within a larger survey, using only ten items.

Future Self Continuity Measurement

Prior to 2020, the only published and validated instrument to measure future self continuity was the single question Future Self Continuity Scale [21], published in 2009 by Ersner-Herschfield et al, which asked participants to select one of seven pairs of overlapping circles that best represented the degree of connection between their present and future selves: the scale primarily measured relatedness. Since 2020, at least two validated instruments have been published, and both instruments are framed through the three latent constructs of future self theory (relatedness, vividness, and positivity). These two instruments are Sokol and Serper's (2020) Future Self Continuity Questionnaire (FSCQ) [15] and Wang's (2022) Multi-Temporal Self Continuity Scale (MTCS) [35]. This study chose to evaluate the FSCQ in the context of engineering education because it focuses exclusively on measuring future self continuity. The FSCQ is included as part of Wang's MTCS, but the MTCS adds questions connecting the present self to the past self [35]. Also, the MTCS potentially primes respondents by asking them to "describe" themselves in the future by writing five complete sentences immediately before the FSCQ questions. Overall, as a narrower and entirely quantitative instrument, the FSCQ was more desirable for this evaluation. The study by Brixton et al (2020) is notable for demonstrating that the three latent constructs of future self theory are correlated but independent factors; however, it studies these relationships through multiple modified scales [29], whereas Sokol and Serper examine a single instrument, the FSCQ, across multiple studies. Notably, all three investigations use 10 years as a time frame for imagining the future, in alignment with the time frame used in the initial Future Self Continuity Scale [21], which all three studies acknowledge as a seminal instrument.

The ten questions on the FSCQ are presented below along with their associated latent construct. Each question offers a 6-point Likert scale for responses (see Appendix A).

Table 1: FSCQ constructs and questions

Construct	Question
Relatedness	How similar are you now to what you will be like 10 years from now?
Relatedness	How similar are your beliefs now to what they will be like 10 years from now?
Relatedness	How similar is your personality now to what it will be like 10 years from now?
Relatedness	How similar are your values now to what they will be like 10 years from now?
Vividness	How vividly can you imagine what you will be like 10 years from now?
Vividness	How vividly can you imagine what you will look like 10 years from now?
Vividness	How vividly can you imagine what your family relationships will be like 10 years from now?
Positiveness	Do you like what you will be like 10 years from now?
Positiveness	Do you like what your personality will probably be like 10 years from now?
Positiveness	Do you like what your actions will probably be like 10 years from now?

Previous validation of the FSCQ

Sokol and Serper's validation of the FSCQ included two studies across seven samples, ranging from 178-550 adults [15]. After employing exploratory factor analysis (EFA), the authors reduced the instrument to the extant ten questions, and internal consistency was confirmed through Cronbach's alpha scoring. Confirmatory factor analysis (CFA), measures of fit, and

internal measures of construct validity were then performed across four independent samples of adults (n= 1,481). The authors note that data demonstrate "convergent, discriminant, and nomological validity. Findings support the coherence of the FSCQ, indicating the scale has adequate test-retest reliability, concurrent and discriminant validity, and an internally consistent replicable factor structure related to the construct of future self-continuity." They compared the instruments' distribution with ten previously validated instruments, including the single-question Future Self Continuity Scale (FSCS). The FSCQ achieved "an internally valid and reliable three-factor structure," valuably extending the single-question FSCS. Sokol and Serper's validation process recruited adult participants using Amazon's MTurk, which they note might limit the generalizability of their findings.

Part 1: Qualitative review of the FSCQ

While statistical analysis may indicate whether students understood the FSCQ's ten questions reliably and in a consistent manner, including noting variations among demographic groups, it cannot capture misperceptions and misunderstandings if the participants' erroneous interpretations are common across demographic groups or do not skew the data. Therefore, this paper's evaluation of the FSCQ also includes think aloud protocols. Think-aloud protocols (TAPs) can be used to understand a participant's thought process during an activity [36], from solving a mathematical word problem or a physics problem [36] to performing an athletic action such as golf putting [37]. They can also yield insight when applied to the situation of a participant reading a survey [38]. In this latter case, TAP consists of a research participant reading survey questions aloud and narrating their thoughts as they read, which can help researchers "to identify potential flaws in test items or misunderstanding of survey questions" [38]. As part of a study aimed at strengthening students' capacity to envision salient future selves, two rounds of TAP readings were conducted to refine a longer instrument that included the FSCQ. The first round was prior to finalizing the full pre- and post-surveys, which incorporated additional items beyond the FSCQ; the second followed its administration to the first participant cohort.

Participants and Data Collection

IRB (exempt) approval was received, all participants provided informed consent before beginning, and participants received a nominal gift card for participation. The first and second TAP rounds included nine and six participants, respectively. Students were recruited by an email to engineering students. Participants were from a variety of engineering majors, genders, ethnicities, and undergraduate year in college, but students were not asked to provide demographic information: the sample size was not intended to provide statistically meaningful data, and no single participant was meant to represent a demographic data point. Rather, rich and thick qualitative data was desired to complement and potentially contextualize the statistical evaluation of the full data set. The first round of TAP occurred prior to administering the survey as part of a study. In the second round, half of the participants (three) indicated that they participated in the study that gathered the data using the FSCQ.

The TAPs were conducted over Zoom, as one-on-one sessions between the researcher and each participant. Following recommended TAP protocols, the researcher first demonstrated the think-aloud process using a survey question not included in the FSCQ. In this demonstration, the researcher read the question aloud, explained her interpretation, and described a possible response. For the FSCQ items, participants were then asked to read each question and think

aloud about what they believed the question asking was how they might approach answering it. If preferred, they could describe how another student might respond. This second prompt of explaining an approach to answering the question was intended to reduce "automaticity" [39]—that is, students simply paraphrasing the language of the question rather than interpreting its meaning. The goal was to elicit students' understanding of the questions rather than a restatement. As needed, the researcher asked clarifying questions but did not follow a scripted interview protocol. All TAPs were recorded, and the researcher also took notes during each session. These notes and transcripts were analyzed to identify recurring points of misunderstanding, ambiguity, and uncertainty.

Results

Three themes emerged when reviewing TAP materials. These ranged from general confusion to imaginative limitations to an imprecise interpretation of language. Each was mentioned by at least two of the nine participants.

1. Preamble needed: In the first round of TAPS, several participants expressed confusion when transitioning from earlier survey items (focused on desirable employer attributes) to the FSCQ questions. To clarify the shift in focus without altering the FSCQ items themselves, a preamble was added to frame the FSCQ as a block of questions:

> This final set of questions asks you to imagine your future self. Suppose you enter a time machine, go 10 years into the future, and meet the person you become. Consider what you think this person will most likely be like.

The preamble was framed in a neutral, non-bias inducing manner [40] and had the additional benefit of framing the responses as reasonable expectations not unfounded aspirations for the future [35]. In the second round, after this change was implemented, no participants expressed confusion about the context of the FSCQ, suggesting the preamble successfully addressed this issue.

2. Imaginative limitations: Several students in the first round of TAPs demonstrated difficulty imagining future family relationships beyond their current family structures. In response to the FSCQ item about imagining family relationships ten years in the future, they spontaneously described the current closeness of their families, using terms such as "close" or "tight knit." When asked follow-up questions to elicit their vision of future relationships, students in this cohort referred only to existing family members—parents, siblings, and older extended relatives such as grandparents, aunts, and uncles. This response pattern suggests a limited capacity to project themselves into future relational roles such as marriage or parenthood, despite the average age of first marriage in the U.S. being 30.2 for males and 28.4 for females [41]. In contrast, three students in the second cohort (two male, one female) explicitly referenced potential future changes in their or their siblings' family lives, including marriage and children. One female participant explained that she was from a rural state and that five of her high school friends were already engaged, which led her to mention "starting your own family." A male participant noted that his older brothers were married and anticipated "they'll have kids." While the small sample size and lack of demographic information prevent broad conclusions, it is plausible that some students in the first cohort also had older siblings or came from culturally diverse backgrounds regarding the timing of family formation. One possibility is that the

addition of the preamble—the only change to the survey protocol between cohorts—prompted students in the second round to think more fully and realistically about their future selves.

3. "Beliefs" and "values" conflation: The series of FSCQ items addressing the latent construct of relatedness did not confuse all TAP participants, but among those who did express uncertainty, a consistent pattern emerged. The opening question—"How similar are you now to what you will be like 10 years from now?"—was sometimes described as "broad" or "vague," but without deeper commentary. However, multiple participants in both cohorts struggled to differentiate between the question asking, "How similar are your *beliefs* now to what they will be like 10 years from now?" (emphasis added) and the question asking, "How similar are your *values* now to what they will be like 10 years from now?" (emphasis added). When narrating their thoughts on beliefs, some students had used the word values in their response. In multiple instances, when presented with the later question about values, students asked to revisit the earlier question. Three types of responses emerged from students who expressed this confusion: 1) some reconsidered and revised their response to the beliefs question based on the later question about values; 2) others affirmed their initial interpretation of beliefs and offered a distinct definition for values; and (3) some explicitly stated that beliefs and values were "the same," "not mutually exclusive," or "tied together." Five participants—three from the first cohort and two from the second—recommended removing one of the two questions. Notably, the question placed between them—"How similar is your personality now to what it will be like 10 years from now?"—did not elicit any confusion or hesitation during the think-aloud sessions. These findings highlight the interpretive overlap students perceive between the terms "beliefs" and "values."

Summary and Discussion of Qualitative Review

The only modification made to the FSCQ was the addition of a preamble, added in response to participants' difficulty transitioning from earlier, unrelated survey items. This revision occurred before the survey was administered to any participants; thus, all versions of the pre- and post-surveys in both rounds of the study included the preamble, preventing comparison of its effectiveness. Across both rounds of TAPs, some participants expressed difficulty distinguishing between the terms "beliefs" and "values."

RQ 1) How do engineering students interpret the FSCQ items?

The qualitative data suggest that some engineering students demonstrated limited imaginative capacity and imprecise language usage when interpreting some of the FSCQ questions, particularly the question about imagining future family relationships and the questions addressing expected similarity in values and beliefs. However, these limitations may not be unique to engineering students, as the general population used in the initial validation the instrument via MTurk may have encountered similar challenges. These interpretive patterns became visible through the think-aloud protocols, which provided insight into students' reasoning processes that would not be apparent from survey responses alone. The addition of a preamble may have helped students imagine an evolution in their future family relationships, but the conflation of "beliefs" and "values" persisted.

Part 2: Statistical analysis review of the FSCQ

The FSCQ was originally validated through rigorous statistical analysis conducted by the instrument's authors using a general population sample recruited via MTurk. The analysis presented below draws on data from engineering students at a large R1 university. In this study, the FSCQ was embedded within a larger pre- and post-survey administered before and after students viewed a series of alumni videos focused on life after graduation.

Participants and Data Collection

Participants were recruited via a general email sent to all engineering majors, including computer science students. An additional recruitment email was distributed through the Center for Engineering Diversity. The study received IRB exempt approval, and all participants provided informed consent prior to completing both the pre- and post-surveys. As compensation, participants received a nominal gift card. The study was conducted in two rounds—one in Spring 2024 and one in Fall 2024—and included a pre-survey, a series of alumni videos discussing life and work after graduation, and a post-survey. To ensure unique responses, participants were screened to prevent duplicate participation. Eligibility was limited to engineering majors aged 18 or older.

A total of 303 responses were collected; 292 (96.37%) contained meaningful data and were retained for analysis. Of these, 195 (66.78%) were from Spring and 97 (33.22%) from Fall. Computer science students made up 109 (37.33%) of the sample, while 183 (62.67%) represented other engineering majors. In terms of academic year, 68 (23.37%) were first-year students, 80 (27.49%) second-year, 72 (24.74%) third-year, 64 (21.99%) fourth-year, and 7 (2.41%) were in their fifth year or beyond. The sample included 168 female (57.53%) and 115 male (39.38%) participants. Most students identified as heterosexual (n = 223, 76.37%). Participants could select multiple racial identities. Reported racial identities included Black (n = 47, 16.67%), East Asian (n = 68, 24.11%), Hispanic (n = 113, 40.07%), Middle Eastern (n = 16, 5.67%), Native American (n = 4, 1.42%), Hawaiian (n = 2, 0.71%), White (n = 51, 18.09%), South Asian (n = 23, 7.88%), and Other (n = 9, 3.19%). First-generation college students made up 36.64% of the sample (n = 107), while 60.62% (n = 177) were not.

Of the 292 valid responses, 161 (55.14%) participants completed the post-survey. Chi-square and Fisher's exact tests were used to examine demographic differences between those who completed the post-survey and those who did not. First-year students were significantly more likely to complete the post-survey (67.6% vs. 51.3%, $p = 0.0258$). No other demographic variables showed statistically significant differences, suggesting that post-survey attrition was otherwise random.

Results

Internal consistency of the three latent constructs was assessed using Cronbach's alpha for the pre-survey, post-survey, and combined datasets. In all cases, the constructs demonstrated acceptable or good reliability, with no meaningful differences between pre- and post-surveys or the combined dataset. The relatedness construct showed acceptable internal consistency across all datasets ($\alpha = 0.777$, 0.784, and 0.777). Vividness also met the acceptable threshold ($\alpha =$ 0.746, 0.783, and 0.759), while positiveness demonstrated good internal consistency ($\alpha = 0.874$, 0.865, and 0.871).

An exploratory factor analysis (EFA) was conducted to assess the factor structure. One-, two-, three-, and four-factor solutions were tested. The first three factors accounted for a cumulative 58.2% of the variance, while the fourth contributed only 2.1%. Based on explained variance, the three-factor solution was retained.

A confirmatory factor analysis (CFA) using the *lavaan* package in R supported the three-factor model. The chi-square statistic was 78.62 with 32 degrees of freedom (normalized $\chi^2 = 2.457$), indicating acceptable model fit. The Comparative Fit Index (CFI = 0.961) and Tucker–Lewis Index (TLI = 0.945) both exceeded the 0.90 threshold for good fit. The Standardized Root Mean Square Residual (SRMR = 0.045) was below the recommended cutoff of 0.08, while the Root Mean Square Error of Approximation (RMSEA = 0.071) was marginally above the commonly accepted threshold of 0.07. Overall, the CFA confirmed the model as a good fit for the data.

Ten multiple linear regressions were conducted—one for each item on the FSCQ—with the absolute value of change between pre- and post-survey responses serving as the dependent variable. Independent variables included semester (Spring vs. Fall), major (computer science), academic year (with first-year as the reference), gender (female, the most common response), racial identity (Hispanic, the most common response), sexual orientation (heterosexual, the most common response), and first-generation college student status. Three statistically significant predictors emerged ($p < 0.05$). Male participants ($\beta = 0.304$, $p = 0.0477$) and East Asian participants ($\beta = 0.446$, $p = 0.0183$) showed significant change on the "Similar 2" item ("How similar are your beliefs to what they will be like 10 years from now?"). East Asian identity was also associated with change on "Similar 4" ($\beta = 0.538$, $p = 0.006$) and "Like 1" ($\beta = 0.502$, $p = 0.007$). These effect sizes fall in the small-to-moderate range, suggesting that while the differences are statistically significant, the magnitude of change in self-perception is modest. No other demographic variables were statistically significant at the $p = 0.05$ level.

Summary and Discussion of Statistical Review

The statistical analysis indicates that the FSCQ retains dimensionality and reliability when administered to engineering students. Internal consistency was confirmed through Cronbach's alpha, and the factor structure was supported by both exploratory and confirmatory factor analysis. Evidence of meaningful change was observed across pre- and post-survey responses for specific demographic subgroups. Male participants showed significant change on one item, while East Asian participants showed significant change on three items. This variation suggests that the instrument is sensitive to change across different student groups and may reflect differences in how students responded to the alumni video intervention. The variation, then, is not an issue of interpretability of the FSCQ (which would have resulted in variations within pre- and post-responses rather than across them), but rather a demonstration of its ability to record meaningful change in students' responses before and after an intervention.

RQ 2) Do the FSCQ's three latent constructs demonstrate internal reliability with engineering students?

When administered to engineering students, each of the three latent constructs in the FSCQ demonstrated internal reliability within acceptable or good ranges. However, in the original validation by Sokol and Serper, even the lowest Cronbach's alpha exceeded 0.86, falling in the good range. Think-aloud protocols suggest potential sources of variation: some students

appeared to conflate two of the four items in the relatedness construct (those concerning expected similarity in beliefs and values), while others showed limited ability to imagine new future family relationships—an element of the vividness construct. Notably, relatedness and vividness achieved only acceptable, rather than good, internal reliability, consistent with the interpretive challenges observed during the TAPs.

RQ 3) Do the FSCQ's the three latent constructs fit the data from engineering students?

The FSCQ is based on three latent constructs [15], [29], and statistical analyses with engineering students indicate a good overall model fit. While think-aloud protocols (TAPs) revealed some interpretive challenges, these had minimal impact on fit as measured by confirmatory factor analysis. The results support the FSCQ's structural validity and its use in engineering education, especially when paired with TAPs to clarify interpretation.

Conclusion

A reliable, validated instrument is needed to assess engineering students' capacity to envision their future selves. Pre- and post-use of such a scale may help evaluate whether specific activities—educational or extracurricular—support that capacity. This paper's evaluation demonstrates the overall validity of the FSCQ for use with engineering students and its ability to detect meaningful change across items when administered before and after an intervention. Although the dataset included demographically diverse respondents, all participants were from a single R1 institution. Including multiple institutions of varying types and sizes may yield different results. Additionally, the nature of an intervention may influence the utility of the FSCQ and should be considered in both study design and future research. In short, the FSCQ offers engineering educators a validated instrument for assessing students' capacity to envision their future professional identities—an essential step in preparing them for the transition to work—and shows promise for use across research contexts, institutional settings, and student populations.

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References

[1] J. Trevelyan, "Transitioning to engineering practice," *Eur. J. Eng. Educ.*, vol. 44, no. 6, pp. 821–837, Nov. 2019, doi: 10.1080/03043797.2019.1681631.

[2] E. Flening, F. Asplund, and M.E. Grimheden, "Measuring professional skills misalignment based on early-career engineers' perceptions of engineering expertise," *Eur. J. Eng. Educ.*, vol. 47, no. 1, pp. 117–143, 2022, doi: 10.1080/03043797.2021.1967883.

[3] B. Lutz and M. C. Paretti, "Exploring the Social and Cultural Dimensions of Learning for Recent Engineering Graduates during the School-to-Work Transition," *Eng. Stud.*, vol. 13, no. 2, pp. 132–157, May 2021, doi: 10.1080/19378629.2021.1957901.

[4] K. Edström and A. Kolmos, “PBL and CDIO: complementary models for engineering education development,” *Eur. J. Eng. Educ.*, vol. 39, no. 5, pp. 539–555, Sep. 2014, doi: 10.1080/03043797.2014.895703.
[5] Y. Xia, S. Cutler, and D. McFadden, “Collaborative Project-based Learning Approach to the Enculturation of Senior Engineering Students into the Professional Engineering Practice of Teamwork,” in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual On line: ASEE Conferences, Jun. 2020, p. 34299. doi: 10.18260/1-2--34299.
[6] S. Habibi *et al.*, “A Modernized Student- and Equity-Centered Teaching Strategy,” *Adv. Eng. Educ.*, vol. 11, no. 3, 2023, doi: 10.18260/3-1-1153-36049.
[7] S. Howe and J. Goldberg, “Engineering Capstone Design Education: Current Practices, Emerging Trends, and Successful Strategies,” in *Design Education Today*, D. Schaefer, G. Coates, and C. Eckert, Eds., Cham: Springer International Publishing, 2019, pp. 115–148. doi: 10.1007/978-3-030-17134-6_6.
[8] D. M. Gilbuena, B. U. Sherrett, E. S. Gummer, A. B. Champagne, and M. D. Koretsky, “Feedback on Professional Skills as Enculturation into Communities of Practice,” *J. Eng. Educ.*, vol. 104, no. 1, pp. 7–34, 2015, doi: 10.1002/jee.20061.
[9] R. Korte, S. Brunhaver, and S. Sheppard, “(Mis)Interpretations of Organizational Socialization: The Expectations and Experiences of Newcomers and Managers,” *Hum. Resour. Dev. Q.*, vol. 26, no. 2, pp. 185–208, 2015, doi: 10.1002/hrdq.21206.
[10] K. Beddoes, “Accounting for Occupational Identity Work in the Attrition of Newcomer Civil Engineers: Theoretical Model,” *J. Civ. Eng. Educ.*, vol. 149, no. 3, p. 04023001, Jul. 2023, doi: 10.1061/JCEECD.EIENG-1917.
[11] H. Matusovich, R. Streveler, R. Miller, and B. Olds, “I’m Graduating This Year! So What Is An Engineer Anyway?,” presented at the 2009 Annual Conference & Exposition, Jun. 2009, p. 14.821.1-14.821.18. Accessed: Jun. 05, 2024. [Online]. Available: https://peer-asee-org.libproxy2.usc.edu/i-m-graduating-this-year-so-what-is-an-engineer-anyway
[12] H. Ramsey and Y. L. E. Wong, “Beyond the Vanishing Point: Using Future Self Theory and Student-Alumni Interviews to Expand Student Perspectives on Engineering Education and Engineering Work,” presented at the 2022 ASEE Zone IV Conference, May 2022. Accessed: Feb. 07, 2024. [Online]. Available: https://peer.asee.org/beyond-the-vanishing-point-using-future-self-theory-and-student-alumni-interviews-to-expand-student-perspectives-on-engineering-education-and-engineering-work
[13] D. Lowe, E. Tilley, K. Willey, and K. Roach, “Student reactions to the development of professional engineering competencies,” *Eur. J. Eng. Educ.*, May 2024, doi: 10.1080/03043797.2024.2354240.
[14] B. Lutz and M. C. Paretti, “Exploring the Social and Cultural Dimensions of Learning for Recent Engineering Graduates during the School-to-Work Transition,” *Eng. Stud.*, vol. 13, no. 2, pp. 132–157, May 2021, doi: 10.1080/19378629.2021.1957901.
[15] Y. Sokol and M. Serper, “Development and Validation of a Future Self-Continuity Questionnaire: A Preliminary Report,” *J. Pers. Assess.*, vol. 102, no. 5, pp. 677–688, Sep. 2020, doi: 10.1080/00223891.2019.1611588.
[16] J. C. Hilpert, J. Husman, G. S. Stump, W. Kim, W.-T. Chung, and M. A. Duggan, “Examining students’ future time perspective: Pathways to knowledge building1,” *Jpn. Psychol. Res.*, vol. 54, no. 3, pp. 229–240, 2012, doi: 10.1111/j.1468-5884.2012.00525.x.
[17] A. Kirn and L. Benson, “Engineering Students’ Perceptions of Problem Solving and Their Future,” *J. Eng. Educ.*, vol. 107, no. 1, pp. 87–112, 2018, doi: 10.1002/jee.20190.

[18] A. Godwin and A. Kirn, "Identity-based motivation: Connections between first-year students' engineering role identities and future-time perspectives," *J. Eng. Educ.*, vol. 109, no. 3, pp. 362–383, 2020, doi: 10.1002/jee.20324.
[19] K. G. Nelson, D. F. Shell, J. Husman, E. J. Fishman, and L.-K. Soh, "Motivational and Self-Regulated Learning Profiles of Students Taking a Foundational Engineering Course," *J. Eng. Educ.*, vol. 104, no. 1, pp. 74–100, 2015, doi: 10.1002/jee.20066.
[20] J. Husman, J. C. Hilpert, and S. K. Brem, "Future Time Perspective Connectedness to a Career: The Contextual Effects of Classroom Knowledge Building," *Psychol. Belg.*, vol. 56, no. 3, pp. 210–225, Jul. 2016, doi: 10.5334/pb.282.
[21] H. Ersner-Hershfield, M. T. Garton, K. Ballard, G. R. Samanez-Larkin, and B. Knutson, "Don't stop thinking about tomorrow: Individual differences in future self-continuity account for saving," *Judgm. Decis. Mak.*, vol. 4, no. 4, pp. 280–286, Jun. 2009, doi: 10.1017/S1930297500003855.
[22] E. C. Blouin-Hudon and T. A. Pychyl, "A Mental Imagery Intervention to Increase Future Self-Continuity and Reduce Procrastination," *Appl. Psychol.*, vol. 66, no. 2, pp. 326–352, Apr. 2017, doi: 10.1111/apps.12088.
[23] J. L. van Gelder, H. E. Hershfield, and L. F. Nordgren, "Vividness of the Future Self Predicts Delinquency," *Psychol. Sci.*, vol. 24, no. 6, pp. 974–980, 2013.
[24] N. A. Lewis and D. Oyserman, "When Does the Future Begin? Time Metrics Matter, Connecting Present and Future Selves," *Psychol. Sci.*, vol. 26, no. 6, pp. 816–825, Jun. 2015, doi: 10.1177/0956797615572231.
[25] K. Strauss, M. A. Griffin, and S. K. Parker, "Future work selves: How salient hoped-for identities motivate proactive career behaviors," *J. Appl. Psychol.*, vol. 97, no. 3, pp. 580–598, May 2012, doi: 10.1037/a0026423.
[26] B. J. Taber and M. Blankemeyer, "Future work self and career adaptability in the prediction of proactive career behaviors," *J. Vocat. Behav.*, vol. 86, pp. 20–27, Feb. 2015, doi: 10.1016/j.jvb.2014.10.005.
[27] Y. Guan *et al.*, "Modeling dynamics in career construction: Reciprocal relationship between future work self and career exploration," *J. Vocat. Behav.*, vol. 101, pp. 21–31, Aug. 2017, doi: 10.1016/j.jvb.2017.04.003.
[28] H. Ramsey, "Engineering Moment as a Pedagogical Approach: Using Narrative Theory to Promote Student Awareness of their Engineering Identities," presented at the 2022 ASEE Annual Conference & Exposition, Aug. 2022. Accessed: Feb. 07, 2024. [Online]. Available: https://peer.asee.org/engineering-moment-as-a-pedagogical-approach-using-narrative-theory-to-promote-student-awareness-of-their-engineering-identities
[29] M. T. Bixter *et al.*, "A test of a triadic conceptualization of future self-identification," *PLOS ONE*, vol. 15, no. 11, p. e0242504, Nov. 2020, doi: 10.1371/journal.pone.0242504.
[30] D. Oyserman and E. Horowitz, "From possible selves and future selves to current action: An integrated review and identity-based motivation synthesis," in *Advances in Motivation Science*, vol. 10, Elsevier, 2023, pp. 73–147. doi: 10.1016/bs.adms.2022.11.003.
[31] C. Manzi, V. L. Vignoles, and C. Regalia, "Accommodating a new identity: Possible selves, identity change and well-being across two life-transitions," *Eur. J. Soc. Psychol.*, vol. 40, no. 6, pp. 970–984, 2010, doi: 10.1002/ejsp.669.
[32] D. Bennett and S. A. Male, "An Australian study of possible selves perceived by undergraduate engineering students," *Eur. J. Eng. Educ.*, vol. 42, no. 6, pp. 603–617, Nov. 2017, doi: 10.1080/03043797.2016.1208149.
[33] J. R. Deters, M. Menon, M. C. Paretti, and M. Webb, "Exploring Interdisciplinary Identity Development Using Possible Selves: An Exploratory Study," in *9th Research in*

Engineering Education Symposium (REES 2021) and 32nd Australasian Association for Engineering Education Conference (REES AAEE 2021), Perth, WA, Australia: Research in Enineering Education Network (REEN), 2022, pp. 404–412. doi: 10.52202/066488-0045.
[34] D. Verdín, A. Godwin, G. Sonnert, and P. M. Sadler, "Understanding how First-Generation College Students' Out-of-School Experiences, Physics and STEM Identities Relate to Engineering Possible Selves and Certainty of Career Path," in *2018 IEEE Frontiers in Education Conference (FIE)*, Oct. 2018, pp. 1–8. doi: 10.1109/FIE.2018.8658878.
[35] K. T. Wang, "Development, Factor Structure, and Initial Validation of the Multidimensional Temporal Self-Continuity Scale (MTSCS)," Ph.D., Hofstra University, United States -- New York, 2022. Accessed: Jun. 09, 2024. [Online]. Available: https://www-proquest-com.libproxy1.usc.edu/docview/2713949081/abstract/2AD86ABAA9D44A26PQ/1
[36] P. Solomon, "The think aloud method: A practical guide to modelling cognitive processes," *Inf. Process. Manag.*, vol. 31, no. 6, pp. 906–907, Nov. 1995, doi: 10.1016/0306-4573(95)90031-4.
[37] D. W. Eccles and G. Arsal, "The think aloud method: what is it and how do I use it?," *Qual. Res. Sport Exerc. Health*, vol. 9, no. 4, pp. 514–531, Aug. 2017, doi: 10.1080/2159676X.2017.1331501.
[38] M. D. Wolcott and N. G. Lobczowski, "Using cognitive interviews and think-aloud protocols to understand thought processes," *Curr. Pharm. Teach. Learn.*, vol. 13, no. 2, pp. 181–188, Feb. 2021, doi: 10.1016/j.cptl.2020.09.005.
[39] E. Charters, "The Use of Think-aloud Methods in Qualitative Research An Introduction to Think-aloud Methods," *Brock Educ. J.*, vol. 12, no. 2, Art. no. 2, Jul. 2003, doi: 10.26522/brocked.v12i2.38.
[40] R. F. Speklé and S. K. Widener, "Challenging Issues in Survey Research: Discussion and Suggestions.," *J. Manag. Account. Res.*, vol. 30, no. 2, pp. 3–21, Jun. 2018, doi: 10.2308/jmar-51860.
[41] K. Westrick-Payne, "A Decade of Change in the Median Age at First Marriage, 2012 & 2022," in *Family Profiles, FP-24-07*, Bowling Green, OH: National Center for Family & Marriage Research. Accessed: Dec. 29, 2024. [Online]. Available: https://www.bgsu.edu/ncfmr/resources/data/family-profiles/decade-of-change-median-age-first-marriage-2012-2022-fp-24-07.html

Appendix A

FSCQ with preamble added

This final set of questions ask you to imagine your future self. Suppose you enter a time machine, go 10 years into the future, and meet the person you become. Consider what you think this person will most likely be like.

1. How similar are you now to what you will be like 10 years from now?
   1- completely different 2- somewhat different 3- a little different
   4- similar 5- very similar 6- exactly the same
2. How similar are your beliefs now to what they will be like 10 years from now?
   1- completely different 2- somewhat different 3- a little different
   4- similar 5- very similar 6- exactly the same

3. How similar is your personality now to what it will be like 10 years from now?
   1- completely different 2- somewhat different 3- a little different
   4- similar 5- very similar 6- exactly the same
4. How similar are your values now to what they will be like 10 years from now?
   1-- completely different 2- somewhat different 3- a little different
   4- similar 5- very similar 6- exactly the same
5. How vividly can you imagine what you will be like in 10 years from now?
   1- not at all 2- not very well 3- somewhat 4- pretty well
   5- very strongly 6- perfectly
6. How vividly can you imagine what you will look like in 10 years from now?
   1- not at all 2- not very well 3- somewhat 4- pretty well
   5- very strongly 6- perfectly
7. How vividly can you imagine what your family relationships will be like in 10 years from now?
   1- not at all 2- not very well 3- somewhat 4- pretty well
   5- very strongly 6- perfectly
8. Do you like what you will be like 10 years from now?
   1- not at all 2- not very well 3- somewhat 4- pretty well
   5- very strongly 6- perfectly
9. Do you like what your personality will probably be like 10 years from now?
   1- not at all 2- not very well 3- somewhat 4- pretty well
   5- very strongly 6- perfectly
10. Do you like what your actions will probably be like 10 years from now?
   1- not at all 2- not very well 3- somewhat 4- pretty well
   5- very strongly 6- perfectly