Developing Knowledge of World History in Engineering Students as a Component of Global Competency

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Abstract

The increasingly global nature of the engineering field requires that today’s engineering students develop more than just technical competency in their chosen specialty. Increasing the global competency of students is an issue currently receiving significant consideration. One component of global competency which has been identified by Hunter’s Global Competence Model and others is knowledge of world history, but relatively little has been done to address this particular topic within engineering education. This paper discusses a new study abroad program developed and implemented at the University of Alabama at Birmingham which aims to increase global competency in engineering students by focusing on world history from a technical perspective and by using experiential learning to engage students with the connection between historical context and modern cultural and social differences. The three weeks of faculty-led travel through Germany gave the students first-hand exposure to historical and cultural sites, in addition to university and industry visits and introductory language lessons. Work is underway to create a complimentary semester-long, on-campus course on the history of materials in order to broaden participation.

Background

“Global competency” has become a buzzword in engineering education circles; everyone seems to be talking about it. As technology knits distant parts of the world ever more closely together, the discussion within engineering education is part of a larger movement to create globally competent citizens [1]. Much effort has been expended to address what, exactly, is meant by global competency, why is it important, how it can be measured, and how it can be improved. By now, the importance of global competency for everyone, and engineers in particular [2,3], has been well documented and evidence of the ability to work in an international, multi-cultural environment is valued by employers [2,4].

Despite more than two decades of discussion, global competency remains notoriously difficult to define. Bill Hunter made one of the largest and most cited attempts to define global competency with input from a variety of international sources, and produced the following definition: “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 [5].” Hunter states that “in order to become globally competent, one must establish a firm understanding of the concept of globalization and of world history. It is here that the recognition of the interconnectedness of society, politics, history, economics, the environment, and related topics becomes important [6].”

From those broad definitions, a number of attempts to identify specific aspects of global competence tailored to engineering have been made. For example, Alan Parkinson and co-workers [7,8] identify 13 attributes of global competence, including an appreciation of other cultures, ability to communicate across cultures (foreign language skills as well as non-verbal
communication), and familiarity with the history, government and economic systems of target countries. Gregg Warnick conducted an extensive literature review to identify common categories for global competence and came up with eight categories [2]. These themes again included the ability to communicate across cultures (including speaking a language besides English), an appreciation and understanding of different cultures, and the demonstration of world and local knowledge, which he defined in part as “familiarity with history, geography, government, market, and public policy issues around the world and in several target countries along with an understanding of the workings and close linkages of the global economy to promote critical and creative thinking concerning the current global challenges [2].”

Grandin and Hedderich summarize global competence in engineers as follows: “[A]n interculturally competent person understands that all individuals’ views of the world have been unknowingly shaped by one’s own culture. This person also has sufficient knowledge of the target culture, including history, geography, customs and so on, to put observations into a meaningful perspective. He or she also understands the importance of clear communication [9].”

As highlighted here, most discussions of global competency include knowledge of history as a means of better understand present status. However, little has been done within the engineering education field to promote global competency of students by focusing on world history. This program at the University of Alabama at Birmingham attempts to address this aspect of global competency through a study abroad program based around studying the development of engineering materials through history, and the interplay between new materials and societal changes.

Program Logistics

The study abroad program was offered during May term as a three-week trip through Germany, led by a UAB faculty member. Although longer programs where students are fully immersed in a foreign language have been shown to be more effective at promoting global competency [2], this shorter itinerary was selected for a variety of reasons. The dearth of American engineering students participating in engineering programs has been well documented; over the last ten years only about 3% of US study abroad participants were engineering majors [10]. This is attributed to the heavy course loads required in engineering programs and the highly-structured, sequential curriculum that makes missing a semester problematic, in addition to difficulties in finding equivalent technical courses which can be transferred back to American institutions [3,11,12]. Therefore, shorter programs offered between semesters are often seen as the best choice by engineering students and consequently developed by many engineering programs [13].

Additionally, this arrangement allows students to travel with classmates and a professor from their home institution. Due to its demographics, UAB has many students who have very little travel experience; many students have never been on an airplane or traveled outside the Southeast region of the country. The university has found that such students are particularly unlikely to participate in study abroad programs where they must travel independently to a foreign country and commit to stay there for an extended period of time. However, students are willing to venture abroad when led by a familiar faculty member and traveling with well-known
The benefits of this type of short-term program, despite the limitations mentioned above, to students with limited or no international exposure are recognized [12].

In order to maximize the utility to students, the program consisted of a three credit elective course, dual-listed as MSE 490/590, so that it could be taken for credit by both graduate and undergraduate materials engineering students. An attempt was made to get other engineering programs at UAB to accept the class as an engineering elective for their students, but the attempt was unsuccessful. For students who did not need or could not use the credits, a pass/fail zero-credit-hour option was offered, so that these students could pay only for the cost of the trip and not unnecessary credits. Of the eleven students who participated in the program, seven were undergraduate materials majors, one was a graduate student in materials, and three were undergraduates in another engineering major. Half of the students had previous international travel experience.

Over the course of the program, students spent seven nights in Aachen, five nights in Cologne, two nights in Bonn, two nights in Esslingen (Stuttgart), and three nights in Munich. To minimize costs, students stayed in multi-bed rooms at youth hostels, except in Bonn where they stayed with host families. Public transport was used exclusively.

**Course Objectives**

The three primary course objectives for the study abroad program were as follows:

- Have students investigate the way that engineering materials developed over time in different parts of the world and how those developments impacted society.
- Allow students to develop a basic understanding and appreciation of German language, history and culture.
- Provide students with first-hand experience of the global nature of engineering challenges and opportunities.

To address the first objective, an academic course was developed specifically for this program called “The Evolution of Engineering Materials.” It covered the history and evolution of engineering materials (particularly metals and metal-working) and the relationship between technical developments and human society, from the Stone Age and Bronze Age, through the Iron Age, the Middle Ages, the Age of Exploration, the Industrial Revolution, and the Modern Era. The primary textbook for the course was “Out of the Fiery Furnace: The Impact of Metals on the History of Mankind” by Robert Raymond (1984). In addition, primary source material from a range of historical periods was used, such as selections from Pliny the Elder’s *Natural History* (78 AD) and the early treatise on mining and smelting, *De re metallica* (1556) by German Georgius Agricola. Emphasis was placed on cultural context; for example, a discussion of biblical references to metals, or using Longfellow’s “The Village Blacksmith” poem (1841) to consider the role of metal workers in society. A variety of excellent resources on the history of materials exist; a partial list is provided in the appendix. Other source material included visits to museums and historical sites, such as the Roman-Germanic Museum in Cologne and the Zollverein Coal Mine and Coking Plant industrial heritage site in Essen.
Assessment in this area was done through periodic reading-comprehension quizzes, completion of a list of terms and relevant geographical areas, an oral presentation, and a final paper. Before the trip, students were asked to choose a relevant topic and prepare a 10-15 minute oral presentation with a 2-3 page handout. Students were guided to topics which, due to time constraints, would not otherwise be covered, such as the development of glass, development of polymers, Damascus steel, and metallurgical development in India or Africa. Students were encouraged to use scientific journal articles on archeological materials as source material. After visiting the Roman-Germanic museum, students were asked to write a one-page paper discussing some aspect of the different materials on display, and how the raw materials and fabrication techniques available to the Romans, as well as societal values, affected these artifacts. The final paper was due about a month after the trip ended. Students were asked to pick a topic related to some aspect of the course and write a research paper of approximately ten pages on that topic, with a special emphasis on the role of engineering materials. Some topics selected include the role of iron alloys in the rise of the industrial revolution, and the importance of copper to the rise and fall of the Roman Empire. Throughout the assignments, an emphasis was placed on allowing students to choose their own areas of investigation, based on personal interests.

To address the second course objective (develop a basic understanding and appreciation of German language, history and culture), students had eleven hours of German language instruction during the first week in-country, which equated to one credit of GN 190 (study abroad German) on each student’s transcript. Visits to sites of historical and cultural importance without an explicit materials connection were made (such as a tour of Charlemagne’s cathedral in Aachen, a tour of a medieval castle along the Rhine River, and a visit to Dachau Concentration Camp). Formal or informal tours of each city were made, guided by a resident or the faculty leader (who spent two years as a resident of Germany). Over the first two days of the trip, a very brief overview of German history was given. Students read articles about issues in modern German (the economy, recycling) and guided by the faculty leader, discussed differences and similarities between Germany and the US, and possible historical reasons for the differences.

As much as possible, opportunities were provided for students to interact with German people, particularly German engineers and engineering students. Students visited two technical universities, and had multiple opportunities to interact with students in both professional and social environments. The American students were particularly interested to learn that German university students pay virtually no tuition. In addition to the final research paper, students were required to submit a 2-3 page reflection paper comparing and contrasting the German vs. American educational system.

In further pursuit of objective three (first-hand experience of the global nature of engineering challenges and opportunities), visits to a government research lab (German Aerospace Center – DLR) and several industry tours were arranged (two foundry operations and a software company). Students were introduced to and heard presentations from both German engineers and Americans working as engineers abroad. The students spent two nights with host families in Bonn, either German families or American ex-pat families. The intention was to give the students the exposure necessary to imagine themselves potentially living and working abroad.
Future Direction

This study abroad program was offered for the first time in May of 2012. Although eleven students is fairly average for an upper-level materials engineering elective course at UAB, the program is necessarily limited in size. This is a perennial problem for global competency initiatives: any program involving study abroad reaches only those students who are (1) already willing and able to travel and (2) able to afford the program. The current plan for implementing a version of this program more widely into the curriculum is to modify the academic portion of the course (The Evolution of Engineering Materials) into a standard semester-long course that would meet the requirements for a university-approved history course tailored to engineering students, since all UAB students are required to take six credits of history. Being developed in conjunction with the history department, the course would provide an alternative to the standard history classes currently offered by the university, and allow engineering students to connect their history requirement to their technical education in a relevant and engaging way.

To repeat the quotation from Bill Hunter given above, “in order to become globally competent, one must establish a firm understanding of the concept of globalization and of world history. It is here that the recognition of the interconnectedness of society, politics, history, economics, the environment, and related topics becomes important [5].” By exploring the evolution of engineering materials, which are at the base of all technological advancements, one is necessarily also considering politics, geography, society, economics, the environment, and all the rest, even without directly encountering another culture in person. Over a semester, topics covered could be expanded to include more information on materials besides metal and areas outside Europe for comparison purposes. An additional unit on materials of the future, considering current societal demands, technology, and availability of raw materials could also be added. It is hoped that the study abroad component will be integrated as a follow-on course for those students interested in and able to travel.

As this was the first offering of the program and the sample size was quite small, no formal measurement of gains in global competency skills was attempted. However, 100% of the students who participated said upon return that they enjoyed the program, that they would like to return to Germany, and that they were seriously considering further study or work in Germany or another foreign country at some point in their future. Since the program ended, the American students have maintained contact with many of the Germans they met via email and social media, and several of the students were able to meet and socialize with their German friends at a recent professional conference, developing the international professional network that is so important in science and engineering. As a result of the program, one student has become very involved with the international student community on campus, and another is returning to Germany in the fall for an extended research experience. For all the students, the knowledge and perspective gained during their travels and studies will not only make them more employable and better engineers, prepared to work and travel in a global marketplace, but also more thoughtful and aware citizens of the global community.
References


Appendix: Resources on the History and Evolution of Engineering Materials

6. On Divers Arts, Theophilus, 1122 (painting, glass making, metal working)
7. De Re Metallica, Georgius Agricola, 1556 (mining, refining, smelting)