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Is Curriculum Complexity Related to Study Abroad Participation? A Cross-Major Comparison at One University

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Introduction

With the increasing globalization of engineering work, it is important that engineering students have opportunities to develop global competence during their undergraduate programs. However, engineering students have historically been underrepresented in study abroad experiences. Although participation has improved in recent years, there remains a need to improve access to study abroad opportunities for engineering students (Jesiek, 2018). Several reasons have been proposed for this gap, including a lack of a tradition of studying abroad in engineering, lack of support from faculty or colleges of engineering, and curricular rigidity that doesn't allow students to go abroad (Grandin & Hirleman, 2009; Parkinson, 2007). Though curricular rigidity is frequently mentioned as a barrier in the literature and anecdotally referenced by many students, little research has explored the relationship between curricular structure and study abroad participation. The recent development of a tool for measuring curricular complexity (Heileman et al., 2017) provides a practical approach for exploring this question.

The purpose of our study is to explore the relationship between curricular complexity and study abroad participation across 48 majors at Purdue University. To accomplish this purpose, we will address the following research questions:

- RQ1: What are the curriculum complexity and study abroad participation rates for the largest majors at Purdue University?
- RQ2: What is the correlation between curriculum complexity and study abroad participation at Purdue University?
- RQ3: Is there a significant difference in curricular complexity or study abroad participation across colleges at Purdue University?

Our project can provide insights to engineering programs seeking to improve study abroad participation about the challenges that may arise from curricular complexity and what strategies may help address this issue.

Background

In this section we will first describe perceptions of how challenging it is to study abroad in engineering programs, then we will define the term *curricular complexity* and explain how it is measured, and finally we will provide a detailed description of the university context where our study takes place.

Perceptions of Challenges for Study Abroad in Engineering

Engineering students have historically been underrepresented in study abroad programs (Institute of International Education [IIE], 2009). Several reports and papers have discussed potential reasons for this (e.g., IIE, 2009; Parkinson, 2007), most notably the Newport Declaration which was developed in 2008 through a summit of engineering educators on the Globalization of Engineering Education. This team of global engineering leaders presented a list of obstacles to the globalization of engineering education which includes such items as: lack of tradition, lack of support from departments or faculty, difficulty transferring credit, and negative perceptions of study abroad. Right at the top of their list is “curricular rigidity,” which they explain by saying “The engineering curriculum is very full and lock-step, allowing little opportunity for students to experiment with things such as language learning, culture study or semesters abroad. In-depth experiences abroad often imply extra time for degree completion” (Grandin & Hirleman, 2009, p. 11). There has been an increase in engineering study abroad in the years since the Newport Declaration was drafted (IIE, 2023), however, the perception remains that it is uncommon for engineering students to study abroad and that it can be hard to fit a study abroad experience into an engineering program. A quick Google search shows that although there are now a range of resources encouraging engineering students to study abroad, there are also many discussions about the challenges of making it happen. For example, articles from websites like Forbes discuss many of the same challenges listed in the Newport Declaration a decade earlier (Klawe, 2019). Conversations on Reddit forums about how to study abroad in engineering tend to devolve into complaints about the tight class schedules and challenges transferring classes (e.g., “Studying Abroad as an Engineer?,” 2022). When we asked ChatGPT whether it was possible to study abroad as an engineering student, the first point the AI recommended for consideration was “curriculum compatibility,” saying that “Engineering courses often have a strict sequence of prerequisites. Ensuring that the courses you take abroad will be recognized by your home institution is crucial. This might require detailed planning and discussions with academic advisors” (OpenAI, 2024). In summary, both academic reports and broader conversations suggest that curricular complexity can be a challenge for students studying abroad in engineering. However, no studies have attempted to measure this relationship, which we wanted to explore in our own context at Purdue University.

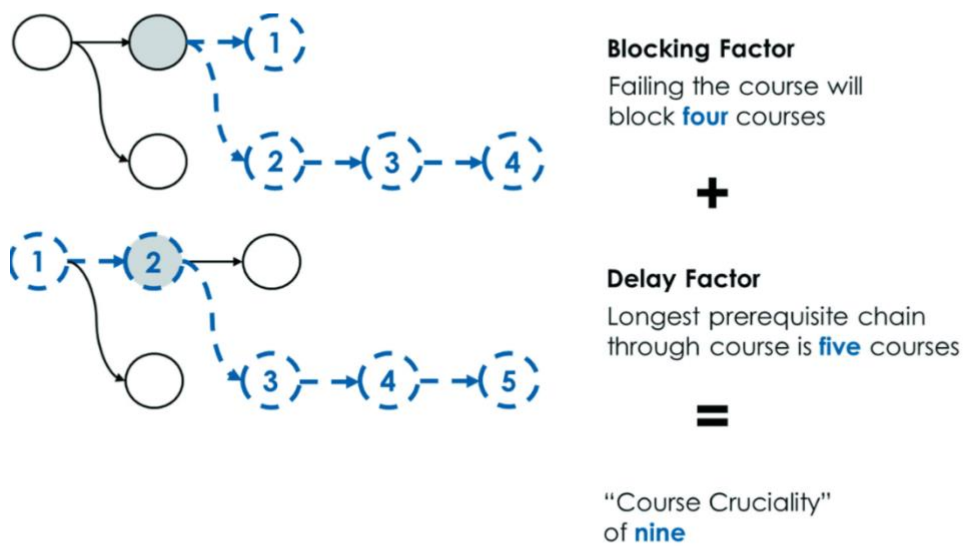
Characterizing the Complexity of the Curriculum

With the aim of providing metrics to support educational reform within engineering programs, Heileman et al. (2017) created a curricular complexity framework combining two components: instructional complexity and structural complexity. *Instructional Complexity* describes the inherent difficulty of course content, the instructional practices, the experience of instructors, and academic support offered to students. *Structural Complexity* describes the sequence of courses in the curriculum as defined using prerequisite and co-requisite requirements. In our study, we focused on structural complexity as the most likely to influence students’ decisions and ability to study abroad.

Structural complexity in the Heileman et al. (2017) framework is operationalized by assigning two scores to each course in a degree program: a blocking factor score and a delay factor score. The *blocking factor score* for Course A is the number of courses that a student cannot enroll in (i.e., they are “blocked”) if the student does not pass Course A. The *delay factor score* for Course A is the number of prerequisite courses in the longest prerequisite pathway that includes Course A. The *cruciality* of Course A within the degree program is found by adding Course A’s blocking factor and delay factor scores. Figure 1 below depicts the blocking factor, delay factor, and cruciality of a course visually. Finally, a total score for the structural complexity of the degree program is calculated by adding together the cruciality of all courses in the most efficient pathway to completing the degree. This structural complexity metric will be higher for programs with more prerequisites and lower for those with fewer prerequisites

(Heileman et al., 2017). In this study, we will refer to this metric as *curricular complexity*, as that is the term used on the Curricular Analytics website used to calculate this metric (Damour Systems, 2024).

Figure 1. Visual example of calculating blocking factor, delay factor, and cruciality scores (adapted from Grote et al., 2020).



This curricular complexity metric has been used across a range of studies within engineering education. Several studies have explored the influence of curricular complexity on graduation rates and time-to-degree for students in engineering programs (Heileman et al., 2017, 2018; Slim, 2016). These studies revealed an inverse relationship between curricular complexity and both graduation rates and time-to-degree. Grote et al. (2020) expanded on this work to compare curricular complexity and graduation rates between first-time-in-college (FTIC) students and transfer students, finding that curricular complexity was related to graduation rates for FTIC students but not for transfer students. Other studies have used curricular complexity to forecast the impacts of changes in curricula within specific departments (Finfrock & Klingbeil, 2023; Reeping et al., 2020). In sum, the curricular complexity metric has most commonly been used to explore different curricular design patterns within engineering curricula and their impact on student graduation rates or time-to-degree.

Fewer studies have compared differences in curricular complexity across degree programs, particularly outside of engineering. Waller (2022) and Grote et al. (2020) considered curricular complexity when comparing student outcomes between engineering disciplines. Reeping and Rashedi (2023) are developing a data set to compare curricular complexity across 13 institutions for five engineering disciplines. Only Slim et al. (2014) have compared curricular complexity of engineering programs to other disciplines, specifically, programs in the school of management at the University of New Mexico (UNM). Their work revealed that the engineering programs are on average more complex than management programs at UNM (average curricular complexity for engineering was 324 compared to 182 for management). Our project therefore contributes two new perspectives to the literature on curricular complexity. First, we compare curricular complexity for the 48 largest programs across all the colleges at Purdue University and second, we explore the relationship between curricular complexity and a unique student outcome – participation in study abroad programs.

Background of International Education at Purdue University

Purdue University has historically been successful with internationalization, earning the 2006 Simon Award for Internationalization from NAFSA: Association of International Educators. Among peer universities, Purdue is strong in the enrollment of international students, study abroad, and international partnerships (IIE, 2023). In 2012, Purdue added the learning outcome of *Interpersonal Skills and Intercultural Knowledge* as a requirement for all students with the aim of having departments build it into their undergraduate curricula. In response to data suggesting that international students were not sufficiently supported at Purdue, the university conducted an extensive survey of faculty, staff, and students and subsequently implemented new support structures to improve global competence on campus (Calahan, 2018). In general, Purdue is a university that has prioritized internationalization on campus and implemented policies to support this goal.

Purdue University has also created support structures for international initiatives at university level and within the College of Engineering. In 2016, Purdue launched the Center for Intercultural Learning, Mentorship, Assessment and Research (CILMAR) to support all Purdue students, faculty, and staff in developing global competence. This office provides intercultural training for study abroad leaders, research seed grants, workshops on global competence, and professional development for intercultural leadership. Within the Purdue College of Engineering, the Global Engineering Programs and Partnerships office provides a central structure for managing global opportunities for engineering students and faculty. These programs include short-term programs, summer undergraduate research abroad, long term study abroad, and a program that combines study abroad and co-op abroad (Purdue University, 2024b). The data available on the office website suggests that there is variation in study abroad participation by engineering major, ranging from 15% of graduates for some major up to 40% for others in the years 2016-2021 (Purdue University, 2024a). In summary, the context for our study is a university with a long history of investment and support for international education, including specifically within the College of Engineering. We provide this context to support interpretation of our results and to help readers determine how transferable our results might be to other universities.

Methods

In this section, we describe the process we used to assemble our data set and then the analysis procedures we followed to address our research questions. We provide a lot of detail about the decisions we made throughout the process of assembling the data set to support others who may be interested in following a similar process at their own institutions.

Cleaning up the Study Abroad and Enrollment Data

We obtained historical study abroad data from the Purdue's Study Abroad Office. This raw data set spans from the 2003-2004 to the 2021-2022 academic year and includes student demographic information and details about their study abroad programs. Identifying information (e.g., student names) was removed. We also removed students with obsolete or inapplicable classifications (e.g., Temporary Students, Undecided, Exploratory Studies) from the data set.

To calculate the percentage of students studying abroad in each major over time, we also needed historical enrollment data for all the majors for the same period. We retrieved this data set from a database that archives department-level enrollment data that is maintained by the Institutional Data Analytics and Assessment office at Purdue university (Purdue University, 2023b). To clean this enrollment dataset, we first needed to match outdated names for academic colleges with their respective modern colleges. Many colleges within the university had been renamed, combined, created, or dismantled from the 2003 to 2023 academic year; for example, the College of Consumer and Family Sciences and the College of Health and Human Services were grouped into the new College of Health and Human Sciences in 2010 (Martin, 2020), and the College of Technology was renamed as the Purdue Polytechnic Institute in 2015 (Purdue University, 2019). The old college data were grouped under the new names.

Next, we reorganized majors affiliated with these colleges, as well as their corresponding study abroad and enrollment data. Many historical majors had been renamed, split into new majors, combined with others into a new major, or disbanded. To address these changes, we first identified the modern names of majors and their concentrations between the Purdue University Admissions list (Purdue University, 2023d) and documentation from the Office of the Registrar (Purdue University, 2023c). Then we used registrar archive catalogs to identify corresponding historical names (Purdue University, 2023e). The historical names were then combined under their modern names. The Honors version of majors were also combined into their affiliated majors due to high curriculum similarity. We created a document tracking all the decisions we made on combining and categorizing old majors and concentrations to a specific modern major. Some examples of these combinations are shown in Table 1 below.

Table 1. Examples of Old-To-Modern Major Combinations

Modern Major	**Old Majors/Concentrations Included**
Agribusiness	Agribusiness Management Agricultural Finance Food Industry Mkt & Mgmt
Communication	Organizational Communication Pre-Communication Mass Communication Interpersonal Communication General Communication PR & Strategic Communication Corporate Communication Publ Rel & Rhetorical Advocacy
Animal Science	Animal Agribusiness Animal Production Animal Products
General Management	Management Pre Mgmt/Management Pre Mgmt/General Management
Biological Engineering	Biological & Food Process Engr

Selecting our Final Data Set

We chose to focus our study on the 11-year range from the 2008-09 academic year to the 2018-19 academic year. We excluded study abroad and enrollment data that were out of this period for two reasons. First, the years earlier than this range had spotty data in the study abroad data set, whereas the 2008-09 academic year appears to have been the first year of consistent data collection. Furthermore, the enrollment data from 2008 onward was classified as “recent” whereas earlier years were classified as “historical” and located in a different database that provided less information. Second, the years later than this range were not representative of typical study abroad participation due to the COVID-19 pandemic. We acknowledge that study abroad trends may shift in the post-COVID era and that it will be useful to update our analysis as new study abroad information becomes available. However, our data set at the time of this study ended in the 2021-2022 academic year, which we determined to still be impacted by ongoing COVID restrictions, and thus we felt that a post-COVID analysis was not yet feasible.

Because the process of measuring curriculum complexity (described in the next section) is time intensive, we decided to focus on the largest majors at Purdue for our analysis. We therefore used the enrollment data set to identify the most populous majors in each college in the 11-year range of our study. We selected 48 majors to include in the final study by considering both the size of the individual major and each college’s enrollment size. Our final list of majors is shown in Table 4 in the Results section. This final data set included 14,213 students who participated in study abroad within the time range of our study. These students traveled to more than 100 different countries, a majority of which were in Europe and South America, though other common destinations included Japan, South Korea, India, China, and Kenya.

Measuring Curricular Complexity

We used the Curricular Analytics online tool (Damour Systems, 2024) to measure the curricular complexities of the 48 majors. We retrieved the degree plans for each major from the Purdue University archive catalogs, including all courses in all terms, and those courses’ prerequisites, corequisites, and credit hours (Purdue University, 2023a). We then transferred this information into spreadsheets to import into the analytics tool. Because we were considering 11 years of data, we needed to decide which year’s degree plan to use. We chose to use the 2014 degree plan for each major because the degree plan catalog only extends back to 2014 and this year was also the closest to the middle of the 11-year range we had selected for our data set.

To account for changes in degree requirements over time, the 2014 degree plan for each major was visually compared to the 2018 degree plan (the end year on our data set). When a significant number of changes occurred in a degree plan, we ran both the 2014 plan and the 2018 plan in the analytics tool and averaged their complexity scores. Specifically, we considered a degree plan to have a significant number of changes when more than three non-elective classes were added, removed, or moved across terms (e.g., the Management major removing one class and adding two new ones over time). Changes in elective classes were considered nonsignificant because electives are generally unconstrained by restrictions of prerequisites and have little to no effect on curricular complexity score. In Table 2, we provide examples of majors with differing levels of changes between 2014 and 2018 along with our determination about whether these changes are considered significant changes or not.

Table 2. Examples of Changes in Curricular Content Between 2014 and 2018 Degree Plans

Major Name in 2014	Major Name in 2018	Credit Hours in 2014	Credit Hours in 2018	Observational Notes of Curriculum Change
Industrial Engineering	Industrial Engineering	123	123	● Identical curricula
Physics	Physics	120	120	● A couple specified classes changed to become broader option pools ● Class positions and credits stayed identical
Management	General Management	120	120	● MGMT 100 in 1st term is removed ● ENGL 420 in 2nd term becomes an elective option, not mandatory ● MGMT 254 & 295 in term 4 are added ● **More than 3 significant classes changed; will analyze both 2014 and 2018.**
Animal Sciences: Animal Agribusiness Concentration	Animal Sciences: Animal Agribusiness Concentration	120	120	● MA 15910 in 2nd term becomes MA 16010; same course content ● AGEC 217 in term 3 changes to become an economics elective pool ● The rest of the degree plan is identical

Many degree plans require students to make choices such as selecting a concentration or choosing from a pool of potential courses. To enter these degree plans into the Curricular Analytics tool, we needed to make these decisions as well. We developed a series of guidelines to follow to ensure consistency across majors and provide a few examples here. In the example of concentrations, we chose the most historically populous concentration for a particular major. When a class slot in a degree plan had a specified pool of options, we chose the class with the fewest credit hours and prerequisites. If the credit hours of a particular class could be personalized (e.g., research credits), the rest of the degree plan was determined first, and then the flexible class was given the remaining amount of credit hours required for that major. Finally, if a degree program required students to take summer classes, these were added as an extra semester on the spreadsheet. This is because the Curricular Analytics tool requires the degree plan spreadsheets to have all classes categorized by semester.

Once we developed the full spreadsheet for a degree plan, we entered it into the Curricular Analytics tool and calculated a complexity score for each major. For majors with two degree plans (i.e., the 2014 and 2018 versions), the curricular complexity scores were usually close to one another. This indicates that most curriculum changes in the time frame of our data set did not significantly change the curricular complexity of the degree plan.

Data Analysis

The goal of our analysis was to explore the relationship between curricular complexity and study abroad participation. We used RStudio (version: 2023.12.0+369) for our analysis.

Table 3 summarizes the variables in our data set and the reasoning for including each variable.

Table 3. Variables and Reasons for Inclusion

Variable	Reason for Inclusion
Percentage of Men Students	Women are more likely to study abroad than men, so majors with a higher percentage of women may have higher study abroad participation.
Percentage of US Citizens	The international diversity of a major has not been explored previously in relation to study abroad participation, but we thought it might be related either by encouraging participation by US citizens or lowering participation since non-US citizens are already studying abroad at Purdue University.
Study Abroad Participation *for each academic year in the data set*	We included each year individually in the correlation matrix to see whether each year's study abroad participation is reflective of the total study abroad participation for a major.
Total Enrollment *summed across all years in the data set*	Larger majors may have more resources to put towards encouraging study abroad participation.
Curricular Complexity	When a major's curriculum is complex, studying abroad may be more challenging because the degree plan does not have space to study abroad.
Total Study Abroad Participation *across all years in the data set*	This is the dependent variable of our study. It is calculated as the percentage of students who studied abroad out of the total enrollment for a major.

To address RQ1, we generated summary statistics for curricular complexity and study abroad participation rates across the 48 majors in our data set. Then, to address RQ2, we created a correlation matrix to identify the relationships between the variables shown in Table 3. We used Pearson's correlation with a Holm correction for the correlation matrix since all our variables are continuous (Field et al., 2012) and Pearson's correlation is robust even in cases where the data is nonnormal (Norman, 2010). Lastly, to address RQ3, we ran the Kruskal-Wallis rank sum test to find out whether there are differences across colleges in curricular complexity or total study abroad participation rates. We chose the Kruskal-Wallis test because our variables violated the assumptions of normality and homoscedasticity and we have small sample sizes for each college (i.e., less than ten majors per college). The Kruskal-Wallis test is a nonparametric alternative to ANOVA that allows for a comparison of means across groups (Field et al., 2012). We only included colleges that had at least five majors in the data set because the *p*-values can be inaccurate if there are fewer than five observations in each group (Field et al., 2012). Therefore, only six out of ten colleges were included in the analysis for RQ3. We used the Wilcoxon rank sum test with the Benjamini-Hochberg correction to conduct post-hoc tests to do pairwise comparisons between groups.

Researcher positionality

The first and third authors of this paper are US citizens, and the second author is a non-US citizen. All authors are students and/or employees of Purdue University and are affiliated with engineering departments at Purdue University. The first author regularly studies topics related to engineering study abroad programs and has ongoing collaborations with the Global

Engineering Programs and Partnerships Office at Purdue. The second and third author have not conducted research on this topic before and have no prior connections with study abroad programs or offices at Purdue.

Results

RQ1: What are the curriculum complexity and study abroad participation rates for the largest majors at Purdue University?

A summary of curricular complexity by major is presented in Table 4 below. The major with the highest curricular complexity is Aeronautical and Astronautical Engineering (Curricular Complexity = 539) and the majors with the lowest curricular complexity are Communication and History (Curricular Complexity = 61 for each of these majors).

Table 4. Curricular Complexity by Major

Major	Curricular Complexity	Major	Curricular Complexity
Aeronautical and Astronautical Engineering	539	Biomedical Health Sciences	158
Nursing	451	Chemistry	152
Chemical Engineering	436	Mathematics	139
Biomedical Engineering	434	Accounting	138
Mechanical Engineering	415	Hospitality & Tourism Management	127
Biological Engineering	409	Psychological Sciences	127
Veterinary Nursing	392	Selling & Sales Management	121
Electrical Engineering	387	Economics	119
Food Science	376	Industrial Management	116
Industrial Engineering	370	Computer & Information Technology	116
Computer Engineering	321	General Management	104.5
Civil Engineering	314	Computer Graphics Technology	100
Materials Science & Engineering	310	Animal Science	93
Biology	279	Organizational Leadership	91
Elementary Education	252	Speech, Language & Hearing	81
Pharmaceutical Sciences	240	Kinesiology	79.5
Wildlife	208	Sociology	72
Computer Science	198.5	Law and Society	72
Electrical Engineering Technology	197	Agribusiness	71
Physics	195	Political Science	68
Mechanical Engineering Technology	190	English	67.5
Construction Management	178	Agricultural Economics	67
Actuarial Science	176	Communication	61
Visual Communications Design	164	History	61

A summary of percentage of study abroad participation by major is presented in Table 5 below. The major with the highest percentage of study abroad participation is Agricultural Economics (Study Abroad Participation = 17.85%) and the major with the lowest percentage of study abroad participation is Pharmaceutical Sciences (Study Abroad Participation = 2.52%).

Table 5. Total Study Abroad Participation by Major (as Percentage of Total Enrollment)

Major	Study Abroad Participation	Major	Study Abroad Participation
Agricultural Economics	17.85%	History	6.33%
Biological Engineering	14.66%	Construction Management	6.09%
Hospitality & Tourism Management	13.68%	Aeronautical and Astronautical Engineering	5.92%
General Management	12.71%	Industrial Management	5.73%
Food Science	12.55%	Computer & Information Technology	4.84%
Mechanical Engineering	11.45%	Biomedical Health Sciences	4.73%
Agribusiness	11.32%	Kinesiology	4.55%
Animal Science	11.05%	Psychological Sciences	4.34%
English	9.72%	Physics	4.28%
Biomedical Engineering	9.49%	Biology	4.19%
Economics	9.27%	Electrical Engineering	4.18%
Communication	8.84%	Electrical Engineering Technology	3.96%
Wildlife	8.46%	Visual Communications Design	3.91%
Computer Graphics Technology	8.37%	Mathematics	3.90%
Selling & Sales Management	8.10%	Sociology	3.77%
Materials Science & Engineering	8.09%	Veterinary Nursing	3.69%
Civil Engineering	7.82%	Organizational Leadership	3.68%
Chemical Engineering	7.76%	Chemistry	3.66%
Industrial Engineering	7.71%	Mechanical Engineering Technology	3.54%
Elementary Education	7.61%	Computer Engineering	3.33%
Political Science	7.18%	Law and Society	2.97%
Accounting	7.16%	Computer Science	2.92%
Speech, Language & Hearing	6.91%	Actuarial Science	2.85%
Nursing	6.86%	Pharmaceutical Sciences	2.52%

A summary of average curricular complexity and percentage of study abroad participation by college is presented in Table 6 below. The college with the highest average curricular complexity is College of Engineering (Avg. Curricular Complexity = 391.78) and the college with the lowest curricular complexity is the College of Liberal Arts (Avg. Curricular Complexity = 85.56). The college with the highest average study abroad participation is College of Agriculture (Avg. Study Abroad Participation = 12.65%) and the college with the lowest average study abroad participation is College of Pharmacy (Study Abroad Participation = 2.52%).

Table 6. Curricular Complexity and Percentage Study Abroad Participation by College

College	# of Majors	Avg. Curricular Complexity	Avg. Study Abroad Participation
College of Engineering	9	391.78	7.31%
College of Liberal Arts	8	85.56	6.50%
College of Health and Human Sciences	7	163.5	7.02%
College of Agriculture	6	204	12.65%
Polytechnic Institute	6	145.33	5.08%
College of Science	6	189.92	3.63%
Krannert School of Management	3	119.5	8.53%
College of Education	1	252*	7.61%*
College of Veterinary Medicine	1	392*	3.69%*
College of Pharmacy	1	240*	2.52%*

*Data from one major, not an average for college

RQ2: What is the correlation between curriculum complexity and study abroad participation at Purdue University?

Table 7 on the next page shows the correlation table for the demographic variables, study abroad participation variables, and curricular complexity scores for the majors in our data set. Study abroad participation for each of the 11 academic years was significantly correlated ($p < .001$) with total study abroad participation, except for the 2018-2019 academic year. We interpret this finding to mean that study abroad participation rates were fairly consistent across the years in our data set. We believe that the 2018-19 academic year was different because the COVID-19 pandemic started in January 2019. None of the other variables were significantly correlated with total study abroad participation. None of the variables in the data set were significantly correlated with curricular complexity.

Table 7. Correlation Matrix Comparing Curricular Complexity and Study Abroad Participation Rates Across Years

						Percentage of Study Abrod Participation for Each Academic Year												
Variable	*n*	*M*	*SD*	% Male	% US citizen	% 08-09	% 09-10	% 10-11	% 11-12	% 12-13	% 13-14	% 14-15	% 15-16	% 16-17	% 17-18	% 18-19	Total_Enrol	CurrComp
% Male	48	41.39	25.42	–														
% US citizen	48	89.18	9.303	-0.51*	–													
% SA: 08-09	48	4.346	3.019	0.06	0.00	–												
% SA: 09-10	48	4.429	3.625	-0.04	-0.06	0.80***	–											
% SA: 10-11	48	5.619	5.204	0.03	-0.05	0.63***	0.76***	–										
% SA: 11-12	48	5.056	3.25	-0.04	0.09	0.60***	0.81***	0.80***	–									
% SA: 12-13	48	6.534	5.529	-0.08	0.10	0.56**	0.71***	0.77***	0.76***	–								
% SA: 13-14	48	6.421	5.121	-0.17	0.08	0.54**	0.73***	0.81***	0.78***	0.87***	–							
% SA: 14-15	48	7.596	4.207	-0.34	0.13	0.45	0.65***	0.49*	0.66***	0.57**	0.59***	–						
% SA: 15-16	48	8.851	4.125	-0.32	0.27	0.41	0.56**	0.48*	0.65***	0.58**	0.62***	0.73***	–					
% SA: 16-17	48	9.39	4.989	-0.39	0.08	0.35	0.55**	0.36	0.49*	0.42	0.45	0.56**	0.58**	–				
% SA: 17-18	48	8.87	4.81	-0.20	-0.03	0.45	0.66***	0.39	0.63***	0.52**	0.53**	0.65***	0.56**	0.81***	–			
% SA: 18-19	48	10.04	8.561	-0.09	0.00	0.05	0.19	0.21	0.19	0.16	0.16	0.19	0.10	0.42	0.47*	–		
Total_Enrol	48	4255	2802	0.24	-0.36	-0.05	0.08	0.00	0.04	-0.07	-0.03	0.04	0.03	0.10	0.17	-0.08	–	
CurrComp	48	204.9	132.3	0.15	-0.17	-0.08	-0.07	-0.07	-0.07	-0.03	-0.12	-0.15	-0.06	0.25	0.19	-0.01	0.21	–
% Total SA	48	6.969	3.536	-0.16	0.04	0.66***	0.86***	0.81***	0.86***	0.84***	0.85***	0.75***	0.73***	0.73***	0.80***	0.40	0.04	0.03

Note: **p* < .05. ***p* < .01. ****p* < .001. Pearson correlation shown for continuous variables. SA = study abroad. CurrComp = curricular complexity.

RQ3: Is there a significant difference in curricular complexity or study abroad participation across colleges at Purdue University?

We used the Kruskal-Wallis test to address RQ3, which is a nonparametric test similar to ANOVA. We used this approach due to both nonnormality and homoscedasticity in our data. We were able to include six out of the ten colleges in our analysis because the others did not have a large enough sample of majors within our data set (Field et al., 2012). Table 8 shows the number of majors in each college.

Table 8. Major Count per College within our Data Set

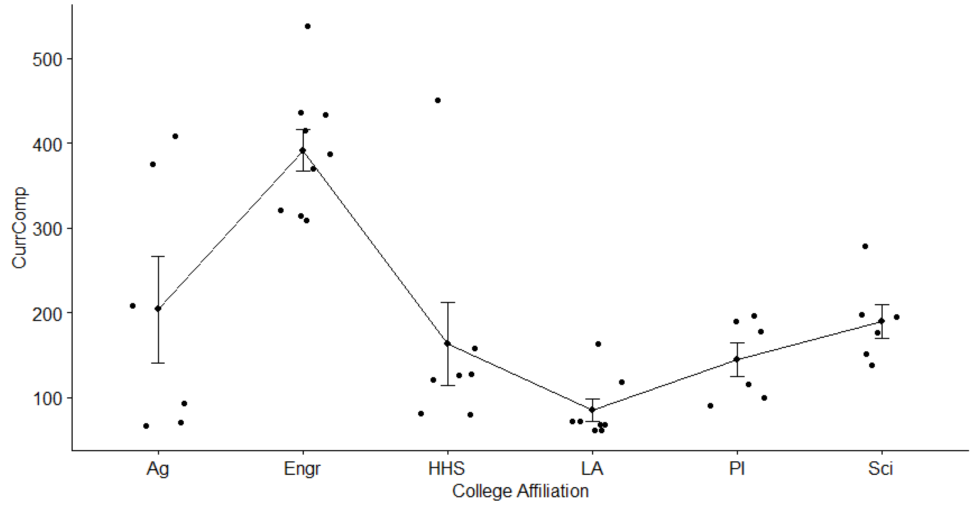
College	# Majors	College	# Majors
College of Engineering	9	College of Science	6
College of Liberal Arts	8	Krannert School of Management	3
College of Health and Human Sciences	7	College of Veterinary Medicine	1
College of Agriculture	6	College of Pharmacy	1
Polytechnic Institute	6	College of Education	1

Note: colleges excluded from the Kruskal-Wallis test are shaded in grey

Differences in Curricular Complexity

We found that there were significant differences between the colleges in the curricular complexity of their majors, $H(\text{df} = 5, N = 42) = 23.41$, $p < .001$. Then, to identify which college(s) significantly differ from others, we ran the Wilcoxon rank sum test compute pairwise comparisons between colleges. We found that the majors in the College of Engineering have significantly higher curricular complexity on average than the colleges of Health and Human Sciences ($p = .044$), Liberal Arts ($p = .003$), Polytechnic Institute ($p = .003$), and Science ($p = .003$). Only the College of Agriculture was not significantly different from Engineering in curricular complexity of their majors. These results are summarized below in Figure 1.

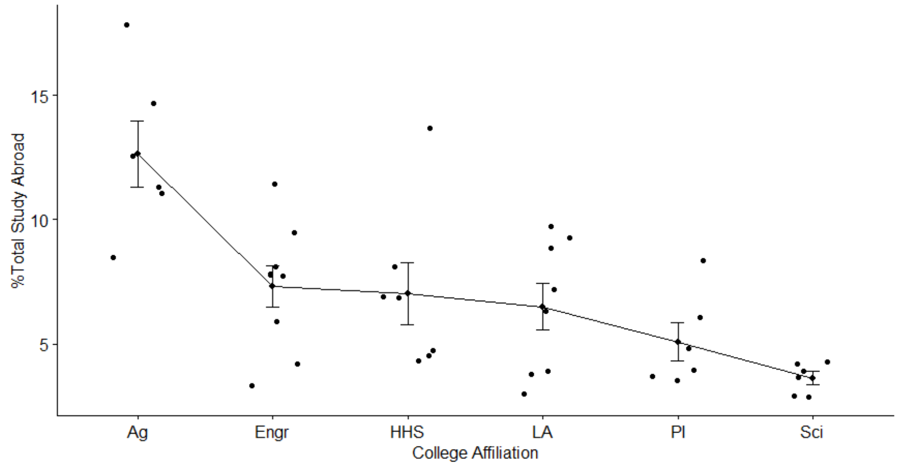
Figure 1. Mean Plot of Curricular Complexity vs. College Affiliation



Differences in Study Abroad Participation

We found that there were significant differences between the colleges in the study abroad participation rates of their majors, $H(\text{df} = 5, N = 42) = 20.27$, $p = .001$. Then, to identify which college(s) significantly differ from others, we ran the Wilcoxon rank sum test compute pairwise comparisons between colleges. We found that the majors in the College of Agriculture have significantly higher study abroad participation rate on average than all of the colleges we included in our analysis: Engineering ($p = .014$), Health and Human Sciences ($p = .030$), Liberal Arts ($p = .014$), Polytechnic Institute ($p = .011$), and Science ($p = .011$). These results are summarized below in Figure 2.

Figure 2. Mean Plot of Total Study Abroad Participation vs. College Affiliation



Discussion

Our study explored the relationship between curricular complexity and study abroad participation at Purdue University. In response to RQ1, we shared a report of the curricular complexity and study abroad participation rates for the 48 largest majors at Purdue, which revealed a large range in both variables across majors. In response to RQ2, we found that curricular complexity and study abroad participation were not significantly correlated with each other. Finally, in RQ3, we identified that there were significant differences across colleges for both curricular complexity and study abroad participation. The majors in the College of Engineering at Purdue have significantly larger curricular complexity than the majors in four other colleges (out of six included in the analysis). The majors in the College of Agriculture have significantly higher study abroad participation rates on average than the majors in all five other colleges we analyzed. In summary, at Purdue University, there does not appear to be a relationship between curricular complexity and study abroad participation rates.

Our study contributes several new insights that can inform future research on both curricular complexity and study abroad participation in engineering. Although we only present data from one university, our study is unique in its comparison of curricular complexity across all colleges at Purdue University. Previous studies have compared engineering majors (e.g., Reeping et al., 2023) or compared engineering to management majors (Slim et al., 2014), which revealed notable differences, but our study found larger variation when all colleges were considered. Our analysis confirmed that engineering majors had the most complex curricula, although the single major in our analysis from the College of Veterinary Medicine was on par with engineering majors. Other colleges with professional degrees (i.e., Education and Pharmacy) also had high curricular complexity when compared to the other STEM colleges (Science and Polytechnic). This finding challenges the idea that STEM majors are similar in curricular structure. Instead, we found that, in general, colleges with *applied* disciplines had more complex curricula when compared to *pure* disciplines (Becher, 1994). This finding could be explained by philosophical and epistemological differences between these types of disciplines, as described in studies of disciplinary culture (e.g., Becher, 1994). Future research could explore whether similar findings hold true in other university contexts.

Our results related to study abroad participation are more complicated to unpack. Although study abroad participation was not related to curricular complexity at Purdue, we identified significant differences across colleges. We were surprised to find that the College of Agriculture had significantly higher participation rates than other colleges in our analysis. This finding is at odds with study abroad participation rates reported in the IIE (2023) Open Doors reports for the past several years, where Agriculture is typically one of the lowest participation rates out of all categories. In contrast, Science fields have seen growth in study abroad over the past several years according to IIE (2023), but at Purdue University the College of Science has one of the lowest participation rates. These differences suggest that institutional and college level context factors may be particularly important in determining study abroad rates and other internationalization activities (American Council on Education, 2023).

Along these lines, there are several context factors that may explain the lack of correlation that we found between curricular complexity and study abroad participation at Purdue. One factor is the institutional investment in internationalization at Purdue (described in the Background section), which may have led to a culture across campus where study abroad is more strongly encouraged as compared to peer institutions. Similarly, within the College of Engineering, there are a range of study abroad programs offered specifically for engineers which are designed to fit into their complex plans of study. Offering programs of different lengths that align clearly with degree requirements may be an effective strategy to overcoming the challenges of a complex curriculum. Finally, despite widely held perceptions that curricular complexity is a key barrier, it is possible that there are other barriers that more strongly influence study abroad participation in engineering, such as negative faculty attitudes towards international experiences (Leask et al., 2021) or lower motivation among STEM students to study abroad in the first place (Niehaus & Inkelas, 2016). Replicating our study at universities with different levels of institutional and college level support for international education will be necessary to further clarify the factors that can hinder and support study abroad participation in engineering.

Our findings have implications for educators seeking to support engineering students in finding opportunities to study abroad. Most notably, fact that the complexity of engineering majors did not hinder students from studying abroad suggests that the significant investment and support for study abroad that is available both through Purdue University and the College of Engineering can overcome curricular barriers to study abroad. Our future work on study abroad participation at Purdue will include exploring how the College of Agriculture and College of Engineering support students in pursuing study abroad experiences to understand what other colleges could learn from their success. Our results do not necessarily overthrow the anecdotal experiences of many engineering students who have struggled to find space in their schedule to study abroad; rather, they suggest that additional support may help alleviate that struggle.

Conclusion

Our study explored the relationship between curricular complexity and study abroad participation rates at Purdue University. We found that there was not a relationship between these variables in our institutional context, despite the fact that the College of Engineering had the highest curricular complexity on average compared to other colleges at Purdue. We found that there were significant differences in curricular complexity across colleges, generally following a pattern where majors in applied disciplines had higher curricular complexity than those in pure disciplines. We also found significant differences in study abroad participation rates across colleges at Purdue that we intend to explore further in future research. We conclude that the significant investment in international education at Purdue and within the College of Engineering may help engineering students here study abroad successfully despite the complexity of their curriculum.

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