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Development of Entrepreneurial Attitudes Assessment Instrument for Freshman Students

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Development of Entrepreneurial Attitudes Assessment Instrument for First Year Engineering Students

Introduction

Over the last decade, the number of university programs that focus on imbuing students, especially engineering students, with entrepreneurial skills have increased dramatically[1]. Research tells us that it is possible to significantly increase student ability in content areas relevant to entrepreneurship through well planned educational interventions[1–4]. However, one challenge faced by entrepreneurship programs is establishment and agreement on comprehensive and well-validated assessment instruments. A meta-analysis by Purzer et al.[5] found 51 different instruments in 29 journal and conference papers that focus on entrepreneurship. Most of these instruments evaluate entrepreneurship as a multidimensional characteristic. They use varying approaches designed to measure knowledge, skills, and psychological characteristics.

Purzer found that while 67% of the instruments focus on skill assessment, only 27% focus on attitudes toward entrepreneurship. This suggests a gap on assessment instruments that explore the mindsets that students use to employ their newfound skills. The skills component of entrepreneurship is a logical focus of entrepreneurship education. Tracking students' growth in knowledge areas provides relevant data tracking entrepreneurial learning and ability. However, attitude components theorized to map to entrepreneurially relevant behaviors comprise an interesting area of study. Attitude characteristics supplement skill-based assessments by identifying specific orientations or responses that are tied to the use of entrepreneurial knowledge. Attitude approaches may allow for a more complete exploration of entrepreneurship education phenomena including the self-selection phenomenon noted within many optional entrepreneurship programs.

This paper presents a study of the validity of one such instrument. The study makes use of a modified version of the entrepreneurial attitudes orientation instrument (EAO) developed by Robinson[6]. The EAO instrument has established a fairly wide base of use[6–8] as a method of discretizing entrepreneurship characteristics, especially in students. However, the instrument's original development population was not students and little evidence of validity on student populations have been reported. The shift to student populations was explicitly warned against by the instrument's original author[9]. The entrepreneurship education field has an overall lack of strong evidence of validity studies on assessment instruments of this type. The lack of focus on validity evidence in entrepreneurship research is a concern specifically noted by Purzer[5]

This study presents a methodical assessment of validity evidence for the EAO instrument on student populations. The paper details the background of the instrument, entrepreneurship assessment in general, as well as techniques for psychometric validation. The method section details the modifications and specific approach undertaken for data collection. The results section details the analysis results from confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) of the study dataset. The paper concludes with a discussion of the study's results, the overall conclusions as to validity, and a discussion of the implications for future work on this instrument and population.

Background

The number of entrepreneurship education programs has grown rapidly around the world, both inside and outside of universities[10–12]. Further, the content, pedagogical approaches, goals, and assessment methods vary widely from program to program. Fiet provides a detailed overview of the current theoretical underpinnings of entrepreneurial content[13] and pedagogical[14] approaches. There remains disagreement and a lack of consensus about what should be taught as entrepreneurship, how it should be taught, and even whether or not it can be taught[1,15,16]. This section details the methods most often selected for assessment within entrepreneurship, their benefits and drawbacks, and the approach to building validity evidence taken in this study.

In the existing sea of educational options, it is paramount to assess the effectiveness of programs in order to evaluate not only the progress of students towards entrepreneurship but also to development of a better understanding of entrepreneurial knowledge, skills, and attitudes. To explore these assessment issues, Purzer et al[5] performed a meta-analysis of current assessment methods in entrepreneurship education literature. Purzer found 51 different assessment instruments in 29 journal articles and conference papers, suggesting little if any convergence on assessment methods. Among the instruments Purzer identifies, surveys were the most common method of assessment, accounting for 24 of 51 instruments. Additionally, Purzer found a lack of rigorous approaches and well-constructed validity arguments within the sampled literature. Literature from Fiet[14] and Duval-Couetil[17], among others, identifies similar gaps.

Background - Instruments

Of the assessment instruments identified by Purzer, 67% focused on assessment or self-assessment of skills. Within the entrepreneurial education realm, skills commonly include students' abilities in areas including management, finance, market analysis, leadership, and teamwork. While these skills are undoubtedly important, Fiet explains at length the issues that exist in aligning educational content to theoretical constructs specifically grounded in entrepreneurship[13]. These oblique content-outcome relationships exist within the lack of findings in literature that support a causal link between skills useful to entrepreneurs and the likelihood or interest of a student practicing entrepreneurship[18]. Some studies have actually correlated 'entrepreneurship skills' to a decrease in entrepreneurial intention[19,20]. This separation between skills and intention is not strictly kept in much of the literature in the field.

Although skills assessment is important from a learning outcomes perspective, the skill base alone does not suggest or explain a path towards entrepreneurship. As Fiet[13] notes, the majority of skills in current models of entrepreneurship are widely studied in other areas of literature. Beyond skills, student paths towards entrepreneurship are explored using a variety of terms including intent, orientation, and characteristics. Robinson[16] provides an overview of methods that attempt to track entrepreneurial intention. He details three primary approaches using demographics, personality theory, and attitude.

The demographics theory has come into use given its perceived ability to identify strong correlations between characteristic experiences and entrepreneurial intention. Authors have explored why children of entrepreneurs are more likely to become entrepreneurs[15]. Others have looked at wealth[21], gender[22,23], and access to social capital[24] as influences on entrepreneurial intention. While these approaches create an interesting discussion of correlations, they are of limited usefulness from an educational perspective due to their static nature, as well as the likelihood of cross correlating with the self-selection bias in entrepreneurship programs noted by Duval-Couetil[25] and Bilan[26] among others. Demographic methods identify *who practices* entrepreneurship rather than any actual orientation or underlying attitudes. They also have a potential to narrow the constructs called entrepreneurial intention to those possessed by groups historically oriented to entrepreneurship. This narrowing is highly problematic.

Robinson[16] also looks at personality and attitude approaches to measuring and tracking entrepreneurial intention. The personality approach has several identifiable problems. First, the approach measures constructs that are more latent within a single person and not constructs specifically oriented towards entrepreneurship. Second, there is no conceptual convergence between the different instruments that measure entrepreneurship, as identified in both Robinson[9,16] and Purzer[5]. Finally, because traditional personality models rely on fixed traits, they do not allow for changes in an individual's characteristics as might be expected through educational experiences. This is especially true when programs seek to track *growth* as an indicator of program success, as is done in the large of studies on which Pittaway offers a summary and assessment[1].

The remaining approach, grounded in attitude theory, also has several drawbacks. Attitude theory strives to situate the constructs measured. It identifies specific behaviors that are relevant to the combination of construct and situation[16]. This is potentially problematic, as Robinson identifies[9], because it ties the construction of an entrepreneurial professional to his or her prior experiences. Situated questions do have a potential to reintroduce some of the bias noted in the demographic approach. However, attitude theory also allows for the construction of scales and items that range from highly specific to quite general. While this makes measures of attitudes less stable, it also makes them a potentially highly effective tool for tracking growth or changes in participant responses and, especially, the impact of educational interventions[16]. These characteristics make the use of attitude measures a highly interesting approach to the study of student entrepreneurship in educational environments. Beyond Robinson's detailed analysis of attitude theory, multiple authors in the entrepreneurship field, including Moreno[19], Zappe[27], and Graevenitz[28] have used attitude theory to develop psychometric instruments.

Background - Validity

Even in cases that purposefully select and build instruments grounded in valid constructions of attitude theory, there remains a need to provide validity evidence of the instrument on a specific population. Messick[29] provides an outline of a modern approach to validating studies making use of psychologically grounded instruments. Of the instruments and studies detailed in the meta-analysis by Purzer[5], few if any of the instruments grounded in psychometric principles provide a significant study of validity.

Two of the most common approaches to building evidence in psychometric surveys are confirmatory factor analysis (CFA) and exploratory factor analysis (EFA). Together, they provide tools for assessing the statistical validity of individual items as well as modeling of potential and theorized factor alignment. CFA, developed in 1969 by Joreskog[30], provides a method of testing a hypothesized model against a known data set. The CFA method is used in almost all psychometric applications. CFA provides strong validity evidence for the support of a theorized item-factor-construct alignment through a measure of goodness of fit of a theorized model to collected data. EFA, as the name implies, provides for a more exploratory testing of potential alignment of items and factors. The method, as detailed by Fabrigar[31] does not test a theorized fit but instead identifies a potential best fit of item-factor alignment using a given dataset. EFA is commonly used by researchers to develop item-factor alignments in the early stages of psychometric instrument construction or to troubleshoot poor CFA results. Both methods are employed in this study.

Instrument

The instrument used in this study combines three components. Each component focuses on different areas of data collection. The three parts include an attitude theory based instrument for collecting information entrepreneurship orientation, a multi-part socio economic status instrument, and several additional questions developed by the authors to collect information to explore ties between demographic and attitude measures of entrepreneurship.

Instrument – Entrepreneurship Component

The attitude theory component, consisting of 75 Likert-type items, is a modified version of the Entrepreneurial Attitudes and Orientation (EAO) instrument originally developed by Robinson et al[16]. This instrument, developed in the early 1990's, used two discrete populations: a population of entrepreneurs and a population of non-entrepreneurs. The goal of the instrument is to establish an attitude theory based method for parsing entrepreneurs and non-entrepreneurs using psychometric survey methods. As described in the background section, EAO makes use of attitude theory due to concerns that other approaches provide poorly grounded arguments for defining or separating entrepreneurially relevant characteristics[9,16]. Since the original development of the EAO instrument, multiple studies have applied the instrument to varying populations[11–16]. The availability of prior studies makes EAO a good candidate for use because of the ability to compare to prior work.

The EAO-derived instrument for this study serves as a minimally modified test for validating factor and scale/sub-scale mapping of the original instrument's constructs on a different population. The authors evaluated each item in the original EAO individually for reasonableness and ease of interpretation by a first-year undergraduate student population. The evaluations focused on ensuring alignment between the experiences that items asked subjects to recall and experiences that first-year undergraduates are likely to have had. In keeping with the goal of minimal modification, changes did not include any adjustment to item-subscale alignment. The modified instrument maintained the four original EAO sub scales: innovation, personal control, self-esteem, and achievement. The breakdown of items by subscale and attitude component appears in Table 1.

Subscale	Affect	Behavior	Cognition	Total
achievement	7	8	8	23
innovation	8	9	9	26
personal control	3	6	3	12
self-esteem	6	4	4	14
Total	**24**	**27**	**24**	**75**

Table 1 Breakdown of instrument items by subscale and component

In the original development, researchers analyzed the sub-scales and found that when populations of known entrepreneurs and non-entrepreneurs were compared the all four subscales demonstrated a difference with high statistical significance ($p<.001$) and effect size ($F>20$) between the two groups[16].

As stated, the goal of this study was to make a first step in developing a derivative instrument for tracking student growth, beginning with first-year students. The authors attempted to minimize modifications to the EAO component of the instrument to test the underlying assumptions, structures, and constructs as faithfully as possible. However, it was necessary to make modifications to some instrument items to better align them to the experiences of students. The modifications generally re-situated items away from business and professionally driven experiences to project and academic focused experiences and situations. This does present some risk in aligning results from the original EAO instrument with the modified version. However, the grounding of attitude theory, in situated cognitive or behavioral reactions that expound underlying constructs, means that questions must target situated responses both to be theoretically valid and to generate engaged responses[35]. If the underlying constructs that define the entrepreneurship divide hold true in student populations, items that elucidate the constructs through population-situated forms should deliver valid results[16,32,35].

Resituating modification to EAO were classified as minor, meaning removal or replacement of one word or word/article pair (e.g. *I believe that one key to success in business is to not procrastinate* was modified to *I believe that one key to success is to not procrastinate*) or major, requiring change to more than one word or word/article pair (e.g. *I take an active part in community affairs so that can influence events that affect my business* was modified to *I take an active part in community affairs so that I can influence events that affect my success*). The goal of the modifications was to model the original intent and construction of the question as closely as possible. In addition to the modifications to reframe items for the population, one item was modified to make it gender neutral by removing the terms 'businessman' and 'his'; this modification was classified as major. Table 2 lists the total number of modifications as well as the breakdown by sub-scale. Of the 75 EAO items, the authors modified 52 in some way, with the majority of modifications (39) being classified as minor.

Row Labels	Unmodified	Minor	Major	Total
achievement	9	11	3	22
innovation	8	12	6	26
personal control	2	8	2	12
self-esteem	5	8	1	14
Total	**24**	**39**	**12**	**75**

Table 2 Breakdown of question modifications by sub-scale

The modified EAO instrument maintained the 10pt Likert-type scale from the original development. Item ordering remained as originally implemented. Items appeared in groups of 15 per electronic page with instructions repeated at the top of each page.

Instrument – Secondary components

In addition to the modified EAO, the instrument also included items collecting demographic information on participants. These items were focused on exploration of socio-economic, gender, or educational correlations apparent in the EAO results that may contribute to the widely discussed self-selection bias concerns in entrepreneurship education[4,21,26]. By collecting this data at a stage *before* students' participation in entrepreneurship programs, the results provide potential indications of social or cultural constructs that are influencing incoming students. This provides an opportunity to separate incoming components of the entrepreneurial self-selection phenomenon from those created on campus.

The demographic questions collected information on parental education, parental entrepreneurial behavior, socio-economic status, gender, ethnicity, and student classification. The major components: socio-economic status, gender, and ethnicity, were adopted with minimal changes from the commonly used APPLES instrument. Based on suggestions from Donaldson and Sheppard[36], two items were added to further clarify and develop a model for student self-identified socio-economic status. The first item asked student's residential ZIP code during high school. The second asked participants whether either of their parents held a degree in engineering.

In addition to the APPLES derived demographic questions, three questions added by authors specifically focused on entrepreneurship experiences. Separated onto different pages, these items were: (1) would you consider either of your parents to be entrepreneurs (2) have either of your parents ever started their own business and (3) how do you believe entrepreneurs are created. For questions 1 and 2, participants responded with a yes or a no. The intent of the pair was to gather basic information on first year students' definitions of entrepreneurship, prior to exposure to on campus entrepreneurship programming. Question 3 gave students a predefined set of selection options. A final item was intended to gather participant's first and second choices of major within their program. However, a configuration error within the electronic survey system presented all students with the engineering choices, rather than choices appropriate for their school. Therefore, the authors excluded it from all analysis.

Study Methodology – Data collection method

The researchers presented the instrument to five class sections covering four different courses. The classes consisted of two sections of the College of Engineering standard first-year class and one section each of the College of Engineering honors first-year class, the School of Management honors first-year class, and the School of Management standard first-year class. The researchers explained the study to students at the beginning of a class session and then distributed the instrument via email for students to complete outside of class. When the authors presented the survey in the classes, they informed students that 100 gift cards were available via raffle as compensation for their participation. The total potential N was 336.

Study Methodology – Response rate

The overall response rate, 33%, was higher than expected but varied significantly between the different courses (Table 3). Of the 336 students who received the survey, 127 completed it for an initial response rate of 38%. Of the 127 complete responses, 15 failed reversed reliability test questions carried over from the original EAO component of the instrument leaving 112 validated responses for a valid response rate of 33%. The rate of response in engineering was higher (40% versus 26%) and had a lower rate of invalidation (9% versus 16%). The invalidated results are being broken out to thoroughly document the invalidation process. Tests of individual response validity relied initially on comparison of reverse scored questions to other questions within the same subscale, as defined by the original EAO. The authors then manually evaluated individual responses that failed the reverse scoring test to check this methods reliability.

College/Course	Population N	Response N	Invalid N	Final N
Business *Honors*	105	43 (41%)	6 (14%)	37 (35%)
Business *Standard*	53	6 (11%)	2 (33%)	4 (8%)
Business Total	**158**	**49** (31%)	**8** (16%)	**41** (26%)
Engineering *Standard*	114	53 (46%)	7 (13%)	46 (40%)
Engineering *Honors*	64	25 (39%)	0 (0%)	25 (39%)
Engineering Total	**178**	**78** (44%)	**7** (9%)	**71** (40%)
Total	**336**	**127** (38%)	**15** (12%)	**112** (33%)

Table 3 Response rates to study by college and section

Study Methodology – Response validity

Concerns that arise in the CFA and EFA analyses, presented in the results section, call into question the viability of reversed questions in the original instrument as a reasonable test of response validation. All the invalidated responses were checked by the authors and found to show at least two of three patterns of invalid behavior. The first pattern was long strings, defined as more than eight, question responses with identical answers. Second, the overall standard deviation of items responses was either significantly below ($\sigma<1.25$) or significantly above ($\sigma>3.0$) the standard deviation of the valid population ($\sigma=2.05$). The high and low pass values match the min and max deviation of responses validated using reversed questions. A comparison of valid and invalid responses variation appears in Figure 1.

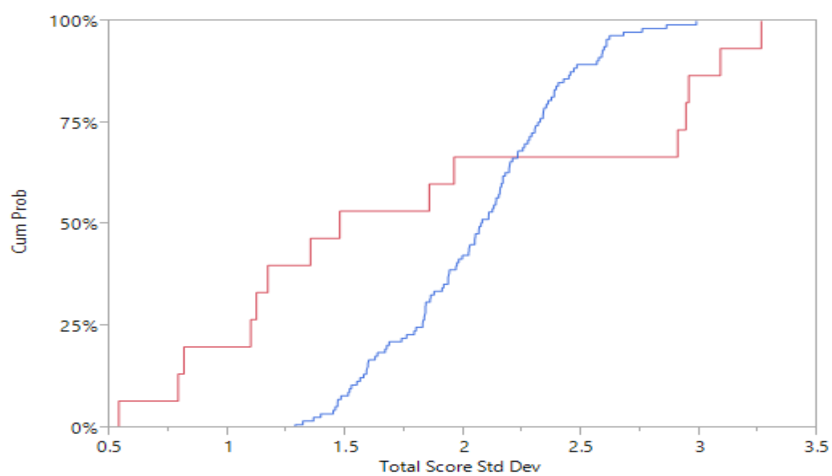

Figure 1 Cumulative Density Function plot of individual response standard deviation to the modified EAO questions separated by valid responses (Blue) and invalid response (red)

Lastly, the authors compared the response times of potentially invalid responses with those responses that passed the reversed questions reliability tests. The completion times of invalid answers were significantly lower than page times of answers that passed the reversed question tests. The EAO component of the survey was broken into 6 pages of 15 items each. The electronic survey software recorded the time spent by respondents on each page. The accumulated timing, shown in Table 4, shows the relative difference between the valid and invalid answers. Valid responses took, on average, 575s (9:35) to complete the EAO component of the survey while the average invalid responses took 480s (8:00). This difference, 18%, indicates the scale of variance between valid and invalid response times. Further, the page times recorded for valid responses were more stable, with more consistent variances than those for invalid responses as seen in Table 4. For assessment of response validity, the authors considered individual page times more germane than overall because of their ability to filter significant high outliers consistent with respondents temporarily halting instrument progression but leaving the survey open in a web browser. If all page times for a potential invalid response were more than 0.5 standard deviations below the valid population, the time criteria triggered.

Page #	Valid Response (sec) Mean (Sigma)	Invalid Response (sec) Mean (Sigma)
EAO Page 1	108 (50.2)	90 (46.6)
EAO Page 2	100 (46.0)	95 (76.7)
EAO Page 3	96 (44.0)	77 (67.4)
EAO Page 4	100 (48.7)	85 (74.8)
EAO Page 5	96 (50.3)	77 (60.3)
EAO Page 6	65 (40.4)	41 (29.2)
EAO Section Total	575 (213)	480 (300)

Table 4 EAO Section Timing data by instrument page

Based on verification via the three criteria noted above, the analysis and results section maintains the reversed reliability questions as the method of respondent invalidation. However, the reversed questions are a notable limitation. In a further development of the EAO instrument for student populations, significant consideration should be devoted to development of reliable methods of verifying reliability and validity of individual responses. The secondary methods employed here; manual inspection of individual responses, the utilization of sigma on Likert type responses, and the use of timing data each have their own limitations. The timing data, as an example, required significant filtering to remove outliers created by respondents pausing to perform other tasks during responses. The maximum single page time recorded, 18,912s (more than five hours) is almost certainly not indicative of actual time spent but, instead, is indicative of a student not taking the survey in a single time block and leaving it open within a browser window. Such uncontrollable confounding factors, whether from student inattentiveness, attempts to ‘game’ the survey to receive survey compensation, or other failures of reliability questions, are common issues in most survey datasets that warrant careful documentation.

Study Methodology - Details of responding population

The final component of the study methodology in this paper is a comparison of the responding population against the 2014 engineering college population to check the demographic alignment of the respondents with the student population. Data were not available to compare against the specific sections, nor data isolating the first-year class as a whole. The data shared reflects college of engineering percentages as of fall 2014. No data were available for a similar comparison of the business school population.

Compared on two dimensions, gender and ethnicity, the two populations generally compare well. The study under-samples males, the dominant enrolled population, by 12% with male students making up 65% of study respondents compared to 77% of the overall engineering population. The ethnic makeup of the respondent population slightly oversamples the dominant population of students. Engineering students who self-identify as white comprised 83% of respondents compared to 77% within the total engineering population. The 6% oversample equates to four more responses than expected. The second largest respondent self-identified ethnic population, students of Asian descent, closely matched the overall population. Asian respondents comprised 10% of the sample, an identical percentage to overall engineering enrollment. The study underrepresented both Hispanic/Latino, 1% compared to 5% expected, and Black populations, 0% compared to an expected 2%, populations.

Data Analysis and Results

The focus of this study is on developing validity evidence for the modified EAO instrument. Focusing on validity evidence for the modified instrument measuring the student population, the analysis and results section details the use of confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) on the dataset. All analysis and results exclude responses that were determined to be invalid. While such a decision is usually not of note, given that the results to follow do not suggest a strong confidence in the instrument as developed, it is useful to explicitly state. The tests of individual response validity, as described in the methodology section, where manually checked and did not rely solely on reversed scale questions.

Data Analysis - CFA

CFA is a theory driven method of statistical factor analysis originally developed by Karl Joreskog[30]. It returns a maximum likelihood of fit of sets individual items to a pre-established set of constructs, in this case the four subscales from the original instrument. CFA was the first analysis run on the study data and explores whether the original instruments theorized subscales are defensible on the study population. The analysis, performed with IBM SPSS AMOS software, tested fit using the comparative fit indices (CFI) and root-mean-square error of approximations (RMSEA). Generally, a CFI greater than 0.90 and an RMSEA <0.05 are considered indicators of a good fit of hypothesized item-subscale pairs. A similar instrument assessment, which was used as guidance in determining the evaluative approach, can be found in Purzer[37].

Overall, the instrument fared poorly in the CFA as shown in Table 5. Neither the overall instrument, nor the four original subscales (the hypothesized model), satisfied the CFI or RMSEA good fit criteria. This indicates a misalignment of items and subscales or other problems with the items and data. The CFI of the overall hypothesized model was only 0.36, well below the 0.90 threshold of a good fit. The overall RMSEA, at 0.09, is above the <0.05 rule

Subscale	Df	X^2	CFI	RMSEA
Achievement	230	376.98	0.69	0.08
Innovation	299	647.12	0.57	0.11
Personal Control	54	88.28	0.84	0.08
Self-Esteem	77	208.64	0.61	0.12
Total	**2694**	**5177.90**	**0.36**	**0.09**

Table 5 Results from CFA analysis of modified EAO Instrument

but does falls into what the marginal fit $0.08<x<=0.10$ range documented in Fabrigar[31]. Similarly, the subscales failed to achieve results indicative of a good fit to the hypothesized factor model. The best performing subscale, Personal Control, resulted in a CFI of 0.84, slightly lower than the target for a good fit. The Personal Control RMSEA, at 0.08, misses the <0.05 good fit criteria but does reach the upper bound of an acceptable fit criteria as deigned by Browne and Cudeck[38]. These results indicate that the best fitting of the four subscales is marginal to acceptable at best. The data acquired through the study does not sufficiently fit the hypothesized model using the original EAO subscale mapping on the modified instruments and new population.

Within the CFA results, the item regression weights also indicated poor fit. On an item-by-item basis, the regression weights of individual items were low and highly variable. A summary of the regression weights by subscale appears in Table 6. Three items had resultant regression weights that indicated they should be scored in reverse of their original conceptualization. That is, they were originally developed as forward scored items, but best fit the theorized model when scored in reverse.

Subscale	Average (std. dev)	Max/Min	Negative Weights
Achievement	0.417 (0.127)	0.607 / 0.140	0
Innovation	0.416 (0.273)	0.757 / 0.107	2
Personal Control	0.411 (0.231)	0.786 / .076	0
Self-Esteem	0.388 (0.250)	0.710 / 0.017	1
Total	**0.405 (0.258)**	**0.778 / 0.018**	**3**

Table 6 Standardized Regression weights summary table

Given the poor results of the CFA for this population with the modified instrument, the authors returned to EFA analysis to investigate the latent factor structure present within this study's dataset. EFA, performed using IBM SPSS software, allows for a fundamental reassessment of the best-fit factor structure using the study dataset. The authors used EFA to both explore the structure of the full data set as well as to compare subsets of the data. Specific EFA runs separating several of the categorical variables allowed the evaluation of any bias. Comparisons within the sample populations were made between dichotomous groups including engineering and business students or male and female respondents.

Data Analysis - EFA

The EFA analysis used an oblique rotation method, Promax, for all runs. An oblique factor rotation method allows for the correlation of factors, which is highly likely in social science research[31]. Strong cross-factor correlations were reported in the initial EAO development work by Robinson[16]. The oblique method does not require correlation between factors, but it does not force orthogonality. Initial EFA runs allowing for 25 iterations failed to converge. Later runs converged between the 25th and 68th iteration depending on the specific data set. SPSS determined the best-fit factor structure without limits on the maximum number as an original step, although specific factor structures were assigned by the authors later.

Based on the guidance in Fabrigar[31], the EFA was carried out in a series of steps to identify a best fit factor structure. Overall, the EFA identifies 20 factors with an Eigen value greater than 1. However, the factors, shown in detail in Table 7, cumulatively account for only 72% of variance. The Eigen values, as plotted in Figure 2, show a strong first factor and a multitude of weaker secondary factors. The strongest of these factors, with an Eigen value of 12.5 captures 17 questions as the dominant loading. Of the remaining 19 factors, 5 captured only a single variable as dominant and another 5 captured 2 variables each.

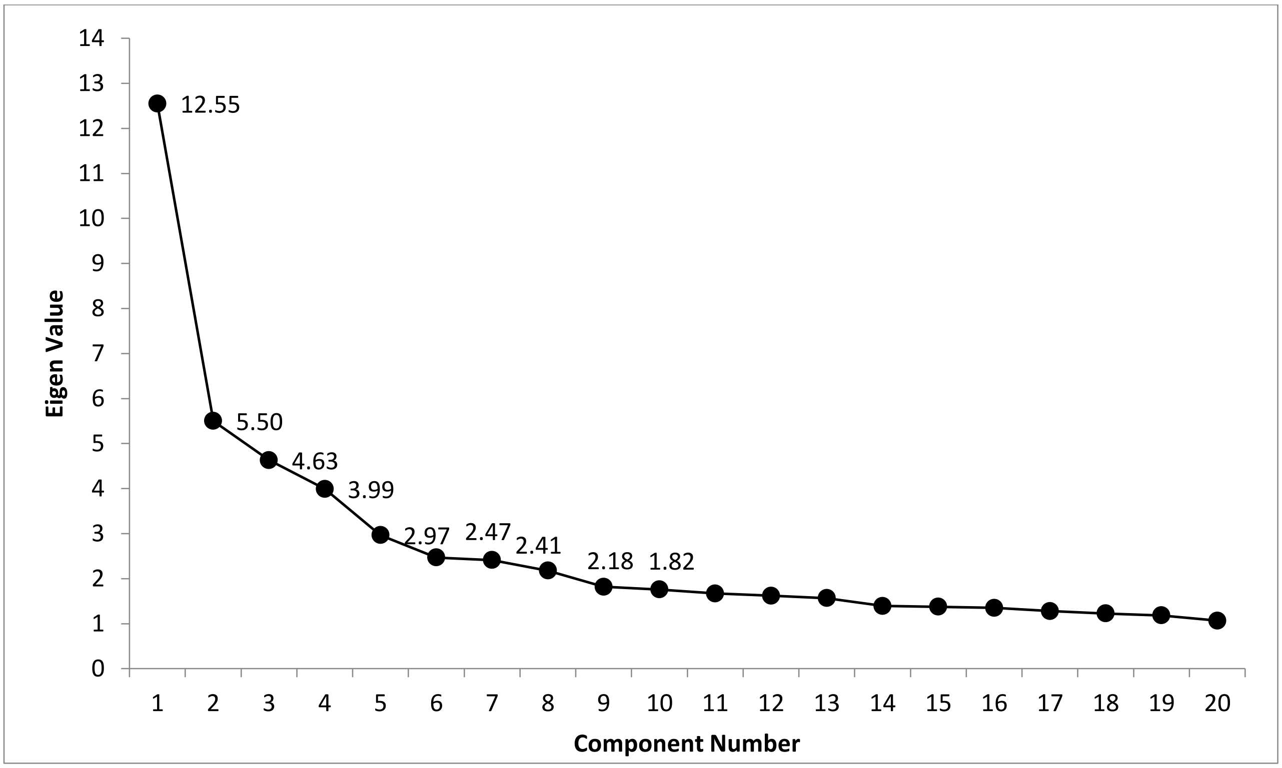

Figure 2 Scree Plot of Full Data Set EFA Eigen Values

In the initial EFA run, a Scree plot (Figure 2) showed a final significant Eigen drop after the fourth factor, from an Eigen of 3.99 to an Eigen of 2.97. All remaining drops were <0.5. Thus, a four-factor analysis was used for a secondary analysis. This four-factor model is not the original four-factor model proposed during the instruments development.

In addition to the full data set, SPSS was used to create spree plots on subsets of the data comparing business vs. engineering and male vs. female populations. A scree plot from each analysis appears on the following pages. Figure 3 shows a scree plot with the business, engineering, and overall populations identified while

Figure 4 compares the male and female populations. When separated from the engineering population, the business population showed a more dominant first four factors. The engineering population, which represents a much higher proportion of the overall responses matches well to the overall Eigen curve. The male and female populations, more evenly proportioned within the responses, showed a similar increased impact of a four-factor model.

The results from the subpopulations show some variations between population groups but overall all support a four-factor model. This serves as important validity evidence that the model is not heavily affected by subdivisions within the student population. These populations have demonstrated variation within other research efforts in entrepreneurship as noted in the background section.

Factor	Eigen Value	% of Variance	Cumulative %
1	12.553	10.595	10.595
2	5.503	5.94	16.535
3	4.633	4.788	21.323
4	3.994	4.734	26.058
5	2.968	4.532	30.59
6	2.469	3.613	34.203
7	2.412	3.271	37.474
8	2.177	3.24	40.714
9	1.821	3.117	43.832
10	1.758	2.999	46.831
11	1.672	2.994	49.825
12	1.622	2.759	52.584
13	1.569	2.575	55.159
14	1.394	2.572	57.731
15	1.377	2.556	60.287
16	1.35	2.534	62.821
17	1.279	2.346	65.167
18	1.225	2.339	67.506
19	1.183	2.284	69.79
20	1.067	2.243	72.033

Table 7 Factor list from EFA results on full data set.

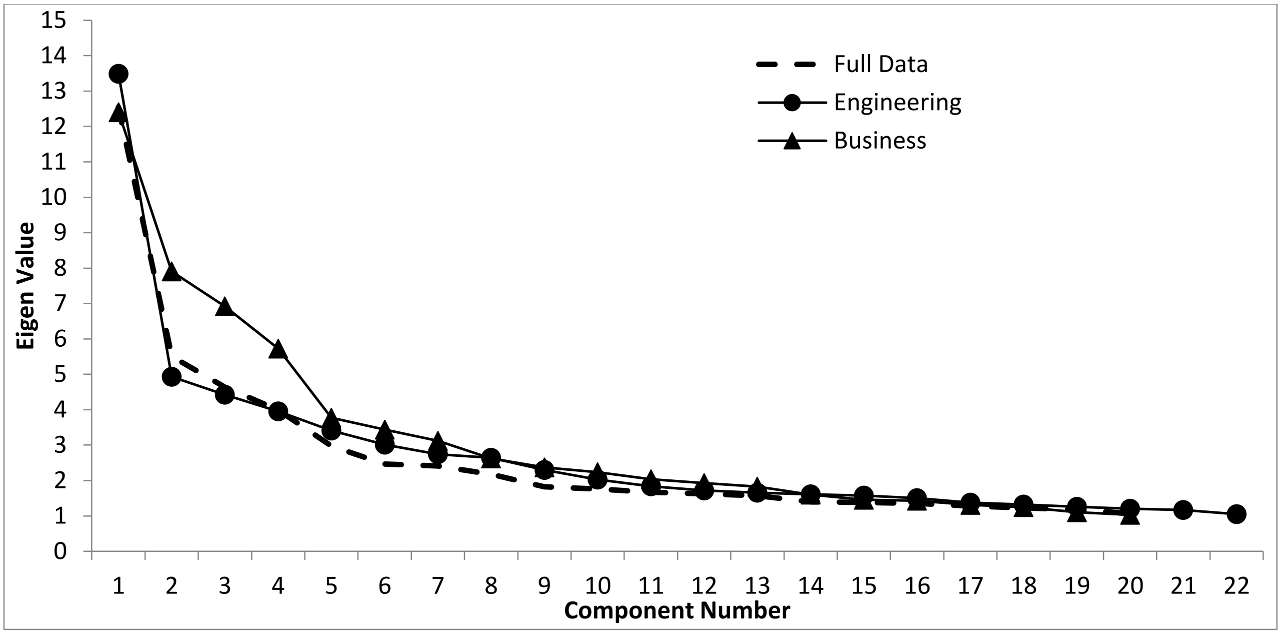

Figure 3 Scree Plot Comparing Factors between Engineering Student and Business Student Respondents

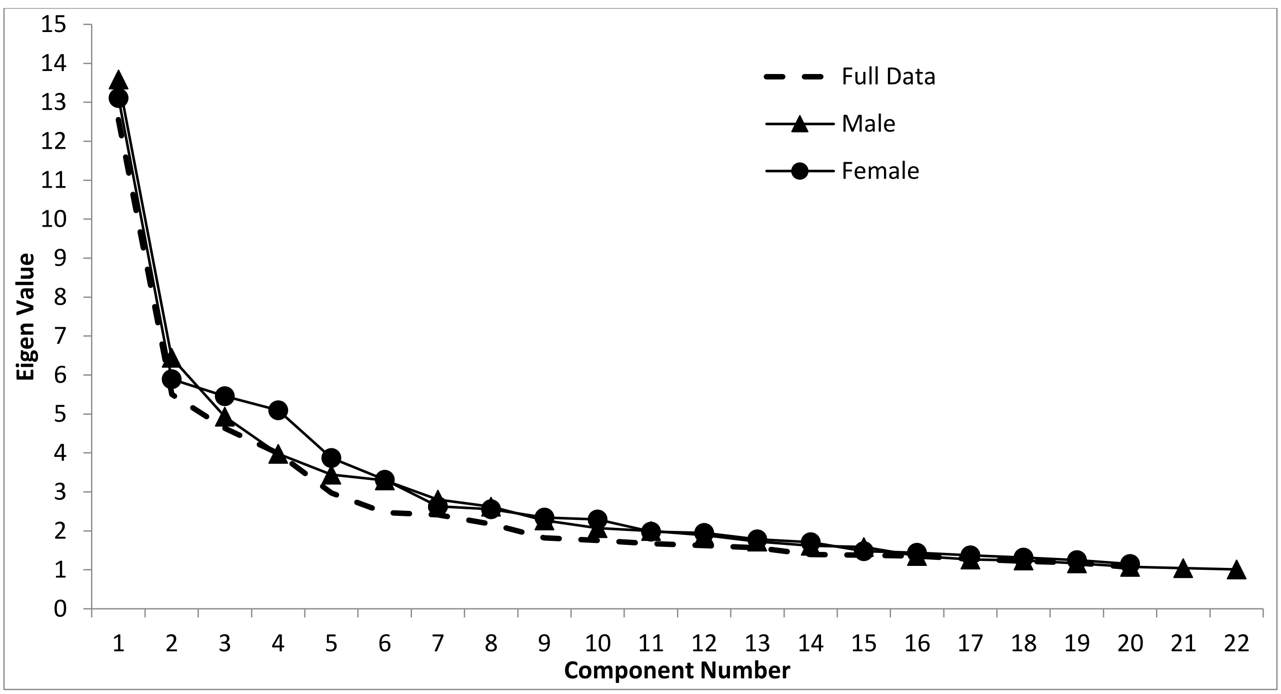

Figure 4 Scree Plot Comparing Factors between Male and Female Respondents

Using the four-factor model, an EFA analysis on the overall data returned the results on the following page. The criteria developed by MacCallum et al.[39] suggest that in this case, with a high communality (0.78) and high ratio of variables to theorized factors (75:4), the overall sample size (N=113) is sufficient. It is likely to result in highly congruent factors and unlikely to produce Heywood cases given the small number of factors.

Generally, items did correlate to well to a single factor. Only 8 items loaded strongly, meaning a correlation of 0.4 or higher, on more than 1 factor. Of the items that loaded on only one factor, the maximum correlations tended (31 of 75) to range between 0.4 and 0.6. As shown in Table 8, 14 of the 75 items loaded on a single, dominant, factor at a correlation of 0.6 or above. Further, 22 items did not load significantly onto any factor, with no loadings above 0.4.

EFA Factor	High (Corr>0.6)	Single	Low (Corr<0.4)	Cross	Total
1	9	7	6	5	27
2	0	15	5	1	21
3	4	2	5	0	11
4	1	7	6	2	16
Overall	**14**	**31**	**22**	**8**	**75**

Table 8 Item loading characteristic by factor and in total

The four-factor model did not relate well to the originally theorized subscales. The relationship between EFA factor assignment and original subscale assignment appears in Table 9. There were patterns within a comparison of the factor tabulation and the original subscales. However, significant blending of the original subscales onto different factors did occur. The achievement subscale items tended (11 of 23) to align most strongly to EFA factor 2. Similarly, the innovation subscale (14 of 26) most commonly loaded on Factor 1 and Self-Esteem items (8 of 14) tended to mainly load on Factor 4. Problematically, personal control items tended to load (6 of 12) most strongly on Factor 1, which was also the dominant item assignment subscale for innovation. Table 9 shows the level to which the scales appear crossed, blurred, or interdependent.

Original Scale	Factor 1	Factor 2	Factor 3	Factor 4
Achievement	7	11	2	3
Innovation	14	3	6	3
Personal Control	6	2	2	2
Self-Esteem	0	5	1	8
Total	**27**	**21**	**11**	**16**

Table 9 Cross-tabulation of dominant EFA item-factor loading with attitude subscale

The last component of the factor structure addressed is potential causes for the results reported above. The two potential causes investigated were the effect of modified versus unmodified questions and whether the factors tended to group reverse scored questions.

The modification of questions does not appear to have any effect on their grouping or reliability. The average maximum factor loading was effectively identical (0.465 in both cases) for the unmodified and major modified questions. The minor modified questions loaded slightly higher at 0.481. The factor structure also shows no apparent grouping of modified or unmodified questions into a single factor. This suggests that the modifications had a negligible impact on the instrument behavior.

Unlike the modifications, there does appear to be a grouping effect of reverse scored items. All but one reverse scored items loaded above 0.3 on Factor 2. The average loading on Factor 2 was 0.470. More importantly, only one non-reverse scored item loaded on Factor 2. This is a phenomenon or method effect commonly reported in psychometric instrument evaluation[40].

Discussion and Implications

From the CFA and EFA results, it is not feasible to make strongly supported inferences from this instrument on this population. The results indicate that a complete and supportable case for the validity of *this instrument in this form collecting data on this population* does not exist. However, there are indications that the underlying attitude constructs have the potential to explore growth and behavior of students' entrepreneurial attitudes and orientations with further development. The results also show some indications that the instrument is measuring at least portions of the intended constructs. Those indications drive a conclusion that further research down this avenue may produce results that are more viable.

First, the EFA analysis contains a set of 40 items that load well, above 0.4, and do so onto a single factor in the intended direction (i.e. not reverse loaded). While the intent of the analysis here is not to perform an item reduction on the instrument, what appears in Table 10 are the items that remain, their original theorized subscale, and their best fit EFA factor.

Row Labels	Factor 1	Factor 2	Factor 3	Factor 4	Total
Achievement	2	8	1	0	11
Innovation	10	2	4	1	17
Personal Control	4	1	1	0	6
Self-Esteem	0	4	0	7	11
Total	**16**	**15**	**6**	**8**	**45**

Table 10 Crosstab of well-loaded items by factor and original subscale

From the remaining items, it may be feasible to reconstruct an instrument from a set of the remaining items that sustains the criteria in Fabrigar[31] for reliability of analysis. Factor 2 can be reduced and aligned to serve as the Achievement construct. The Self-Esteem attitude construct can be reduced and modified to align to Factor 4 quite well. What complicates redevelopment of the instrument from a statistical validity standpoint is the use of Factor 1 and the attitude constructs of Innovation and Personal Control. Of the 6 Personal Control questions, 4 load on factor 1. A similar percent, 10 of 17 Innovation questions also load on Factor 1. It is important to note that the impact of reverse scored questions was intentionally included in this analysis to focus on a holistic view of the instrument. Further analysis is likely possible here by focusing more on item level versus factor level analytical techniques.

It is not possible, with this data, to fully reassess the implications of further modifications to the instrument as suggested by the EFA work. As described in Purzer[37] there are significant risks in reassessing the psychometric basis, subscales, and constructs within an instrument when applying it to a new population. The overlap of the innovation and personal control subscales provides a case study of this. The items designed to assess personal control and innovation on adult, professional, populations do not factor two different constructs on the first year students, but instead, one strongly overlapping factor.

The authors theorize that the most likely cause is that the personal control and innovation constructs in this population load more generally on a single construct characterized as something resembling risk tolerance or risk understanding. Said more simply, the factor alignment represents actual constructs rather than measurement error. Student's willingness to look beyond rules and known methods may contribute to how they perceive their control over situational outcomes. The inverse may also be true. Students who feel control over the outcome of a situation may be more likely to take innovative approaches and abandon models that they receive through instructional content. This alignment, of the innovation and personal control constructs, seems plausibly linked in student minds

The authors believe this correlation is worth further exploration to see if these coalesced constructs hold throughout students' careers or begin to diverge towards the model proposed by Robinson. Robinson reported considerable correlation between constructs, but found that they maintained an oblique rather than orthogonal factor relationship[16]. A divergence from the Robinson model due to, or in spite of, entrepreneurial educational interventions would provide a better way of understanding students' trajectories to the practice of entrepreneurship.

The problematic results from CFA and EFA should also be interpreted through the only significant statistical difference within demographic comparisons. Female students' scores were inseparable from males overall, and on the subscales intended to score achievement ($p=0.79$), personal control ($p=0.84$), and innovation ($p=0.91$). However, when looking at the self-esteem subscale, the probability of difference was much stronger ($p<0.10$). The mean shift suggests lower self-esteem in women. Though the probability is not highly statistically significant, it is notably different from the other subscales. This measured signal can be reliably found in other literature[41] on national student populations that share strong characteristics with the population in this data set. In comparison, the null gender difference on innovation is also well supported in literature, even in measures specifically tied to entrepreneurship[22].

Two questions, then, remain from the instrument's results and developmental analysis. First is the question of if the instrument measures entrepreneurship. While the EFA and CFA results indicate that it is unlikely that the instrument measures entrepreneurship in the way intended in the original development, it is effectively impossible to indicate whether the instrument tracks or measures a tendency to engage in entrepreneurship later as a professional. Such a phenomenon may occur through the latent constructs identified through EFA were the students later career paths tracked. As students' progress, the instrument may also converge towards entrepreneurial behavior in a way that shows growth, alignment, and separation between the manifestations of the intended constructs in entrepreneurs and non-entrepreneurs. Both areas indicate interesting paths for future study. This presents problems to several other applications of the EAO instrument on student populations.

When the original EAO instrument was applied to students in Singapore[6], researchers suggested a link between the scores students achieved and their self-perceptions on their entrepreneurial intention. Similarly, Moreno uses a modified EAO instrument to track changes in student intention during an educational intervention[19]. The instrument has also been used to compare community college and university students[33] and measure the change in students during participation in an incubator program[42]. None of these studies make strong cases for validity.

One study, by Miao[32] did perform a CFA analysis on data from a group of professional entrepreneurs and found similar results to those found in the original development. It seems probable that there is strong, repeatable support for the EAO instrument on professional populations, but that the instrument, based on this analysis and the other implementations, does not hold for students as Robinson suggests[9].

The second question, and a potentially interesting takeaway from this work, is a question about how students define entrepreneurship. Appended to the EAO instrument were two questions that explored the diversity of first-year students' definitions of entrepreneurship. Students were asked, first, whether they considered either of their parents to be an entrepreneur and, later, whether either of their parents had ever started their own business. This approach was taken to explore the definitions of entrepreneurship students hold from social, cultural, and parental influences prior to introduction to entrepreneurship programs at Purdue University. Using a strict definition of entrepreneurship, these questions should have returned answers largely identical to alternate form reliability questions.

Question	DID NOT Start A Business	Started A Business	Total
NO Parental Entrepreneurs	69	7	76
Parental Entrepreneurs	12	25	37
Total	81	32	113

Table 11 Paired questions on student self-identification of parental entrepreneurship

The authors hypothesized, prior to data collection, that a portion of the population would return results of parental entrepreneurship without parental business formation — a 'crossed' answer — suggesting a more expansive definition of entrepreneurship that could be later explored for influences from social and cultural phenomena surrounding entrepreneurship. However, the questions returned results that are more complex. While a statistically significant number of responses did suggest the hypothesized disconnect, a non-trivial number of responses also indicated parental venture formation without an accompanying indication of parental entrepreneurship. This disconnect suggest a, perhaps, more profound indication of a shift in student definitions of entrepreneurship when combined with the parental entrepreneurs who have not founded a business. With entrepreneurship, and entrepreneurship education, becoming a something approaching a cultural phenomenon, exploring student definitions of entrepreneurship, ideation of entrepreneurial career paths, and qualitative expectations, or understanding of the associated programming looks to be fundamentally important for understanding student growth in a grounded fashion that can later be built to quantitative measures. This problem is unlikely to be unique to this instrument and is a view shared by the discussions in Purzer[5], Fiet[13], and Robinson[9].

The results from the CFA and EFA analyses do not support validity with this instrument measuring this population. Though the results provide evidence that the intended attitude driven phenomena likely exist within the instrument, the modifications conducted here did not converge to a functional instrument. The attempt to modify Robinson's[16] work on adult populations to this new, student, population supports the other work by Robinson[9] documenting the difficulty of merging research on student and professional populations in entrepreneurship.

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