AC 2009-1126: MORE TO SAY: ANALYZING OPEN-ENDED STUDENT RESPONSES TO THE ACADEMIC PATHWAYS OF PEOPLE LEARNING ENGINEERING SURVEY

Micah Lande, Stanford University

Micah Lande is a Ph.D. candidate in Mechanical Engineering and Design at the Center for Design Research at Stanford University. He is researching how engineers learn and apply a design process to their work. Micah is a co-Editor-in-Chief of Ambidextrous, Stanford University's Journal in Design. His academic interests include design and engineering education, design thinking and foresight thinking, creativity and innovation, and interdisciplinarity and multidisciplinarity in higher education. Micah is a 2009 ASEE-ERM Apprentice Faculty Grant recipient. He has a B.S in Engineering from Stanford's Product Design program and has a M.A. in Education from the Stanford School of Education program in Learning, Design and Technology.

Sarah Parikh, Stanford University

Sarah Parikh is a third year graduate student at Stanford University working on her Ph.D. in Mechanical Engineering with a focus on Engineering Education. She received a B.S. in Mechanical Engineering from the University of Texas at Austin in 2006 and received a M.S. in Mechanical Engineering with a focus on microscale heat transfer from Stanford University in 2008.

Sheri Sheppard, Stanford University

Sheri D. Sheppard is the Burton J. and Deedee McMurtry University Fellow in Undergraduate Education, Associate Vice Provost for Graduate Education, and Professor of Mechanical Engineering at Stanford University. She is also a consulting senior scholar at the Carnegie Foundation, having directed the Preparations for the Professions Program (PPP) engineering study, and co-authored the study's report Educating Engineers: Designing for the Future of the Field (2008). Before coming to Stanford University, she held several positions in the automotive industry, including senior research engineer at Ford Motor Company's Scientific Research Lab. She earned a Ph.D. at the University of Michigan.

George Toye, Stanford University

George Toye is a Consulting Professor in Mechanical Engineering at Stanford University. Engineering and education have been his foundation interests. He has served as Associate Directors of Stanford's Center for Design Research and the Stanford Learning Lab (now known as the Stanford Center for Innovation in Learning). Today, although also actively involved as consultant in a variety of technology sectors, education remains a central theme in his academic and entrepreneurial activities. George earned a Ph.D. at Stanford University for his work on management of non-homogeneous redundancy in fault tolerant electromechanical systems design.

Helen Chen, Stanford University

Helen L. Chen is Research Scientist at the Stanford Center for Innovations in Learning and Research Associate in the Center for the Advancement of Engineering Education. Her current research interests focus on the application of ePortfolio pedagogy and practices to facilitate teaching, learning, and assessment for students, faculty, and institutions. She is also interested in the exploration of the affordances and scalability of these kinds of social software tools and their implications for the design and evaluation of innovative learning spaces to support formal and informal learning.

Krista Donaldson, Stanford University

Krista Donaldson is a Researcher and Lecturer at Stanford University. Her interests include

design and development, reconstruction and engineering education. She received her Ph.D. from Stanford in Mechanical Engineering and Design where her work focused on product development to promote economic growth in less industrialized economies. Krista has taught at Kenyatta University and the University of Cape Town, and worked as an engineer and designer in a variety of capacities. She is the author of the Engineering Student Survival Guide.

More to Say: Analyzing Open-Ended Student Responses to the Academic Pathways of People Learning Engineering Survey

Keywords – Open-ended Survey Responses, Student Academic Experiences

Abstract

A final, optional open-ended question in the Academic Pathways of People Learning Engineering Survey (APPLES) that asked "*Is there anything else you want to tell us that we didn't already cover?"* elicited free form responses from 37 percent of the 4,266 survey participants. This paper explores their responses. After data cleaning, 880 responses were anonymized by individual and institution. The responses were rated on a numeric value (1-5) ranging from negative (criticizing) to neutral to positive (complementing). Responses were also coded using an emerging thematic coding scheme. The emergent topics were organized by whether the comments addressed school or individual issues. Topics suggested by the open-ended responses related to the *School* category were: Advising, Co-op, Gender, Social and Teaching (Curriculum) and Teaching (Language). These responses were mostly found to the extremes, both positive and negative, of the scale of positive/negative comments. Topics suggested by the open-ended responses related to the *Individual Beliefs* category were: (engineering as a) Calling, Challenge, Future, Lifestyle, Money and Understanding. These responses were mostly found to be neutral on the scale of positive/negative comments. Our analysis showed that the subjects' open-ended responses added qualitatively to student-voiced passions, concerns and experiences that could not be easily captured in a multiple choice question format.

Introduction

The APPLE Survey (or APPLES – Academic Pathways of People Learning Engineering Survey) is a 10-minute online survey offered to undergraduate engineering students. This instrument was one research component of the Academic Pathways Study (APS), a branch of the NSF-funded Center for the Advancement of Engineering Education that seeks to understand academic and professional persistence in engineering. APPLES focused on understanding how students at American institutions navigate their undergraduate education to become engineers, and considered their backgrounds, experiences and decisions.

The APPLES instrument is based on the Persistence in Engineering (PIE) survey[1,2] that was administered as part of APS longitudinal research with 160 students at four universities from 2003 to 2007. The first administration of APPLES ("APPLES1") took place at the four APS institutions in 2007.[3,4] A modified version of the survey ("APPLES2") was administered at 21 American universities in Spring 2008.[5]

This second APPLES instrument asked 49 multiple choice and 1 open-ended question. Multiple choice questions were carefully designed to gather information around well-conceived items that

addressed larger constructs being examined. (Chen[4] lists the APPLES constructs and their constituent items from APPLES.)

The final optional open-ended question that asked "*Is there anything else you want to tell us that we didn't already cover?"* elicited free form responses from students. Respondents were able to describe additional issues about their undergraduate engineering experience. The collected open-ended responses added qualitatively to the student-voiced passions, concerns and experiences that could not be easily captured in standard survey format, and offered a rich addition to the emerging quantitative research findings from the APPLES2 survey instrument. This paper focuses on this free text data gathered from the APPLES2 deployment.

Research Methods and Participants

Survey responses from 4,266 participants at 21 sites were collected in the APPLES2 deployment. 1597 (37%) survey participants submitted text responses to the final optional open-ended question. The balance, 2687 (63%) survey participants, gave no response and left the question response box blank (Figure 1).

Data Cleaning for Null Content

The data set was cleansed to remove null responses, responses that had no applicable or relevant content. Comments were considered null if the text responses were empty ("No", "Not at this time"), survey specific ("Great Survey!") or solely demographic information otherwise asked in the survey ("I'm a transfer student"). Using this criteria, two researchers coded and identified 717 student responses as null responses, and were excluded from further analysis. This was done by first individually and independently reviewing responses in Microsoft Excel and noting if the comment was a null response. Then, differences in coding were discussed and resolved between the coders. For inter-rater reliability, Cohen's kappa was moderate at .532. The resulting 880 student comments with responses amounted to 21% of the survey participants (Figure 1).

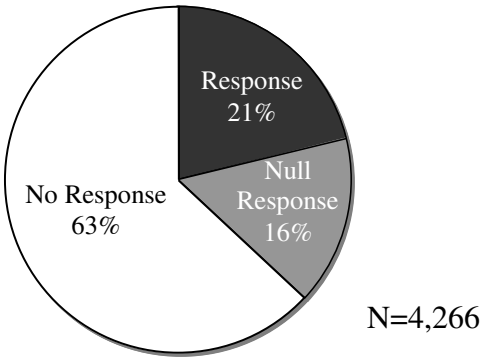

Figure 1. Distribution of Open-Ended Response Types Among Response, Null Response and No Response. Of 4,266 APPLES subjects, 37 percent responded to the open-ended question.

Data Cleaning for Individualized Institution Reports

As part of each institution's participation in the APPLES, individualized school reports were generated and shared with the institution's local campus survey coordinator and senior

administrators. To maintain student anonymity, a data cleaning schema was developed and implemented for each set of school survey records. Student names were redacted and replaced with a generic placeholder indicating that information was removed, i.e. [*name*], with brackets and italicized words to indicate the edit. The same was done for any other information that could possibly help to identify the individual student through organizations, companies, or other affiliations related to the institution. For each response, an attempt was made to keep a generic placeholder like [*student group*], [*company*] or [*under represented minority*] to preserve the context of the comment. Names of other individuals (like faculty and staff) were also redacted if the comments about them were negative. Again, generic descriptors were used to describe the removed information, i.e. [*professor*] or [*advisor*]. If the comment about an individual faculty member or staff person was positive their name was retained. Group and organizational names (that could not identify the student) were retained whether or not the comment was positive or negative. Course/class numbers and names were similarly kept. Curse words were excised and replaced with a more innocuous [*expletive*] placeholder. Comments were then spell checked and misspellings corrected.

Data Cleaning for Cross-School Analysis

For further cross-school analysis of student responses (and to prepare the same data set for archiving), an additional step of anonymizing the aggregate data set was done. School specific information such as the school name, individual names, course number and names and other identifiers were given generic replacements such as [*institution*], [*name*], [*introductory computer science course*].

Grading Comments as Negative and Positive

Student responses were graded by two coders for the negative and positive value of the comment. A scale of 1-5 was used to indicate how negative (criticizing), neutral or positive (complementing) the comment was. A value of 1 was considered *very negative*, 2 *slightly negative*, 3 *neutral*, 4 *slightly positive* and 5 *very positive*. Comments coded in the extreme categories (1 or 5) relied on indications such as exclamation marks, rather damning or laudatory language and comments otherwise conveyed much displeasure or excitement about the topic described. Comments without tone or opinion were marked as neutral. Comments that were only slightly negative or positive were categorized as that. All 880 responses were sorted alphabetically (to randomize the school affiliation), printed out, scored by hand and then entered into a Microsoft Excel spreadsheet. Differences in coding were discussed and then resolved between the coders. Twenty percent (176 coded responses) were sampled for inter-rater reliability and a weighted kappa for this sample segment of responses was moderate at .599. Example comments demonstrating the breadth of negative and positive comments are given below in Table 1.

Table 1. Examples of Negative-Positive Comments

1=Very Negative:

a. …I would never suggest anyone to join the [school of engineering] because of the way I was treated for being female!
(1, Gender)

b. …If the institution doesn't give a [expletive] about how many classes they are offering based on how many students are enrolled and needing certain classes... they should pull their heads out of their [expletive] and stop wondering why the enrollment at their university is going down…
(1, Teaching (Curriculum))

2=Slightly Negative:

c. School was very expensive and [my institution] needs to start accepting more transfer credits.
(2, Money)

d. I find that I have learned much more outside of class than in class, partly due to some professors who did not understand the material they are supposed to be presenting.
(2, Teaching (Curriculum))

3=Neutral:

e. One has to have a balance of school, work, and a social life
(3, Lifestyle)

f. I made my decision to study engineering because of my involvement in FIRST robotics.
(3, Calling)

4=Slightly Positive

g. Having a co-op really opens up your eyes to the world of engineering; you get a sense of the vast amount of career paths that are available with an engineering degree, as well as the chance to "test-drive" your future.
(4, Future)

h. I have generally had good experiences with engineering. A lot of math involved…
(4, Teaching (Curriculum))

5=Very Positive:

i. Engineering is a fantastic platform that gives a graduate incredible problem solving skills that can easily be used in any facet of business and life in general.
(5, Future)

j. Cooperative education has been an amazing experience, and made me love engineering. Co-ops should be required for all engineering students!
(5, Co-op)

Notes:

- ellipses denote comment excerpted from entire student comments
- notation used describing each item is (negative-positive scale value, thematic topic)

Collecting Emerging Topics and Themes

To make meaning of students' responses, comments were read through multiple times to generate and refine an emerging thematic coding scheme. These topics were grouped by whether they were comments about *School* or *Individual Beliefs*. Definitions for the *School* and *Individual Belief* themes are listed in Tables 2 and 3, respectively. Our rationale in delineating school versus individual was to capture an appropriate level of granularity. Issues at the *School*

level can be addressed by institutions but not easily by the student. Similarly, *Individual Beliefs* may be more difficult to alter when attempted to be addressed at the institutional level.

Table 2. Coding Scheme (Themed Category and Topics): *School*

School	Advising	Issues with regard to student advising and mentoring, either formally or informal
	Co-op	Co-operative work arrangement between college and industry
	Gender	Issues of gender and "other"
	Social	Social norms of engineering
	Teaching (Curriculum)	Comments about pedagogy and curriculum
	Teaching (Language)	Comments about English language proficiency

Table 3. Coding Scheme (Themed Category and Topics): *Individual Beliefs*

Individual Beliefs	Calling	Engineering as a life's calling, something meant to be or not meant to be
	Challenge	Engineering is hard, or too hard
	Future	Issues of career placement or worries about after college
	Lifestyle	Work/life balance
	Money	Financial concerns
	Understanding	"Knowing" what engineering is, consists of, practice of

Coding Comments by Thematic Category and Topic

Student responses were graded by two coders according to thematic categories and topics defined in the above Table 2 and Table 3. Coders were given these definitions and a pair of example coded responses for each topic. The 880 responses were sorted alphabetically (to anonymized and disassociate by school data clustering), printed out, scored by hand, and then entered into a Microsoft Excel spreadsheet. Any differences in coding were discussed and then resolved between coders. Twenty percent (176 coded responses) were sampled for inter-rater reliability; a weighted kappa for the sample segment of responses was very good at .832. Example excerpts and passages are listed in Table 4 and Table 5.

Table 4. Example Passages of Student Responses to *School* Category Thematic Topics

School	Advising: a. …I had difficulty getting any advising help… *(2, Advising)* b. …the academic advising from [my institution]'s central advising has been incorrect, inconsistent, and typically rubbish (at best) *(2, Advising)* Co-op: c. …Co-ops are the key to learning what engineering is like… *(4, Co-op)* d. I had very little idea of what a job in engineering consisted of before I became a co-op student. I think these types of programs are crucial to creating capable engineers. *(4, Co-op)* Gender: e. I have noted that there are very few women in my classes. For example, in my [course] lab I am the only female! *(1, Gender)* f. As a female engineering student, I have noticed that the engineering courses at [my institution] are generally not composed of more than 5-10% female students. For me, this can be overwhelming at times. *(2, Gender)* Social: g. …Engineers have poor social communication skills and don't get girls. *(2, Social)* h. In my work experience with engineers, many of them lack sufficient communication skills to explain to clients in everyday language, why a certain design won't work, etc. *(2, Social)* Teaching (Curriculum): i. Engineering classes should start as soon in the college career as possible and should largely consist of hands-on and industry-relevant activities. *(3, Teaching (Curriculum))* j. I often feel like the teachers in my engineering and science classes do not take an active interest in ensuring that I and my fellow classmates completely understand the material that is being presented. *(2, Teaching (Curriculum))* Teaching (Language): k. …many professors speak poor English. *(2, Teaching (Language))* l. It is very hard to learn from TAs who cannot speak English very well and who cannot understand our questions. *(2, Teaching (Language))*

Table 5. Example Passages of Student Responses to *Individual Beliefs* Category Theme Topics

Individual Beliefs	Calling: a. I have always enjoyed finding out how things work and building and this led me to be an engineer. *(4, Calling)* b. …For me it was wondering who made cars… once I got into school I realized I was in the right profession, and than found out engineers touch almost every field and I love it. *(4, Calling)* Challenge: c. Engineering classes are very hard; however I cannot picture myself studying another major because most of them are bother[some] and non-interesting. Work hard or die alive! *(5, Challenge)* d. tough program, but completion comes with a sense of accomplishment *(3, Challenge)* Future: e. I studied engineering to go into business. I feel a technical background with study in business will make my goals of company ownership a reality… *(3, Future)* f. I will probably work in something involving some engineering knowledge, but I don't want to solely be an engineer. Currently, I'm more inclined to seek a career in energy policy or consulting. *(3, Future)* Lifestyle: g. One has to have a balance of school, work, and a social life *(3, Lifestyle)* h. …I sometimes feel as if earning an engineering degree requires a lot of sacrifice especially in terms of social involvement and a healthy lifestyle. For example, consistently having to do at least 5 hours of homework 7 days a week and consistently not getting more that 4 hours a sleep a night. *(2, Lifestyle)* Money: i. …School is too expensive. I would enjoy it much better if I wasn't financially stressed about it. *(2, Money)* j. The tuition is ridiculous. *(2, Money)* Understanding: k. Need to do a better job marketing engineering programs to students. Many people who would do well in engineering do not pursue a degree simply because of lack of knowledge and exposure. *(2, Understanding)* l. It is difficult to learn that much about engineering without taking a class in engineering… *(3, Understanding)*

Additional emerging themes materialized out of this ongoing iterative analysis – outside the scope of our determined categories. These are interesting to note but do not directly feed into immediate further analysis. A *Disenfranchisement of Possibility* comes through; a complaint that somehow-nobody-told–me-this-is–how-it-was-going-to–be. It is a clamor that there was insufficient knowledge of engineering/industry/school provided. Also evident was a *Plutocracy of Difficulty* attitude that this engineering pathway is but for a few hardy souls. This is akin to Stevens' *Meritocracy of Difficulty*[6] coupled with a sense that *I am* that one who will persevere successfully. Examples passages are shared in Table 6.

Table 6. Additional Emerging Themes

Additional Themes	Disenfranchisement of Possibility (Nobody told me): a. `Engineering was NOT the major for me. I choose it because I was not informed at all about engineers and what they do. I am very dissatisfied with engineering and my college experience.` *(1, Understanding)*
	Plutocracy of Difficulty: b. `Only 1 in 3 [discipline] engineering freshman at [my institution] graduate with a degree in aerospace engineering. I'm going to be one of them.` *(2, Challenge)*

Results

It is illuminating to read student responses and hear their voiced passions, concerns and experiences that could not be easily captured solely in a standard multiple choice question format. At times, through their comments, the situations and barriers students describe encountering are wrenching. But for each extremely bad or frustrating comment, there is usually a paired positive one to be found. In reviewing the student responses for each "[*my institution*] sucks" it seems there is a complimentary "[*my institution*] rocks." Due to the very nature of the question asked and examined in this paper, perhaps the wide range of responses is to be expected.

Table 7 and Table 8 summarize the distribution of negative to positive comments across topics. Numbers with a shaded background indicate the mode for that topic. For example, looking at *Co-op* in Table 7, its mode is (4) *slightly positive,* at 52 percent of the time.

Table 7. Distribution of Negative-Positive Comments for *School* Theme Topics

		Negative		*Neutral*		*Positive*	
		1	2	3	4	5	*n*
School	*Topic*						
	Advising	5%	71%	12%	12%	–	*66*
	Co-op	2%	17%	26%	52%	4%	*54*
	Gender	7%	55%	31%	7%	–	*29*
	Social	4%	50%	31%	15%	–	*48*
	Teaching (Curriculum)	4%	59%	27%	9%	1%	*324*
	Teaching (Language)	5%	74%	21%	–	–	*19*
	Total						*540*

Notes:

- mode of each topic/row is indicated by shading
- dash denotes reporting 0%

Table 8. Distribution of Negative-Positive Comments for *Individual Beliefs* Theme Topics

		Negative		*Neutral*		*Positive*	
		1	2	3	4	5	*n*
Individual Beliefs	*Topic*						
	Calling	6%	12%	45%	35%	2%	*66*
	Challenge	1%	33%	52%	14%	–	*97*
	Future	2%	20%	48%	27%	3%	*96*
	Lifestyle	3%	42%	30%	21%	3%	*33*
	Money	–	67%	29%	5%	–	*21*
	Understanding	–	22%	70%	7%	–	*27*
	Total						*340*

Notes:

- mode of each topic/row is indicated by shading
- dash denotes reporting 0%

Whereas the topics under the *School* theme tended toward the extremes, those assigned to the *Individual Beliefs* theme category tended to be more neutral. The number of responses sorted by topic is generally even with an exception of the *Teaching (Curriculum)* topic, which had 324 comments. For future work it could be useful to unpack this item into sub-groups for further analysis.

The *School* theme category topics are generally ordered with more negativity than the grouping of the *Individual Belief* theme category topics. It is interesting to note that both *Co-op* and *Money* are exceptions here. It may be that these two topics are much more concrete than the other more abstract items or that, in reflection, the categorization of each should be reconsidered. In other words, finding benefit from experiencing a co-op experience and being worried about the financial overload of tuition could be construed as a miscategorization.

Conclusions

These open-ended responses provided a rich addition to the emerging quantitative research findings from the APPLES2 survey instrument. Issues important to students such as advising and gender were not subjects that were probed as part of the multiple choice survey questions. And considering the numbers of hours students spend awake outside of class there is a considerable amount of untapped experiences outside the classroom to be understood.

The topics related to the *School* category were: Advising, Co-op, Gender, Social and Teaching (Curriculum) and Teaching (Language). These responses tended to the extremes, both positive and negative. The topics related to the *Individual Beliefs* category were: (engineering as a) Calling, Challenge, Future, Lifestyle, Money and Understanding. These responses tended to be neutral on the scale of positive/negative comments.

Open-ended students responses to the question "*Is there anything else you want to tell us that we didn't already cover?"* added qualitative descriptions and substantiations to the data collected with personal and sometimes passionate descriptions of student experiences. This study of responses will inform further iterations and deployments of the APPLES instrument.

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