Engineering in German

Interactive Qualifying Project

Advisors:

PROFESSOR U. BRISSON
PROFESSOR D. DIMASSA

Written By:

JONATHAN ANDREWS
BRANDON KNOX

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Abstract

WPI's German curriculum provides students with fast-paced language learning and culture exploration, but lacks STEM topics that engineering students would like to use in a global workplace. We have created a framework for slowly introducing STEM topics into the German curriculum. From conducting two separate surveys among students and interviews with faculty, we found there is mixed interest from the current WPI community in STEM inclusion with German courses. With these results we structured the framework to maintain the current curriculum and slowly add STEM topics in small amounts. This additive process can continue until new courses and international connections with companies and universities can be established.

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CHAPTER 1

INTRODUCTION

Worcester Polytechnic Institute is a private research university focusing on the instruction and research of technical arts and applied sciences, and so STEM (Science, Technology, Engineering, and Mathematics) topics are the focus of most of the curriculum. There are, however, plenty of subjects that do not fall under the category of STEM, including foreign languages. Research into foreign language education, a survey of WPI undergraduates, and a few faculty interviews suggest that STEM integration in language classes could have a positive impact on student interest in foreign language. This project focuses on the feasibility of maintaining the stability of the current German program at WPI by introducing and modifying language courses in the German sequence to include relevant and practical STEM topics. Some inspiration on the value of this endeavor comes from the preface to An Introduction to Scientific German,

> "The German language is an indispensable means for the better understanding of the German civilization and culture. In the field of research it is essential to the study of the most recent progress made in German industry, science, and technology. The scientist, however, is not primarily concerned with oral expression; he regards the language as an instrument for further his knowledge in his own particular field."

Our project examines current benefits of foreign language education and feasibility of language-engineering integration. Much of the research revolving around student and professor opinions dealt with not only whether students would be receptive to the idea, but also the different levels of engineering topic integration within foreign language classrooms. These potential plans ranged from introducing some engineering modules into the standard classes to adding additional courses designed around a specific subject.

Currently at WPI, students who choose to fulfill their humanities requirement through learning German take a set of six classes that teach the language, culture, and brief history of

Germany. While these courses are interesting and important for students to take and learn about German culture, there are not specific vocabulary or structures taught to be used in the field of engineering. Discovering a way to implement a course that bridges these two topics would benefit students by helping them become more fluent in German vocabulary specifically used in industry, which could lead to more job opportunities after graduating. This expansion to the program would allow students to combine their knowledge of engineering and the German language to enhance their communication within their industry of choice. With Germany having a reputation for engineering excellence, this could be a unique opportunity for potential partnerships with German companies later on in one's career.

In order to gauge the interest of WPI's student community, relevant information was gathered through a social media-distributed survey, free-response questions given to German students in-class, interviews with a few faculty members about their opinions and ideas on the future of the German program, and discussion with German professors about the structure and design of modifications that could be made to the current German curriculum.

CHAPTER 2

LITERATURE REVIEW

Distinction between disciplines inherently exists in their differences. Fields of study exist as a tribute to these differences, and they tend to remain separate in order to preserve the purity and focus of given topics. With increasing globalization, however, engineers frequently work abroad but lack foreign language skills to communicate effectively. In recent years, the combination of engineering and language acquisition has become more prevalent, with universities across the United States implementing double major programs where students earn a degree in both an engineering field and a language. Since it is a relatively new topic, there is limited research regarding the relation between the two topics, the best ways to integrate them, and the possible benefits that such an integration may provide. In this section we will discuss the research that we have completed on the topic to help us develop a better understanding of the current methods used to best integrate the two disciplines.

According to Adolf Melezinek's Klagenfurt School of Engineering Pedagogy, there are several variables that influence the functions of teaching and learning: the teaching method is the "how," the instructional objective is the "why," the subject matter is the "what," the media is the "with what," the audience is the "who," and the influence of a socio-cultural environment is the "where" (Rüütmann, 12). Most of these components surround the common practice of dissecting a topic into facts, presenting those facts in a logical order, and summarizing with the element that was at first dissected as a single system. The presentation of this information as new is what makes it "teaching." However, the key component of this exhibition is that it is a presentation. The flow of information is in one direction, from the presenter to the students. This practice is commonly seen in engineering lecture halls and classrooms, and is generally devoid of connections to anything other than the subject itself. Such a connection may be considered a distraction and not be pertinent to the topic of engineering itself.

Foreign language education, on the other hand, is vastly more effective when taught through

connections to different disciplines. According to Sonali Banergee, there are “5 C’s” that form the foundation of this idea: Communication, Communities, Comparisons, Connections, and Cultures (16). Communication concerns use of a language over simply the knowledge of it. It revolves around what can be done with vocabulary, grammar, and sentence structure in oral and written form. Community allows for an extension of the classroom into the homes and other multilingual environments (going abroad, foreign language guest speaker, foreign email exchange, etc.). Comparisons encourage students to compare and contrast languages and cultures. This promotes discoveries of patterns of similarities and differences across languages and cultures. Further analysis leads to a deeper understanding of one’s own language and culture. Connections integrate language education with common themes as a means to intertwine language with other topics of education. Culture distinguishes the points of view, ways of life, and contributions to the world of the people whose language is being learned. Such topics expose one’s own culture by means of comparison, and promote learning of both cultures simultaneously. These disciplines transcend the language being taught itself, and help students to learn a language by engaging their interest beyond the technicalities of the language.

Through her experiments with STEM education in a Hindi classroom, Banergee implies that a successful engineering education is not without the 5 C’s as well (17). Communication is essential to teamwork, communities allow for cooperation, comparisons drive innovation, connections solve global problems, and cultures influence the ethics of engineering. She continues with this idea by considering that integrating foreign language education and engineering education would be mutually beneficial in that each enriches the other, and further supports the idea of the 5 C’s.

Banergee gives an example of a Hindi language class, in which STEM topics have been used to supplement the language education with real life usage of the language in industry. These STEM topics are not abstract applications, but rather specific examples of use of the Hindi language in India. The two examples given concerned the science behind predicting the monsoon season and monitoring tiger populations. When learning about these subjects, not only were students engaged due to the interesting nature of the topics, but also the real life application of what they were learning. In-class discussions allowed for students to learn the specific vocabulary associated with these STEM subjects, as well as practice their pronunciation and communication abilities. This sort of cross-discipline education allowed for not only a more in-depth language learning experience, but also exposure to some close-to-home, real-life STEM applications.

Just as STEM education about monsoons and tigers can be incorporated into a Hindi classroom, engineering instruction can be integrated into any foreign language classroom. The 5 C’s can be applied in many ways in order to properly engage students in a language, but in order to maximize the potential to learn in an engineering school, it makes a great deal of sense to focus on engineering topics to cater to the interests of students. The curriculum itself is not entirely transformed–rather STEM topics are simply preferred over more traditional components of the class. If a lesson revolves around having students show their understanding and practice

speaking, be it through conversation or presentation, it wouldn't matter whether the topic was India's monsoon season or Franz Kafka's Die Verwandlung (The Metamorphosis). Students would learn new vocabulary and practice their conversational skills all the same. So although different vocabulary would be taught, and different content would be covered, ultimately students could benefit all the same from a purely language-structure point of view. Grammar, sentence structure, and vocabulary transcend the content they give form to, but culturally, there is no replacement for classical literature.

Similarly to the method of the 5 C's potential use in a combined STEM and German classroom, Sarah Danielle Schoettler of Portland State University wrote a thesis on Content Based Instruction (CBI) within the combined classroom. A popular source Schoettler used in her thesis was Content-Based Instruction in Foreign Language Education: Models and Methods written by Stephen B. Stryker and Betty Lou Leaver. As the title of this book suggests, it mainly focuses on CBI specifically with foreign language education. Content Based Instruction is a suitable fit for teaching a STEM class with foreign language integration. With this method the instruction focuses on the STEM content presented in the foreign language rather than building blocks of the language such as sentence structure. Students learn the grammar of language as it is introduced in the STEM content rather than starting with grammar lessons. A drawback to this idea is that the language and STEM principles are presumably learned at a slower pace than when just learning the STEM content.

When teaching with this method, an example of the language integration is reading a laboratory assignment in German with the supplied vocabulary that the students would need for comprehension. This instruction method teaches them new vocabulary along with sentence structures in German. Additionally with this example, students work with and learn the imperative forms of certain verbs and how they affect sentence structure as well. "Highlighting these structures in the text and then reproducing them will help the students acquire certain structures and vocabulary through maximum exposure of the language" (Schoettler 58).

This example demonstrates the "top-down" approach that CBI courses take to teaching, identified by Stryker (6). With the top-down approach, the overall meaning of the article is discussed and revealed before analyzing one sentence at a time for structure and vocabulary. The traditional form of teaching focuses on sentence structures and vocabulary first is referred to as the "bottom-up" approach according to Stryker. The top-down approach is suitable for German courses in which STEM subjects are an integral part of language learning, because of the opportunities for completing lessons like the laboratory assignment mentioned above.

The CBI classroom approach is comparable to Krashen's theory of language acquisition. According to Krashen's theory, language learning relates to the conscious learning of a language, when by contrast language acquisition is the subconscious process of learning a language for effective communicative use. This idea aligns well with the combined learning of a STEM subject and a language. As Schoettler discusses, acquiring a language is known to be achieved best when

the learner is constantly exposed to content in that language, especially if that content is in their field of interest. Research suggests that the reading should be linguistically authentic and at the correct reading level.

When implementing this type of teaching, instructors should follow a rule from Krashen's hypothesis. Salazar mentions that this rule is referred to as "i+1," which states that foreign language learners are able to comprehend a language level '1' above their proficiency level 'i' (Salazar 2). He then states that it is necessary so that in the second language, there is a development of higher proficiency levels (Salazar 2).

Stryker supports the idea of using linguistically authentic materials because it gives students a better understanding of how the language is used to communicate and also contains a "natural redundancy" allowing for better comprehension (7). By "natural redundancy," Stryker is referring to the tendency of sentence structures and vocabulary to be used multiple times within an article or any type of document. When identifying a repetitive structure or set of vocabulary, a reader tends to hold on to the information better than reading it once in an entire document (7).

Contrary to Content Based Instruction, which is the main focus of the thesis completed at Portland State University, is Language Based Content Instruction (LBCI). The main difference that Stryker mentions is that LBCI works with students at varying levels of language proficiency as the class is taught in English for a majority of the time. Professors at SUNY have integrated language education with all different types of courses in a unique way for many years. Instead of creating entirely new classes at the university, they add "language across the curriculum" (LxC) sections to lower level classes with typically high-enrollment to give students a unique opportunity of studying the basics of a language without much more of a workload than normal. Within some of the popular classes at SUNY, faculty who are supportive of the program must define a "thread" of assignments that can be exchanged with a set LxC prepared lessons. These lessons are created by the LxC staff, therefore nothing additional is required from the professor of the course besides their permission.

The LxC program at SUNY-Binghamton has been available since the early 1990s. Throughout the years, the LxC program has been offered in many different courses in a total of 14 different languages. Meanwhile this program didn't require additional professors to be hired and no existing professors were asked to do much more work because most of the Language Resource Specialists (LRSs) for the different sections have been international graduate students, which tends to be the main concern when introducing new courses at a college. With this, Stryker does reiterate that there is no grade for the LxC component, but it does appear on their transcript as a zero credit course with either a pass or fail.

Most students seem to find the LxC program interesting and beneficial to participate in since it exposes them to the content they are learning about in an additional language of their choice. In the first few years of this program studies were conducted to gauge the value of it in the participants' coursework, and it did yield a slightly positive effect in the students' reading

comprehension along with better grades in the course compared to courses where they did not participate in LxC. The last outcome Stryker mentions is the tendency of LxC students to show more interest in taking language courses, studying abroad, and having international careers.

Students' learning styles have a profound effect on how they respond to teachers and material in a classroom environment. Ivana Šimonová points out that STEM topics and foreign languages are taught in very different ways, and therefore different student learning styles strongly affect how well a student learns a subject (8). Engineering pedagogy usually revolves around lectures. There is a room of quiet students; a professor speaks, demonstrates, and communicates at the students. Foreign language pedagogy is much more interactive in the classroom. Classes consist of speaking exercises with partners, class-wide conversations, and in-depth discussions normally concerning topics covered by the 5 C's.

Essentially, engineering and foreign language require two completely different teaching styles—rightly so, because they are completely different topics—and students respond differently to both of them based upon their own learning style. However, on this notion, if foreign language were to be supplemented with engineering, the contrasting teaching styles could benefit the students as a whole in the idea that there would be something for everyone.

According to Šimonová, specific applications of a language being learned aids in motivating students to put in the work that will allow them to succeed (10). When a student is first exposed to engineering, it quickly becomes apparent how vastly complicated and interesting it can be. This influences a student's enthusiasm on the topic. In the case of an engineering school, it is safe to assume that students in general will be predisposed to be interested in engineering and may not share the same enthusiasm for foreign language (because it is radically different from engineering, yet still complex and interesting). In the interest of this consideration, using engineering as a medium to teach a foreign language could potentially be a powerful motivator for students. This connection is an example of cross disciplinary education, a widely used modern method to teach engineering topics in general (Adams 1). That sort of association between engineering and language promotes learning of both, which should lead to smarter, more well-rounded students who are extremely motivated to learn.

The greatest success in learning a foreign language came from students who worked in small groups, experienced the language in context (literature, culture, etc.), and found practical applications of what they learned (Šimonová 10). This approach is evidence of the effectiveness of the 5 C's and only further promotes the integration of engineering in the foreign language curriculum. The language of engineering is just one of the many practical applications in learning a foreign language.

In industry, communication is paramount in any engineering environment, and is particularly difficult on the global scale due to the diversity of engineers' languages and cultures. According to Danielwicz-Betz and Kawaguchi, in one's native language, there is a whole host of specialized vocabulary and a terminology that is necessary in professional environments (57). Much of this

language is only learned when studying the complex topics that require it–it is not the standard vernacular that comes with learning a second language. Much of the professional language of engineering can be just as foreign as an actual foreign language, and so it is a particularly challenging barrier to overcome professional communication in a foreign language.

In addition to the difficulties of learning a foreign language with a focus on specialized vocabulary and professional terminology, there are stereotypical barriers to overcome as well. The typical engineering student is normally viewed as a “geek” or a “nerd” and this has a strong association with a lack of social and communication skills. Although this is a generalization and is certainly not applicable to everyone, it is not entirely false. In this particular case, foreign language can be used to support a STEM education just as STEM curriculum can be used to support a language education (as aforementioned by Banergee). Foreign language education has a lot of curriculum based around conversation, small group interaction, and discussion. This can serve as a means to educate about and practice social interaction—perhaps a more daunting barrier than the language itself. There is no drawback to integrating language and STEM topics.

Chapter 3

Methodology

Our focus for this project was gauging students' and faculty interest in including engineering topics in German program at WPI for students who want to successfully utilize their second language in industry. Our main goal was to gather enough opinions from WPI students and faculty in order to make an informed recommendation for the future of the German program and its continued stability. In order to accomplish this goal, we conducted surveys and interviews throughout the WPI community. []

3.1 Gauging Interest

3.1.1 Survey for WPI Undergraduate Students

Our first objective was to determine the interest of the students and faculty through interviews and surveys. The interest of the students was determined by creating a survey on an online software (Qualtrics) and posting it in all four of the current WPI class Facebook groups (2017-2020). In order to potentially increase the sample size, an incentive was offered upon completion of the survey. Although ultimately the incentive was arbitrary, we offered a drawing for a $50 Amazon gift card with admission being a valid WPI email address. With the data gathered we could perform statistical analysis on the results, looking for trends within the sample as a whole or with respect to certain subgroups such as class, major, and humanities interest. With the responses we could see a quantitative value of student interest, giving us an initial idea of how this integration plan would be received. For the purpose of the survey, questions were structured to be abstract enough to be applicable to any foreign language, although those taking German were the key demographic of the research as a whole. Additionally, we created a more indepth, free-response survey for students currently enrolled in German classes to gauge their

interest separately. This survey was conducted in class after presenting the premise and possible outcomes of our project. Speaking directly to the students for which this project is most relevant allowed for feedback beyond what the survey alone could provide due to the questions being structured as free responses.

A potential problem with surveys in general is response bias. With an audience as targeted as ours, we expected to get very supportive responses. A wider range of responses would allow for reference points for the most positive and negative effects of integrating STEM into the German program, or at the very least reference some neutral perspective against either of them. Given the theoretical nature of this project, it was difficult to find a negative angle from which one could look at it. The main fact was that the results of this project would essentially be inconsequential to anyone who would be taking the survey. Should this project result in new developments in curriculum at WPI, by the time any changes could take effect even the youngest among those surveyed would have either graduated or at the very least completed their humanities requirement. The solution to this survey problem was to create a control. A control allowed us to be able to measure just how positive the survey results were by comparing them to the control results. The control element was the German program as it currently exists. This way the comparison can be made between the current curriculum and the changes that can be made to it. Each different change, as presented in the survey, could be either compared to other changes or to the control itself as the reference.

The main constraint of the survey, besides the aforementioned possible response bias, was effective distribution. Because distribution was limited to posting a link to the survey on the WPI Facebook class pages, responses could have been limited to those who spend more time on social media. According to Facebook's facts and figures, however, between eighty-five (85) and ninety-nine (99) percent of college students use Facebook (Collegiate Times, 1). Considering that the WPI class pages have approximately the same amount of people therein as the actual class sizes themselves, we made the assumption that almost all students at the very least had access to this survey.

3.1.2 Key Survey Questions and the Reasoning Behind Them

One component of writing the survey was the necessity to gather as much data as possible while remaining relevant to the information we were trying to find. There is an adage in statistics: "correlation does not imply causation." It was important to take any association between one data point and another skeptically, but because we could not predict any correlation we might find (true or otherwise), it was worth at least collecting some information we might not need. Therefore, the survey began by asking respondents for their class year and major. We did not expect to find any correlations with class year, but there was data to be utilized from the students' majors. For example, a figure published on WPI's website states that about sixty-eight (68) percent of WPI students' majors revolve purely around engineering. We could compare the percentage of

our respondents who are engineering majors in order to judge whether or not the sample is representative of the entire undergraduate student body.

The next question listed all of the possible subjects that students could study for Humanities and Arts at WPI and asked them to select all of the subjects that they had taken or at least planned to take. This question had two goals. The first was to gauge what the state of humanities and arts class interest was at this time by comparing the proportions of students taking classes in each subject. The second goal was to be able to separate the students and ask them specific followup questions. Depending on whether they had selected any languages as classes that had taken or plan to take, they would be directed towards one question or another in order to be able to provide reasoning behind their class choices.

For the students who answered that they had taken or planned to take a language, the structure of the question relied on students marking all the answers that they thought accurately represented why they would take a foreign language. If they did not think any of the options represented them, they had the opportunity to write in any reasons in their own words. This question was an attempt to quietly assess the pragmatism of WPI students who take foreign language classes. Although the "5 C's" are a crucial component to learning a language, a student's motivations to take a language class are not necessarily even distributed between all five C's. The question's answers did not actually mention the five C's by name because they would be slightly out of context from the respondent's perspective. Instead, the selectable reasons existed on a spectrum of marketable skills. In this context, we interpreted how pragmatic the student sample was based off of the popularity of the reasons they took or planned to take a language class. The most mechanical output of taking a language arguably is being able to speak and understand the language. One could also argue that the most profound outcome of a language class would be learning the culture. However, a purely pragmatic person would choose the mechanical ability to speak a language due to its net value to that person. Thus, we could use the results of this particular question and compare it to how students responded in further questions as a means to determine how pragmatic they really are. Students who did not or would not be taking a language class were asked to write why foreign language was not for them, and all students who had or would take a non-foreign language class were asked to list why they chose those classes as well.

The three relevant questions that came after this had students rank different options for a modified foreign language program. In order to make the questions applicable to as many respondents as possible 1) there was an option to keep the program as it is, and 2) no language was specified. Although the goal of this survey was to assess student interest in modifying the German program, making this section generic made it easier for students to imagine which modifications they would prefer on any language's programs.

The first ranking question compared the ideal time commitments of students and the corresponding degree they could get out of it–no degree, a minor, or a (double) major. The different levels of popularity for how each option is ranked could indicate the extent to which the German

program should consider STEM module integration. No degree was the control (as this is the path for most students who take German) and if it was most popular would suggest integration in the core classes–that is to say that a student interested in STEM would not have to take any more time than they otherwise would when studying German to take the STEM integrated classes. Earning a minor would suggest that students would be willing to take a few courses beyond the core six to earn the minor (easily attainable given WPI's graduation requirements). Earning a major would of course be the most time consuming and would suggest that students are willing to commit more than half of their time to earning the degree. We did not expect much support for this option, but if it was popular it could influence a much larger-scale expansion of the German program.

The second ranking question dealt with ranking different levels of STEM education in a language. The control was no integration–as the courses currently stand–and the other options were language classes with some integration and language classes that were completely focused on STEM topics. The results of this question hinged on students' ideal language class. The popularity of each option would represent whether or not students thought there was value in adding any level of STEM into language classes.

The third ranking question determined students' ideal plan for time abroad. The options were no time abroad (the control), being abroad for 1-2 quarters (equivalent to abroad IQP centers), and being abroad for a summer and a semester (with the possibility of an internship). This question was particularly important because WPI is a very globally active school. 65% of students complete at least one project off-campus, and there are more than forty project centers across six continents. Because the majority of students already spend time living and working off-campus (abroad), spending more time abroad could be either financially impossible or possibly postpone graduation if certain requirements are not met on time. Essentially, this question sought to determine how committed the average student could be to a language program if it offered options for time abroad.

The results of the these three ranking questions would return the best option for the extent of modifying the German program–in which classes STEM inclusion should be focused, how much STEM material should be included, and which abroad options would best benefit the students.

3.1.3 Survey for Students Enrolled in German Courses

A separate free-response survey was created specifically for the students currently in German courses to ascertain their interest in the German program modification because they represent the key demographic of students who would be most affected by a change in the program. We briefly spoke about the research components of the project in front of all four German classes in B Term and then handed out the survey, which was mostly free response questions hoping to understand exactly how each student felt about the different aspects of the project.

The survey opened up with simple questions asking the students to list their major, class,

reason for taking German, and interest level from their previous German classes (if applicable). The first key question on the survey directly asked the students if including STEM in the German curriculum would raise their interest level, which is essentially the basis of the entire project. Following that question were two more asking students if the aforementioned STEM inclusion would influence them (positively or negatively) to either go abroad or complete an international internship. These questions were moreso looking in the future of an expanded German program where students could set up these opportunities more easily. Along with these questions, the students were asked if they would be willing to postpone graduation by a year and complete a study abroad and an international internship one after the other. We were sure to mention the year postponement in an attempt to separate strong supporters of the idea from students who could not foresee any caveats with spending a year abroad.

The next question the students responded to asked if they liked the idea of a completely new German course existing specifically for STEM integration in German. This, like the first key question would give us a better idea on exactly how we should go about modifying the program. The last question the students answered simply asked them which STEM topics would work well if covered as modules or as a whole new course for the program. With the results from this question we could see which topics should be prioritized if any STEM integration were to happen.

With the survey results we created two separate Excel spreadsheets for the Beginner and Advanced German students and recorded the key points of all the responses on a question by question basis. We kept the spreadsheets separate so that we could compare the responses from students who were just beginning the German program to students just finishing the core six classes. After recording the responses we could mark each by and large as positive, neutral, or negative so as to get a sense of the classes' sentiments, per question, as a whole quickly.

3.1.4 Interviews of WPI Faculty

We discussed the future of the German program with three faculty members by conducting interviews with them in December. We identified professors that had a connection with the German language, developed a short list, and emailed them. We successfully organized interviews with Professor Burnham (Physics/Biomedical Engineering) and Professor Kazantzis (Chemical Engineering) from the list. We also set up an interview Professor Rivera (Spanish) to gain insight the process of creating new language courses (specifically with a specialized topic) and the resulting growth in the program.

In the interviews with Professors Burnham and Kazantzis we asked if they had any experience teaching in German or working in German industry. If they had, we could get a good understanding of what it's like to teach STEM topics in German compared to English and understand the difficulties of teaching in a second language. We also discussed the feasibility of our project goals and whether or not our plans could be implemented with success based upon their experiences. The main goal of the discussion was determine how beneficial a modification to the

German program would be for students.

Our discussion with Professor Rivera focussed on the process of creating the Business Topics in Spanish courses. His work to create a specialized language course was parallel to our research into STEM and language integration. Much of the interview covered some of the nuances of the Business Spanish course, including if it could be counted as credit towards a minor and what it consisted of in terms of content and lesson plans. The success of the Spanish program was one influence for the modification of the German program, and so Prof. Rivera's insights were very valuable.

CHAPTER 4

FINDINGS

There is a lot of data when considering whether or not the German program at WPI should be modified. 276 undergraduates responded to our thirteen question survey, 73 German students answered free response questions, and 3 faculty members discussed foreign language and STEM education with us. The survey to the student body was the most volatile data collection because it was voluntary and we had no control over who decided to answer it.

Of the approximately 4,100 undergraduate students at WPI, about seven (7) percent completed the survey. Regardless of the fact that our survey was smaller than we had initially intended, we can conclude that the distribution accurately represents the entire undergraduate body. As mentioned in the Methodology, comparing the demographic results of the survey to published WPI facts and figures (accurate for the entire undergraduate body) would determine whether or not the sample properly represented the population. We found that the distribution of certain majors in the sample matched the published numbers of the population exactly, meaning that the results were most likely not biased by uneven distribution.

There is a trend concerning the class year of the students who responded and the number of responses. In general, there seemed to be more responses from the younger classes. This can be explained due to two parameters, and the true reason could be one or the other or both. The first reason is the size of the student bodies. WPI's newer classes tend to have more students that the older ones. This is a matter of applying the retention rate to the older classes (where each year students are lost due to dropping out or transferring) and considering that WPI is constantly expanding (evidence found in the scarcity of housing for incoming freshman classes). The second reason revolves around how much a person uses Facebook. This varies from person to person, but in general there is a trend where younger classes tend to spend more time on Facebook than older classes (Journal of Applied Developmental Psychology). These two points can both be valid, but there is no way of knowing the impact of one influence versus the other (Junco 22).

We used results from the surveys along with research to assess how such a modification to the German program would best be introduced into WPI. We found:

- In general, foreign language enrollment is in slight decline.
- A majority of students responded positively to introducing STEM topics in language classes.
- Current German students are interested in STEM-focused classes beyond the core six language/culture classes.
- Students want to spend time abroad as a means to experience a language in its native setting, and are influenced by STEM topics in that language.
- Students value an internship abroad more than studying abroad, time and monetary constraints considered.
- Students value humanities for the contrast with the STEM topics they are so entrenched in.
- Most students value their time and other interests more than pursuing a minor or major in a language.

4.1 Finding 1: In general, foreign language enrollment is in slight decline.

Over the last twelve years of available data, foreign language enrollment is in slight decline. On average, 1.04% less seats are taken each year whereas non-foreign language humanities increase enrollment by 0.68%. These values are based off of weighted averages for plotted each academic year (see figure 4.1). Enrollment is defined as the number of taken seats over the number of available seats for each class per subject per year. This value ignores class cap sizes and purely represents how filled a given class is. Instead of just averaging the enrollment for each year for all the languages or other humanities, a weighted average takes into account how much of the enrollment a given subject represents. The trend lines represent the linear best-fit to the data points. A negative slope indicates declining enrollment and likewise a positive slope shows growth. This slope value is the percent change per year for the enrollment values it represents. The R^2 value is a metric for how well the trend line fits the data points. An R^2 value of zero indicates no correlation and one indicates a perfect fit of the data. Anything in between can be interpreted as the percent of the data that is accurately represented by the trend line. The R^2 values of the trend lines of both the foreign language and other humanities data sets were 0.57 and 0.74 respectively, and this suggests that the trends represent most of the data. Concerning the below graph, the foreign languages averaged together are Arabic (AB), Chinese (CN), German (GN), International Student English (ISE), and Spanish, and the other humanities averaged

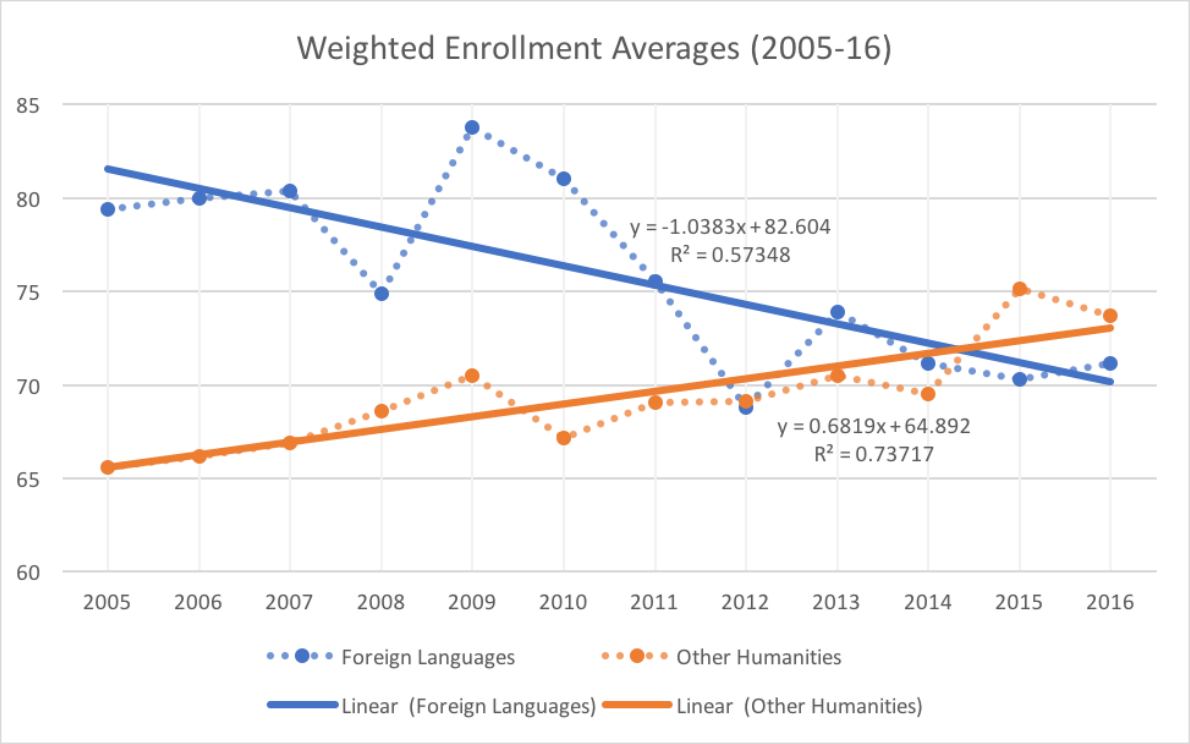

Figure 4.1: *Weighted Enrollment Percentages: Foreign Language vs. Other Humanities Trends, 2005-16*

together are Art (AR), English (EN), History (HI), Music (MU), Philosophy (PY), Religion (RE), and Writing (WR).

The significance of this data is less that foreign language used to have higher enrollment than other humanities (or that other humanities now have a higher enrollment) and more that foreign language enrollment is in slight decline and other humanities are showing growth. The structure of foreign language and the structure of other humanities does not allow them to truly be comparable. The logistics of foreign language education warrant smaller classroom caps than other lecture-based classes and thus the enrollments for each on average can follow different trends. If a foreign language fills 22 seats in a class capped at 25 does it outperform a history lecture with 22 out of 50 filled? The language may have above average enrollment and the history lecture may be below average, but in the end the same number of students attend the same number of classes. The only comparable classes are those with similar structure and course caps such as two foreign languages or two lecture-based subjects.

The size and success of the German and Spanish programs are very comparable due to their similar structures. The enrollment percentage (taken seats over available seats) between the two shows no reliable correlation between one subject or the other to suggest that either is declining or growing (see figure 4.2). Spanish has had a higher enrollment percentage for 7 out of the last 12 years, but that hardly constitutes a decisive difference between the two programs. The trend

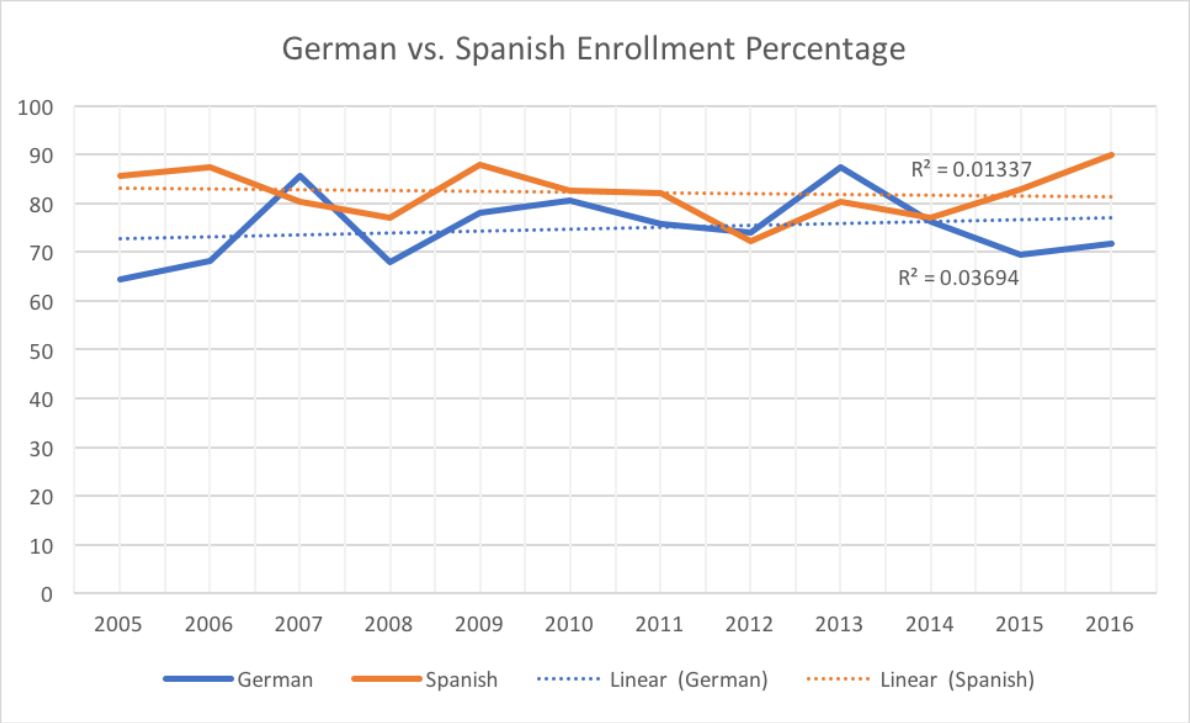

Figure 4.2: *German vs. Spanish Enrollment Percentages, 2005-16*

lines (dotted) show a slight decline in the Spanish program and a slight growth in the German program, but largely these should essentially be considered horizontal lines due to the fact that the R^2 values are so low. Consistently, however, the Spanish program has had more than double the number of students in the German program (see figure 4.3).

The quantitative reasons behind Spanish's popularity are not a component to this paper, but there are two main differences between Spanish and German. First, there is a trend that many students who take Spanish at WPI took some prior Spanish classes in high school. The most recent data about students who take a foreign language in American high schools says that 70.9% take Spanish and 4.9% take German (US Dept. of Education). The German professors at WPI confirmed that most of their students do not come in with prior German experience. The second advantage of Spanish is the addition of two business-based Spanish courses. These two classes, in the 2016-17 school year, had 92% enrollment—2% higher than Spanish classes overall. Professor Rivera, creator of the curriculum for the two courses, told us that the courses have "increased interest in the language—no question." Since the Spanish business courses date back to at least the first year of available data in this data set (2005-06), it is impossible to see the quantifiable rise with respect to more recent Spanish and German course performance.

Over the last 12 years foreign language enrollment has been in decline. The German program has generally maintained its enrollment percent to a degree, but is not entirely stable.

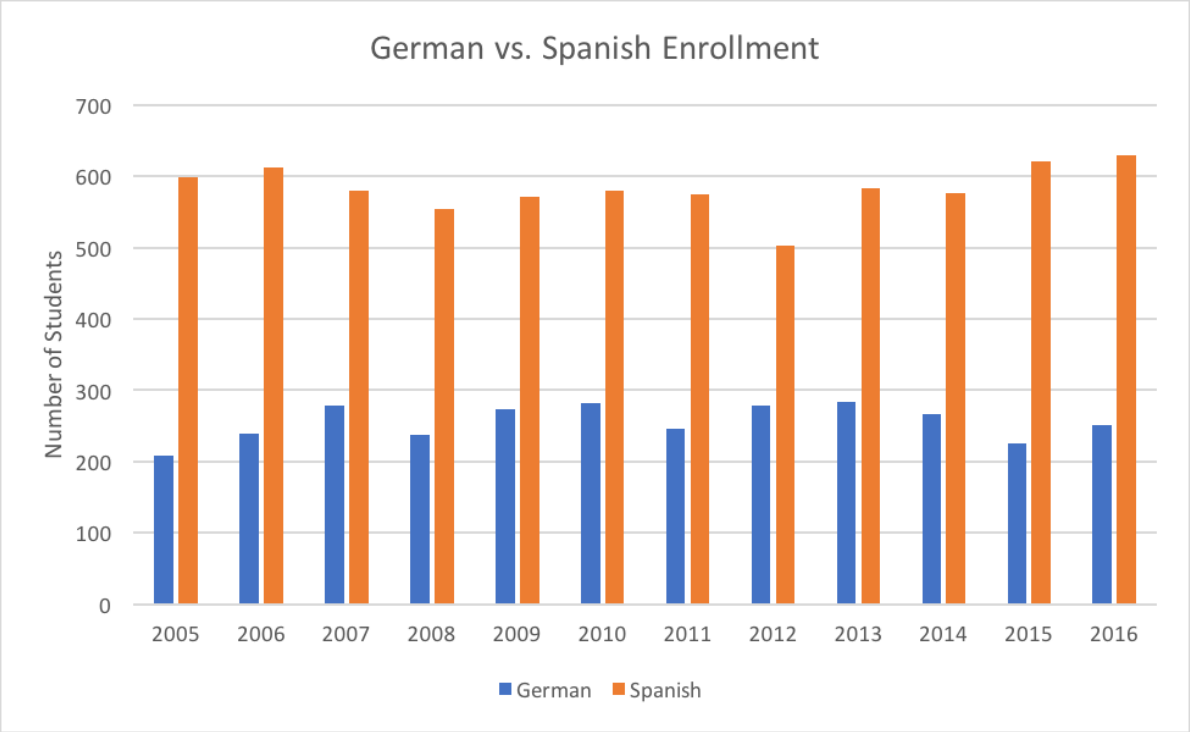

Figure 4.3: *German vs. Spanish Enrollment, 2005-16*

4.2 Finding 2: A majority of students responded positively to introducing STEM topics in language classes.

The survey available to undergrads had students rank different versions of a foreign language class structure in terms of how a given structure would influence them to take a foreign language class. Students were most inclined to take a foreign language class with some STEM integration, but preferred no integration at all (the current structure) over classes that focused purely on STEM topics. A voting system can represent this data wherein ranking a choice first earns it three votes, second earns it two votes, and third earns it one vote. Supplementary STEM integration earned 619 votes whereas no STEM in language classes and language classes that were completely STEM earned 589 and 340 votes respectively. With this voting system it is possible to have the most votes and not be the most wanted first rank, however that is not the case here. Supplementary STEM had the first rank over no STEM (119 vs. 117) as well as in the aforementioned total vote.

In the survey specifically for the German classes we asked whether introducing STEM topics in German classes would have a positive, neutral, or negative effect on their interest in taking the classes. With this question we also asked them to give a reason for how they answered to receive a better understanding of what students would want from such a class. Across both courses the responses were mostly positive including over half of the students from the beginner sections

and one student less than half from the advanced sections with each containing many neutral responses as well. Between both classes overall, about 54% of responses were positive, 14% were neutral, and 32% were negative.

From the Beginner class, answers commonly reflected the idea that STEM integration would help the students incorporate their German language learning with their major in school and when seeking a job. Another response that multiple students gave was they thought learning extra vocabulary would be interesting enough just for the sake of knowing extra terms, which may be linked to the possibilities of using the language in the future. One student specifically mentioned that his high school integrated STEM with Spanish classes and it was very enjoyable. One other response suggested that learning about industry, research, and education within Germany in greater depth would also be interesting. Although there were many different positive responses, most of them shared a common theme which is that including STEM in the German classes would make learning the language more meaningful.

Of the 23 responses from the Advanced class, 11 were positive. Students seemed to like the idea of utilizing a second language in their field of study, whether it be in college or in the workplace after graduation. One student specifically responded that with STEM the language learning becomes more practical for the students who are looking to use it within their career field and therefore it is an attractive option for them.

Receiving relatively similar responses from students at the beginning and end of the German program proves that including STEM would be a positive influence a majority of students at all class levels. Without this confirmation, an argument could be made that students finishing the program are looking to add variety to the classes or that new students have not experienced much of the interesting culture and therefore do not consider topics they might miss out on as a result of STEM inclusion. With the majority of responses being positive from this singular question, it is clear that STEM inclusion would be taken well by the students in the German classes and therefore supports the idea of our German program modification.

4.3 Finding 3: Current German students are interested in STEM-focused classes beyond the core six language/culture classes.

Among the Beginner German students, over 70 percent thought that an expansion to the curriculum through STEM inclusion sounded like a good idea. This high interest may be attributed to the fact that there really was no negative side to adding these classes. From the students' perspective there would just be more German classes that would be available for them to take. However, about half of this 70 percent did seem to express interest in the sense that they would take the class(es) if they were available. Making up the other 30 percent of responses for this question were mostly neutral, where the student generally thought it would be interesting to see

them offered, but that it would not really affect them. Out of all 49 students, only 4 explicitly stated that expanding the German program would not be a good idea, with reasons that are similar to those against STEM integration.

Over 79 percent of the Advanced German students responded positively to the idea of introducing new courses to the program with STEM integration, with a majority of those students mentioning that they would take one of the courses. A few students suggested to structure the courses so students would take them after the core German curriculum just like the German Film and German Literature classes that are offered now. To expand on this idea, most responses suggested that these added courses should count towards a German minor and could also count as a STEM credit in place of the English equivalent of the same course (i.e. Calculus I in German could be counted as credit towards the Calculus I requirement). Both the beginner and advanced German classes made suggestions for courses that could be created and taught as post-core classes. Almost everyone suggested some combination of calculus and physics/chemistry, but a unique answer was a scientific writing course. A noted problem with teaching math and science in German is the fact that those topics normally transcend language being very equation heavy and not too reliant on vocabulary.

Some students also mentioned the idea of making just a section of labs and conferences for specific courses taught in German. The main lectures would be in English, but having some language specific classes would allow for at least some practice in working with the language in a STEM environment. Similar to the labs and conferences, another student gave the idea of making the new classes worth something like 1/12th of a unit, where it meets maybe once or twice a week and supplements the courses like Calculus and Chemistry with German vocabulary and assignments.

4.4 Finding 4: Knowledge of STEM topics in a language gives students more confidence to study abroad.

In the survey available to all students, respondents preferred the idea of going abroad a short period of time (one or two terms) over either not going abroad or going abroad for an extended period of time. The motivation for this choice largely revolved around the time commitment and return-on-investment of the trip. Essentially, students concluded that there is language-based value in going abroad, but not to the point where costs get too high or graduation is postponed.

Among the Beginner German students, most responded positively to the prospect of studying abroad, which was expected seeing as so many students at WPI go abroad, whether it be for an exchange program, IQP, or MQP. Slightly more than 60 percent of the students responded completely positively, and a few mentioned specifically that they would feel more confident going after learning STEM related vocabulary in German. For the other 40 percent of students, they either did not want to go in the first place or they already plan on studying abroad and STEM

inclusion would not influence them at all. An interesting correlation is that all of these students were taking German to only learn the language.

When asked about how STEM integration would influence their thoughts of studying abroad, two thirds of the Advanced German students reacted positively. Although some did mention that they already decided they were not going abroad, they still noted that the inclusion of STEM topics would influence their decision in a positive manner if they were still deciding. One student in particular mentioned that having the STEM background would make it easier to work or get their Master's degree in Germany. The other third of the responses for this question were considered neutral or negative because they said STEM would have no influence on their decision to go abroad, but as expected no one said it would influence them negatively.

4.5 Finding 5: Students value an internship abroad more than studying abroad, time and monetary constraints considered.

Due to the thriving engineering environment in Germany, we asked the German students more in-depth about the idea of going abroad within the context of having an internship in a German-speaking environment. Among the beginner-level students, more than 70 percent of students showed interest in this internship option, explaining that it is more practical than just studying abroad and would also help them gain experience in the work field. As many students know, experience helps build professional relationships and is important when applying for jobs after college and obtaining that experience in a different country and culture is even more valuable. That is why so many students showed particular interest in this internship option. As for the other 30 percent, the responses voiced a general concern that their proficiency level in German would not be high enough to operate in a work environment overseas. This concern is very reasonable, but hypothetically if this internship program currently existed, the students would be required to be at a certain level of proficiency before even being considered for an internship overseas.

Advanced students were also more interested in an internship than the study abroad, with 17 out of 24 students responding positively. Most positive responses revolved around the idea that they would receive the benefit of work experience while enhancing their language skills all together and in the workplace. Another benefit students see in an internship compared to studying abroad is the possibility of getting paid rather than paying to attend school on top of the travel and living costs. This is only a possibility because in Germany the company that is providing the internship decides whether or not to pay interns, but even if the student is not paid an internship would be cheaper than studying abroad Some students also noted that an internship would be more relaxed than attending school. On the other hand, one student who is interested in studying abroad gave a neutral response for the idea of an internship saying that it

would be more stressful and would require more responsibility.

4.6 Finding 6: Students value humanities for the contrast with the STEM courses they are required to take.

From the in-class surveys completed by the German students specifically, we found that more than 15 percent of students look at German as their class to “get away” from the overwhelming STEM classes they are required to take. A portion of students from both the Beginner and Advanced classes presented this idea when asking them how including STEM into the six core German classes would affect their interest in taking German. In response these students mentioned that they are interested in the language and culture presented in the German curriculum and would rather the classes be focused purely on that rather than littered with STEM topics, which are the theme of essentially every other class they take at WPI. This information, while unsupportive of our goal for this project, provides an interesting and important argument for the negative effects that the possible results could cause. The argument created by the small group of students aligns with the reasoning behind the Humanities & Arts (HUA) Requirement of every undergraduate student at WPI. The HUA Requirement is summarized on its official website as “An important part of the WPI Plan, the distinctive Humanities & Arts (HUA) Requirement teaches you to transcend barriers, understand thoughts and connections, and comprehend how the history of the world matters to your present and future life” ("Humanities & Arts Requirement"). This led us to realize that it is important to avoid changing the German program to the point where it no longer satisfies the requirements that are set forth by the Humanities & Arts Department in addition to the WPI Plan. As a result of this we decided to use this argument in order to better structure our proposed German program extension so that it maintains its integrity as a HUA Requirement and satisfies the reasonable ideals for as many students as possible.

4.7 Finding 7: Most students value their time and other interests more than pursuing a minor or major in a language.

Students find great value in taking a language and have a great appreciation for the language and culture they learn in foreign language classes. However, in general they would prefer to take classes and learn the essentials instead of further pursuing a language to the point of earning a minor or second major in it. Data from the survey showed that students were most inclined to not have a degree in language, but a close second was to have a minor. When ranking the options between having no degree, a minor, and a major (with a voting system just like in Finding 2), having no degree was ranked first with 634 votes followed by a minor and a major with 591 and 323 votes, respectively. Just as in Finding 2’s ranked analysis, it was possible that the choice

voted most for rank 1 did not receive the most votes. Again, this was not the case, and no degree had 150 votes while a minor had 93 (see Appendix A, graph ??). For most students, having a minor is attainable, but a having a double major would make it difficult to graduate in four years. The smallest time commitment would be to not work towards even a minor, and therefore would be the easiest path. This is most likely the reason why students picked that option over others.

CHAPTER 5

RECOMMENDATIONS

Based on our background research and findings we have created a list of recommendations for Professor Brisson and Professor DiMassa. The first of which can be implemented in the coming year or two, while the following may take a couple years to assure the program has enough support and interest from faculty and students.

5.1 Introducing STEM topics into the current German core curriculum

5.1.1 Content of the Core German Classes

As it stands, the German curriculum follows a very carefully structured tour of the German language, history, and culture. Students learn how to read, write, and speak German by practicing everyday situations in class, reading excerpts of German literature, and discussing Germany's history and culture (both in English and German). Integrating STEM into German courses as they exist would inevitably eliminate some of the current content. Ideally, an integration would maintain the same level of language, history, and culture, but would cover at the very least some STEM vocabulary and phrases.

We suggest this content can be added in small amounts to the current German classes. Most of the classes consist of many vocabulary quizzes of terms from the textbook that we think could include a section of STEM related vocabulary that is assigned to be learned with each set of new terms from the textbook. Along with the vocabulary could be a weekly worksheet for the students to complete as an additional homework assignment. If this seems to be too much additional content to make the students accountable for, perhaps the STEM related assignments and vocabulary could be made voluntarily and account for bonus points on quizzes and for the

homework assignments. This would also be a good indicator for the number of students that are interested in the additional STEM content and be used as a guide for future STEM inclusion.

5.1.2 Faculty Recommendations

Although there seem to be plenty of students in the current German curriculum interested in an additional course for the German program, that does not necessarily mean we can jump right into adding such a course. This would either call for a new faculty member or adding on to a current faculty's workload and there may not be many students who are realistically ready to take such a course. Since both of these options would not be a cheap investment for the university, we suggest that the STEM inclusion is introduced in small amounts in the current classes as mentioned in the section above.

5.2 Create and Introduce a "STEM Topics in German" course

5.2.1 Choosing a Topic

There are quite a few different routes that could be taken when adding a new course to the German program that focuses on STEM topics. As mentioned in Finding 3, a majority of the students felt that Physics or Calculus would make for the best STEM topic to create a German class with, however one student mentioned a scientific writing course. Our recommendation for the first "STEM topic" is scientific writing because of its use in a wide range of jobs and fields of study. A scientific writing course would expose students to a lot of new vocabulary and prepare them to be able to read/translate engineering periodicals published in German. Such a skill would be very practical and valued in a German workplace, and students of a practical nature would be particularly interested in learning it.

5.2.2 Developing the Curriculum

With a scientific writing course, Professor Brisson or Professor DiMassa could teach it and organize multiple guest lecturers (i.e WPI German-Speaking Professors) to come in throughout the course and teach the class for a day about their field of study in German. To go along with the guest lecturers, students could write reports reflecting on everything they learned from each professor. From background research we know that a similar class has been taught in the German program where multiple teachers were team teaching the course that integrated STEM topics. This class may cause some professors to bring on a slightly larger workload than normal, but preferably avoids the situation of hiring another German professor to teach the class.

5.3 Establish connections with German universities and companies

From our background research, we found that universities with large foreign language programs develop connections with colleges in other countries and set up an exchange program. WPI's current German program currently has an exchange program with the University of Applied Sciences in Konstanz, Germany that is successful, but think it is important to expand the opportunities and also give the option of international internships. This aligns well with part of WPI's New Strategic Plan, which is looking to facilitate more internship/co-op opportunities as mentioned by Professor Burnham in our interview with her. The internship connections should first be formed with companies in Germany to give students in the exchange program an internship opportunity after they are finished with their classes. We recommend that connections are established with companies that focus on all different types of engineering so that any student who wants to complete an international internship can do so.

After a few years of the German program expanding, exchange connections should be made with other universities in Germany as well. Having connections with multiple universities gives students the option of where they will be located in Germany and allow them to choose a school near where they are completing an internship if they so choose to do that. Different universities are better for certain major's compared to others so having a variety lets students find the best fit for them. Finally, if the German program expands as we hope it does then having connections with multiple universities will ultimately allow more students to study abroad. With only one university to exchange with, some students who want to study abroad not be able to even if they are qualified.

CHAPTER 6

CONCLUSIONS

The goal of Engineering In German was to maintain the stability of the German program at WPI by integrating STEM topics into the current curriculum. In order to properly achieve this we surveyed students and interviewed faculty members of WPI to attain their level of interest regarding our proposed expansion and therefore partially determine the feasibility of the expansion. Through two separate surveys, we were able to gauge the interest of the student body from a Qualtrics survey sent out to a majority of the student body via Facebook and of German students through an in-class survey handed out in all the German classes taught in B Term. From these surveys we found the overall interest level in taking a language here at WPI along with how STEM inclusion would affect those interest levels of all students and specifically of those in the German classes. Interviews with three professors at WPI also lead to discovering what their interest levels were along with an insight to what the process of creating a course at WPI entails.

The interest levels of both the entire student body and specifically of the German students yields a promising incentive to continue pursuing the inclusion of STEM in the German program here at WPI, whether it be in the form of new classes or included in the current courses. If this STEM inclusion is implemented in moderation without interrupting the current curriculum too much, it seems the interest levels in taking German classes would raise overall and possibly result in more students taking German for their HUA Requirement. An increased number of students would then just further the potential need and possibility of expanding the German program more as time goes on. This could ultimately open new opportunities such as a network of international internships or a larger exchange program in Germany in which the students at WPI would have the option to participate.

Appendix A: Qualtrics Survey open to All Students

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Engineering, in German

Thank you for taking the time to answer this survey. These questions serve to provide us with data for our IQP, "Engineering, in German." At the end, you can enter your WPI email address for the chance to win a $50 Amazon gift card. All answers are anonymous and participation is voluntary.

Which class are you in?

- ❍ 2017 (1)
- ❍ 2018 (2)
- ❍ 2019 (3)
- ❍ 2020 (4)

What is you major? Select all that apply.

- ❑ Actuarial Mathematics (1)
- ❑ Aerospace Engineering (2)
- ❑ Applied Physics (3)
- ❑ Architectural Engineering (4)
- ❑ Biochemistry (5)
- ❑ Bioinformatics & Computational Biology (6)
- ❑ Biology & Biotechnology (7)
- ❑ Biomedical Engineering (8)
- ❑ Business (9)
- ❑ Chemical Engineering (10)
- ❑ Chemistry (11)
- ❑ Civil Engineering (12)
- ❑ Computer Science (13)
- ❑ Economic Science (14)
- ❑ Electrical & Computer Engineering (15)
- ❑ Environmental & Sustainability Studies (16)
- ❑ Environmental Engineering (17)
- ❑ Humanities & Arts (18)
- ❑ Industrial Engineering (19)
- ❑ Interactive Media & Game Development (20)
- ❑ International & Global Studies (21)
- ❑ Liberal Arts & Engineering (22)
- ❑ Management Engineering (23)
- ❑ Management Information Systems (24)
- ❑ Mathematical Sciences (25)
- ❑ Mechanical Engineering (26)
- ❑ Modern Language (32)
- ❑ Physics (27)
- ❑ Professional Writing (28)
- ❑ Psychological Science (29)
- ❑ Robotics Engineering (30)
- ❑ Society, Technology, & Policy (31)

At WPI, which humanities subjects have you studied or plan on studying?

- ❑ Arabic (AB) (1)
- ❑ Art (AR) (4)
- ❑ Chinese (CN) (5)
- ❑ English (EN) (16)
- ❑ German (GN) (7)
- ❑ History (HI) (8)
- ❑ Humanities (HU) (9)
- ❑ International & Global Studies (INTL) (10)
- ❑ International Students English (ISE) (17)
- ❑ Music (MU) (11)
- ❑ Philosophy (PY) (12)
- ❑ Religion (RE) (13)
- ❑ Spanish (SP) (14)
- ❑ Writing (WR) (15)

Display This Question:

If At WPI, which humanities subjects have you studied or plan on studying? Arabic (AB) Is Selected

Or At WPI, which humanities subjects have you studied or plan on studying? Chinese (CN) Is Selected

Or At WPI, which humanities subjects have you studied or plan on studying? German (GN) Is Selected

Or At WPI, which humanities subjects have you studied or plan on studying? Spanish (SP) Is Selected

Or At WPI, which humanities subjects have you studied or plan on studying? International Students English (ISE) Is Selected

What lead to your interest in a foreign language? Select all that apply.

- ❑ To learn the language (1)
- ❑ To learn about the culture (2)
- ❑ To try something new (3)
- ❑ To gain communication skills (4)
- ❑ To be fluent abroad (5)
- ❑ Others: (6) _____

Display This Question:
If At WPI, which humanities subjects have you studied or plan on studying? Arabic (AB) Is Not Selected
And At WPI, which humanities subjects have you studied or plan on studying? Chinese (CN) Is Not Selected
And At WPI, which humanities subjects have you studied or plan on studying? German (GN) Is Not Selected
And At WPI, which humanities subjects have you studied or plan on studying? Spanish (SP) Is Not Selected
And At WPI, which humanities subjects have you studied or plan on studying? International Students English (ISE) Is Not Selected

What has kept you from taking an interest in foreign language class?

Display This Question:
If At WPI, which humanities subjects have you studied or plan on studying? Art (AR) Is Selected
Or At WPI, which humanities subjects have you studied or plan on studying? History (HI) Is Selected
Or At WPI, which humanities subjects have you studied or plan on studying? Humanities (HU) Is Selected
Or At WPI, which humanities subjects have you studied or plan on studying? International & Global Studies (INTL) Is Selected
Or At WPI, which humanities subjects have you studied or plan on studying? Music (MU) Is Selected
Or At WPI, which humanities subjects have you studied or plan on studying? Philosophy (PY) Is Selected
Or At WPI, which humanities subjects have you studied or plan on studying? Religion (RE) Is Selected
Or At WPI, which humanities subjects have you studied or plan on studying? Writing (WR) Is Selected
Or At WPI, which humanities subjects have you studied or plan on studying? English (EN) Is Selected

In general, what is/was your motivation for picking non-foreign language humanities?

Hypothetically, if there existed a foreign language program with STEM topics integrated with the language, how likely would you take classes in that program? Drag the slider to indicate your answer. "0" equates to not likely at all, and "10" equates to extremely likely.

_____ Likelihood (1)

Did you know that at WPI you can double major with a science/engineering related subject and a modern language?

- ❍ Yes (1)
- ❍ No (2)

Please rank these options from best (1) to worst (3) in your opinion. Take into consideration your personal interests, your future career plans, and your ambition as a student. Drag each option into its appropriate position.

_____ Simply take foreign language classes (least time consuming) (1)
_____ Major in a science/engineering related subject and minor in a foreign language (somewhat time consuming) (2)
_____ Double major with a foreign language and a science/engineering related subject (most time consuming) (3)

Please rank these options from best (1) to worst (3) in your opinion. Take into consideration your personal interests, your future career plans, and your ambition as a student. Drag each option into its appropriate position.

_____ Foreign language classes as they currently exist (1)
_____ Foreign language classes as they currently exist with supplementary STEM topics (2)
_____ Foreign language classes that focus on purely STEM topics (3)

Please rank these options from best (1) to worst (3) in your opinion. Take into consideration your personal interests, your future career plans, and your ambition as a student. Drag each option into its appropriate position.

_____ Staying on campus to take foreign language classes (1)
_____ Going abroad for 1-2 terms to study foreign language (2)
_____ Going abroad for a summer and 2+ terms to work an internship (3)

Again hypothetically, if there existed a double major program which integrated STEM topics with the language, allowed for both a study abroad and an international internship, but had the caveat of it prolonging your graduation for A YEAR, how likely would you pursue a degree in that program? Drag the slider to indicate your answer. "0" equates to not likely at all, and "10" equates to extremely likely.

_____ Likelihood (1)

Thank you for participating. Please enter you WPI email below if you'd like to be entered into a drawing to win a $50 Amazon gift card. The drawing will be held Thanksgiving Day (before Black Friday and Cyber Monday).

Do you really, really, really want that $50 Amazon gift card? For the chance to have multiple entries into the drawing, please leave some constructive feedback on this IQP. Every distinct, constructive thought concerning the application of STEM topics to foreign language and studying/working abroad will earn you one more entry in the drawing. Those who answer this response will remain anonymous (a third party will link the value of the response to your email).

APPENDIX B

Appendix B: Survey Results

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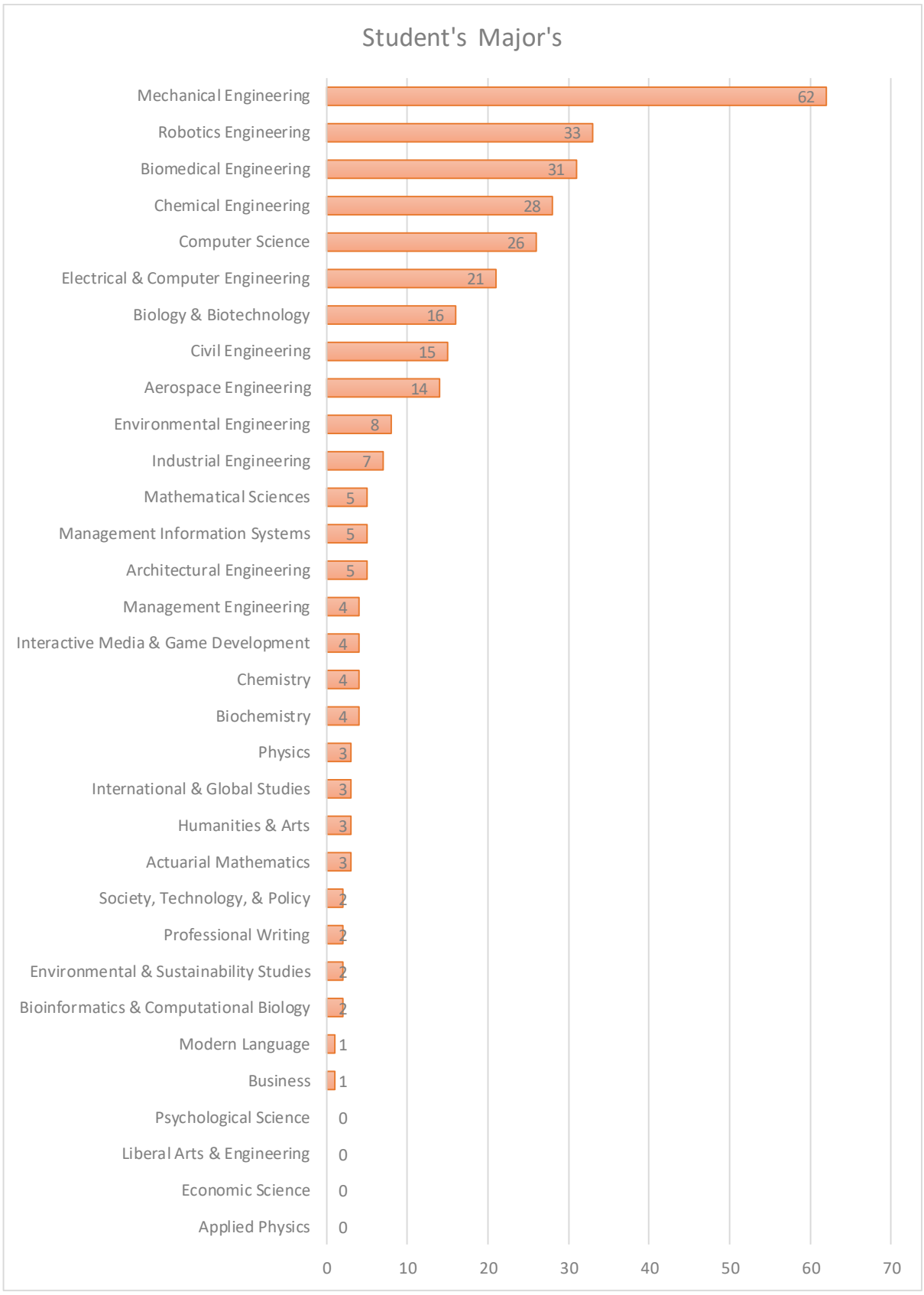
Student's Major's
Mechanical Engineering 62
Robotics Engineering 33
Biomedical Engineering 31
Chemical Engineering 28
Computer Science 26
Electrical & Computer Engineering 21
Biology & Biotechnology 16
Civil Engineering 15
Aerospace Engineering 14
Environmental Engineering 8
Industrial Engineering 7
Mathematical Sciences 5
Management Information Systems 5
Architectural Engineering 5
Management Engineering 4
Interactive Media & Game Development 4
Chemistry 4
Biochemistry 4
Physics 3
International & Global Studies 3
Humanities & Arts 3
Actuarial Mathematics 3
Society, Technology, & Policy 2
Professional Writing 2
Environmental & Sustainability Studies 2
Bioinformatics & Computational Biology 2
Modern Language 1
Business 1
Psychological Science 0
Liberal Arts & Engineering 0
Economic Science 0
Applied Physics 0
0 10 20 30 40 50 60 70

Table B.1: *Student's Major's*

Major	%	Count
Mechanical Engineering	22.46%	62
Robotics Engineering	11.96%	33
Biomedical Engineering	11.23%	31
Chemical Engineering	10.14%	28
Computer Science	9.42%	26
Electrical & Computer Engineering	7.61%	21
Biology & Biotechnology	5.80%	16
Civil Engineering	5.43%	15
Aerospace Engineering	5.07%	14
Environmental Engineering	2.90%	8
Industrial Engineering	2.54%	7
Architectural Engineering	1.81%	5
Management Information Systems	1.81%	5
Mathematical Sciences	1.81%	5
Biochemistry	1.45%	4
Chemistry	1.45%	4
Interactive Media & Game Development	1.45%	4
Management Engineering	1.45%	4
Actuarial Mathematics	1.09%	3
Humanities & Arts	1.09%	3
International & Global Studies	1.09%	3
Physics	1.09%	3
Bioinformatics & Computational Biology	0.72%	2
Environmental & Sustainability Studies	0.72%	2
Professional Writing	0.72%	2
Society, Technology, & Policy	0.72%	2
Business	0.36%	1
Modern Language	0.36%	1
Applied Physics	0.00%	0
Economic Science	0.00%	0
Liberal Arts & Engineering	0.00%	0
Psychological Science	0.00%	0
Total	100%	276

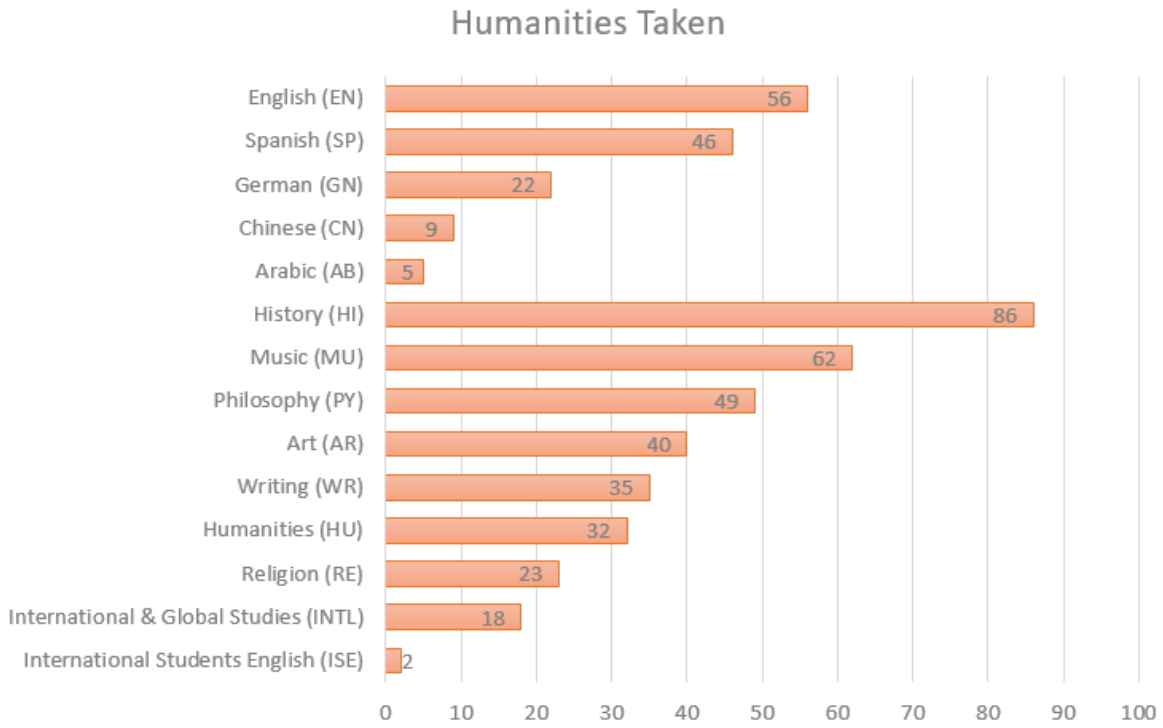

Table B.2: *Humanities Taken*

Humanities	%	Count
English (EN)	20.44%	56
Spanish (SP)	16.79%	46
German (GN)	8.03%	22
Chinese (CN)	3.28%	9
Arabic (AB)	1.82%	5
History (HI)	31.39%	86
Music (MU)	22.63%	62
Philosophy (PY)	17.88%	49
Art (AR)	14.60%	40
Writing (WR)	12.77%	35
Humanities (HU)	11.68%	32
Religion (RE)	8.39%	23
International & Global Studies (INTL)	6.57%	18
International Students English (ISE)	0.73%	2
Total	100%	274

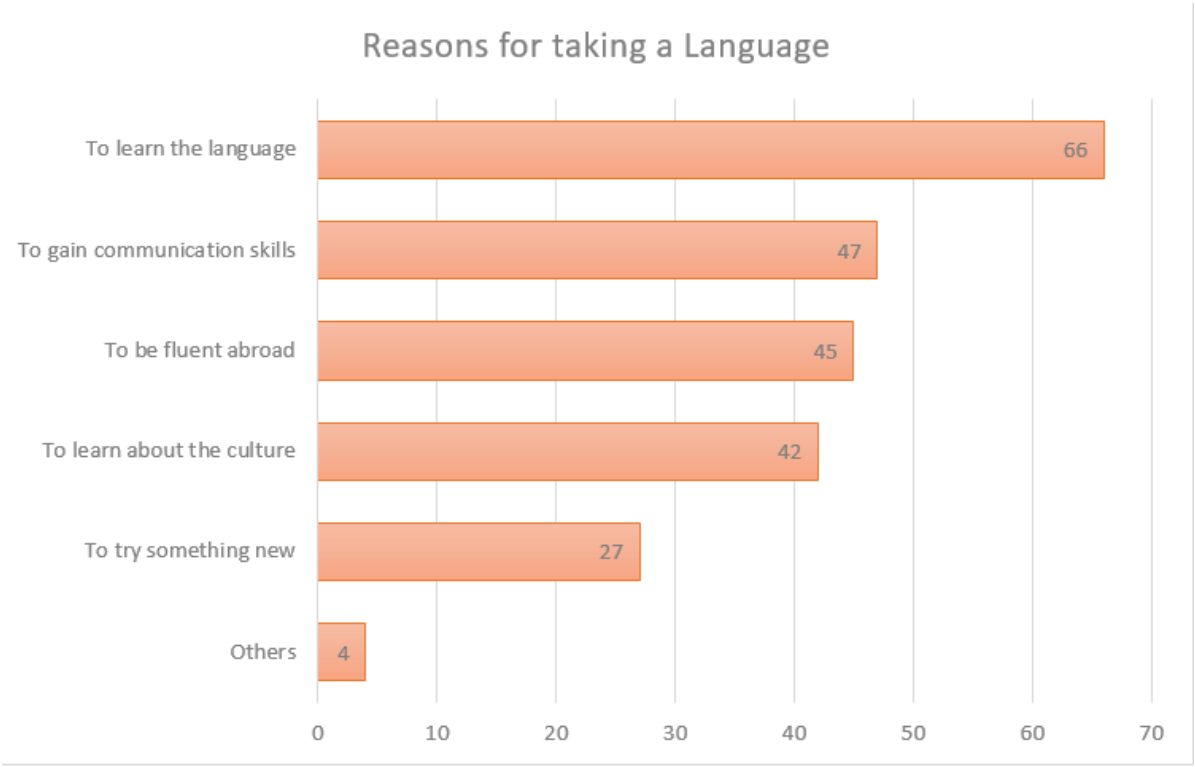

Table B.3: *Reasons for Taking a Language (Students could Select more than One)*

Reason	%	Count
To learn the language	84.62%	66
To gain communication skills	60.26%	47
To be fluent abroad	57.69%	45
To learn about the culture	53.85%	42
To try something new	34.62%	27
Others:	5.13%	4
Total	100%	78

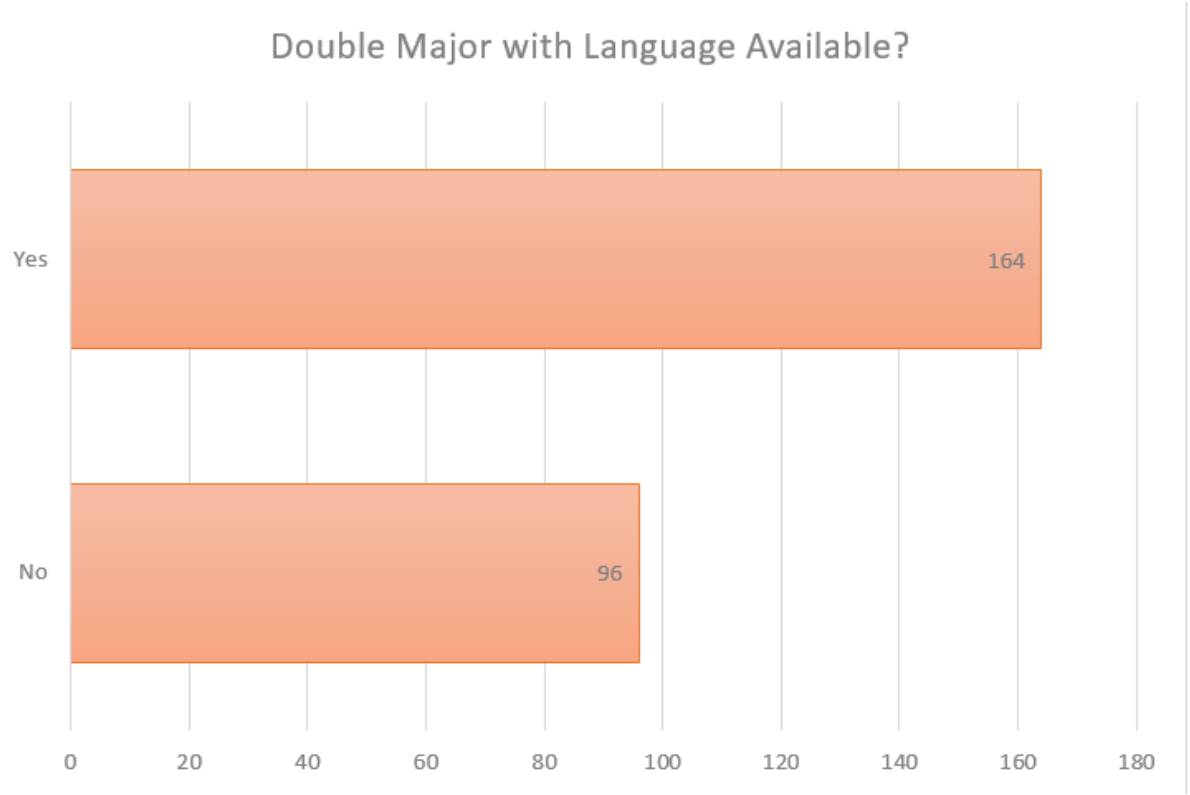

Table B.4: *Did you know you could double major with engineering and a language at WPI?*

Option	Students
Yes	164
No	96
Total	260

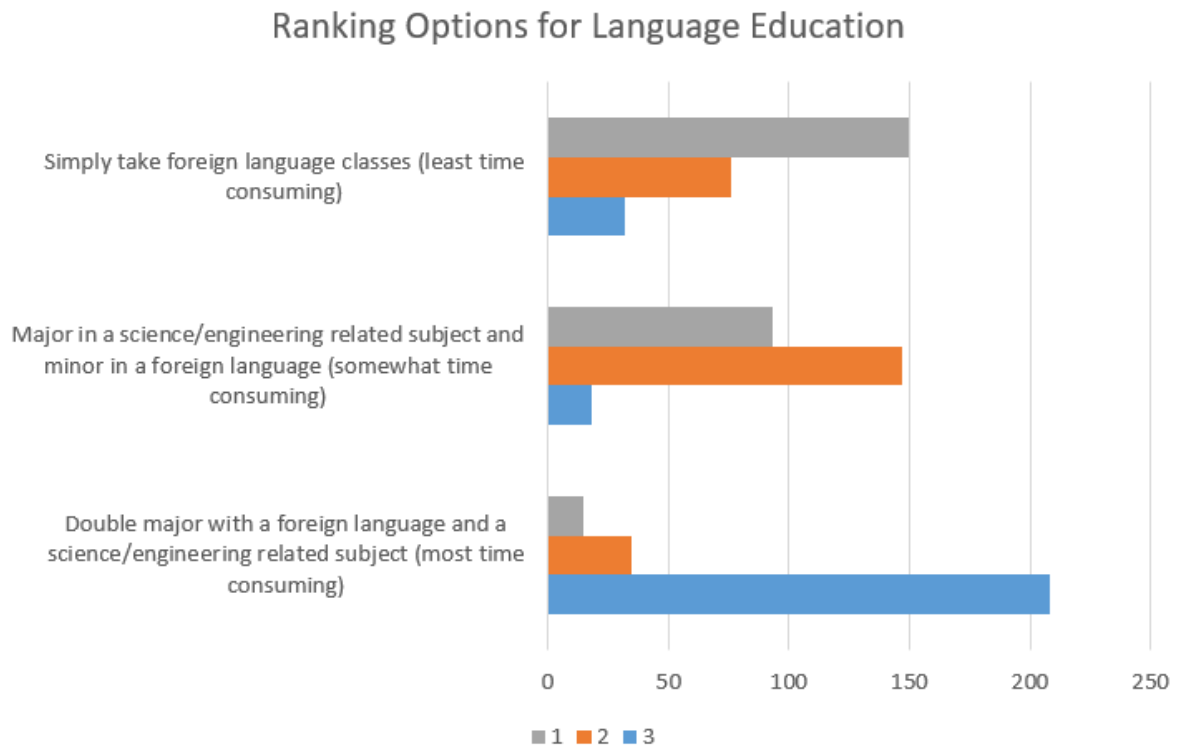

Table B.5: *Ranking Options for Language Education (Best to Worst)*

Option	1		2		3	
Simply take foreign language classes	58.14%	150	29.46%	76	12.40%	32
Major in a science/engineering related subject and minor in a foreign language	36.05%	93	56.98%	147	6.98%	18
Double major with a foreign language and a science/engineering related subject	5.81%	15	13.57%	35	80.62%	208

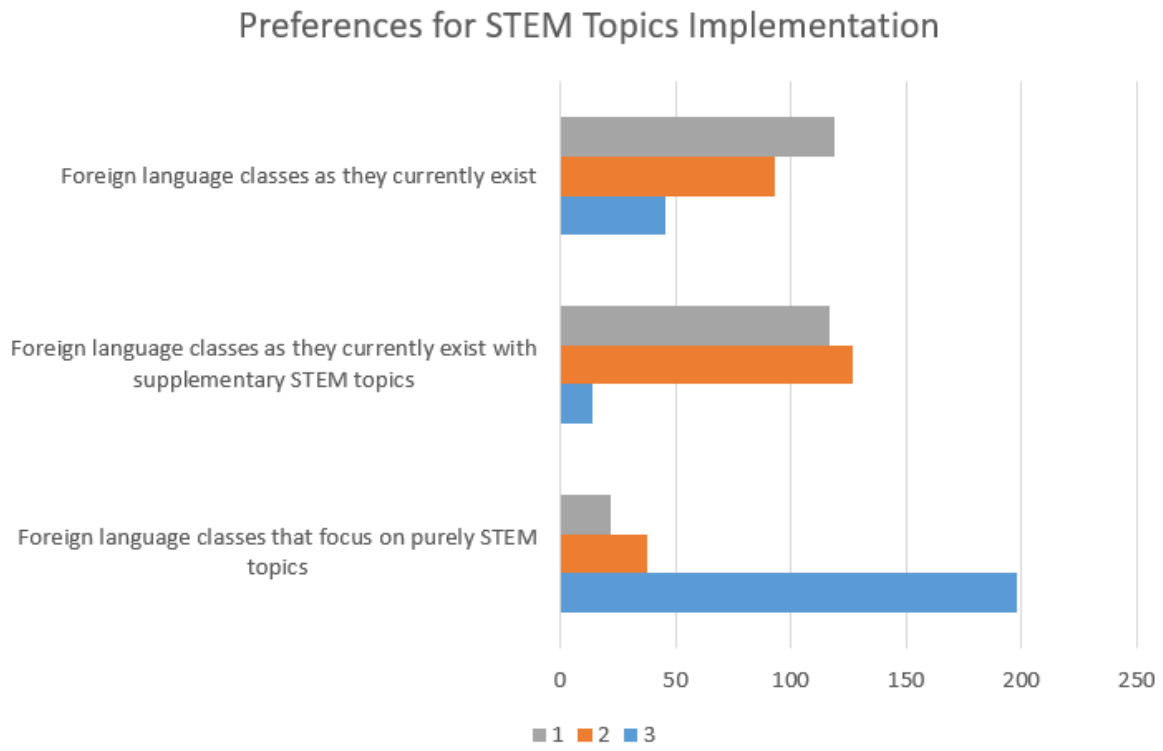

Table B.6: *Student's Rankings for Integrating STEM Topics into a Foreign Language Program*

Option	1		2		3	
Foreign language classes as they currently exist	46.12%	119	36.05%	93	17.83%	46
Foreign language classes as they currently exist with supplementary STEM topics	45.35%	117	49.22%	127	5.43%	14
Foreign language classes that focus on purely STEM topics	8.53%	22	14.73%	38	76.74%	198

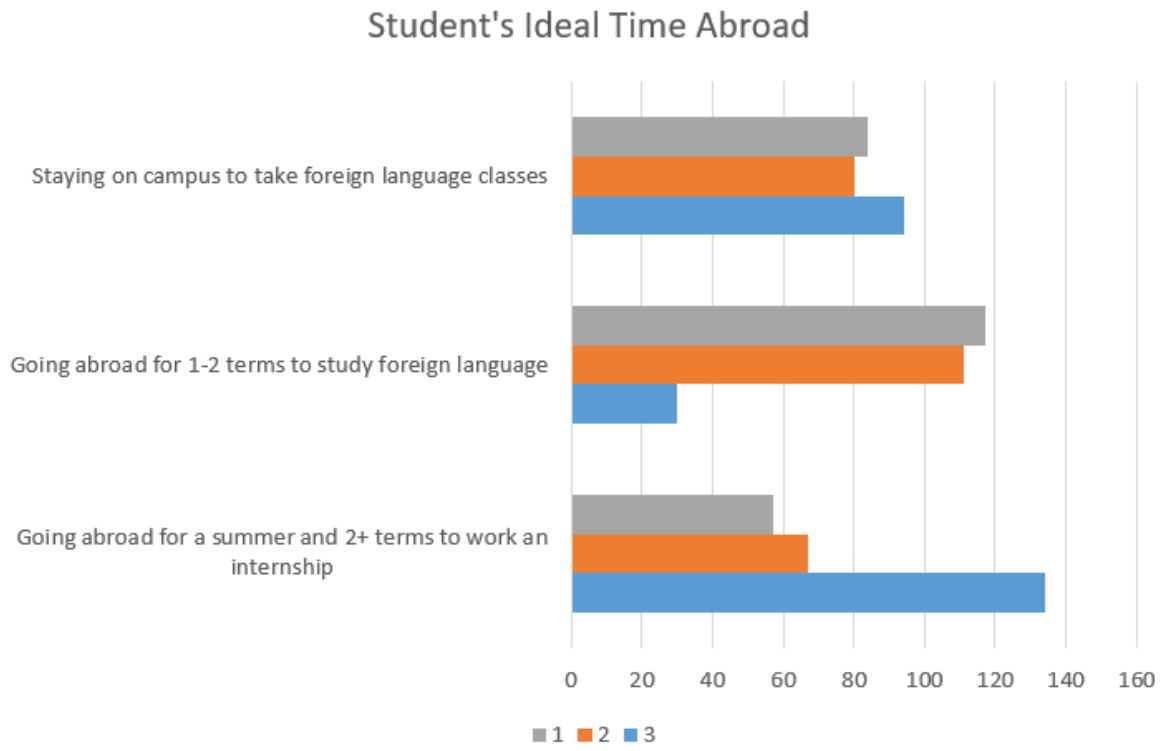

Table B.7: *Student's Ideal Time Abroad*

Option	1		2		3	
Staying on campus to take foreign language classes	32.56%	84	31.01%	80	36.43%	94
Going abroad for 1-2 terms to study foreign language	45.35%	117	43.02%	111	11.63%	30
Going abroad for a summer and 2+ terms to work an internship	22.09%	57	25.97%	67	51.94%	134

APPENDIX C

Appendix C: Survey for Students Enrolled in German Courses

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“Engineering in German” In-Class Survey

What class year are you?

What is your major/minor?:

Why did you choose to take German?

How interesting have the German classes that you have taken so far been? (On a scale from 1-10)

1 2 3 4 5 6 7 8 9 10

Would including STEM curriculum in the German program make you more or less interested in taking it? Why is that?

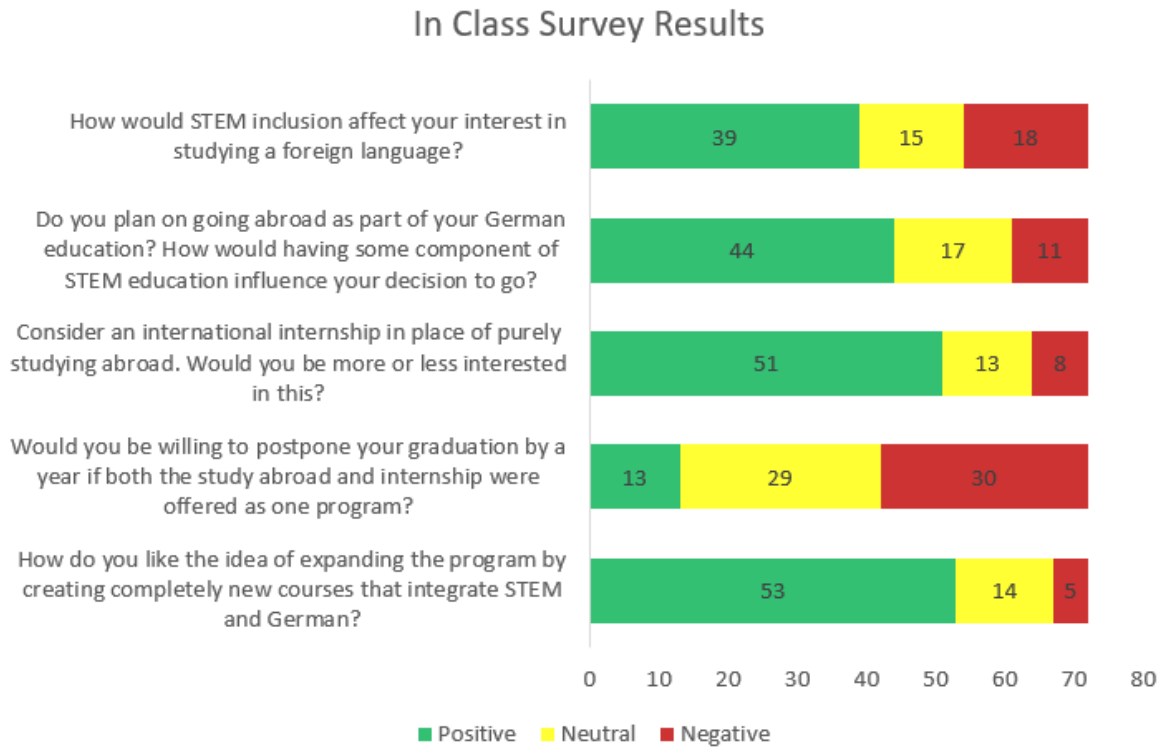
Do you plan on going abroad as part of your German education? Would having some component of STEM education abroad influence your decision to go? Would this be a positive or negative influence?

Same question as above, but this time consider an international internship in place of purely studying abroad. Would you be more or less interested in this, and what about it would make it better or worse than studying abroad.

Would you be willing to postpone your graduation by a year if both the study abroad and internship were offered as one program? What are your concerns with such a program, and would you be willing to do it?

How do you like the idea of expanding the program by creating completely new courses that integrate STEM and German?

Do you have any suggested STEM topics to integrate with German? If so, which ones (Physics, Calculus, etc.) and why?


In Class Survey Results
How would STEM inclusion affect your interest in studying a foreign language?
39
15
18
Do you plan on going abroad as part of your German education? How would having some component of STEM education influence your decision to go?
44
17
11
Consider an international internship in place of purely studying abroad. Would you be more or less interested in this?
51
13
8
Would you be willing to postpone your graduation by a year if both the study abroad and internship were offered as one program?
13
29
30
How do you like the idea of expanding the program by creating completely new courses that integrate STEM and German?
53
14
5
0
10
20
30
40
50
60
70
80
Positive
Neutral
Negative

APPENDIX D

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