Purdue University
Purdue e-Pubs

School of Engineering Education Graduate Student Series

School of Engineering Education

6-14-2015

# Identifying Sources of Information That Students Use in Deciding Which Engineering Major to Pursue

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122nd ASEE Annual Conference & Exposition
June 14 - 17, 2015
Seattle, WA
Making Value for Society
Paper ID #12858

# Identifying sources of information that students use in deciding which engineering major to pursue

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# Identifying sources of information that first year engineering students use in deciding which engineering major to pursue

## Abstract

This study explores the sources of information that first year engineering students use to decide which engineering major to pursue for their undergraduate studies. The purposes of this study are twofold: (1) to understand how students make an informed decision of which engineering major to pursue and (2) to help the First Year Engineering (FYE) program administration improve the informational resources they provide the students. This study was framed within the FYE population of a large Midwestern university and was commissioned by the FYE program.

FYE administration conducts regular student surveys for feedback and improvement purposes. We analyzed different survey data collected over a period of one year and found out that students identified "Self-Led Exploration of Engineering Disciplines" (SLE) as the single most important source of information in selecting a major. SLE is a broad, ill-defined term, which students may interpret differently. Hence, we developed a qualitative study to investigate how students perform SLE. We conducted individual interviews with 12 students enrolled in the FYE Program. These students were selected so that they were representative of the entire student population in terms of gender. The qualitative findings of this study reinforce that the students are basing their decision of a major using SLE. These findings also helped us unpack the meaning of SLE, and we further came up with 6 different types of SLE. Finally, our findings also indicated that direct interaction with people was highly valued by the students while selecting a major.

## Introduction

From the vocational standpoint, literature on career decision-making is abundant. As early as 1979, Harren advanced a comprehensive model for career decision-making focused on college students at the undergraduate level[1].

We explore one part of Harren's model: the sources of information used by students during what Harren defined as the *planning* stage. According to Harren:

> *This stage is characterized by an alternating, expanding and narrowing process of exploration and crystallization. The expanding aspect of exploration involves searching for information or data about the Task and about the Self-Concept in relation to the Task*[1].

The *Task* here can be related to the particularities of the career or major, which is the aim of this study. On the other hand, the *Self-Concept in relation to the Task* has a strong connection to the *Competence Beliefs*, as defined by Eccles and colleagues in their expectancy-value theory[2]. This second part presents an interesting opportunity for further exploration, but is out of the scope of this paper.

Similar studies have been conducted in the context of specific programs. In a qualitative study, Lewis et al. identified five factors that students assessed in deciding whether to major in computer science: ability, enjoyment, fit, utility and opportunity cost[3].

A study by Martin et al. showed the different sources of social capital involved in student's decision to choose engineering as a major. Social capital sources included high school counselors and teachers, college advisors and faculty, family or friends who were engineers, as well as previous engineering-related activities such as camps and career days. These findings suggest the great importance of social resources in electing to pursue engineering. In this investigation, we examine social resources further[4].

First Year Engineering (FYE) programs are common in universities in the United States. They usually administer integrated curricula, aiming to offer students stimulating environments and problem-solving experiences from an interdisciplinary stance[5]. These programs expose students to a broad concept of engineering and particularities of various fields. Such exposure not only provides students with relevant information for the selection of a major but may also benefit the engineering profession by increasing student attainment and persistence[6].

This study was conducted on FYE students at a large Midwestern university. One of the aims of the FYE program is to provide different resources to help students make an informed decision about which major to pursue. These resources include various in-class activities such as guest speakers from different engineering departments and faculty advising.

The purpose of this study is twofold. Firstly, we aim to uncover the resources students use to make an informed decision about which engineering major to pursue. Secondly, based on the findings, we will provide recommendations to the FYE administration on ways they can improve the program and learning experiences for students.

This paper starts by discussing the context, analyzing previously available quantitative data sets, and discussing preliminary results based on these. We then discuss the usefulness of performing interviews and describe participant demographics. This is followed by creation of an interview protocol, analysis of the transcripts, and discussion of our findings. We conclude by providing recommendations for FYE administration and future directions of this research. Figure 1 illustrates the salient features of this study, the procedures used and the end product of each step.

## Methods

### *Context and Preliminary Data*

At the start of this study, the FYE administration provided us with three datasets. Two of them were the results of official surveys filled out by FYE students: 1) Transition to Major survey (TTM) and 2) End of Semester survey (EOS). The third dataset came from a classroom activity implemented by the Environmental and Ecological Engineering department (EEE) with their students. In the following sections, we will discuss these data sets, the preliminary results acquired from the data analysis, and the necessity of probing further using a qualitative approach.

| Phases of the Study | Procedure | Product |
|---|---|---|
| Quantitative Data and Data Analysis | Basic statistics applied on data already collected:<br>- Transition to Major survey (TTM)<br>- End of Semester survey (EOS)<br>- EEE Data | - Descriptive Statistics |
| Connecting Quantitative and Qualitative Phases | - Quantitative results informed interview protocol development<br>- Email invitation sent to FYE student population | - Interview Protocol<br>- 12 Interview Participants |
| Qualitative Data Collection | Semi-Structured interview | - Audio recorded files<br>- Text transcripts of interviews |
| Qualitative Data Analysis | Content Analysis of transcripts | Codes and themes |
| Integrating Quantitative and Qualitative Results | Interpretation of Qualitative results and connecting them with Quantitative results | - Discussion<br>- Implications<br>- Future Research |

Figure 1: *Phases of the study, procedures used and end product of each step. Figure adapted from Ivankova et al.*[7]

*Transition to Major (TTM) Data and Results*

At the end of their first year in FYE, students are required to respond to a *"Transition to Major"* survey which asks the respondents to provide: 1) personal and demographic information, 2) their top two major choices in order of preference and 3) to rank the sources which were important for students in making their decision of major. We analyzed the data collected from this survey from three different semesters (Summer 2013, Fall 2013, and Spring 2014) and found that of the 13 different sources of information, *Self-Led Exploration* (SLE) was ranked as the most important by the students.

Table 1 presents the consolidated results of the TTM surveys for Summer 2013, Fall 2013, and Spring 2014. Students were asked to pick the resources they found useful from a list of 13 items and rank them in order of importance, with the most important on top of the list. As indicated in table 1, SLE is not only the resource most often selected by students, but also the highest ranked on average (a lower number in this case means, a higher rank).

At Purdue University, ENGR131 is offered to FYE students in the first semester. This course has been specifically designed to provide a broad experience of different engineering disciplines. ENGR132 is offered in the second semester as a follow-up to ENGR131. Both the courses are mandatory for all FYE students. Unless otherwise indicated, the activities listed in Table 1 take place in ENGR131.

Table 1: *Students' ranking of the resources used in deciding their engineering major*

| Item | Occurrence | Average rank |
|---|---|---|
| Self-led exploration of engineering disciplines | 496 | 2.26 |
| Advice from family or friends not at Purdue | 349 | 2.89 |
| Advice from other Purdue students | 344 | 2.95 |
| An "Engineering Your Major" session | 274 | 2.63 |
| An extracurricular activity or experience | 256 | 2.83 |
| Guest Presentations in ENGR131 | 166 | 3.15 |
| Advice from a faculty member | 162 | 3.48 |
| Advice from an FYE Advisor | 136 | 3.51 |
| An engineering seminar course | 120 | 3.79 |
| Class material in ENGR132 | 74 | 4.72 |
| A disciplinary seminar course | 64 | 4.45 |
| Other class material in ENGR131 | 58 | 5.59 |
| Other | 50 | 2.80 |

*Note.* Data gathered from 800 respondents. The sum of occurrences does not add up to 800 since students could pick as many items as desired. Average rank for a particular item was calculated only within the answers that included such item. Lower numbers denote higher ranking. "Guest Presentations" refer to a formal activity where representatives from the different majors present their disciplines within a class. Similarly, the "Engineering your Major" sessions are lectures organized by an Engineering Student Council, aimed to present the different majors to FYE students.

*End of Semester (EOS) Data and Results*

The second survey that students respond to at the end of their first semester in FYE is the End of Semester survey. The EOS survey asks them about the usefulness of the ENGR131. In this survey, students answer an open question: *Did activities in ENGR131 help you decide which Engineering professional school to enter? Please explain.*

From a sample of 178 answers (Fall 2013), responses indicate that 54% of the students found the activities useful, 9% believe the activities reinforced their already-made decision, 21% did not find them helpful because they already knew which major to pursue, and 16% did not find them helpful at all. Hence, 30% (9% + 21%) of the students seemed to have a solid idea of the major they wish to pursue before entering FYE. This finding suggests that many students are undergoing some experiences and doing some sort of explorations which are helping them decide which engineering major to pursue before enrolling in an Engineering undergraduate program, which is our a-priori understanding of what SLE means.

The answers to the EOS survey also provide some clues as to the activities students found most useful. Since the answers to the open questions are in a narrative form, we decided to use content analysis to make sense of the answers. While the results of the first survey informed us that SLE is what the students are doing, the results of this survey give us a better sense of what kind of SLE is being done by the students.

Figure 2 presents the EOS survey content analysis results. Software for qualitative research was used to perform word counting on the open-ended answers. Words referring to similar concepts were discussed amongst the research team and aggregated in instances where they were synonymous. Words with a count of two or higher were included.

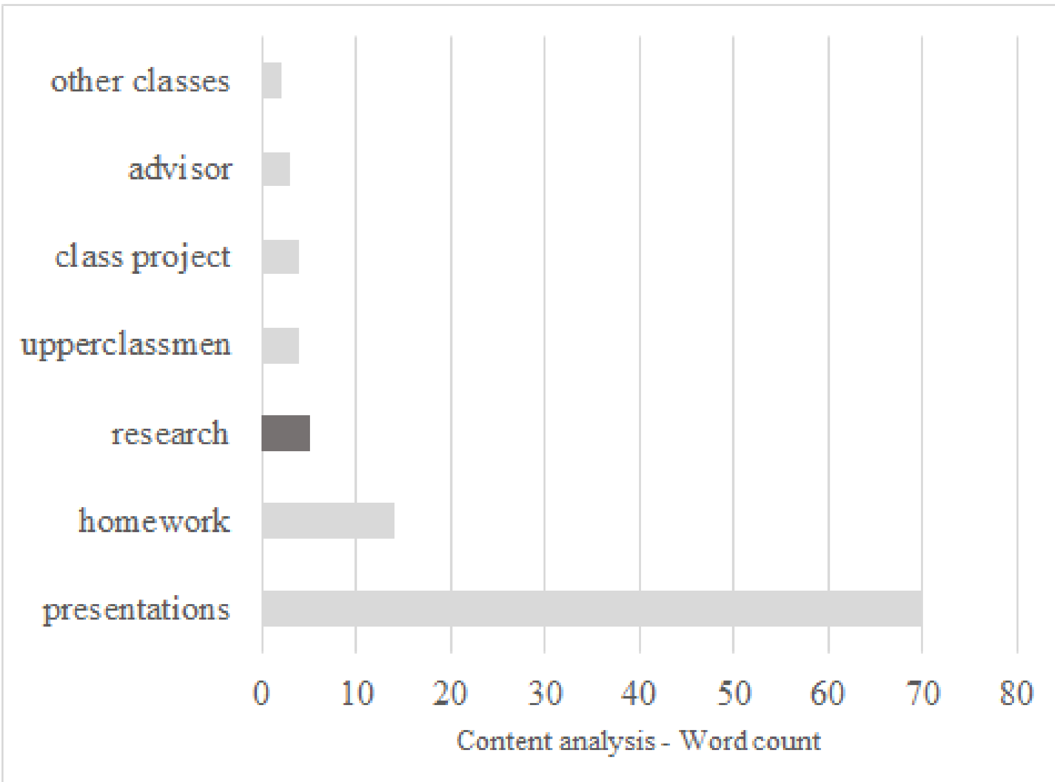


Figure 2: *Word count of the activities regarded by FYE students as useful in deciding their engineering major*. The figure only shows the results where the word count was greater than 2. "*Presentations*" and "*homework*" occur in the context of ENGR131, whereas "*research*" emerged spontaneously in the list, something we were not expecting to see. Upon reflection and observation of survey responses to this question, we realized that while the question was asking students about the activities in ENGR131, they reported doing some research on their own which helps them make a decision regarding their major.

Figure 2 shows that the activity students find most helpful are the presentations. However, an additional finding can be highlighted from these results: After the activities occurring in the context of the ENGR131 course, the first item that emerges from the content analysis is "*research*".

*Environmental and Ecological Engineering (EEE) Data and Results*

In addition to the information provided by the FYE program administration, we had access to the results of an activity conducted with students entering a particular engineering program at the same institution (Fall 2014). The activity is designed to evaluate the ease of access and relevance of the information provided on the webpage of the program. However, we are particularly interested in two questions that students answer as a pre-survey part of the activity.
The first questions reads: *When choosing your intended major in engineering (e.g. Civil, Environmental, Mechanical Engineering), what kind of research have you performed on the different majors?* It is worth noting that this question is more open than the one presented in the EOS survey since it does not mention a specific course or set of activities.

Using structural coding we performed content analysis and word counting on the answers provided to the aforementioned question[8]. Three of the researchers coded individually, shared their results, and negotiated the discrepancies to agree upon a final coding scheme. Although inter-rater reliability was not calculated, the level of agreement between the individual coding results was high. The results are presented in table 2, where "*Research*" emerges as the main resource used by students.

Table 2: *Word-count of the EEE activity pre-survey, question 1*

| Code | Count |
|---|---|
| Research | 41 |
| online research | 28 |
| other research | 13 |
| People (nonacademic) | 33 |
| family & friends | 23 |
| other engineers | 10 |
| People (academic) | 27 |
| upperclassmen | 17 |
| advisor | 7 |
| professors | 3 |
| Presentations (ENGR131 & Others) | 18 |
| Experiences | 7 |
| work experience | 1 |
| high school | 2 |
| homework | 4 |

*Note.* The count of the indented codes were added to produce the total count of the main (non-indented) codes.

The second question presented to the students in the pre-survey reads: *What will most influence your decision when choosing your engineering major?* Although out of the scope of this study, the answers to this question (not discussed here) provided us with a hint of students' perceptions of *value* in the choice they made[1]. We identify here an interesting opportunity for further expanding this research.

The results of the TTM survey revealed that the students are mostly doing SLE to decide which major they intend to pursue. The EOS survey revealed that some students are doing SLE even before they enroll in the engineering undergraduate program whereas many of them are doing SLE while in the FYE program. It is important to note that the students mentioned the topic of *Research* in a survey that asks only for the activities within a course. *Research* was not one of the explicit activities, which further reinforces the idea that SLE is the main activity that helps students make a "major" related decision.

However, we were still unsure about the kinds of SLE these students were doing as both surveys are not directly asking them these questions. As mentioned previously, table 1 lists the ranking of the resources important for students in making a decision. Although SLE makes it to the top of the results, some other options on the list could be classified as SLE (e.g. advice from family or friends) but are listed as separate options on the survey. This does not give any perspective as to what kinds of SLE are being performed by the students.

The EEE survey played an important part: unpacking some types of resources students used when performing their self-directed research. Ultimately, this type of research is what we relate to SLE. To understand the meaning of self-led exploration, gain insight into the process used by students to make a major choice, and learn more about the kinds of research the students were doing, we decided to interview FYE students.

*Participants and Interview Protocol*

In order to further probe the concept of SLE, we conducted interviews on a sample of 12 FYE students. We sent an email invitation to all students from the current ENGR131 course. Twelve students were then selected on a first-come, first-served basis, following the characteristics of the FYE population at the institution in terms of gender. Based on data from Fall 2013, the sample consisted of nine men and three women.

The qualitative information we gathered was audio recorded. The intent was to capture not only the verbal content but also the non-verbal cues that students may have exhibited such as voice inflections, hesitations, etc. Additionally, audio recordings also provided validation and coherence between what interviewees said and what they meant.

The interviews were set up in focus booths, with minimum disturbances during the conversation. After getting acquainted with the interviewee, the interviewer described the purpose of the study and requested them to sign an IRB consent form. The interviews were semi-structured, as often times the interviewers had to ask additional questions in order to clarify comments made by the students. The average time for an interview was approximately 15 minutes.

The interviewers followed an interview protocol developed by the research team and approved by the institutional review board. The interview questions are presented in table 3.

The first 3 questions helped us get students engaged in thinking about their decision-making process. Questions four and five are directly related to our research question and were purposely stated without any relation to the major choices described by the students in order to get a broader view of the resources they used. Question six allowed us to examine the value-beliefs students have regarding their preferred major choice and look for possible relations between their value-beliefs and the nature of the resources used[5].

Table 3: *List of structured questions asked during interviews*

| Number | Question |
|---|---|
| 1 | What are your top-two major choices in order of preference? |
| 2 | What do you think (choice one) is? |
| 3 | What do you think (choice two) is? |
| 4 | How did you arrive at those ideas, definitions, and constructs? |
| 5 | Thinking about your previous answer, what other resources did you use to inform your decision? |
| 6 | Why do you want to be a (choice one) engineer? |

*Data Analysis*

The data was manually transcribed by us and then analyzed and coded using structural coding, particularly focusing on answers to questions four and five[6]. The names of the students were also converted to pseudonyms to ensure anonymity of the participants. To analyze the data, we listened to the interviews and followed along with the transcript. Codes were created as we listened and read through the interviews. The SLE prefix was assigned to every instance that explicitly evidenced resources and activities proactively sought out by the students. A code was then assigned to identify the kind of resource used. This scheme allowed us to approach activities that could be both SLE and non-SLE related.

Table 4: *Descriptions of the most relevant interview codes*

| Code | Count | Description |
|---|---|---|
| SLEOR | 10 | Research conducted online by the student of their own volition. Self-led online research. |
| SLEP | 8 | Proactive discussions led and sought out by the students of their own will with professionals (professors and practicing engineers) |
| SLESYN | 6 | Explicit and deliberate synthesis of information initiated by the student from diverse sources in an effort to define specific disciplines more clearly for themselves. |
| SLEPE | 6 | Experiences that happened before college including engineering electives and engineering outreach activities (such as robotics) in high school that were sought out by the student of their own will. |
| SLECW | 5 | Electives the student enrolled in during college. |
| SLESA | 5 | Discussions initiated by the students with peers and upperclassmen. |
| PE | 6 | Experiences that happened before college, including field trips, high school classes, and museum visits. These experiences were part of school programs or were initiated by faculty or parents. |
| GS | 6 | Guest speaker presentations from different engineering schools appointed by FYE administration to inform students about the schools. |

*Note.* We provide verbatim excerpts typifying the SLE codes in the findings section.

In order to determine the weight or importance of the particular source of information, various instances of the same code within the same interview were coded independently if they referred to different sources. This allowed us to determine not only when a resource was used by a student, but also how important it was and the different contexts in which it proved useful. Table 4 presents the most recurrent SLE and non-SLE related codes (those with a count of 5+) and their descriptions. There were 11 SLE related codes and 10 non-SLE related codes.

As stated earlier SLE is the top ranked resource in the TTM survey. In an attempt to determine if any of the other twelve TTM items included SLE, in table 5 we mapped the most frequently occurring codes from the interviews back to the survey items. Some of the 12 items map to both SLE and non-SLE related resources.

Table 5: *Mapping most prevalent codes to the TTM survey items*

| TTM item | Related codes |
|---|---|
| Self-led exploration of engineering disciplines | SLEOR, SLESYN |
| Advice from family or friends not at Purdue | SLEP |
| Advice from other Purdue students | SLESA |
| An "Engineering Your Major" session | GS |
| An extracurricular activity or experience | SLEPE, PE |
| Guest Presentations in ENGR131 | GS |
| Advice from a faculty member | SLEP |
| Advice from an FYE Advisor | - |
| An engineering seminar course | - |
| Class material in ENGR132 | - |
| A disciplinary seminar course | SLECW |
| Other class material in ENGR131 | - |
| Other | - |

Not all codes are illustrated in the table. For example, throughout the interviews there are instances in which “Advice from family or friends not at Purdue” was not self-led. However, the self-led instance of this resource dominated the interviews and it is therefore the one listed in the table.

**Findings**

The qualitative findings reinforce that students are basing their major-choice largely by using SLE, as foreshadowed by the surveys. In addition, the interviews helped us explicate the meaning of SLE and also revealed the importance of direct contact with people. We will discuss these findings in the subsections that follow:

*Prevalence of SLE*

Using self-led exploration to make a decision of major is the top choice for students both in the quantitative results and qualitative findings. Codes related to SLE account for as much as 65% of the total instances we identified in the transcripts, supporting the results of the surveys.

*Unpacking SLE*

The open answers to the interview questions helped us unpack the broad SLE concept into more specific sources and activities, ranging from online research to interactions with students and professionals. We now discuss the most recurrent codes and provide excerpts to help the reader make sense of their meaning.

**SLEOR** includes online research on official webpages of the schools/departments, the Bureau of Labor and Statistics, and other sites that provide information not only about the definition of the programs, but also the job market, salary perspectives, flexibility, etc. For instance, regarding information about the programs themselves, Roberto mentioned:

"*Just going on websites and looking up the majors and like, specifically here the courses you'd take at Purdue to prepare you for work in the field.*"

On the other hand, regarding the specific definition of the profession, Nancy mentioned:

"*...I mean (laughs) my professors never said to use Wikipedia as a source, but I did look up, you know, mechanical engineering on Wikipedia.*"

**SLEP** refers to the interactions with professional engineers sought out by the students. As described by the following students:

Caroline: "*And I was talking to a woman who works for Honda as a chemical engineer and she's like, we really don't learn about like the chemicals that you use and like that, we learn how to like, we learn the process of coming down to a solution. That's how like, that really is more like what engineering is than like using like chemistry or using physics in your life. So that's kind of what like helped me realize what engineering was.*"

Michael: "*Um, in terms of mechanical I haven't had a whole lot of hands on experience myself I can say but I've heard a lot of things I've talked to other engineers who are mechanical and that's the best I can really say to answer that.*"

**SLESYN** is particularly interesting, for it indicated a higher order and more complex process than simply gathering information. It connotes an intentional use of the information gathered. As expressed by Nancy:

"*...um, they have like all of those statistics [on the websites], and so basically I was just comparing all of the different engineering fields with one another, you know, um… I was trying just to determine, you know, what would the salary be and after college, what's the job market like.*"

Janice provided another interesting way of looking at SLESYN, which overlaps with SLEOR:

"*...And I also go online and try to read about things, so I can think of better questions to ask.*"

**SLEPE** interestingly describes experiences prior to college that are not a part of FYE activities such as robotics teams in high school.

Cristina, Ernest and Nancy all mentioned high school robotics team experiences.

Jack's high school experience describes other courses that elucidate SLEPE:

"*Yeah, I had a few engineering classes throughout high school. Sophomore through senior year I took like ... they weren't like actual ... well they were actual engineering classes but they were like electives and they just kind of went over a lot of which was going over the different kinds of engineering, what that engineer would do and civil and chemical always stuck out to me…*"

**SLECW** entails electives mentioned by the students as important in helping them inform their decision. Jack commented on this:

"*Uh, online, over summer you would look them up cause there were other schools that I was applying to that made me choose my major before I would go there. They didn't have a first year engineering program which is a big reason why I came here so I didn't have to make that choice right away because I didn't want to choose incorrectly and I took the [elective] class here and that helped a little bit.*"

Jack's excerpt is also of note because he mentions the benefits of an FYE-type program.

**SLESA** comprises interactions with other students, either peers or upperclassmen, which students initiated in order to gain other perspectives on their decision-making process.

Harry mentioned two interesting things: "*Just talking with like, talking with my peers that are going through the same thing.*"

He also said: "*Um, the only two students that I've been talking to are the, my teachers. They're peer teachers. They're both juniors um, one's a mechanical and the other is a chemical so like I've been talking to them.*"

These quotations from Harry illuminate the importance of peer and upperclassmen interactions. Both Harry and Cristina mentioned experiences that took place outside the formal education environment:

Harry spoke about his fraternity as a resource: "*Also, my fraternity, the guys at my fraternity, the older guys have helped me to figure out like, in terms of what they did and what could do. So that's helped too.*"

Cristina mentioned that she "*also talked to a few different engineers about what they do and some engineering students, umm, at different colleges where I visited.*"

*Importance of direct contact with people*

Guest speakers presentations, both sponsored by the FYE administration and the Engineering Student Council, were the first non-SLE related activities in the TTM survey, and also appeared at the top of the qualitative analysis, as indicated by the dominance of the GS code within the non-SLE related sources. Therefore, guest speaker presentations play an important role in the student's decision making process.

We observed throughout the qualitative findings that talking to engineers who are experts in their fields is also very important for the students, both in a self-led and a non-self-led way. These experts may be faculty, advisors, parents, family members or other people in industry. As depicted by George and Bob in some passages we coded as PE:

George: "*Well, my dad was a laser operator back at that time, so he was a little bit of a gadget geek, like we all are, all of us aspiring engineers in anything, um, and so he's bringing home like new computers and, um, showing me how like the lasers original had a punch tape style of software and that's how they run, and he was showing how the first machine languages basically is evolving into some of the new stuff… and so that got me sparked into the computers.*"

Bob: "*Well all the fact that I had experience in an engineering environment prior to going to this as an electrician a nuclear electrician in the navy, so oh I was like I should be able to work in this field quite easily.*"

It is worth noting that the sample consisted of two non-traditional FYE students. These students were older, more mature, and had professional experience. We found these two students were using the same types of resources the younger students were, but their previous experiences allowed them to use the resources with a deeper understanding and confidence. The following quote by Bob shows that he is using his previous experiences to deepen his exploration of a possible major:

Bob: "*So, a lot of it was research before I came to ... came back to Purdue. I actually took a break. I was a physics student prior to this and I came back because I really didn't really want to be a physicist.*"

These student narratives were complexly interwoven. Their rich experiences allowed them to use the same resources in a more deliberate way, as shown in this quote:

Bob: "*... I went back this time around to IR (Industrial Roundtable), this year and talked with a whole bunch of people and asked them if they would hire an electrical engineer what would they do, so I did a lot of independent research like talking to random people...*"

Explicating SLE revealed a broad spectrum of activities, from performing online research to talking with more knowledgeable others. This contact with people proved to be paramount to guiding students' exploration. Lastly, previous experiences from mature students enriched their decision-making process.

**Validity and Limitations**

In this section we will address some validity concerns and limitations:

- As bias in qualitative research is inherent, qualitative data was analyzed attempting to increase trustworthiness. For example, all researchers have an engineering background, which made it easier to understand and interpret the engineering jargon students used in the interviews. Additionally, the verbatim transcripts of the interviews were triangulated by at least two researchers for accuracy and correct interpretation.

- Since the methods in this study are not guided by a theoretical framework, the results of this study are not generalizable and are local to Purdue University and its FYE program.

- The limited scope of our study influenced the design of the interview protocol and questions. As a result, the interviews were shorter than expected, missing the opportunity for in-depth exploration of emerging themes (e.g. the importance of talking to practicing engineers).

**Recommendations & Future Directions**

Based on our findings, we have the following recommendations for the FYE administration:

- The FYE administration should provide more information on their website: Salary and job-market information, a day in the life of an engineer, and useful links.
- Since our findings suggest the guest presentations are playing a key role in the students decision making process, we recommend that the departments work on improving their presentations, aiming to present students realistic and accurate description rather than overselling their programs.
- The FYE administration can improve the TTM survey by asking students to list examples of self-led exploration as answers to open ended questions.
- The FYE administration should encourage students to explore career experiences on their own by interacting with practicing engineers. The University's alumni network could be utilized as a resource to provide professionals.
- In order to encourage students to extract and synthesize information from multiple sources, ENGR131 should present a breadth of different resources with information about different majors. The resources should emphasize diversity of career opportunities (e.g. different professional pathways, prospective jobs, salary, etc.) and experiences possible for engineers.

The following bullet points present some of the future directions:

- Question six of the interview protocol (*Why do you want to be a (choice one) engineer*?) was intended to collect information about the student's values associated with their decision regarding their major. Responses to this question can be analyzed for more in-depth insights into student's expectancy values, particularly exploring relations between students' attainment and the type of resources they prefer to use.

- Students mentioned guest speakers and info-sessions frequently in the interviews. Further investigations based on this could include 1) how the info-sessions impact students' decisions and 2) recommend suggestions for improvement to departments on how to further improve their presentations.

- A recurring theme throughout our interviews that proved useful to students was the importance of talking to practicing engineers. This theme can be explored in further studies to better understand how to harness it as a resource in FYE classes.

- It would also be interesting to see if there is a correlation between sources of information and perception of values related to the decision of major that they make.
- It will also be useful to know the faculty's (instructors and advisors) perspectives on how students make their decision. How involved are they in the student's decision making process and how much are they impacting this process. In short, are they giving students SLE related ideas?

## Conclusions

The qualitative findings help us understand how students make an informed decision of which engineering major to pursue by highlighting the importance of SLE, the importance of direct contact with people, especially practicing engineers (SLEP), and the usefulness of providing an environment that encourages deliberate self-led synthesis from multiple sources (SLESYN).

Unpacking SLE allowed us to 1) define this term with respect to the exploration students were doing complementary to classroom activities in order to make a decision of major and 2) make informed recommendations to FYE administration to refine those resources students identified as their main sources of information. The recommendations we've provided based on our findings of SLEP and SLEPE are congruent with findings from Martin et al. that suggest to help enhance social capital utilization by increasing information flow to students and leveraging "peer groups and institutional support systems".

## Acknowledgments

This work is made possible by internal department funding. Any opinions, findings, conclusions, and recommendations expressed in this material are those of the author(s). We would also like to thank all the other departments, faculty members, and individuals who provided valuable input, and feedback for this study.

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