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Development and Application of a Questionnaire to Measure Student Attitudes Toward and Understanding of Engineering

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Introduction and Background

Student attitudes and perceptions toward engineering at various "stages" in their academic development can be an important factor in persistence to degree completion. For example, some studies report that the diversity gap in STEM participation may be attributed more to perceptions and beliefs than to academic preparation or achievement levels [1-5]. To the extent that such perceptions and beliefs form an inaccurate (or "negative") vision of a future engineering career, curricular approaches that aim to form a more "positive" vision may be warranted. These approaches can be pedagogical, such as collaborative and project-based learning [6-8], content-based by aiming (for example) to expose the positive contributions of engineering to society [9-12], or both. All other things being equal, curricular features than can foster among students a more positive identification with engineering, i.e. sense of fit or belongingness, should be preferable. It is reasonable to assert, as well, that approaches of this nature will result in a more well-rounded professional preparation [13].

Meaningful assessment of strategies for impacting students' sense of fit is predicated on the availability of well characterized, reliable and valid survey instruments that are aimed at probing related student perspectives. Such surveys will enable engineering educators to gauge the effect of curricular features (entire programs, courses, units or modules), pathways, pedagogical approaches, pseudo-professional experiences, etc., on sense of fit within the profession. They can also be employed to explore how student perceptions/attitudes change over time, particularly as they encounter the first year of an engineering academic program and how these perceptions/attitudes and their aforementioned evolution may depend on gender or other identity categories. The purpose of this paper is to describe the psychometric characterization of a questionnaire that was developed to measure student attitudes toward and understanding of studies and careers in engineering. The work was motivated by the desire to gain a better understanding of our students' incoming (as they begin first year studies) perceptions and beliefs and to monitor changes as they progress, and the lack of an existing survey instrument that adequately captured the range of characteristics we wished to measure.

In particular, knowledge of changes in student attitudes were sought as a response to a course developed for first year engineering (FYE) majors [12]. This course, *Engineering and Society*, contains elements that are common among FYE courses such as the study of engineering disciplines, ethics, and a team-based design project, yet it uniquely focuses on the connections among engineering/technology and society and the development of technology within a societal context. This allows us to integrate ethics and the engineering design experience with the technology and society content, which provides a platform for analyzing current technological systems and exposes students to the breadth and diversity of engineering. Aside from meeting ABET and University-level outcomes, *Engineering and Society* strives to clarify students' perceptions of the broad nature of engineering problem solving, and to positively impact their attitudes toward engineering studies and careers.

Since 2011, when the course was piloted on a large scale, we have administered a self-constructed questionnaire to measure student attitudes before and after taking the course. Our findings have consistently shown a significant increase in students' understanding of the broad nature of engineering and engineering problem solving, self-confidence with respect to engineering problem solving and design, and their sense of fit within the engineering profession. These increases were also significantly greater than those measured among the fall semester control group, consisting of first year engineering students enrolled in physics instead of *Engineering and Society*. These findings, and a significant body of research demonstrating, among a variety of reasons, the importance of students' sense of belonging to their persistence in engineering studies and careers [e.g. 14, 15] and – for women in particular – the evidence that negative perceptions toward engineering can be dispelled by framing engineering studies and careers within a broader context to demonstrate societal relevance [4, 16], have suggested the need for (1) a more systematic investigation of gender differences in our students' experiences; and (2) a rigorous psychometric analysis of our questionnaire to characterize its validity and reliability with the intent to make it more widely available to others wishing to evaluate target student populations. The second objective is the subject of this paper.

Methods

Survey Development

The Engineering Attitude Questionnaire was developed by Authors (1) and (2) to provide a measure of student changes in attitudes toward and understanding of engineering as a result of their participation in the *Engineering and Society* course. Most of the attitude items were adapted from a number of existing questionnaires [17-20], while original items were created to measure course objectives related to students' understanding of the breadth of engineering and interactions with society. The questionnaire contains 23 items that use a Likert-type format with five options ranging from strongly disagree (1) to strongly agree (5). The items are specifically intended to measure students':

1. Confidence in the engineering curriculum
2. Satisfaction with the decision to study, and comfort level or sense of 'fit' within engineering

3. Self-confidence (general performance, within engineering problem solving and design, and team work)

4. Understanding of the broad nature of engineering and engineering problem solving (creativity, teamwork, ethics, and society context)

The Questionnaire items, included in the Appendix, were originally segregated into these categories based largely on our interpretation of the question characteristics, their original source (for items adapted from other surveys), and to better facilitate the interpretation of results. The analysis reported in this paper was conducted according to established psychometric principles and methodologies in the sociological and educational sciences [e.g., 21]. Scale reliability has been reinforced through an item analysis conducted with responses from multiple rounds of survey administration. The use of items drawn from existing questionnaires helped establish content validity, while subsequent factor analysis has been used to support construct validity and to explore the underlying dimensions of the instrument.

Sample

The survey data used in this analysis was collected from a purposeful sample of survey responses from incoming first year engineering students over three consecutive fall semesters (2013, 2014 and 2015). This questionnaire is one of a number of pre-enrollment surveys and concept inventories administered to all incoming engineering students. Incoming engineering student surveys completed during these three semesters totaled 512, 510, and 464, respectively. Pre-surveys that were matched with a corresponding post-survey completed by the same student at the end of each semester were retained for this analysis (Table 1).

Table 1. Student Sample

Year	N	Male	Female
2013	382	~80%[a]	~20%[a]
2014	405	295	110
2015	403	305	98

[a] Gender information was collected only for ¼ of the 2013 sample; percentages are based on data collected, which are similar to other years and, in fact, to the institution as a whole.

Analytical Methodology

Item responses were converted to numerical values according to a predetermined preferred direction of response, with values ranging from one (least preferred response) to five (most preferred response) in order to calculate summated rating totals for each subscale [22, 23]. Blank responses were individually omitted from the analysis.

The item analysis included a combination of statistical analyses together with qualitative evaluation of each item's contribution to the overall objectives of the survey. Statistical procedures, performed with RStudio open source and enterprise-ready professional software for R (www.rstudio.com) and SPSS (IBM SPSS Software, www.ibm.com/analytics/us/en/technology/spss), primarily involved assessing the item discrimination index (as measured by the corrected item-total correlation coefficient), which correlates each respondent's score on an individual item with his/her overall score on the scale, as well as each item's contribution to the overall scale reliability, as indicated by Cronbach's α. It must be stated that a higher level of alpha might not be indicative of uni-dimensionality of the group of items as a whole and, likewise, a lower alpha might indicate a prospective level of difficulty in psychometric testing and thus the items might require additional testing methodologies to ascertain their internal consistency [24].

Factor Analysis was used to support the validity of the survey. Confirmatory Factor Analysis was applied based on the four a priori item groupings we had previously identified on a conceptual basis, yet while the group of items reflected a great deal of homogeneity within these constructs, the methodology failed to identify the underlying latent patterns. Exploratory Factor Analysis (EFA) has long been used by psychologists to test the latent factors of human intellectual abilities. Proposed in late 19th/ early 20th century by the English Statistician Sir Francis Galton and later propagated by statisticians like Charles Edward Spearman, Karl Pearson, and MacDonnell, the methodology of Factor Analysis aims at bringing about an order among variables which might have some underlying connecting patterns. An EFA does not impose a preconceived structure to the construct of variables [25], rather it tends to identify such constructs through a process of variable reduction. The key aim of the process is to measure the dimensionality of the instrument by identifying the number of latent variables that underlie a set of observations. These may include aspects of uniqueness, error due to measurements and aspects of reliability. The underlying patterns in the EFA are measured in the form of Principal Component Analysis (PCA), the preferred technique for undertaking exploratory data analysis to ascertain the underlying patterns in the data points.

EFA can be used to define how various groups of items address similar theoretical constructs, supporting the instrument's validity by defining the underlying themes or meanings of groups of items that co-vary with one another. This can help to better explain the general construct of the instrument as a whole, and in turn allows the researcher to further explore survey data in light of a reduced number of variables or constructs. In terms of survey development/refinement, EFA provides a basis for identifying questions that do not fit in well with the instrument as a whole, and can shed light on the degree of uniqueness of each item – providing a mechanism for reducing the number of items in a scale by streamlining or eliminating highly-correlated items within a single construct.

Results

Test statistics for each of the 23 questionnaire items are included in Table 2. The average discrimination index, as measured by the corrected item-total correlation coefficient, is 0.402. Individual values range from 0.229 to 0.601, well above acceptable values for items used in an educational questionnaire (>0.15) [26]. All survey items contribute favorably to the subscale reliability. Overall, the internal consistency reliability coefficient (Cronbach's α, 0.827) is well above minimum acceptable levels [24, 25], indicating strong item covariance and an adequately captured sampling domain. In other words, the analysis demonstrates that all of our survey items are contributing value to the overall questionnaire.

Table 2. Item Summary Statistics

Item	Average Mean response ± SD	Corrected Item-Total Correlation Coefficient	Cronbach's Alpha if Item Deleted
Q1	4.05 ± 0.68	0.243	0.825
Q2	3.77 ± 0.78	0.320	0.823
Q3	4.45 ± 0.63	0.483	0.817
Q4	4.47 ± 0.66	0.302	0.823
Q5	4.07 ± 0.74	0.425	0.819
Q6	4.28 ± 0.66	0.389	0.820
Q7	3.28 ± 1.25	0.380	0.822
Q8	4.50 ± 0.63	0.418	0.820
Q9	4.08 ± 0.73	0.333	0.822
Q10	3.94 ± 0.67	0.229	0.826
Q11	3.38 ± 0.84	0.341	0.822
Q12	3.61 ± 0.81	0.287	0.824
Q13	3.34 ± 1.46	0.364	0.826
Q14	4.45 ± 0.61	0.539	0.816
Q15	4.35 ± 0.59	0.601	0.814
Q16	4.09 ± 0.82	0.362	0.821
Q17	3.36 ± 1.40	0.339	0.827

Q18	4.23 ± 0.67	0.517	0.816
Q19	4.18 ± 0.69	0.511	0.816
Q20	4.10 ± 0.74	0.482	0.817
Q21	4.25 ± 0.63	0.592	0.814
Q22	4.54 ± 0.56	0.456	0.819
Q23	3.93 ± 0.82	0.331	0.822
Average		0.402	reliability = 0.827[a]

[a] Values for Cronbach's alpha internal consistency reliability coefficient, α, are considered 'good' at 0.8 [23].Minimum α values should be at least 0.70 for a set of items in social science scales [27] and can be as low as 0.60 for educational assessment scales [28].

Questionnaire items have been previously grouped into four categories that align with domain knowledge, for the purpose of analyzing and reporting student responses in terms of a manageable number of variables, or subscales, that were conceptually sound [9-12]. The item analysis was repeated for each of these four subscales to test the statistical validity of our approach. Results, shown in Table 3, indicate that while the groupings were logical on a conceptual basis, a different approach might improve the reliability of each subscale. The high degree of correlation among items in the first group (Confidence in Engineering Curriculum) indicates high consistency among responses – to the extent that we may be able to combine or eliminate some of these items, following further analysis. Items in the remaining groups, with the exception of items Q17 (Group 2, Satisfaction and Sense of Fit) and Q5 (Group 3, Self Confidence), all discriminate adequately among respondents (corrected item-total correlation coefficient > 0.15), and when these two items are left out these groups all demonstrate acceptable internal consistency (Cronbach's Alpha close to or greater than 0.60). Items Q5 and Q17 are negatively worded and reverse-scored; the inconsistency of responses to this question format is an artifact that has been noted by others [29, 30].

Principal Component Analysis was undertaken primarily to gain an understanding of the principle components that contribute to the similarity or dissimilarity of the underlying patterns among the questionnaire items. The analysis demonstrated a low degree of variance among the variables, pointing to the fact that the underlying patterns are largely homogeneous in nature. This result is not surprising given that all participants belong to a similar age group and have similar educational goals (engineering).

Table 3. Item Summary Statistics, by Group

Item	Corrected Item-Total Correlation Coefficient	Cronbach's Alpha if Item Deleted
Group 1: Confidence in Engineering Curriculum		
Q15	0.622	0.893
Q18	0.790	0.857
Q19	0.790	0.857
Q20	0.705	0.878
Q21	0.090	0.858
Average	0.739	reliability = 0.893
Group 2: Satisfaction with Decision to Study Engineering, Sense of Fit within Engineering		
Q14	0.456	0.367
Q16	0.377	0.373
Q17	0.085	0.672
Q22	0.417	0.396
Q23	0.295	0.427
Average	0.326	reliability = 0.497
Group 3: Self Confidence		
Q1	0.210	0.348
Q2	0.328	0.252
Q3	0.346	0.268
Q5	0.026	0.580
Q6	0.275	0.309
Average	0.237	reliability = 0.401
Group 4: Understanding of Engineering Profession & Engineering Problem Solving		
Q4	0.210	0.576
Q7	0.403	0.513
Q8	0.334	0.550

Q9	0.351	0.542
Q10	0.253	0.566
Q11	0.253	0.566
Q12	0.233	0.571
Q13	0.358	0.542
Average	0.299	reliability = 0.588

Figure 1 shows a discriminant coordinate plot and Biplot for the survey data. The discriminant coordinate plot (a), suggests the existence of three different principal components underlying the data. Though PC1 and PC2 explain much of the variability of the data, including an underlying middle component at the intersection of these two components may provide a better understanding of the data. The same is evident from the Biplot (b), which points at the directional component of the questions.

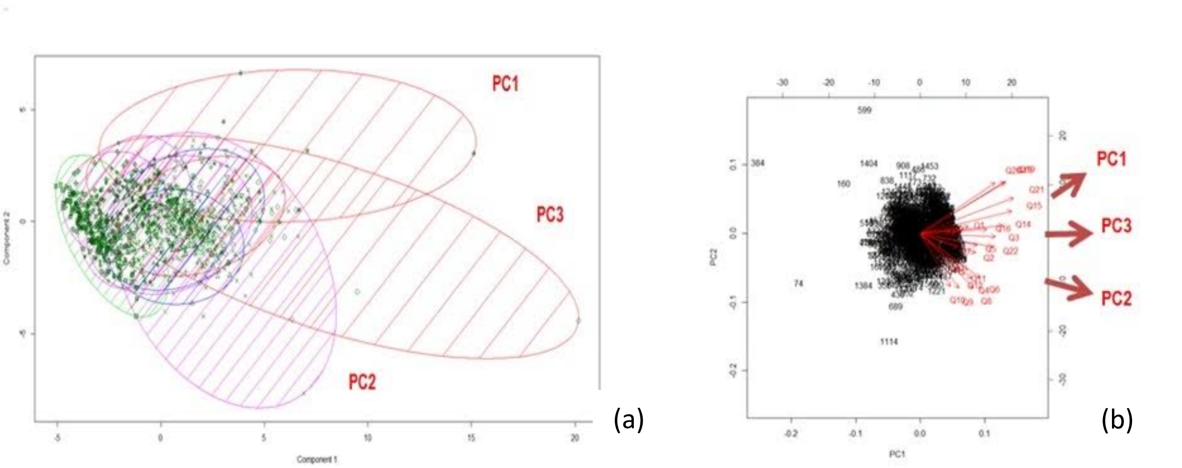

Figure 1. Principal Components Analysis, (a) Discriminant Coordinate Plot; (b) BiPlot

Exploratory factor analysis of the questionnaire data also suggested the retention of three factors, explaining 44% of the variance. The orthogonally-rotated factor structure elucidates a framework for the questionnaire that primarily supports our conceptually-defined item groupings, as shown in Table 4.

Table 4. Factor Loadings and Item Groupings

Factor 1	Factor 2	Factor 3	Item #	
Group 1: Confidence in Engineering Curriculum				
0.518	0.480	0.252	15	I can succeed in an engineering curriculum.

0.814	0.188		18	I will succeed (earn an A or B) in my math courses.
0.826	0.170	0.133	19	I will succeed (earn an A or B) in my physics courses.
0.702	0.150		20	I will succeed (earn an A or B) in my chemistry courses.
0.765	0.291	0.204	21	I will succeed (earn an A or B) in my engineering courses.
Group 2: Satisfaction with Engineering, Sense of Fit				
0.343	0.567	0.231	14	At the present time, I am satisfied with my decision to study engineering.
0.225	0.399	0.234	16	At the present time, I feel confident that I will keep my chosen engineering major throughout college.
0.265			17	At the present time, I am exploring other non-engineering majors at Clarkson University.[a]
0.236	0.571	0.175	22	A degree in engineering will allow me to get a job where I can use my talents and creativity.
0.156	0.422	0.164	23	I will feel “part of the group” (i.e. I will fit in) if I get a job in engineering.
Group 3: Confidence and Capability to become an Engineer				
0.284	0.212		1	On the whole, I am pleased with my performance as a student.
0.207	0.22	0.413	2	I feel confident about applying a systematic design process to an unfamiliar problem.
0.328	0.474	0.269	3	I am capable of becoming an engineer.
0.232	0.297	0.244	5	I have almost no understanding of how to approach solving a new problem or challenge.[a]
0.129	0.425		6	I feel confident working as a member of a team.
Group 4: Understand Broad Nature of Engineering and Engineering Profession				
0.406	0.138	0.273	4	Creativity is important to the engineering process.
0.151	0.305		7	The role of engineers is limited to technical problem solving.[a]
0.494	0.109		8	Collaboration and teamwork are essential components of the engineering process.
0.281	0.149		9	Ethical problem solving is an important part of engineering design.
0.196	0.143		10	Engineering design is influenced by the societal context in which it takes place.
0.807			11	I understand how engineering decisions are made.
0.109	0.644		12	I understand the relationship between engineering and the society in which it is practiced.
0.349			13	Engineers are responsible for solving technical problems with little or no collaboration with other professionals.[a]

[a] Negatively worded items were reverse-scored for analysis.

The analysis reveals the presence of two latent variables, although the structure is not clean. At once, the inconsistency of the two negatively-worded items identified by the item analysis (Q5 and Q17) is confirmed. Furthermore, with the exception of a few items, the factor structure separates quite neatly the items in our first and fourth conceptual groups, which primarily load onto Factor 1, from those in our second and third conceptual groups, which primarily load onto Factor 2.

Items that load onto Factor 1 simultaneously describe students' self-confidence toward the engineering curriculum and their understanding of the breadth of the engineering profession, including skills such as teamwork and collaboration, ethics, and problem solving. There are a few exceptions. Q7, which loads onto Factor 2, is a negatively worded item describing the 'narrowness' of the engineer's role. This item pairs with Q4 and Q8 for reliability purposes; as with Q5 and Q17, the inconsistent factor loading may well be explained by the item's negative format, and the high standard deviation in student mean responses. Q12, which also loads onto Factor 2, addresses the students' understanding of the relationship between the practice of engineering and broader society. It relates topically to Q10 (influence of societal context on engineering) and Q11 (engineering decision making process), and these three items appear to be capturing nearly the same information. Q10 does not load well into the factor structure and displays a high uniqueness of variance (0.94), although the item contributes positively to the survey (Table 2) and the conceptual group (Table 3). Q11 and Q12, which more directly quiz the respondent on the contextual connections among the engineering decision making process and its relationship with societal need, display a high degree of correlation (Pearson correlation coefficient = 0.52), a larger uniqueness of variance for question 12 (0.57) vis-à-vis question 11 (0.34) and a high degree of loading for question 11 onto Factor 1. This implies that question 12 indeed captures a large part of question 11. From an interpretation perspective, it can be stated that a respondent who has a contextual understanding of the relationship between society and engineering will also have a deeper understanding of the engineering decision-making process, which aligns with the expected framework of understanding and supports the positioning of these two items together within the same underlying construct. Taking into account these results regarding Q10, Q11, and Q12, it may be desirable to exclude one of these three items in future survey administration.

The items in group 1 related to students' self-confidence toward engineering coursework within Factor 1 are highly correlated with one another (Pearson's correlation coefficient ranges from 0.54-0.73, data not shown). These items are all course success expectation questions; the high correlations, high factor loadings and relatively low uniqueness of variance (0.27-0.48, data not shown) suggest not only that these items are measuring one underlying construct, but moreover, it may be desirable to reword or eliminate some of them.

Factor 2 describes students' satisfaction with and sense of fit within engineering, and their confidence and capability to become an engineer. We might call this category "engineering career success expectations." Most of the items in the second and third conceptual groupings load onto this factor. Exceptions to this rule include 2 negatively worded items that are included in the survey for reliability purposes. Q17 is a negatively worded version of Q16 (staying/leaving the engineering major). Q5 and Q2 are negative and positive versions of the same basic question relating to student confidence in problem solving, although the poor factor loadings may indicate a problem with the wording of these items. In fact, although its content fits within this group of questions, Q2 is the only item that loads onto Factor 3, and has a relatively high uniqueness of variance (0.74). Similarly, the content of Q1 also makes it a logical fit for this group; the poor factor loading might be explained by the fact that it is the initial survey question, a 'warm up' if you will, and also extremely broad in nature. Both Q1 and Q2 do discriminate among the respondents and both contribute positively to the reliability of the questionnaire and also to this group of questions, as demonstrated by results of the item analysis (Tables 2 and 3). The analysis points to the need for a closer qualitative look at Q1, Q2, and Q5, to re-evaluate their wording and their alignment within the questionnaire's framework.

Discussion

This study sought to investigate the reliability and validity of a self-constructed questionnaire that has been used for the past five years to monitor changes in first year engineering students who participate in a course that focuses on the broader aspects of engineering and societal influences on engineering and technology. The findings show that, by and large, the survey items all contribute positively to a reliable instrument that measures students' understanding of the broad nature of engineering, their confidence in engineering coursework, their satisfaction with the decision to study engineering, and their sense of fit or belongness in engineering. We had previously categorized the items into these four groupings for the purpose of data analysis and interpretation, and this conceptually-created structure has been, by and large, confirmed by EFA. The analysis has identified two underlying dimensions, each of which captures most of the items in two of our four self-created categories. The dimensions can be described as (1) confidence in studies, coursework, understand engineering; and (2) satisfaction with decision to study engineering, feeling of belongingness, sense of confidence in engineering capabilities and skills.

The analysis reveals some interesting relationships among the various aspects of engineering-related attitudes among the nearly 1200 students who participated in this study. One finding of interest is the correlation between students' understanding of engineering, and their confidence in succeeding in engineering coursework. While our study does not attempt to establish a cause-and-effect relationship, this finding may in fact support the value of pre-engineering programs in secondary school, for preparing students with a higher level of confidence in an engineering curriculum.

On the other hand, we found that among our students the feelings of belongingness and sense of fit in engineering do not necessarily align with either their confidence in engineering *coursework* or their *understanding of what engineering* is all about. Students may be confident in their coursework and have a good understanding of engineering (even in a broader, societal sense) yet still not feel like they belong in engineering. Students' sense of fit is more strongly aligned with students' sense of capability in engineering and engineering skills, their ability to see themselves as an engineer. Thus, students sense of belonging in engineering, their self-actualized view of themselves as an engineer, is more strongly connected to their internalized sense of being capable and having the right skills, than it is to their confidence in coursework and overall understanding of what engineering is all about. This is a finding that warrants further study.

The high degree of homogeneity among the survey items, and the large number of survey items that are capturing closely related information, is reflected in a somewhat unclear factor structure. This analysis has identified opportunities for improving our survey as we move forward:

[1] We will consider the possibility of removing altogether one of three items that focus on engineering within a societal context (Q10, Q11, Q12).

[2] Currently there is a positively-worded/negatively-worded pair of items (Q2 and Q5) that address students' self confidence with respect to problem solving. These items do not align well within the survey structure. These items were intended to probe students' self-perceived skills and abilities to solve new, challenging problems. Conceptually, they fit within the second dimension of the questionnaire that encompasses engineering capabilities and skills. We suspect that their poor performance results from vague or confusing language, and will address this as we move forward.

[3] The EFA results identified a strong correlation among four items that ask students about their confidence in engineering coursework (mathematics, physics, chemistry, engineering), suggesting that some of these items may not be necessary in future survey administrations. The degree to which one or all of these specific items may be relevant may change according to the specific group of students being surveyed. For example, if used in a pre/post analysis of a first semester engineering course, changes in student responses to questions about chemistry and physics may be more influenced by the variability in student exposures to/enrollment in these courses than by their experience in the engineering course (i.e. not all first semester students take physics or chemistry). Similarly, a study that looks at gender differences may wish to include all four items in order to probe more deeply at gender differences with respect to students' affinity with chemistry and life sciences, vs. mathematics and physics [31, 32].

[4] The analysis revealed a problematic issue with the first item in the questionnaire, which asks students how they feel about their performance as a student. This item does not align with any of the survey dimensions, statistically or conceptually. We need to develop and test an additional item or set of items that flush out and resynchronize the self-view point.

[5] Finally, and more broadly, the current format of the survey is tightly aligned with the factor structure that has been elucidated in this analysis, with items positioned together

within their factor/conceptual groupings. Future rounds of survey administration will re-number the items into a more randomized pattern, or even a variation of patterns for different students (i.e. the use of four or five different survey forms), in an effort to more accurately capture deeper underlying patterns in student responses.

Conclusions and Future Work

In conclusion, the analysis presented here generally confirms the validity and reliability of an engineering attitude questionnaire that has been developed to measure students' attitudes toward and understanding of engineering. The survey has been valuable for evaluating and assessing the impact of a first year engineering course on students' affective development. What we have shown by subjecting the questionnaire to a rigorous set of psychrometric procedures is that this survey can be used with confidence in a wider variety of applications. Minor improvements will increase the questionnaire's performance and utility.

Our future work is two-fold. In terms of survey development, our next steps will be to adjust the survey to reflect the potential improvements brought to light by this analysis. A revised survey will be administered and tested among the incoming class, Fall 2017. At the same time, we will continue our systematic investigation of gender differences in our students' experiences, using historic data collected with the survey in its current form. Ultimately, we will continue this research in the future with our improved instrument, also looking more deeply at the connections/correlations between and among our identified attitude constructs (specifically, 'what' is students' sense of fit related to?) and the nature of these relationships among various groups of students – including gender differences as well as differences between students who participate in our first year course vs. those who do not.

Finally, acknowledging that the diversity encompasses identity categories beyond gender, it would be valuable to explore differences in attitudes/perceptions among majority/underrepresented racial and ethnic groups. The makeup of our student population makes it unlikely that we can draw valid conclusions about underrepresented minority students at our institution. However, with the addition of suitable demographic questions the survey could be used by others interested in the impact of related curricular or co-curricular programs.

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Appendix: Student Attitude Survey

This survey contains statements about your beliefs and attitudes about yourself. Please express your agreement with each statement. There are no "right" or "wrong" answers. Please think about each statement before answering and be honest!

Today's Date ____________________________

This survey is anonymous. Please provide the following information so we can generate a study code for your survey:

What are the first two letters of the town where you were born? ____________
What are the last two letters of your mother's first name? ____________
What are the last two letters of your middle name? ____________
On what day of the month were you born?
(e.g., if your birthday is December 2, your answer is "2") ____________

What is your gender? Male identified Female identified Gender nonconforming

Are you majoring in Engineering or Engineering Studies? YES NO (circle one)

	PART I. ALL STUDENTS	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
1	On the whole, I am pleased with my performance as a student.	1	2	3	4	5
2	I feel confident about applying a systematic design process to an unfamiliar problem.	1	2	3	4	5
3	I am capable of becoming an engineer.	1	2	3	4	5
4	Creativity is important to the engineering process.	1	2	3	4	5
5	I have **almost no** understanding of how to approach solving a new problem or challenge.	1	2	3	4	5
6	I feel confident working as a member of a team.	1	2	3	4	5
7	The role of engineers is limited to technical problem solving.	1	2	3	4	5
8	Collaboration and teamwork are essential components of the engineering process.	1	2	3	4	5
9	Ethical problem solving is an important part of engineering design.	1	2	3	4	5
10	Engineering design is influenced by the societal context in which it takes place.	1	2	3	4	5
11	I understand how engineering decisions are made.	1	2	3	4	5
12	I understand the relationship between engineering and the society in which it is practiced.	1	2	3	4	5
13	Engineers are responsible for solving technical problems with little or no collaboration with other professionals.	1	2	3	4	5

	PART II. ANSWER ONLY IF YOU <u>ARE</u> AN ENGINEERING OR ENGINEERING STUDIES MAJOR	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
14	At the present time, I am satisfied with my decision to study engineering.	1	2	3	4	5
15	I can succeed in an engineering curriculum.	1	2	3	4	5
16	At the present time, I feel confident that I will keep my chosen engineering major throughout college.	1	2	3	4	5
17	At the present time, I am exploring other non-engineering majors at Clarkson University.	1	2	3	4	5
18	I will succeed (earn an A or B) in my math courses.	1	2	3	4	5
19	I will succeed (earn an A or B) in my physics courses.	1	2	3	4	5
20	I will succeed (earn an A or B) in my chemistry courses.	1	2	3	4	5
21	I will succeed (earn an A or B) in my engineering courses.	1	2	3	4	5
22	A degree in engineering will allow me to get a job where I can use my talents and creativity.	1	2	3	4	5
23	I will feel "part of the group" if I get a job in engineering.	1	2	3	4	5

	PART III. ANSWER ONLY IF YOU <u>ARE NOT</u> AN ENGINEERING OR ENGINEERING STUDIES MAJOR	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
24	I would feel "part of the group" if I got a job with an engineering company.	1	2	3	4	5
25	I could succeed in an engineering curriculum.	1	2	3	4	5
26	I would find an engineering curriculum interesting.	1	2	3	4	5
27	At the present time, I would consider changing my major to engineering or an engineering-related field.	1	2	3	4	5
28	I understand how business professionals, technicians, and scientists work together with engineers to solve problems.	1	2	3	4	5