Work in Progress – Development and Validation of the Ambassador Questionnaire

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Motivation and Background

Each year, thousands of undergraduate engineering students engage in co-curricular outreach activities using a common model known as ambassadorship, in which students are trained to design and deliver presentations and hands-on activities to middle and high school students. Because the ambassadors' mission is to promote diversity among the future STEM workforce, interactions focus on pro-social messages about engineering that appeal to young audiences and students from historically underrepresented groups. Ambassadors also engage in self-government and have opportunities to represent their college to industry leaders and the local community. The national Engineering Ambassador Network has grown to include more than 30 colleges and universities, and reached more than 200,000 K-12 students and teachers in 2017 [1].

Relatively little is known about the potential impact of ambassadorship on undergraduate students' professional development and future career intentions. A recent survey of 30 engineering outreach programs revealed that less than ten percent routinely assess the impact of ambassadorship, although leaders expressed a desire to do so, for program evaluation and research purposes [2]. Previous, mostly qualitative research has found that ambassadorship can impact various aspects of students' self-perceptions. Ambassadorship has been associated with self-reported changes in leadership and communication confidence, perceived belonging within and representation of the engineering field, and an appreciation for membership within a diverse, supportive professional community [3]. Furthermore, ambassadors often identify with historically under-represented groups and many endorse a role for social engagement and social justice in engineering. If studied on a larger scale, the impact of ambassadorship could reveal links between national efforts to change the conversation with broadening participation and increasing resilience and retention [4] in STEM fields.

One challenge to this agenda is the lack of access to valid measures of ambassador related constructs of interest. This *Work in Progress* paper describes the development and preliminary steps towards validation of the Ambassador Questionnaire (AQ), a measure of the impact of engineering outreach on undergraduate students who conduct their activities. Our objectives were to (1) examine existing questionnaires measuring constructs of relevance including academic confidence, engineering career motivation, engineering beliefs, professional skills, and interpersonal skills; and (2) create and pilot test a measure that could be used to assess the potential impact of outreach activities on students' professional perceptions and aspirations. The scope of the present paper is limited to reporting the reliability and factor structure of a sample of student ambassadors who completed the measure at the outset of the academic year.

Methods

A review of literature revealed existing resources measuring undergraduate engineering students' motivation and self-efficacy, future intentions, and engineering-related beliefs. These include the Longitudinal Assessment of Engineering Self-Efficacy (LAESE) [5], the Project to Assess Climate in Engineering (PACE) survey [13], the Laanan Transfer Students Questionnaire (L-TSQ) [6], the National WEPAN pilot climate survey [11] Academy of Engineering Changing the

Conversation survey [12], Assessing Women and Men in Engineering (AWE) retention surveys [4], and Engineering Ambassador Network exit interviews [13,14]. Questions were aggregated and organized thematically to yield 466 items. The authors reviewed the list and removed duplicate and irrelevant items (e.g. pertaining to students' perceptions of specific course experiences or taking engineering courses in specific educational contexts). Items were then grouped thematically using constructs identified in previous research on ambassadorship and outreach participation as a tentative guiding framework [3, 8-10]. Groupings emerged as follows: academic confidence (19 items), ambassadorship, engineering career interest and motivation (12 items), engineering beliefs (13 items), professional skills (28 items), and interpersonal skills (20 items). Nine demographic and open-ended items pertaining to ambassadorship experiences and goals were added. Sample subscale items can be found in Table 1.

Table 1. *Sample Subscale Items*

Subscale	Item
Academic Confidence (AC)	I am confident I can succeed in my engineering courses.
Engineering Career Interest and Motivation (ECM)	Someone like me can succeed in an engineering career.
Engineering Beliefs (EB)	Engineers help to make the world a better place.
Professional Skills (PS)	I can deliver engaging outreach presentations.
Interpersonal Skills (IS)	It is easy for me to make friends.

The resulting 101 items were reviewed by an expert panel of four Engineering Ambassadors Network chapter advisors and one independent educational researcher familiar with the ambassador model and training program. Items were assessed for their face validity and importance for inclusion given the goals of the AQ. Experts used a Likert scale with response options ranging from "not at all important" to "very important." Interrater reliability for expert panel ratings was calculated using a two-way mixed effects consistency model and revealed an ICC value of .52. However, upon consultation with the expert panel and further review of the data, we learned that one rater intentionally did not respond to about one-third of the items. We made the decision to remove this rater from the reliability analysis, reiterated the calculation and arrived at an acceptable ICC of .71. The panel recommended that 66 of the 101 items be retained for the pilot version of the AQ (64 for pre-test version, 66 for post-test). This included five demographic type items, 12 items related to Academic Confidence, 11 items focusing on Engineering Career Motivation, 10 items that identified Engineering Beliefs, 15 items associated with Professional Skills, nine Interpersonal Skills items, and two open-ended items (four for the post-test version). Other items were determined to be unimportant for the purposes of the measure, duplicative, or vague.

The 64 pre-test items were piloted through an online Ambassador Questionnaire (AQ), which was administered to 168 outreach ambassadors from 11 colleges/universities with existing or newly forming Engineering Ambassadors chapters. The sample was primarily female (67%) and white (69%), with most respondents in their junior or senior year in college (68%) but serving their first year as ambassadors (51%). Participants responded using a 5 point Likert scale with anchor points of Strongly Disagree to Strongly Agree. We conducted two phases of exploratory factor analysis (EFA) to examine the factor structure with the 57 scaled-response items. Because

moderate inter-item correlations were observed, we chose Varimax rotation [15,18]. Finally, we measured internal consistency reliability using Cronbach's alpha coefficients.

Results

Diagnostic procedures indicated the removal of four items with excessive low intercorrelations and six items that failed to load on any factor at or above .40. The Kaiser-Meyer-Olkin value was .83, indicating sufficient sampling adequacy. Bartlett's test of sphericity (p>.001) revealed that the correlations among the 47 retained items were suitable for EFA. The EFA initially extracted six factors and explained 54% of the variance. We retained theorized subscales of Academic Confidence, Engineering Beliefs, Professional Skills, and Interpersonal Skills. The Engineering Career Motivation subscale did not hold, with some items loading on Academic Confidence and some items breaking into their own factor, which we labeled Ambassadorship. Two items focusing on equity in engineering careers loaded on a separate factor. A follow-up EFA specified five factors, explained 50% of the variance, and moved the two equity items to the Ambassadorship subscale. Cronbach's alpha coefficients suggested strong internal consistency, with a whole scale coefficient of .93 and subscale coefficients ranging from .75 to .90. Table 2 presents factor loadings by construct and item.

Significance

To our knowledge, this is the first survey measure to allow researchers and practitioners to investigate the impact of engineering ambassadorship on particular features of undergraduate students' self-perceptions, beliefs, goals, and considerations for using ambassadorship-related skills in their future activities. Our preliminary findings include a robust structure to the measure and the potential to investigate group- and time-related differences in students' perceptions.

Future Work

Data collection efforts are ongoing so that after validation with a larger sample, the measure can be made available to researchers and practitioners. Future work using this measure might meaningfully explore relations with undergraduate engineering students' motivation for their coursework and their personal identification with the domain [18,19]. In addition, the measure might be useful in exploring differences in beliefs and expectations among students of varying gender, ethnic, and socio-economic groups.

Table 2. *Factor loadings by construct and item for preliminary construct validity examination.*

Item Topic	**Subscale**				
	Professional Skills (PS)	**Engineering Beliefs (EB)**	**Academic Confidence(AC)**	**Interpersonal Skills (IS)**	**Ambassadorship**
PS Delivering outreach presentations.	.767				
PS Providing peer critique.	.731				
PS Leadership skills.	.727				
PS Designing presentation slides.	.726				
PS Creating engaging presentations.	.725				
PS Integrating changing the conversation into presentations.	.692				

PS Working collaboratively with other ambassadors.	.562				
PS Being a member of ambassador team.	.556				
PS Team problem solving.	.553				
PS Group conflict resolution.	.535				
PS Synthesize other points of view.	.507				
PS Weigh alternative perspectives.	.487				
PS Organize info for others.	.469				
PS Apply engineering to real life.	.435				
EB Engineering connects to real world.		.812			
EB Engineering makes a difference.		.810			
EB Engineers shape future.		.809			
EB Engineers improve world.		.777			
EB Engineering is essential.		.727			
EB Engineering should be diverse.		.668			
EB Engineers are innovative.		.652			
EB Engineers solve problems.		.606			
EB Engineers are creative.		.460			
EB Society values engineers.		.417			
AC Engineering is right choice for me.			.745		
AC Succeed in engineering.			.715		
ECM Will like career in engineering.			.712		
ECM Can succeed in engineering.			.666		
AC Satisfied with engineering major.			.637		
ECM Engineering allows for creativity.			.599		
AC Succeed in math.			.577		
ECM Choice to study engineering.			.557		
AC Complete in specific major.			.502		
AC Succeed in engineering without sacrificing other interests.			.491		
AC Help-seeking within engineering.			.439		
IS Help-seeking within university.				.774	
IS Feel included in university.				.716	
IS Mentor figure presence.				.657	
IS Relate to others in academic settings.				.647	
IS Cope with identity isolation.				.569	
IS Participate in non-academic activities.				.544	
IS Make friends with people who differ.				.528	
ECM Ambassadorship aiding success.					.740
ECM Ambassadorship aiding career goals.					.720
ECM Same opportunities in the field.					.559
ECM Ambassadorship helps with understanding of engineering.					.551
ECM Equal treatment in the field.					.465

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