Exploring the Factors Related to Chemical Engineering Students' Study Abroad Choice

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Abstract

Studying abroad can teach engineering students about the differences in engineering in different contexts and the importance of incorporating diverse perspectives in their work. When institutions are designing study abroad programs, there is value in understanding how students are making their decisions of whether and where to study abroad so that program leaders know what to prioritize and emphasize. This study uses the theoretical framework of the push-pull model of international exchange choices to analyze students' answers of how they chose a study abroad program for an undergraduate chemical engineering unit operations lab. Students could choose to enroll in a summer lab course at their home institution or one of two destinations in Europe. Pull factors draw interested students toward a specific choice, which is the focus of this study. The results indicate that program-specific aspects are valued by students, along with cultural connections and personal connections. Costs, which can be financial, personal, or duration based, also are significantly weighed by students. Institutions can use these discoveries to know what information to present to students and which program design considerations seem to matter to students as they seek to build interest in a specific study abroad program.

Introduction

It is valuable for engineering programs to help their students develop global engineering competencies before they enter increasingly international workplaces [1], [2], [3]. One way that engineering programs encourage global engineering competency is through study abroad programs. Studying abroad helps students develop their global attitudes and perspectives and apply their global competencies in an authentic context [4], [5]. Studying abroad can have high barriers to entry, with factors such as cost, rigid engineering curricula, and the opportunity cost of passing on an internship or other work experience as most prevalent obstacles [6]. With so many potential barriers to entry, there is a need for further research to illuminate the factors that lead students to choose to enroll in international programs.

Different types of study abroad programs encourage various skills and fit the needs of different students. The variations of program designs can include length, language of instruction, degree of immersion, emphasis of engineering, and more [7]. Instead of exploring a broad scope of programs, this study looked at a single population of students who had the choice to meet the same degree requirement between three programs that primarily varied on the following dimensions: location, length, cost, and exchange type. In this study, chemical engineering students were interviewed and asked how they decided which program to enroll in for a summer lab course out of three choices: 1) remaining on their home campus, 2) an exchange program to Germany, and 3) a direct enrollment in Denmark.

Purpose

The purpose of this qualitative study is to explore the factors that engineering students consider when making the decision of which study abroad program to select. Their decisions are explored

through interviews and analyzed through the lens of Mazzarol and Soutar's [8] model of the push-pull characterization of study abroad choices.

Research Question

1. Which types of pull factors do chemical engineering students identify as influences on their decisions of where to study abroad?

Theoretical Framework

Mazzarol and Soutar [8] designed their push-pull model of study abroad choice to characterize why students make the decisions they do when it comes to enrolling abroad as an international student. The pull factors make a destination attractive to a student, which is influenced by the host country, sending country, and the student themself [8]. The initial definition of this framework came from a survey of over 2,000 international students in the 1990's to learn how different factors were weighed in their decisions to enroll abroad. They examined each step of the process; from deciding to study overseas, to personal and financial costs, to destination factors, and specifics of the host institution [8]. In this study, the theoretical framework was used as a lens for analysis with both a priori and emergent codes. The a priori pull codes are listed and defined below.

Pull categories:

- Knowledge of the institution-Students are making their decision based on the specific institution at which they will study. These factors often include variables such as easily accessible information about the institution that is also presented in ways of interest to the student.
- Environment-The environment in which students are studying includes factors such as the local climate, available tourist attractions, and general lifestyle factors that differ depending on students' interests, such as a lively nightlife or a quiet, safe town.
- Proximity-Distance and accessibility to students' home is an important factor of consideration.
- Social links-Having friends or relatives currently living or studying at their destination are considered social links.
- Personal recommendations-Family, advertisers, professors, or overall reputation of an institution can be a pull factor. Considerations include people the student knows visiting the location in the past, as opposed to currently being located there in social links.
- Cost-Considerations include both economic costs (the cost of living, fees, travel cost) and social costs (safety, access to visa, racial discrimination, crime).

Literature Review

Prior studies have examined the factors that influence students' decisions of the destination in which they wish to study abroad. Eder et al. [9] interviewed students from several different countries using the same theoretical framework as this study about how they selected one U.S. university to study at for a semester or year. The primary pull factors were college-specific, physical geography, and U.S. culture. The students said that they wanted to enroll in specific

courses or programs and asked their home university for recommendations of where to go. They also cited warm weather in the American south and ease of travel to other states, along with either enjoying the similarity of or wanting to learn more about U.S. culture [9].

Kim and Zhang [10] explored the similarities and differences between Korean students' interest to study abroad for short and long-term programs through a survey. The pull factors of priority for short-term programs were tuition, interest/fit, and quality of universities. The top three factors for long-term programs were the same. Language and culture were less important for long programs. This result is similar to Kosmaczewska's [11] findings that the host university, environment, and affordability were the most important factors for European students enrolling in short-term programs.

Multiple studies have corroborated the finding that social and personal ties are important factors to students. Nyaupane et al. [12] noted that students weighed factors differently depending on if they had traveled abroad previously or not. If they had not, external frames of reference for a country were very important. Overall, academic motivations and social ties were extremely important. Bretag and van der Veen [13] found that in deciding to enroll in a short-term trip, experiencing new cultures and having fun were high priorities for students.

Our study adds to this existing literature by examining a student population who had a clearly defined choice between three options. The factors cited by students will reveal how they balance different interests in their choice of where to enroll. It is unique from prior work in that these discrete options were tied to the same disciplinary requirement for completing a particular course in students' plan of study, and all students in the department had to make this decision, not only students who might have the predisposition to inquire about study abroad options.

Contexts

The students in this study are all third or fourth-year chemical engineering students at a U.S. university. As a part of their degree program, they are required to take the Unit Operations Laboratory course in the summer. This course features hands-on labs using a variety of equipment. Students can choose to take the course at one of three universities. The most popular option is taking it at the home university, where the students enroll as a summer student for a six-week course. During this time, they complete eight lab assignments in groups of four. This option is the only section graded on a traditional A-F scale instead of a pass/fail grading system.

Alternately, students can choose to enroll in one of two study abroad options to complete the course requirement. The longest program is at a German university, whereby students spend eight weeks in an exchange program enrolled in the Unit Operations Lab alongside students from the German University. Students complete six lab assignments in groups with U.S. and German-enrolled students and complete 40 hours of research assisting a graduate student during the program. They live in dormitories with local and other international students. This version has the fewest hours of work within the class required per week.

The third option is a direct enrollment program at a Danish university. This course takes place over four weeks; only students from multiple U.S. institutions are enrolled in the course, which is taught by local faculty. Their assignments are graded by a home-institution faculty who travels with them. It is considered an intense month, and students are discouraged from traveling during

the program so that they can meet the course's work requirements but may arrive in Europe early or stay late after the course is complete.

Methodological Approach

The research presented in this paper leverages an existing dataset of interviews which had been analyzed in a related study for different purposes [14]. The previous work concentrated on the push factors influencing students' decisions about whether to pursue study abroad opportunities. The present study extends this inquiry by examining the specific pull factors that attract students to each of the destinations and options within the context of study abroad.

The primary data collection method was interviews with the goal of the students' individual attitudes and perceptions [15]. An invitation to participate in an interview was extended to all students enrolled in the program. Their answers when asked about their motivation for selecting a particular course option were analyzed within the framework of the push-pull model of study abroad choice [8].

Data Collection

The researchers recruited student participants through email invitations, sent by both the home campus faculty and the research team. Participation was voluntary and there were no external incentives offered. Additional on-site recruitment was conducted by the research team, who attended the lab sessions and invited the students to participate in interviews regarding their study abroad experiences.

Although focus groups were initially planned, scheduling challenges led to the adoption of individual or paired interviews, which did not appear to influence the nature of the responses compared to focus groups. When a question about the role of finances in program selection was asked, all participants elected to respond, often specifying that they chose the most affordable option. The openness in discussion may have been aided by the peer relationships that the students had fostered through prior shared classes and major-related interactions at their home institution and experiences abroad.

Interview durations ranged from 20 to 45 minutes and were conducted with the expressed consent of the participants for both audio-recording and subsequent transcription. All interview records were anonymized. For this paper, repeated or filler words have also been removed from the quotes for clarity. While most interviews were conducted face-to-face, a few were facilitated via Zoom at the request of the students after the researcher's departure from the program site.

The interviews were semi-structured and served as a component of the home university's assessment of their chemical engineering lab program. All students were asked "Why did you choose this track of the UO lab?" Follow-up questions asked them to specify why they chose one study abroad over another or if they had studied abroad, where they would have chosen to go.

Participants

This study was looking at a single population: chemical engineering students from one U.S. university who had finished their third or fourth year in the program. Their answers were

compared in this study after they had chosen different programs to enroll in for the unit operations lab course. All students in each program were invited to participate. The total student population invited to participate was 85 students, of which 50 students were studying at the U.S. university, 11 students at the German university, and 24 students at the Danish university. The number of students who agreed to participate in our research study were five students in the U.S. option, seven students in the Germany program, and six students in the Denmark track.

Analysis

An a priori codebook was created based on the push-pull framework and defined in the Theoretical Framework section. The students' answers were coded structurally based on the existing codes and the researchers were open to emergent codes. Structural coding categorizes quotes based on their content and is analyzed based on frequency in a well-defined qualitative study [16]. Quotes that described a pull factor which did not fit into the codebook were collected, labeled, and categorized into emergent themes. The coded quotes were put into categories based on context and codes. Exemplary quotes are included in the results section.

Limitations

This study is designed around a specific course context offered by a single institution. The insights are useful in seeing students' priorities, but this study is not generalizable since each program option within that course has specific characteristics. The data source for this study is students' opinions as opposed to other stakeholders' perspectives, such as instructors and program administrators, which could be a valuable future study. Additionally, there is an opportunity for self-selection bias in this study. All students enrolled in the courses were invited to participate, but their engagement was optional. There could be differences in opinion between those who chose to participate and those who did not. Finally, data were collected once travel resumed after COVID-19 restrictions, but study abroad participation had not reached pre-pandemic levels at that time. There is the possibility that student engagement in these programs has not yet returned to a new stable state.

Research Quality

The relevant answers from the interviews were thematically coded based on the codebook and emergent themes. The codebook and coding were corroborated by multiple authors, two of whom performed the interviews and one who acted as an external researcher. One author did the initial coding which enabled consistency in the initial coding. The other interviewer reviewed the results and offered feedback. During a peer debriefing session, data which could have had multiple codes were discussed until a consensus was agreed upon [15], [17].

Results

The pull factors led students to enroll in a specific option for the course over the other ones. Cost, recommendations, and course specific factors such as location and duration seemed to play the most prominent roles in students' decision-making.

Knowledge of the institution did not appear to be a significant pull factor for any of the programs. None of the students mentioned the host institutions by name in any of the interviews. Since students take a particular course in this short-term program, it seemed that the course itself had more impact on decisions than the university's qualities. In Germany, multiple students cited the fact that it was an exchange program as intriguing to them. An exemplar quote is "Germany is an exchange program rather than Denmark. So, we would actually get to interact with German students, which I thought would be valuable." Students in the Denmark program did not discuss the program being direct enrollment as influencing their decision.

Environment includes lifestyle of the area, the town itself, and the climate. The only student who mentioned the city of the program was a student on the U.S. program who had heard good things about the town in Germany, saying that if they had elected to go abroad "From the student perspective I hear that Germany… has like a little bit better of a town and the experience is better." It seems that the cities were not a significant pull factor, but several students mentioned the location of the country in Europe, which is closely related to environment. Many students in the Germany program described the country as "centrally located" and that the location would make traveling easier and cheaper. Students in Denmark were happy to be in Europe, and one mentioned that they wanted to travel nearby to Sweden, and another mentioned attractions in Copenhagen, saying "I was able to actually visit (Lego's) corporate campus on Saturday in Billund, Denmark, and visit the only official Lego Museum in the world…both of those were an appealing aspects for me for going to Denmark."

Proximity in terms of distance to home or ease of traveling home was not mentioned by any program. This finding is surprising for the students staying in the United States. We learned that the nearness of their home to the university did not seem to impact students choosing to stay there.

Social links did not seem to be a reason that students wanted to cite in their program choice. The only time this consideration was mentioned unprompted was a student on the Denmark program making a disclaimer that even though their friends were with them, they did not choose the program because of their friends. They said that "it was an added bonus that a lot of my friends in the major decided to go to the on the Denmark track as well, but I honestly did not discuss with them which we were applying to."

Personal recommendations seemed to have a significant influence on students in each program. Many students talked to alumni of the program, and some students who went abroad had family connections within the country. Recruiters, professors, and reputation were not commented on, so it seems that social connections have a larger impact for these students. On the Germany program, a student heard from a peer that the Germany program's exchange elements were a benefit, saying "I was lucky enough to have alum friends who did the Germany and Denmark programs in the past. Asking them about their experience, Germany seemed like a much more well-rounded experience where it's more like a true study abroad." A student also had a family connection to Germany: "my mom actually lived in Germany for four years, so I wanted to see that aspect too, where she grew up and what it was like." Multiple students in Denmark had family connections to the country. One students' family had visited before and said "I take (my family's) thoughts into consideration too and they really wanted me to visit. They said it's a great place." Another identified that they wanted to travel to a country because of their family's ethnic

background “I think (I chose this program) just because my family, we're Scandinavian so I grew up with that influence of just food, architecture, so I just wanted to be here."

The same student offered a unique reason for choosing the Denmark program. The student went on to describe their specific interest in Scandinavian culture, which can be considered an emergent code aligned with personal recommendations.

> I knew I wanted to Denmark because I'm really like intrigued by the culture of Scandinavia in general...I actually took a reading seminar my sophomore year about the culture of Denmark, so I got really interested in everything here like Hygge, and all the different like components of a more socialist economy, how things run here. Obviously, there's a lot of differences between how things run here and how the government works in America.

Cost, in terms of personal decisions and finances, was a factor commonly mentioned. Students in both programs abroad and in the U.S. option said that they made their decision based on comparing financial costs. In the U.S. program, several students said they would rather use their money to travel instead of study abroad and the international programs were too expensive with all the costs factored in. One student explained:

> I already have an apartment in [home city] for the whole year. Based off the costs of the other locations it didn't really make sense for me to also go abroad… I would have rather spent that money fully committed to (traveling) versus also having to do with five credit lab.

All students going abroad received a scholarship from the home university. For in-state students, going to Germany was cheaper than Denmark. It is the same tuition as their home institution but had added costs for travel and housing. Bringing up duration, one student said “This program is a lot cheaper than Denmark. It's comparable to the [home university] one...I’m spending less to go to Germany for twice as long." Another student also mentioned that they found travel to be cheaper in Germany than Denmark. Out-of-state students perceived that Denmark was comparable in price to their home university and Germany was more expensive.

> Basically a big motivation was the money factor. I'm an out-of-state student. So, if I'm gonna pay around the same amount of money to go to Denmark or to take the same class in [the U.S], I feel like 9 out of 10 times I was gonna take it in Denmark.

Similar to the students staying in the United States, one student said that they would also rather be focused on enjoying their travel abroad than interspersing it during the program like the students in Germany were.

Duration was an emergent pull category that is specific to this program and has similarities to cost. Students in the U.S program talked about the social or professional cost of spending their summer overseas. One student had a co-op which overlapped with the trips abroad. Another had a personal priority that led to the U.S. course’s duration being best: “[U.S.] finishes the earliest, and therefore I can leave the earliest to join my friends to bike across the country.” Students chose the Denmark and U.S. options because they preferred a short duration. A student in Denmark planned to travel after:

> Being here in Denmark we're here for four weeks, and then if I'm here for an extra two weeks, I get to travel around Europe and have my own vacation, whereas if I was in Germany, I'd have had to run labs for those two weeks.

Many students in Germany said they liked the program having a longer duration of eight weeks, as opposed to four for the Denmark program. It was the most common factor brought up in the Germany program, and it was mentioned by every student except one. They emphasized using the extra time during the course to travel and some mentioned that it would affect the lab's pacing. When asked why they chose Germany over Denmark, an exemplar answer was:

> The reason I chose Germany specifically over Denmark is one is a little longer of a program. Denmark is around 4 weeks; this one is about 8. So, I thought I'd have a lot more free time and weekends to visit other countries and travel around. Mainly I thought I would have a lot more free time to do what I would want to do.

Global engineering also was an emergent code. Since this is an engineering course specifically, there was discussion from students about seeing how engineers work overseas and what engineering is like in other places. A student in Germany said that they were interested in "seeing chemical engineering is around the world." Students in the Denmark program were specifically interested in Danish engineering. One student said, "I was really interested in going to another country and seeing the culture of the country itself but also how they work and study here." Another student was particularly interested in learning how to become a global engineer:

> I love engineering, and I would like to be an international engineer…I had been a lifelong Lego fan and Lego was (created) here. Besides the actual art, and the creativity and imagination that the company continues to inspire people today, they're also an engineering marvel. They are master polymer manufacturers and producers; their quality assurance is unmatched in their position of polymer molding. So, they're a fascinating case study in terms of supply chain management.

Language learning was only an official part of the course program in the Germany. Even though the students in Denmark would be in a country with a non-English national language, students on the Denmark program anticipated interacting with many people who could speak English. None of the students talked about their desire to learn a foreign language with respect to their overall choice to study abroad. Language learning was instead described as a pull factor and an advantage to the Germany course when a couple of students were making their decision. A student in Germany who chose this program over the one in Denmark explained:

> I knew that pretty much everyone there [Denmark] speaks English, because no one really speaks Danish, and that was only four weeks, and you didn't take a language course there, whereas here we were supposed to take like a German language course.

Future career opportunities were mentioned by the students in the Denmark program, specifically their interest in securing future engineering jobs in Europe or attending graduate school outside of the United States. They viewed their abroad experience with this program as being helpful to explore this possibility: "I'm really interested to come (to Europe) because I'm not sure I want to move here and work here instead of the United States."

The Germany program included a supervised research component with a graduate student. Because of this particularity of these contexts, we saw that the students' interest, or lack of, in research was a pull factor. Students who had previous research experience or were considering graduate school were happy to have the opportunity to do research abroad, such as in the case of the following student:

> One was that Germany had research in it and I'm a student researcher at [the home university]. I really liked doing research and I was like, okay, this is gonna give me the opportunity to explore another subject and potentially let me narrow down my graduate school options.

Discussion

There were aspects of each course that were specific to this program and drew students to it. These included duration, aspects of an exchange program, and the location of the country. It was a benefit that there were different options and students could choose the one they preferred. Students in the Germany program wanted the option to take a language course and expand their foreign language skills, so the specific aspects of this program made it a pull factor. Some students also wanted to engage in the undergraduate research in that program.

There are some pull influences that institutions have less control over. Personal recommendations from family or friends were significant to students but it appeared that recommendations from the university were not. This is aligned with Bretag and van der Veen's [13] findings on the importance of fun and culture. One student was interested in Scandinavian culture in particular because of her family's background. Institutions could encourage students to make connections that offer personal recommendations by supporting program alumni panels for recruitment and answering questions.

Institutions should know that social links, proximity, and knowledge of the host institution were not mentioned frequently by students. These factors should not be emphasized by program leaders in the future because students do not seem to prioritize them.

The university is doing a good job of providing financial aid for programs that are abroad and comparable in cost to staying in the United States. This element was a very significant factor to students in their decision making, which corresponds with Kim and Zhang's finding that tuition is always a top consideration [10]. The program could expand financial access and lessen the opportunity cost by incorporating internships abroad, which students said they were missing out on. They could also encourage the students in the Germany program to emphasize their research experience as valuable work experience on their resume. There were some mentions of global engineering, and this notion may be an area that the university can inform students of more in the future. This is a new finding since there have not been many past studies on pull factors that focused on programs that are for engineering studies.

Conclusions

This unique context illuminated students' priorities when deciding where to study abroad. Personal backgrounds and recommendations are strong pulls to specific programs. We saw in

this study that financial support is an important factor that universities should continue to support when creating and promoting such programs. Providing multiple options that had logistical differences such as duration and level of immersion was an opportunity for students to choose the best fit for their specific circumstances. A future study could continue to explore the emergent *global engineering* code and see how that is present in other programs. This type of study could also be expanded to include the perspective of program leaders and compare it to that of the students.

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