

AC 2009-2396: ASSESSMENT OF MECHANICAL ENGINEERING STUDY ABROAD PROGRAMS IN GERMANY: EXPERIENCES AND LESSONS LEARNED

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Assessment of Mechanical Engineering Study Abroad programs in Germany: Experiences and Lessons Learned

Abstract

This paper discusses the continued developments and the current status of study abroad programs for the mechanical engineering students at Kettering University. In particular, this paper outlines the study exchange with schools in Germany in which there is an equal number of students in exchange over two or three year span between the Kettering University and the participating schools in Germany. Programs at other countries such as Australia, China and Mexico are also available to the Kettering University students, while efforts are under way to explore opportunities in other parts of Europe and in Asia. Such study abroad programs provide an opportunity and promote understanding across technical programs and other nations.

This paper will discuss the continued efforts that include setting up of study abroad program policies, course mapping and course equivalency, students' advisement, grading differences, student expectations, role of the faculty advisors, program assessment and finally, the lessons learned for continuous improvements of such programs. Technical Universities that wish to start new study abroad programs and those who already have study exchange in place would benefit from the experiences, findings and recommendations presented in this paper.

It is now well understood that engineering students who have international study experience in a diverse cultural and college environment are more likely to be hired and prepared for the global market place. During the last few years, there has been a steady increase in the number of students studying abroad. The academic standards have also been raised to maintain good quality programs offered abroad. Evaluation and assessment of the study abroad programs is an important aspect of accreditation criteria. This will be addressed in this paper to some extent. The paper concludes with a discussion of new prospects to expand the study abroad programs to other parts of Europe, to other countries such as Asia and Latin America.

Background and Introduction

Kettering University's engineering academic and cooperative education make it unique among Engineering Schools in the United States. One of the main purposes of the international programs is to provide students value-added technical and cultural experiences. During the last four years, the Kettering University study abroad programs have been steadily growing with over 90 engineering students per year participating in study abroad programs in Germany alone. Under these study programs, the students typically live abroad for three to six months and interact with other international students, professors and in some cases industry employers from different cultures and academic and industrial traditions. Students return from these experiences feeling happy, confident and knowledgeable about the world in addition to having a personal satisfaction of their exposure to other cultures.

The status of Kettering University's study abroad programs was discussed and presented at one of the earlier ASEE conferences^{1,2}. That paper documented the development and implementation of study-abroad programs for engineers and also the evaluation process of these programs followed at that time. The purpose of these International Programs is to provide students value-added technical and cultural experiences. Study-abroad is an investment in the future and prestige of the University and an excellent way for students to gain technical and cultural expertise. Under this program, the students live abroad for three to six months and interact with other students and professors from different cultures and academic curricula.

Up until the end of year 2006, there used to be three main International Activities at Kettering University: a) Study Abroad for Kettering University students (out-going students), b) Study at Kettering University for Foreign Exchange students (in-coming students) and c) Matriculating (tuition-paying and degree-seeking) foreign students at Kettering University. However, with the new administration at Kettering University, all these three categories have been consolidated in to one unit and a new structure of Office of the International Programs (OIP) emerged.

To sustain Kettering University's study abroad programs and to have them continue to grow and develop, we will need to examine what needs improvement, what lessons have we learned in running these programs and examine if there are other ways of cultural exchange for faculty besides the students. Part of what we know lies in the literature in the field of International Education. An ever increasing body of literature suggests that evaluation and assessment of study abroad programs and faculty exchange will become increasingly important as we try to acquire funding from new sources and garner support from new academic disciplines. Careful review of programs will help both students and the faculty to nurture a respect for international exchange. Engineering students typically do not have the variety of International Program offerings as for example language or humanities students have. As a result, Engineering faculty and administration have less experience with study abroad than their counterparts in Arts and Humanities area. In addition, a good evaluative process for study abroad programs can help the University as a whole in the accreditation cycle and help student retention goals. Fortunately, the author has several cycles (one term each year) of teaching and monitoring the exchange programs in Germany as a guest professor and hence has a first hand experience of the benefits and limitations of such study abroad programs. A brief review of literature follows.

Literature Review

There are numerous articles on study abroad published by ASEE, The Chronicle of Higher Education³⁻¹⁴ and many other international education sources like DAAD⁴, Institute of International Education⁵ (IIE), etc. Only a few related references are mentioned in this paper and therefore the list is by no means complete. Study abroad programs and international educational experience in some form or the other have been in existence for many decades. Here at Kettering University, we have seen enrollment in study abroad programs in numbers from less than 20 to 80 students in the same period of time. Driving this trend is a strong commitment by the President of the University to increase numbers of students who study abroad in addition to the expectation among students that studying abroad is an integral and

important part of their undergraduate education. Kettering University sends the majority of its students to Western Europe (mostly to Germany). While Americans who study abroad typically study in the humanities and social sciences, notable increases have been seen in business and technical fields such as engineering and in hard science fields.

Safety has been one of the main concerns for all study abroad programs in the years following September 11, 2001. This, in addition to the current world economy has been very challenging to maintain good number of study abroad student applicants. In the continuing debate over the future of International Study, one question that needs to be continuously addressed is how to judge and evaluate the merit and worth of study abroad programs. This question is crucial to ask now if we are going to build solid, and long-lasting technical exchange programs that win the respect of faculty, administrators, students and parents.

At the several ASEE Conferences (2001 to 2008), many papers were presented on study abroad programs, which addressed the general benefits, evaluation and assessment of such study abroad programs. One of the examples of assessment procedures was discussed in the paper by Rogers¹⁰, (sponsored by Siemens-Westinghouse), and another by Petersen et al¹¹. At the ASEE 2006 Conference Brito, et al¹² outlined their experience of holding several world conferences in Brazil on the scope and research in engineering education.

At Kettering University, there are several steps followed to establish a new study exchange program that can take up to six months or more. Students who are typical in their Junior term of studies apply up to one year or more in advance to study abroad. They basically prepare their course plan for each of their academic terms until they graduate. One of the main functions of the faculty advisor is to make sure that the courses offered at the host school transfer back (with a Pass or Fail grade). Due to high demand for study abroad in the Mechanical Engineering at Kettering, the minimum cumulative grade point to apply for study abroad as well as to pass a course at the host school has been raised from a mere Pass grade (D Grade) to Fair grade (C grade). Currently, more than 80% applicants have their GPA above 90%. Students typically take up to 16 credits (4 courses) including the social science course that is required to be taken whether for credit or for no credit. This social science course is called Germany With in Europe. With more and more countries joining the European Union, the importance of teaching this course becomes more essential for the American Students. With the new OIP structure, new ways of faculty-led study abroad programs are being investigated at Kettering University. One of the examples of such faculty-led study abroad programs is offered by Bradley University¹³.

Study Abroad Program Evaluation and Assessment

The first step in creating an evaluation process of an International Program is to look at what is already in place in terms of assessment at the University. Joan Gillespie¹⁴ points to the importance of study abroad assessment in her article *Colleges Need Better Ways to Assess Study Abroad Programs*. In the 1970s, the assessment movement at U.S. Colleges and Universities shifted our focus from the *institution* to the *student*, from *teaching* to *learning*. In study abroad programs, we know now that our attention should focus on students as “intercultural learners” rather than academic tourists. Just like the Universities undergo regular

assessment cycles to meet accreditation standards, international programs must also go through a regular evaluation in order to establish and maintain quality programs. Some of the models on evaluation and assessment of study abroad programs include: student environment, resources for academic support, and student learning. Achievement of the student learning area includes mastery of course material, development of critical-thinking skills, language proficiency and intercultural competencies defined by measurements of cognitive, personal and social growth. Quality is measured by qualitative data such as students' awareness of cultural knowledge and quantitative data (such as the number and kind of opportunities that expose students to the local intellectual and material culture).

Engineering study abroad programs still do not have a process in place to stress the importance on the value of language development that are critical part of evaluating the quality of a study abroad program. Quantitative measures of linguistic progress by using entry and exit tests and oral proficiency interviews are standardized ways of assessing academic achievement in international programs. Language learning has been closely linked to a better understanding of the local culture.

Other topics in assessing technical study abroad programs include issues surrounding the grading scales and grading standards of the foreign institutions as part of the returning students' transcript. Usually at Kettering University we record the credit simply as "Pass/Fail" for the study abroad courses. These grades do not affect the students' GPA. This process is being revisited as the grading system and accountability and responsibility of the students to maintain high academic standards while enjoying the rich cultural experiences abroad.

The process of creating an assessment plan is continuous and never-ending. It is, however, necessary in order to maintain the quality and integrity of the institutions and accrediting bodies. The task at hand involves having a consistent assessment across international programs. Additionally, it requires adequate staff time and funds invested in the process so that evaluation is a regular part of the planning and operation of the study abroad programs. The following are some suggested criteria for evaluation. Some of the following criteria are intended to give focus and direction while allowing flexibility to Universities who tailor their own study-abroad programs:

- Does the program help to fulfill the institutions overall mission, general goals and strategic plan?
- What academic quality or distinction does the program provide?
- Is the program comparable in academic rigor to the home institution?
- What distinct advantage is given for basing the program abroad?
- What rationale is offered for the program's location?
- How desirable is such a program, given the institution's academic mission and the mission of cross-cultural education in general?
- Does the program take advantage of integrating the students' into the local culture, academic and social life?
- How available are the resources and support services abroad to ensure a viable program of high academic quality?

- What is the level of student and faculty interest and commitment in maintaining this particular kind of program?
- Will there be any financial support to augment the students' expenses for study abroad?

The Task Force on Study Abroad of the American Association of Collegiate Registrars (AACRO) came up with criteria for program evaluation in five general areas:

- a) Basic information
- b) Academic Aspects
- c) Interaction with the Host Culture
- d) Administrative aspects
- e) Sources of information

Many of the criteria mentioned above are fulfilled to a great extent for the ME and the other department study abroad programs. Due to the growing number of engineering students studying abroad at Kettering University, there is an ever increase in need for standards to assess the academic quality of foreign programs. This is particularly important if engineering exchanges are to grow throughout higher education. In addition to assessing the academic merit of the engineering curriculum, the unique qualities of international study make it necessary to take a look at other important factors of such an experience such as cultural and linguistic knowledge that students learn on an international exchange. Faculty oversight of such international programs is essential if the programs are to gain respect. The faculty should also play a central role in the evaluation and assessment of a study abroad program as a way of improving the quality of a program; not only for curriculum improvements, but factors such as how well do students adjust socially, linguistically and culturally are of equal importance.

As mentioned before, in spite of some difficulties and limitations, there are many other universities in the US that have developed study abroad programs. In looking at the literature presented in these papers, one can observe that not many universities have developed the course assessment tools necessary to evaluate the particular program and course educational objectives. Although currently there are no uniform guidelines to assess the individual study abroad programs by ABET, each of the participating Universities have developed their own assessment and evaluation tools necessary to justify their study abroad programs. The intention of this paper is to discuss the assessment and evaluation tools developed jointly by the author in consultation with faculty at the host institution(s).

Description of ME Study Abroad Experiences for Kettering University students

Students who are eligible to study in one of the partner universities in Germany are asked to take a maximum of sixteen credits, normally encompassing three ME and/or Technical courses and one Liberal Studies course, titled "Germany within Europe". This course corresponds to an Advanced Social Science course at Kettering, entitled "Topics in Social Science, SSCI 308. The language course, "German for Beginners" is for enrichment with no credits. A sample course offering at University of Konstanz (with 10 Kettering University students) is given below:

University of Konstanz (Spring Term)

Courses	Course Equivalence at KU	Pre- or co-requisites
Design of Mechanical Components	Machine Design – I	Solid Mechanics
Fluid Mechanics	Fluid Mechanics	Thermodynamics
Germany with in Europe	Topics in Social Science	COMM 101, SSCI 201 and HUMN 201
Finite Element Analysis	ME Technical Elective	Solid Mechanics, CAE
Heat Transfer	Heat Transfer	Fluids, Thermodynamics
Introduction to Automotive Powertrains	Powertrains	Solid Mechanics

Implementation Plan and Assessment:

The Study Abroad programs are approved on a departmental basis with consultation and cooperation of the other participating departments such as Liberal Studies department. There are one or two faculty members assigned to oversee each Study Abroad program (advisors) who are responsible for advisement, mentoring, monitoring and assessment of that program. Ahead of time, the program coordinator pre-determines, in consultation with appropriate faculty, which courses will transfer directly back to Kettering as if courses were taken at Kettering University. Assessment of course is therefore needed. No two courses of the same title are taught the same way in different parts of the world, nor do they have the same course content. The assessment process is carried out via course portfolios and a competency matrix (end-of-course outcomes-based survey). Students are asked to compile course portfolios and keep track of assignments, notes, HW, reports, projects, etc. Individually, students are asked to fill out course evaluations and a competency matrix rating the contribution of the course in helping them achieve certain outcomes. These outcomes are the program educational outcomes of the ME program at Kettering University. Operational elements of the study-abroad programs are as follows:

- Students are advised on an individual basis or as a group by the international student coordinator (typically one or two terms in advance and approximately six months to one year) prior to going abroad.
- Students are informed six months to one year prior to travel how the transfer of courses is going to occur and the correspondence (equivalence) of courses taken abroad with Kettering courses. These are placed on the Kettering website.
- Students fill out several forms, including the course registration form that bears the department’s signatures.
- Students are asked to fill out a competency matrix (outcomes-based survey) rating the contribution of each course taken abroad to their achievement of certain outcomes.
- Students are asked to fill out an end of the term course and program evaluations.
- Students are asked to write an essay documenting the usefulness and contribution of the course to their professional and personal growth.
- Students are asked to itemize a list of recommendations for the purpose of program improvement.

- Students' grades will be sent directly and officially from the program abroad to the Office of International Programs at Kettering University. The OIP would then inform the registrar about the courses and associated grades. Every Study abroad program must make the passing grade clear to the students while attending their courses and also to the coordinator and registrar at Kettering University.
- Students are viewed as ambassadors and true representatives of Kettering University. Therefore only qualified (students with an 85% WAG or above) are encouraged to participate in various study abroad programs.

Course Portfolios

The following information is sent to students, typically via e-mail both before and during their study abroad term:

1. Keep a Portfolio for each course that contains a collection of each course notes and students' work (assignments, exams, projects, etc) exhibiting the achievement of certain skills and abilities. They also fill out a "competency matrix" upon completion of the course, to help students reflect on their learning. This matrix features specific outcomes, of which the course may target some, and provides the ME program with students' perception on where and how these outcomes were achieved. All students are expected to submit this portfolio up on return from a study abroad program directly to the Director of Study Abroad Programs.
2. A meeting will take place (students and coordinator) on a certain convenient day during the terms following the study abroad term at Kettering to discuss lessons learned and potential areas for improvement.
3. Formulate and list any recommendations for the improvement of the study abroad program.

Figure 1 shows an example of students' performance in Machine Design course taught by the author. In addition to classwork and homework, two midterm exams and a comprehensive final project have been given to do the assessment of their overall performance in the course. The results show satisfactory performance by them. The students consisted of a diverse population from three different countries and the overall teaching and learning experiences were very good.

Lessons Learned

We have learned several lessons at Kettering University over that last several years regarding the improvement and expansion of study abroad programs. These lessons will be important to us in terms of creating a relevant assessment program for international programs. Many of these areas are unique to Kettering University such as the limits that our academic calendar put on students who want to study abroad. The academic calendar at Kettering makes it particularly difficult to send a large number of students abroad. The academic year is divided into four eleven week quarters. Students are divided into two sections: A-Section and B-Section. There are very few schools abroad (or even within the USA) that can accommodate

this calendar, meaning that most programs must be tailor-made to fit the Kettering calendar requirements. The reality at Kettering University is that the majority of students study abroad in the Spring term (April to June) since that is when most of our foreign partners can provide accommodate with minimum problems. A final lesson that we have learned is that we must do a better job at balancing the numbers of students who go on one program versus another. In the past years, our study abroad programs either had too little or too many students. As a result, we are trying to create a system that more adequately balances the number of students on various programs.

We are currently creating a more systematic approach to advising for study abroad. The advisor meets with the students to discuss course pre-requisites, courses abroad and courses when the students return to Kettering University. We communicate through an International Programs Committee (IPC) consisting of Faculty and Administrative staff. The IPC is a useful forum where students, faculty and administration can come together to communicate their efforts at Internationalizing Kettering. This committee was born as a result of what we learned from different offices and departments taking on International Activities without consulting with other parts of the University. In addition, it joins the various departments and offices that conduct International activities. An evaluative process is still not in place for all of these areas, but we know that we must create a process that will address these areas fully to help us improve the programs. With the newly formed OIP structure at Kettering, we anticipate a more streamlined system of activities with equitable distribution of efforts put in by the faculty and the staff to promote the study abroad activities.

Conclusion

In conclusion, the numbers of engineering students who participate in international academic exchanges is growing rapidly. More students within the mechanical engineering field are asking for and going on study abroad programs where they take a term to study coursework at a foreign university. The academic standards at the time of applying to study abroad and to pass the courses taken abroad, has been raised to around 85%. The Evaluation and assessment procedures for these study abroad programs will ensure that the quality and reputation of such programs remains high. Provided that the faculty, administration and students are involved in the creation, maintenance and evaluation of such programs, there is no reason why these programs will not be able to grow and flourish. Assessment and evaluation of programs will make international programs a more convincing option for faculty and ultimately benefit the students in creating the highest quality study abroad programs. Finally, plans are under way to promote faculty-led study abroad programs and also open doors to more new study abroad programs in Latin America and Canada.

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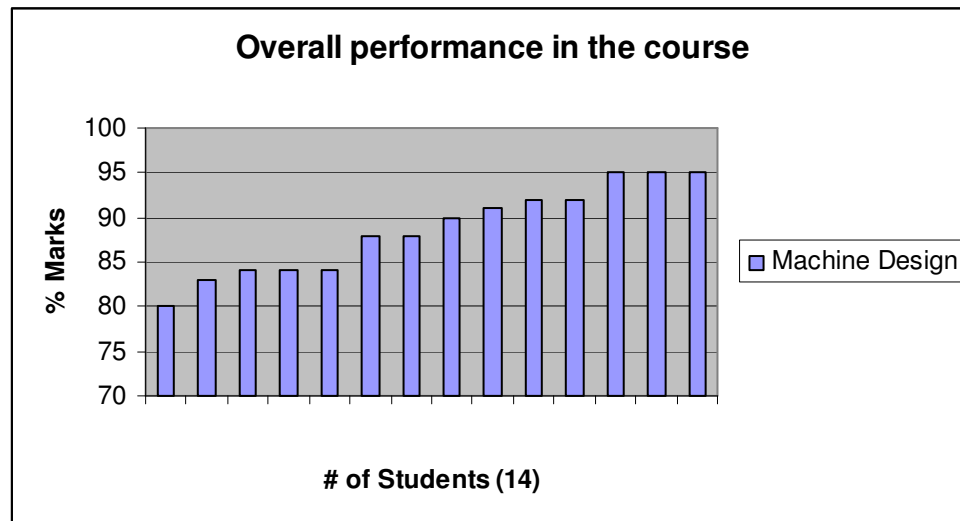


Fig. 1: Students performance on final exam (average 88.64%)