

Competencies Required of Engineering Students Conducting International Projects

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ABSTRACT

Given the importance of students working in international environments, this study identifies the important competencies that engineering students need so that they could work effectively. The list of competencies was identified using a realist synthesis methodology. The context of the research was thirty-seven U.S. students who worked on twenty-two international projects with companies and research centers in India. The outcome was development of multi-media case studies based on the projects. The students spent a semester preparing for the project, eight weeks working on the project, and a semester developing the case studies. Each project was evaluated and students interviewed to identify the competencies that were utilized by the students. Analysis of these evaluations showed that successful projects trained the students to be competent in the technology domain of the project and encouraged them to communicate well with their counterparts.

KEYWORDS

Case Study Analysis, Collaboration, Competencies, Engineering, International Projects

INTRODUCTION

By 2050, 8.2 billion of the 9.2 billion people on Earth will live in developing countries, and economic growth in these countries is likely to equal or exceed that in the developed world (Lutz, Butz, & Samir, 2015). At present, the U.S. economy is growing at a 1 to 2 percent rate, whereas the Indian and Chinese economies are each growing at 6 to 8 percent. Stephen D. Bechtel, Jr., the Chairman Emeritus and Director of Bechtel Group, Inc. (2006) states that “We must be able to manage and integrate globally constituted, multi-cultural teams that design and procure equipment, materials, and services internationally.” Projects are expected to become even more complex, leading to a higher level of professionalism in project management, an increasing need for better governance of publicly funded projects, and more project-oriented organizations with higher levels of individual and organizational project management competencies (Schoper, Gemunden, & Nguyen, 2016). Future engineering students, both in the US and other countries, need to know how to communicate effectively, think globally, be environmentally conscious, and appreciate the impact of social/cultural dynamics on a team environment in order to remain competitive in this kind of economic climate. A vital part of this process is for engineering educators to give their students opportunities to work on international projects (Jesiek, Zhu, Woo, Thompson, & Mazzurco, 2014). Therefore, we formulate the research question: What are the important competencies that engineering students need so that they could work effectively on international projects?

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Past research provides some guidelines in answering this question. A study based on a Delphi study of twelve subject matter experts developed a conceptual model that identified international contextual knowledge, global engineering preparedness, personal and professional qualities, and cross-cultural and communications skills and strategies as the major elements that the experts considered important for success (Levonisova, Huang, Streiner, Cunningham, Ragusa, Besterfield-Sacre, & Matherly, 2014). A wide-ranging literature review on engineering practice in global context finds that global engineering competency, technical coordination, engineering cultures, ethics, standards, and regulations are the most important competencies (Jesiek et al., 2014). A recent study identified 81 competencies and divided them across 11 dimensions (Rezende & Blackwell, 2019; Dotsenko, Chumachenko, & Chumachenko, 2019). But, none of these articles identify the important competencies required of engineering students who participate in international projects. This article addresses this gap in literature.

The next section provides further details on the potentially important competencies for international engineering education projects identified through a review of the literature. We then move on to discuss the methodology used in this research, describe the twenty-two international projects conducted during the period 2007 to 2013, and present the results of the data analysis. Finally, we discuss the findings and limitations of this study, and suggest possible directions for future research.

LITERATURE REVIEW

Even though there are many different definitions of competencies, the following two definitions are appropriate given the international nature of the projects analyzed in this paper. Competencies for project management can be defined as the knowledge, aptitudes, attitudes, and behaviors that are needed to carry out a piece of work that has a definite starting and end point (Boyatzis, 1982, 1996). Competency represents the ability to demonstrate appropriate behaviors in the application of relevant knowledge and skills in order to achieve effective performance in the context of a specific project (Hager & Gonczy, 1996).

Many of the world's most pressing science and engineering challenges and opportunities are trans-national in nature, and the leading scientific and engineering facilities, resources, and expertise charged with investigating them are located around the globe. The National Science Foundation (NSF) urges universities to develop a globally-engaged STEM workforce that is capable of performing in an international research environment (NSF, 2015). We therefore searched for articles that discuss the competencies needed to conduct successful international collaborative projects.

In international conflict resolution (Tjosvold, Wan, & Tang, 2016; Lewicki, Weiss, & Lewin, 1992), an effective strategy is to employ third-party facilitators who help the parties reach a settlement. They might use mediation, arbitration, contextual knowledge, or other strategies to bring about resolution to issues that arise (Tjosvold et al., 2016; Lohr, Graef, Bonatti, Mahoo, Wambura, & Sieber, 2017). Even though third-party facilitators provide strong assistance, participants in an international project need to have specific competencies.

We identify the specific competencies by performing a literature review (Table 1). This table lists the objectives of each study, identifies competency dimensions and maps them to competency items. When the authors found a large number of competency items, they created a few competency dimensions and then mapped them to the items.

The first study looked at students studying project management in South Africa and the United Kingdom. Compared with their peers in the United Kingdom, students in South Africa reported higher levels of overall experience and usage of online learning materials and lower levels of blended learning and individual critical evaluation skills. They recommended that future studies seek to understand the competencies that impact learning experiences when the students perform projects across different countries (Ojiako, Chipulu, Marshall, Ashleigh, & Williams, 2015).

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