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Foreign Language and the Globally Competent Engineer: More Than Just a "Soft Skill"

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Cover Page Footnote

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I have learned what it means to understand another culture and how its engineering designs can be intricately tied to that culture. If I could take the time to better understand the cultures of all people I work with, I could better understand and evaluate the decisions of others.

- Engineering student, May 2015

Introduction

The rationale for emphasizing global competence in the education of today's engineering student has been proven highly valid in a world of rapidly shifting global opportunities and challenges. Increasingly international projects and teams, the demand for engineering services on an international basis, and increased business with recent emerging economies have charged universities with the responsibility of producing graduates capable of succeeding across cultural and national borders. While many would agree that a key component of global competence is cross-cultural communication, the role of foreign language aptitude as it relates to cross-cultural communication in the engineering fields has yet to be defined. Educators are not in agreement as to how much exposure to a second language engineering students need so as to be characterized as globally competent (see Chang, Parkinson 2009). Given the tight scheduling constraints of most engineering programs, it is also unclear how universities may include requirements for L2 proficiency. This paper argues that L2 competence lies at the heart of true global preparedness for engineers. The ability to communicate in a second or third language is a skill that takes the global competence of an engineer to a heightened level, and implies directly that L2 proficiency should not be categorized as a "soft skill" of lesser importance in engineering education. Engineering education should strive to develop cross-cultural appreciation, communication, and understanding through an interdisciplinary approach. It is difficult to state this idea more concisely and clearly than in the words of Maurizio Seracini, founder and director of the Center for Interdisciplinary Science of Art, Architecture, and Archaeology at the University of California San Diego, who applies science and engineering developments to the study of art history and to art restoration. In a lecture given to our program during our Florence stay, he stated: "An engineer with a broad culture is much richer than an engineer focused on one field."[1] As one program participant

recalled, Seracini emphasized the "liberal arts mind" for the engineer. Along with several colleagues, Seracini recently published a paper making the case to put the Arts into the middle of STEM, transforming it into STEAM. If the U.S. is to remain relevant, there must be "collaborative education outreach ventures that emphasize the value of applied science in engineering in hard sciences … with the softer science of cultural heritage diagnostics providing an engagement mechanism, moving from STEM education towards STEAM education by deploying the art, architecture, and archaeology studied under cultural heritage diagnostics into the melee."[2] Competence in a second language is one of the mechanisms through which engineers can build up an ethos of cross-cultural communication, cultural sensitivity, and global competence. Taking a cue from the student quoted at the beginning of this article who hopes to better understand the cultures of others, educators should reexamine the role that language education plays in the engineering curriculum, and situate it at the very heart of the educational experience aimed at producing a globally competent engineer.

Attributes of the Globally Competent Engineer

Defining the elusive term "global competence" is not an easy task. Hunter et al. describes global competence as "having an open mind while actively seeking to understand cultural norms and expectations of others, leveraging this gained knowledge to interact, communicate and work effectively outside one's environment."[3] In her study, Deardorff presents multiple definitions of global (or intercultural) competence; the two of her definitions that are most highly rated by educators include the attributes *linguistic competence* and *foreign language proficiency*.[4] Working from definitions such as these, the notions of cross-cultural communication and foreign language competence surface as key components that make up the definition of the term "global competence."

A number of recent studies have established skill sets and attributes that characterize the globally competent engineer (see May and Tekkaya,[5] Parkinson,[6] Rajala[7]). The cases reviewed in Jesiek et al.'s 2014 study focus on global engineering competence as it relates to professional fields.[8] In a 2009 article, Parkinson identifies 13 "dimensions or attributes" of the globally competent engineer, a few of which reflect and expand upon the language used in the Accreditation Board for Engineering and Technology (ABET)[9] document outlining engineering program learning outcomes. The ABET Criteria for Accrediting

Engineering programs states that students should show an ability to "communicate effectively;" Parkinson emphasizes an ability to "communicate across cultures." The ABET document states that students should possess "an ability to function on multidisciplinary teams;" Parkinson specifies that students be "proficient working in or directing a team of ethnic and cultural diversity." Three of Parkinson's attributes specifically mention communication or language (numbers two, four, and five); the remaining nine attributes also allude to the importance of communication in appreciating other cultures, issues, and differences (see Parkinson 2009 for full description).

Interestingly, the 11 engineering program outcomes outlined in the ABET document do not address the issue of L2 acquisition. ABET outcome (g) states that students should show "an ability to communicate effectively." ABET outcome (h) follows, stating that engineering students should "show the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context." There seems to be some disconnect between these two outcomes; outcome (g) does not mention L2 proficiency, and, as noted in May and Tekkaya, outcome (h) fails to address the issue of communication. If communication is to take place across cultures (as implied in the wording "global context" of outcome (h)), it follows that the globally competent engineer should possess at the very least a conversational ability in second or third language. As seen in Parkinson's list of attributes, L2 proficiency plays a role in the education of the globally competent engineer; outcome (4) states that the global engineer should "speak a second language at a conversational level" and outcome (5) takes L2 competence one step further, asserting that the global engineer should "speak a second language at a professional (i.e. technical) level. In his explanation of attribute (4), Parkinson states:

Learning the language of another country is a key in developing a deep understanding of the culture and is an impressive gesture of goodwill and reaching out to cross cultural boundaries. Learning a second language also promotes tolerance for others who have learned English as a second language.[10]

Furthermore, the global engineer who can speak a second language at a professional or technical level takes this skill to the next level and as he or she can "conduct engineering activities in a second language." Interestingly, Parkinson's survey of academics and professionals on the relative importance of the 13

attributes illustrates that industry representatives working for globally operative companies gave more weight to the role of language competence than the faculty from the 11 universities surveyed. Specifically, the ability to speak a second language at a technical level was rated as 3 on a scale from 1 (not important) to 5 (essential) by the academics surveyed; the same attribute was rated 3.5 by the industry representatives. While the rankings from this one survey cannot be applied indiscriminately to all fields and professions, industry's trend toward placing a higher value on second language skills continues to rise. In the summary of the 2008 meeting between engineering educators and global executives held in Rhode Island, the urgent need for increased L2 competence emerged as a theme among members of the private sector. In the proceedings from that meeting, the group expressed the idea that "engineering educators need to gain greater respect for the important 'soft skills' associated with international work and study experiences."[11] Tomorrow's globally competent engineer will continue to be more highly valued for her or his ability to communicate conversationally and professionally in more than one language, facilitating the crossing of cultural and national boundaries and the lifelong learning that characterizes a "citizen of the world."

The Language Perspective

In 2007, the Modern Language Association (MLA) published findings on the role of foreign language in higher education, and the necessity to understand other cultures and languages was identified as one of the "five imperative needs to which higher education must respond in the next 10 years, if it is to remain relevant."[12] The MLA also stressed interdisciplinary courses and collaboration between departments in higher education. Most importantly, the 2007 MLA document emphasizes that language is more than just a skill; it is a "complex multifunctional phenomenon that links an individual to other individuals, to communities, and to national cultures." This language mirrors that of the American Council on the Teaching of Foreign Languages (ACTFL), publishers of the *World-Readiness Standards for Learning Languages*. According to the ACTFL document, "language learning contributes an important means to communicate and interact in order to participate in multilingual communities at home and around the world. This interaction develops the disposition to explore the perspectives behind the products and practices of a culture and to value such intercultural experiences."[13] Clearly, both organizations agree that knowledge of more than one language can link a person to others on more than simply a linguistic level, and that language learning

must remain an essential component of higher education in the United States. Recently, however, the profession has noticed a downward trend in the enrollment of students in foreign language at the post-secondary level. In February 2015, the MLA published updated findings on enrollments in languages other than English,[14] and results for 2013 show a decrease of 6.7% of post-secondary students studying a second language from the 2009 survey. (However, the drop in 2013 should be understood in the broad context of a reported decrease in the overall number of enrollments in higher education between 2012 and 2013.) This shifting trend is worrisome, especially considering the ever increasing need for globally competent graduates. Of crucial importance is the noteworthy fact that even in a time of "financial constraints, challenges to the profession, and a general disregard for language study," unique programs such as those run by University of Rhode Island and Purdue University, among others, can be seen as models for building bridges between engineering and languages.[15] The innovative idea of collaboration between language departments and engineering programs has led to the continued success of the Annual Colloquium on International Engineering Education as a venue where colleagues from all over the world can meet to "disseminate the model bridging engineering with the languages."[16]

Study Abroad

According to the 2015 Open Doors study released by the Institute of International Education,[17] and in contrast to the MLA findings, study abroad by U.S. students has more than tripled in the past two decades, from 1993/94 to 2013/14. Today, one in ten U.S. students participates in some type of study abroad experience before completing an undergraduate degree (whether or not these students take language classes prior to studying abroad is another interesting research question). According to the IIE, 62% of students studying abroad participated in a short-term program, identified as eight weeks or less. While these short-term programs are more flexible and tend to cost less, "educators must work hard to make these experiences meaningful, with contact with local populations and not just fellow American students."[18] Of particular interest is the number of STEM students who study abroad. During both the 2012/13 and 2013/14 academic years, the STEM field as a whole comprised about 23% of the majors of students studying abroad, characterizing it as the most popular field of study of all US students abroad during that year. However, this number is misleading when considering the high number of U.S. students who major in STEM fields (36% of all U.S. undergraduates); with

these ratios in mind, STEM students continue to be under-represented in study abroad. Reasons for this could range from the constraints of crowded curricula which prohibit semester-long study abroad programs, to lack of L2 proficiency in STEM students, which makes choosing a host country for study abroad prohibitive. Unfortunately, the IIE does not collect data on study abroad destination by fields of study.

At Bucknell University, during the 2014/15 and 2015/16 academic years, 15% of all engineering students participated on a semester-long study abroad program. Of these students, only 13% studied abroad in non-English speaking countries (approximately six students per year). Of these students, very few had any language preparation prior to studying abroad. Specifically, during the 2014/2015 academic year, only one student attended a semester-long program in a country where English was not the first language (and where the requirement was five semesters of language prior to departure). During the 2015/2016 academic year, eight engineering students from Bucknell University participated on a semester-long study abroad program where English was not the first language. Five of these students had language classes prior to departure (two had one semester, and one student each had two, three, and four semesters respectively). Ultimately, out of approximately 200 engineering students who graduate per year from Bucknell University, only about 2-4% have had a semester-long study abroad experience in a country where English is not the primary language, and of that number few have had more than one semester of language preparation. While an ideal solution (fitting a semester-long study abroad program into a tight curriculum and including language preparation) might not be feasible for all students, a possible interim solution lies in the opportunities offered by short-term study abroad programs that integrate language education.

History of the Program

A three-week study abroad program for engineering students at Bucknell University, entitled "Engineering in a Global and Societal Context," was first offered in May 2004.[19] Since its inception, the program has been organized and run by faculty members, giving program coordinators considerable freedom in choosing country of study, program theme, and course components. The three-week course fulfills an elective requirement of the engineering curriculum that is based on three of the ABET learning outcomes (g), (h), and (i): students should

show an ability to communicate effectively, the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context, and a recognition of the need for, and an ability to engage in life-long learning. If students choose not to participate in the summer study abroad program, they must fulfill the global and societal elective on campus from a list of approved courses (all language courses fulfill this elective for engineering students). Between 2004 and 2014, an average of 25 students participated on the program each year, typically as rising juniors or seniors. In the first decade of the course's existence, 7 out of 11 of the programs were taught in countries where English was not the primary language. (In 2013 there were two simultaneous programs offered, hence the total of 11 programs). In May 2015, the global and societal study abroad program took place in Italy under the title "The Importance of Place for Engineered Systems" and was directed and taught by three faculty members, one from each of the following fields: Chemical Engineering, Computer Science, and Italian Studies. Twenty-eight students participated on the program. For the first time in the program's history, a language component was added as a mandatory portion of the course. A program outcome was added as well: students shall demonstrate, at minimum, a novice-mid level competency in spoken Italian. The intention in adding this language component and associated program outcome was to enrich the students' experience while abroad by helping students connect more readily to the culture and society of their host country. The outcome of this experiment on the one hand exceeded expectations, as shown through the indirect assessment method of student self-perception in comments from journals and exit interviews, and simultaneously highlighted the limitations of such a short program with limited L2 instruction, which led to discussion and suggestions for improvement in future years.

Instructional Methods

One of the goals of Bucknell University's three-week study abroad course is to create an interdisciplinary engineering curriculum appropriate for all students on the program. Throughout the May 2015 course in Italy, students were exposed to visits that incorporated civil, chemical, environmental, mechanical, and computer science engineering. In Pisa, students met with a civil engineer who had been a member of the operations team monitoring the settlement of the south side of the Leaning Tower and contributor to topographic surveys, from whom they learned firsthand about the field tests, results, positive outcomes, and drawbacks of

preliminary under-excavation of the Tower. While in Venice, students learned from a group of environmental engineers about MOSE, a system of underwater retractable defense barriers that protect city and its ecosystem. In Florence, Seracini gave examples of how engineers and art historians must work side by side on multi-layered diagnostic testing of paintings in an attempt to slow the decaying process of ancient artwork. While in Modena, computer scientists working at IK Multimedia stressed the importance of place as they revive the tradition of musical instrument invention in Italy, with the perspective of selling products globally. In Rome while vising the university Tor Vergata, students learned about the Italian engineering curriculum and how it differs from their own. Although engineering lectures focused on issues that were perceived as predominantly Italian, students were encouraged to frame these issues in an international context during follow-up discussions.

Italian language classes were included in the existing time and resource constraints. Prior to departure, students were exposed to very basic Italian pronunciation, alphabet, numbers and some simple phrases during mandatory meetings taught by the Italian faculty member (see Appendix A). While in Italy, students participated in 30 minutes of intense language training per day, usually held in the common room at the hostel. Students were asked to purchase a basic Italian grammar eBook prior to departure for use on the trip. Other components of the language portion of the study abroad course included games and communicative exercises in the target language and contextualized language learning in real-life situations. Due to time and resource constraints, language instruction was often superficial, with the ultimate aim being that of helping students achieve novice-mid level communicative ability in Italian (according to ACTFL, novice-mid level speakers can express themselves in conversations on very familiar topics using words, phrases, and simple sentences and questions that had been highly practiced and memorized[20]). Each student was also asked to produce and submit three short videos in Italian, one each week. The purpose of the videos was to encourage students to use their novice-mid level language skills in real-life situations that became increasingly more challenging as the program progressed. The first two videos involved ordering a gelato or a cappuccino at a *caffè* and purchasing a product at a *tabaccheria*, requiring a simple exchange between student and cashier. The third and final video pushed students to test their interpersonal communicative skills, as they were asked to film themselves conversing with Italian engineering

students in Rome (an evening with Italian students was organized as part of the program schedule). The course also included various non-language related assignments that had been included during previous years: student presentations on pre-assigned topics related to subsequent engineering lectures, daily reflective journal entries, and a final term paper in which students were asked to reflect on the course learning objectives, and consider how the course might impact their future and professional career.

Observations

In an attempt to "take the temperature" of students regarding their perceptions of Italy, Italian stereotypes, and Italian culture, students were asked to respond to a short questionnaire prior to departure, in which they were asked to answer the following questions:

1) What are the first three points that come to mind when you think of Italy?

2) List three points that you expect not to be surprised about while in Italy with our course

3) List the most important facts you already know about the country of Italy, the people of Italy, and Italian engineering.

In answering the first question, most students mentioned Italian art, food, architecture and history. Six out of 28 students mentioned industry or engineered products as one of the first three points that came to mind when they thought of Italy. When asked to list the most important facts they knew about Italian engineering, 23 students focused on ancient or medieval architecture (such as the Colosseum and Tower of Pisa), and five students mentioned contemporary engineering issues such as flood control in Venice or modern manufacturing. In a nutshell, before participating on the program, the typical student did not perceive engineering as a relevant factor related to Italy, and when asked to consider Italian engineering he or she focused on superficial knowledge of cultural landmarks. Through the varied program of the course, which included visits to industrial sites, manufacturing companies, university engineering programs, and historical monuments, we strove to present a balanced view of Italian engineering and its constraints, both in contemporary and historical contexts (see Appendix C for detailed itinerary). As can be inferred by the many comments made in the closing

entries of student journals, students concluded the course with a preliminary understanding of Italian engineering problems, challenges, and solutions. Although self-reporting is, admittedly, a form of indirect assessment of course learning outcomes, student self-perception in journal comments indicate increased cultural sensitivity, tolerance of others, and open-mindedness at the conclusion of the program. Student comments from final journal entry include:

As engineers, it is important to keep our minds open to the idea of multiple solutions coming from a variety of sources in order to paint the broadest picture of a situation.

It may be that the Italian culture reaches backward in time and encourages innovation.

I noticed the lack of female engineers in the places we visited.

Building something new isn't always the solution. Preservation has its benefits.

One of the ways we hoped to help students become more culturally aware while in Italy was through language instruction. Students were asked to complete a language survey prior to departure (after having been exposed to "survival" Italian), and to complete the same survey again on the final day of the program. The survey asked them to rate how comfortable they felt communicating in Italian in a variety of novice to intermediate level situations, with statements ranging from "greet your hotel owner in Italian" to "ask a question in Italian following an engineering lecture" (see Appendix B for full questionnaire). As seen in the results in Table 1, the majority of students felt uncomfortable with all of the situations pre-departure, whereas at the end of the program the majority of students felt extremely comfortable with the first four situations (in which they were asked to use typical novice-mid level discourse consisting of simple words and phrases and memorized questions), and progressively less comfortable with the remaining situations, which presented situations requiring intermediate-level discourse. The results of this survey show that on average, students believed that they were able to carry out these novice-mid level communicative tasks by the conclusion of the program.

Table 1

Rate your level of comfort using Italian in the following situations (1 = extremely uncomfortable; 5= extremely comfortable)
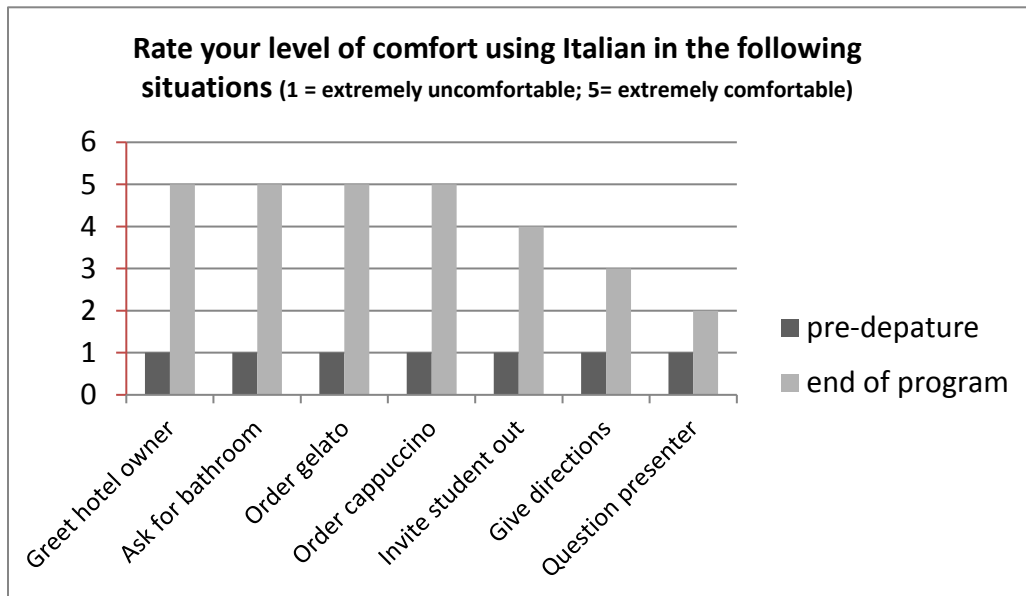
The intensity of our program and the many hours of faculty to student contact also led to qualitative observations of language acquisition while on site. As early as program day two, students with no formal Italian language background were observed using conversational expressions (*grazie*, *ciao*, *per favore*, *vorrei*) to order breakfast at the *caffè* by their hostel in Florence. Soon after, students began asking for clarification on grammar points taught the previous day (i.e., definite articles versus indefinite articles; gender difference). After receiving a somewhat superficial introduction to a grammar point, students observed authentic language use and subsequently asked for a more detailed explanation, often while moving from one cultural or educational site to the next. Notably, this authentic interaction stimulated students to want to know more and helped create interest in language and culture through direct contact with people and their language and culture. Such successful interactions on site with native speakers left students excited and motivated to push themselves further with their language acquisition, creating a self-reinforcing cycle (see Semann for further discussion on motivation[21]). In exit interviews, students observed:

If we hadn't done the Italian unit, I would have tried, gotten frustrated, and given up after a few days. Having language class made me more confident to ask Italians and [the professor] for more information.

Knowing key phrases helped us navigate foreign cities while remaining more respectful towards the lifestyle of the citizens and better representing our university and the U.S.

The combination of learning some Italian and visiting different engineering venues allowed us to be part of the culture for three weeks instead of outsiders looking in.

Faculty noted that students reported positively on their own attempts at language use. For example, one student commented, "when someone says *prego*, I know that they understand that I said *grazie*." This comment indicates a certain comfort level with vocabulary comprehension, pronunciation, and cultural and societal norms. Another student commented (on program day two), "I practiced a few times before asking for the check in Italian (*il conto, per favore*) and I did it and the waiter understood me!" Exchanges such as these, while linguistically limited, are the first steps that students must take in an attempt to communicate across cultures and to eventually speak a second language at a conversational level (two of Parkinson's attributes of the global engineer). As one student summed up, "There are so many uses of the word *prego*! It's a cultural term that Italians love to use." On the whole, students were interested in trying to communicate in Italian, and curious to understand more about the language and culture. These observations confirm that on average, students met or exceeded the language learning outcome; by the conclusion of the three-week program they were able to demonstrate novice-mid level competency in spoken Italian.

The evening of interaction with Italian students was a pivotal moment for many students. Conversing with Italian students served as a moment of cross-cultural understanding, and gave our students confidence in their emerging Italian language skills:

One of the coolest experiences in Italy was the opportunity we had to sit down with Italian engineering students who were close in age to us. It was rewarding to be able to hold a fairly decent conversation with a student who spoke almost as little English as we spoke Italian.

I quickly learned that 'knowing a little bit of English' does not have the same connotation as we have when we say we know a little bit of Italian. This meeting made me further think about how Italians are much more worldly students than we are in America and have a more global perspective when it comes to learning in general.

Perhaps one of the most valuable and memorable moments of the trip was meeting the Italian engineering students. We were forced outside of our comfort zones, and I believe it was one of the best unconventional learning experiences of the trip. While at first we were awkward and quiet, by the end we were laughing uncontrollably, engaging in unforgettable conversations.

Admittedly, these students were probably not having "unforgettable conversations" about Italian engineering practices in Italian. However, their openness during this event, which was clearly outside of their environment and their comfort zone, and their positive self-reflection afterward, are reactions that point toward emerging global competence and correlate directly to the definition provided by Hunter et al. at the beginning of this article.

Much can be discerned from the observations faculty members made upon reading student journals. Seventeen out of 28 students mentioned the language barrier within their first three journal entries while in Italy (without being formally prompted to do so). Overall, the opening comments are negative, and include phrases such as "nerve-wracking," "overwhelming and confusing," and "awkward" in descriptions of dealing with the language barrier. In their final journal entries, the majority of students mentioned language in a positive light (four out of 28 mentioned it in a negative light, using such terminology a "challenging" and "a bit difficult"). Five did not mention it at all, and the majority of the group (19 students) discussed the language component of the course using words such as "unique," "useful," "significant," and "rewarding." One student commented that the class "completely changed how I view languages and gave me a passion and desire to become more educated both in foreign languages and in understanding global culture." This remark came from a student who had reported feeling "awkward" and "needing help" at the beginning of the program, and who had sworn off foreign language study after negative experiences learning in high school. Another student sums up the experience:

As engineers, language is not a typical subject for study, and so being able to develop [minimal] competency in Italian was exciting. Though my knowledge is little, I think the few Italian words I know would put me at a great advantage if I were ever working with an Italian client or coworker.

Getting a taste of Italian language was extremely helpful, and taught me how crucial communication is, especially in an engineering sense. I know that in an engineering related field, I am going to have to communicate with others who speak a different language. In order to meet the goal and produce the best product possible, clear communication between parties is essential. Even if one just knows simple phrases and gestures, it can go a long way in making things clearer.

In the final journal entry, a number of students mentioned their newfound openness to working abroad someday, and their realization of how important language skills would be if they were presented with this opportunity. (Post-program, one student expressed interest in securing an internship in Italy after graduation, specifically at one of the engineering plants we visited while on the program. Program faculty were available to intermediate the application process, had the student decided to apply.) Finally, students were also asked how many semesters of Italian they believed they needed to take to be able to understand and contextualize the role of engineering in Italian culture, history, and society. At the conclusion of the program, group reaction to this statement was evenly split (see Table 2).

Table 2

How many semesters of Italian do you need to take to be able to understand and contextualize the role of engineering in Italian culture, history, and society?

- 1-3 semesters
- 4 semesters
- 6 + semesters
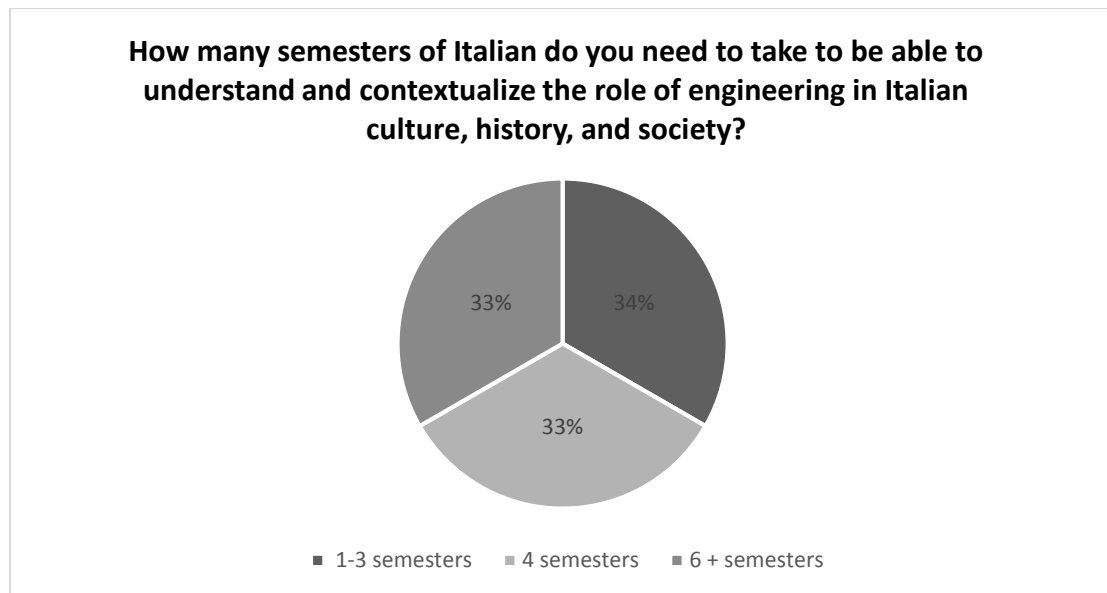
Notably, five students (about 18% of the group) replied eight semesters, and ten semesters of language and content courses constitutes a major in Italian Studies at our university. Student comments in journals reflect the fact that the majority of our students realized that while the amount of language they learned during the three-week course helped them operate on a day-to-day basis in Italy, it was not nearly enough to be able to contextualize the role of engineering in Italian society:

I would have liked it had Italian 101 been a requirement for the ENGR 290 course. I feel like what we covered [here in Italy] wasn't quite enough to feel comfortable getting by without the professor.

We didn't learn enough Italian for it to add to the engineering context. If we come back, it will be easier to pick up some Italian.

The cultural and language components of the class helped me get by socially, but not in an engineering context. We would have needed a couple of semesters to be able to have these [engineering-related] discussions in Italian.

Limitations and Suggestions for Improvement

Considering the unquestionably significant role of the global engineer in today's world, and the continuous professional debate revolving around the topic of L2 study in the engineering curriculum, further study on this issue is imperative. Suggestions for improvement on a similar short-term study abroad program include:

- More exposure to the L2 before the program; ideally at least one mandatory semester of study prior to departure. Specific learning outcomes linked to written and spoken communication proficiency as well as cultural competency could be established by the individual university.
- Increased contact between American students and host country students in an attempt to burst the American "bubble" which often exists while abroad. Although our program included two events in which students interacted directly with their Italian counterparts, we would include additional, earlier, and more frequent opportunities in future offerings.
- More unstructured time throughout the program. Student journals suggest that some of their most meaningful learning moments occurred during unstructured interaction with Italians, the language, and the culture.

When considering the role of L2 study, engineering faculty should remember that language learning is an "asset that will ultimately benefit students, [as opposed to] a course requirement or a hurdle" that must be overcome.[22] In order for global engineers to achieve the ultimate goal of increased cultural sensitivity, which includes tolerance of others and their perspectives as well as the ability to behave ethically across cultures, L2 competence must remain at the heart of the curriculum.

Conclusion

Perhaps the overall impact of this course on our students can best be summed up in the words of one of the participants, who echoed a sentiment expressed by others as well:

This course has truly been a learning experience. In terms of history and culture, I have learned a lot. I have learned facts ranging from understanding how buildings were constructed to learning how powerful and expansive the Medici family was. I have learned about the life of an Italian student and how it differs from that of an

American student. I have learned that a product does not need to be mass produced to be successful. It may just be enough that it is made well and carefully. I have learned to never stop innovating and to ensure that the next product is always the best product. I have learned that with careful thought, one can extract a lot of information from something that seems so simple. I have learned that engineering is often a global profession requiring the knowledge and respect of other cultures. I once again became excited to learn about a language and its related culture. Language allowed me to feel much more comfortable on this trip and gave me a sense of confidence. I would say it is accurate that the language portion of this trip revitalized my desire to learn a new language. This trip would not be the same without these experiences.

The ability to speak a second or third language opens the door to communities, cultures, and professions, and gives the learner a deeper understanding of his or her own self. Quite truthfully, "experience with foreign language makes it clear that a language is not a series of grammatical formulas, but rather the expression of the culture of a society."[23] Foreign language study should no longer be referred to as a "soft skill" secondary to other aspects of engineering curriculum; rather, it should lie at the heart of the educational experience of any global engineer. Perhaps there is no concrete answer to the question: How much language preparation does an engineering student need in order to become globally competent? As is apparent from the student comments in this study and in others, any amount of language training is better than none at all. Exposure to a second or third language is beneficial at all levels; at the novice level it heightens motivation and encourages conversational competence, while at the intermediate and advanced levels it might eventually lead to the ability to converse on technical topics in the second language. Most importantly, a learning experience that includes L2 exposure encourages the development of attributes which have been proven essential to the engineer who is ready and able to take on the challenge of succeeding in a world that transcends cultural and national boundaries.

Appendix A: Introductory Italian "Survival" Course

Day 1: Greeting and presentation

Grammar points covered:

- Formal versus informal greeting and presentation
- Formal titles
- What is your name? (My name is …)
- Where are you from? (I am from …)
- How are you? (Today I'm feeling …)

Day 2: Alphabet and numbers

Grammar points covered:

- Pronunciation of all Italian letters and combinations of letters
- Numbers 1 through 100
- How old are you?

Day 3: How much does it cost? Where is/are …?

Grammar points covered:

- How much does it cost? (singular versus plural)
- Use simple vocabulary and numbers to ask and answer questions about cost: book, *gelato*, coffee, *panini*, hat, shoes, jacket.
- Where is …?
- Use simple vocabulary to ask answer questions about location: Where is the bathroom? The street? The meeting? The restaurant? The station? The ticket office?
- Where are the students? The luggage?

Day 4: Review and useful expressions

Grammar points covered:

- General review of previous lessons
- Useful phrases: What does *caffè doppio* mean in English? How do you say *thank you* in Italian?
- Other useful phrases: I don't speak Italian. Speak slowly, please. Can you repeat, please? I didn't understand. I don't know. Do you speak English? Please help me. Thank you very much!

Appendix B: Survey, Italian Language

Rate your level of comfort using Italian in the following situations in Italy from 1 (extremely uncomfortable) to 5 (extremely comfortable). Remember, in all of these situations you are responding / communicating in Italian.

1. You arrive at your hotel and the owner greets you. You respond, asking how she is doing.

2. After a lecture in an Italian university, you ask where the bathroom is.

3. You walk into a *gelateria*, order a *gelato*, and pay.

4. You walk into a corner bar, order a *cappuccino* and a pastry, and pay.

5. You encounter an Italian engineering student whom you have already met on a prior occasion. You ask how he is doing, and ask if he wants to join you and your friend for a *gelato*.

6. An Italian tourist stops you on the street after a week in Florence and asks you for directions to the Duomo. You direct him to the Duomo.

7. After an on-site industry lecture in Italy, you approach the presenter and ask a question about the cultural impact of the product or process that she discussed.

Appendix C: Detailed itinerary of places visited, engineering lectures presented, and engineering problems confronted

Day	Location	Morning Event	Afternoon Event	Evening
1	Florence	Arrive in Italy Bus to Florence (Tuscany)	Arrive in Florence Welcome walking tour	Dinner and general discussion
2	Florence	University of Florence by lecture by local faculty member, "Wireless Networks" Engineering problems confronted: How do choices and	Visit to University of Florence computer lab with local faculty	Student presentation: Leaning Tower of Pisa

		decisions affect the next group of engineers who will work on a project? How can engineers make an informed decision about something they cannot measure?		
3	Pisa	University of Pisa lecture by local faculty member, "Topographical and Geotechnical Challenges of Tower Stabilization" Engineering problems confronted: What effect does soil quality have on tilt and rotation of the Tower? What is the life expectancy of engineering solutions made today?	Pisa Tower tour and climb accompanied by local faculty member	Student presentation: Construction of Duomo
4	Florence	City center history lecture by local faculty member, "Florentine Monuments on a Human Scale" Engineering problems confronted: How were towering monuments built to human scale, beginning in the 1400s? How did Brunelleschi overcome the engineering challenges of his time (scarcity of wood for building scaffoldings, use of heavy materials)?	Visit to Galileo museum (history of telescopes, barometers, thermometers, surgical equipment) A look at engineering history: Innovations which at the time were met with opposition and later become the basis of today's modern inventions.	Student presentation: Galileo Galilei
5	Viareggio	Day trip to Viareggio (break day)	Day trip to Viareggio	Student presentation: Parmigiano reggiano production

6	Florence	Galleria dell'Academia lecture by local faculty member, "Michelangelo's Intelligent Eye: Thought, Design, and Execution of the David" Engineering problems confronted: How must engineers tackle a project so that the components fit together upon its completion?	Visit to the Uffizi Gallery	Student presentation: IK Multimedia Electronics, music technology
7	Florence	Art and art history restoration lecture by local faculty member, "A Future for the Past: Science and Technology for Conservation and Preservation of World Cultural Heritage" Engineering problems confronted: How can engineers know what to save, what to remodel, what to renew?	Free time	Free time
8	Modena	Bus to Modena (Emilia-Romagna)	Arrive in Modena Welcome walking tour	Student presentation: Enzo Ferrari
9	Maranello	Azienda Agricola Moscattini, parmigiano-reggiano factory, tour by factory owner of 50 years. Engineering problems confronted: Wherein lies the delicate balance between the human and industrial components in a family-owned factory? What is the importance of place in the production of parmigiano-reggiano cheese?	Visit to Ferrari museum (emphasis on eco-friendly engines)	Student presentation: balsamic vinegar production

10	Maranello/ Formigine	Acetaia Leonardi, balsamic vinegar factory, tour by factory owner. Engineering problems confronted: How would automating any part of the balsamic vinegar production process alter the final product? What is the importance of place in the production of balsamic vinegar?	IK Multimedia Electronics lecture, "Innovative Technologies in Music Production" Engineering problems confronted: What are the benefits and drawbacks of 100% local manufacturing and design? How do the needs and wants of the customer influence product design?	Student presentation: Venice
11	Venice	Bus to Venice (Veneto)	Arrive in Venice Welcome walking tour	Student presentation: waste treatment plants in Italy
12	Venice	Venice Aquae Expo lecture by local engineer on MOSE, a system of retractable defense barriers protecting Venice from damaging floods Engineering problems confronted: How much should a city spend on a defense system that has a 100 year life expectancy?	Free time in Venice	Student presentation: flood control around Venice
13	Bassano	Anaerobic Digester and Waste Water Treatment Plant, tour and lecture by plant engineer Engineering problems confronted: How do engineers design plants that close the loop in the waste management process? How do plants operate successfully in residential areas?	Visit to Bassano del Grappa	Student presentation: building restoration

14	Rome	Bus to Rome (Lazio)	Arrive in Rome Welcome walking tour	Student presentation: Colosseum
15	Rome	City center history lecture by local faculty member, "Uncovering Ancient Structures: The Colosseum, The Forum, Palatine Hill" Engineering problems confronted: What methods did the Romans use to stabilize building foundations 2,000 years ago?	Continued lecture on ancient Rome What can we learn from the Romans, whose structures are still standing after two millenia?	Student presentation: Pantheon
16	Rome	Vatican tour and lecture by local guide (Saint Peter's Basilica, Sistine Chapel)	Vatican tour and lecture by local guide (Saint Peter's Basilica, Sistine Chapel)	Student presentation: Italian university system
17	Rome	University of Rome, La Sapienza lecture by local faculty member, "High Performance Computing" Engineering problems confronted: How can limitations of a product (such as the microchip) push engineers to design solutions to seemingly unsolvable problems?	Guided tour of Pantheon, Fountain of Trevi, and Piazza Navona by local historian	Dinner with Italian engineering students
18	L'Aquila	Menarini Pharmaceutical Plant tour and lecture by plant engineer Engineering problems confronted: How much attention must engineers pay to controlling variability and safety in design? How do engineers	Guided tour of L'Aquila city center by local historian; discussion of reconstruction following devastation of the 2009 earthquake Engineering problems confronted: How can new buildings be constructed to	Prep for closing presentation

		deal with legal issues in the production and distribution of medications worldwide?	withstand future natural disasters?	
19	Rome	University of Rome, Tor Vergata lecture by local faculty member, "Empowering Diversity in Engineering through International Study and Competition" Engineering problems confronted: How can the Italian university system offer global education and career development support to its engineering students?	Student closing presentations Assignment: Select an engineering topic that, in your opinion, highlighted the learning objectives of the course. Discuss the topic in relation to the historical, cultural, and societal framework of Italy. Does the importance of place play a role in the product or design?	Final dinner
20	Fly	Return to US		

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