AC 2012-4167: ADAPTING CURRICULAR MODELS FOR LOCAL SERVICE-LEARNING TO INTERNATIONAL COMMUNITIES

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Adapting Curricular Models for Local Service-Learning to International Communities

Introduction:

In recent years, respected voices in both engineering industry and education communities have called for a globalization of U.S. undergraduate programs. One document, the Newport Declaration, composed and endorsed by participants in the National Science Foundation (NSF) funded Summit Meeting on the Globalization of Engineering Education on November 6, 2008[1], states a variety of motivations for pursuing globalization –from developing national competiveness to honing global citizenship. Though the motivations for doing so may vary, globalizing engineering education is a noticeably rising trend in engineering education as marked by an increase of global engineering programs. Such global engineering education programs (surveyed by Parkinson[2] and Downey et al.[7]) provide immersive, study-abroad experiences intentionally designed to inculcate competencies in engineering students as preparation for their increasingly globally-integrated profession.

The signees of the Newport Declaration voice a well-recognized need in engineering education. Though the only explicit mention of global awareness in the ABET EC2000 outcomes is that engineering graduates should "understand the impact of engineering solutions in a global…context," a driving impetus in developing the ABET EC2000 outcomes was an awareness of the current and future globalization of engineering practice[3,4]. Moreover, the National Academy of Engineer's scenario-based report *Engineer of 2020* notes the currently interlinked global economy and provides a scenario on the increasingly globally-integrated world[5]. In *Engineering for a Changing World*, Duderstadt provides a summative snapshot of many of these voices, stating that engineers "must appreciate the great diversity of cultures characterizing both the colleagues they work with and the markets they must compete in."[6]

Although the *need* for engineering education to prepare engineers for a globalized future may be well-recognized, the prominent voices in engineering education seem to be wrestling with practical approaches to addressing this need by asking two salient questions:

1) What attributes characterize globally competent engineers?[7, 8, 9, 10]

2) How can post-secondary education engender such global competence?[7, 8]

This paper explores these questions and examines the possibility of Engineering Projects in Community Service (EPICS) as a transitional experience to engender global competency among engineering students. The curricular-based model of EPICS supports vertically-integrated, multi-disciplinary, engineering service-learning projects at a Purdue University. Historically, this long-standing program has paired student design teams with local, community partners. In this paper, we document how these partnerships have been expanded to global communities, and how the current curriculum, in both local and global contexts, can be used to engender global competency in engineering students. We consider the efficacy of EPICS to engender global competency by examining three case studies: (1) a project focused on designing energy-efficient

housing with the local Habitat for Humanity (HFH) affiliate, (2) a design to support a Habitat for Humanity building project in the Central Plateau region in Haiti, and (3) the design of a cybercafé for a rural community in Haiti.

Global Competencies and Engineering Education

While a growing body of literature seems to be addressing the question of global competency in engineering, we narrow our focus on three significant sources that explicitly name suggested global competencies. Perhaps the simplest, albeit broad, way of understanding global competency in engineering students has been suggested by Downey et al. as the "*knowledge*, *ability*, and *predisposition* to work effectively with people who define problems differently than they do"[7] (emphases ours). Others articulate specific learning outcomes associated with each of the knowledge, ability, and predisposition components of this broad competency as highlighted in Table 1. Parkinson synthesizes literature on global engineering education to produce a list of thirteen specific global competencies.[9] Lohmann et al. synthesize their own set of global competencies for twenty-first century engineers and further state that (1) global competence results from students' experience in some international study or program and (2) knowledge gained in the international study or program should be related to the students' discipline.[8] Many of these named global competencies may be measured by valid and reliable instruments (as surveyed by Bielefeldt et al.[11])

However, all of these articles acknowledge that even though they pose suggestions for global competencies, the question of what makes an engineer globally competent remains an open one. Jesiek et al. provide a useful mechanism of understanding these competencies by suggesting that they may be represented on a spectrum of psychological dimensions that emphasize "*attitudes* like openness and respect toward other cultures, *behavioral* flexibility and adaptability toward other cultures, and *knowledge* of cultural differences."[10] A partial list of these global competencies (as listed in these three sources) may be seen in the first column of Table 1. This table does not provide an exhaustive list of these named global competencies, and they do not include competencies that are specific to students that participate in some kind of intensive international experience or undergo intensive language training. Moreover, we have classified these competencies according to the psychological dimensions named by Jesiek et al., as seen in the second column.[10]

Regarding the question of educational approaches that could engender global competencies, the literature primarily points to students' international experiences. As noted earlier, Lohmann et al. argue that global competency *results* from such experiences (suggesting a strong relationship between global competency and experience).[8] Furthermore, Downey et al. provide taxonomy of five curricular structures that can engender global competencies: four of which require students to travel to another country for some extent of time.[7] While Parkinson primarily seeks to provide definition to global competence, he too lists "hav[ing] a chance to practice engineering in a global context" among other global competencies listed on Table 1.[9]

However, despite strong support of the efficacy of international experiences to engender global competence in engineering students, Parkinson notes challenges for such experiences to thrive,

Global Competency	Psychological Dimensions[10]
- Knowledge of how engineers and non-engineers from other nations define problems differently.[7] - Broad, multidisciplinary base of knowledge[8] - Familiar with the history, government, and economic systems of several target countries.[9] - Understanding of cultural differences relating to product design, manufacture, and use.[9] - Understanding of the connectedness of the world and the workings of the global economy.[9] - Understanding of the implications of cultural differences on how engineering tasks might be approached. [9]	**Cognitive:** "knowledge of cultural differences" [10]
- Ability to analyze how peoples' lives and experiences in other countries may shape or affect what they consider to be at stake in engineering work. [7] - Refined and diverse interpersonal skills.[9] - Ability to live and work comfortably in a nationally, ethnically, and/or culturally diverse team.[8, 9] - Ability to effectively deal with ethical issues arising from cultural or national differences.[9] - Ability to communicate (unspecific to language) across cultures.[9]	**Behavioral:** "flexibility and adaptability to cultural settings" [10]
- Appreciation for other cultures.[9] - View of self as a "citizen of the world" as well as citizen of a particular country.[9] - Appreciation for the challenges facing mankind, such as sustainability, environmental protection, poverty, and public health. [9] - Predisposition to treat co-workers from other countries as people who have both knowledge and value.[7]	**Attitudinal:** "attitudes like openness and respect toward other cultures" [10]

Table 1: A mapping of global competencies to psychological dimensions

including student participation and institutional support.[2] Yet a study conducted by Jesiek et al. suggests that students with lower global competence are less likely to participate in such international experiences.[10] In other words, the opportunities designed to engender global competency in students might only be reaching students with a high level of global competency to begin with. They suggest the need for "stepping stone"[10] (or transitional) experiences to begin improving student attitudes of openness and respect toward other cultures. We consider in this paper how EPICS might fit as such a stepping stone experience. While service-learning, specifically EPICS, is not specifically designed to engender global competence in engineering, the results of the three case studies illustrate student growth in the general cognitive, behavioral, and attitudinal domains of global competency.[10]

Overview of Service-Learning

Service-learning is the intentional integration of service experiences into academic courses to enhance the learning of the core content and to give students broader learning opportunities about themselves and society at large. Service-learning has been defined "a credit-bearing educational experience in which students participate in an organized service activity that meets identified community needs and reflect on the service activity in such a way as to gain further understanding of the course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility."[12] Service-learning balances the activity that is benefiting the

community partner (service) and the academic content (learning). The "service" is designed to enhance the "learning," and the academic content is required to perform the service – each strengthens the other. While the pedagogy of service-learning is indeed adaptable to many institutions, settings, and disciplines, this pedagogy has four pervasive, key characteristics: *academic connection* to the course's learning outcomes, *service* to underserved communities, *reciprocal partnership* with the university (faculty and students) and the community, and student *reflection* of the activities as a means of boosting student learning.[13]

Overview of EPICS

EPICS is an engineering-centered, multidisciplinary, service-learning program at Purdue University that has received national recognition. Students enrolled in the EPICS courses learn design while they develop projects for local or global community partners. In the 2011-2012 academic year, over 500 students from more than 70 majors within the College of Engineering and across the university have participated in EPICS. This program is structured with student-led divisions, each with 8-20 students, a faculty or industry mentor, and a graduate teaching assistant (TA). Each division has one or more not-for-profit agency/ies (such as a museum, government service, charity, etc.) as a community partner(s). The students work with their community partner(s) to identify, develop, and deliver projects that meet the community partner's needs. Examples of such community needs (in addition to the case studies already mentioned) include designing assistive technology for people with disabilities, developing database software for human services agencies, and developing engaging science-educational technology for elementary students.

An EPICS team is defined by its relationship with a community partner rather than being defined by a specific project. Consequently, a single EPICS division typically supports multiple projects concurrently, with students working on individual projects on smaller sub-teams. The teams identify the needs in conversations with the community partner and will often continue the project across multiple semesters. Once projects are deployed to the community partner, new projects are identified with the same partner. The relationships that define the individual teams are intentionally long-term. This structure provides students with an authentic experience and many opportunities to demonstrate competencies expected of them. Currently, EPICS supports over 90 projects distributed across over 30 teams.

Local and Global Partnerships of EPICS

Though EPICS was initially developed with local community partnerships, the program has recently extended to international stakeholders via community-service organizations that focus on developing nations. The students on projects associated with such global community partnerships primarily collaborate with their partnering community-service organization to develop the requirements for the project. However, although the EPICS experience is "at home" for these students, in their design, they demonstrate high regard for the global stakeholders of the project. Because the students are limited in their access to the global stakeholders, the deliverables often expected within these kinds of partnerships are detailed design documents that are given to the project partners. This provides a well-reasoned design that the project partner, who has more intimate and informed knowledge of the stakeholder culture, can then employ in

order to continue to collaborate (in person) with international stakeholders on the usage of the design. The students in EPICS are still expected to design with all stakeholders in mind, but with the limitation of accessibility to the international stakeholders, the project partner's judgment becomes a critical factor in the global-based projects of EPICS.

Our discussion of how EPICS might inculcate global competence primarily highlights teams with international stakeholders. Such focus does seem appropriate for this discussion. However, the EPICS curriculum is not restricted to developing such competence in these globally focused teams. Teams with stakeholders in a local context might also develop some of these same competencies as broadly characterized by the cognitive, behavioral, and attitudinal psychological dimensions.[10] As noted by Downey et al., a single culture is not necessarily bounded by national borders.[7] While considering cultural differences that are within the same nation may arguably not engender "global" competency (by some definitions of global competency), experiences that consider a broad range of cultural difference, such as EPICS, can at least serve as a significant transitional experience to student participation in more internationally immersive programs designed to develop such global (transnational) competencies. While not specifically designed to provide the rich, transformative experience of an international experience, such a transitional experience might appeal to a broader audience of engineering students than those who opt to participate in international experiences.[10]

Collective Case Study

We now consider three projects in EPICS, as described earlier, that demonstrate the program as one that can address globally competent engineering students. We are employing the collective case study method, which is a means of examining and comparing multiple cases to (in our case) demonstrate EPICS as a transitional program for engendering global competencies.[14] As described by Creswell, a case study is "an in-depth exploration of a bounded system."[14] In our cases, we bound such exploration to the activity of three distinct projects in their final semester (or fall semester of 2011 if the project is ongoing), and their relevance to honing global competencies in engineering students. In each case, as we consider the global competency gained, we examine the students' cognitive, behavioral, and attitudinal response to the varying "cultures" that characterize both stakeholders of the project and the students themselves. This collective case study was conducted primarily for the purpose of program evaluation and has been approved by the IRB.

The sources employed to examine these cases were the design documentation and student reflections from the designated semester. Following a description of each of the projects (cases), we examine how the themes found in the projects related to engendering global competency as generally portrayed in the cognitive, behavioral, and attitudinal dimensions.[10] We note when significant competencies were learned in the project teams if (1) multiple student reflections indicate such learning or (2) the team's design document indicates such learning. The results of our analysis are summarized on Table 2.

Partner	Project	Objective	Cognitive: "knowledge of cultural differences"[10]	Behavioral: "flexibility and adaptability to cultural settings"[10]	Attitudinal: "attitudes like openness and respect toward other cultures"[10]
HFH local affiliate	SHADE (Sustainable Housing through Affordable Design and Education)	- Identifying green building strategies for affordable housing. - Analyzing energy efficiency of current HFH housing - Developing instructional materials for other HFH affiliates to construct similar green homes.	- Identified clear economic constraints of the stakeholder.	- Developed ability to work with a variety of people. - Recognized need for frequent communication with project partners - Developed communication skills among teammates	
HFHI (Habitat for Humanity, International)	Central Plateau	- Evaluating earthbag housing as a potential solution to HFH housing in the Central Plateau region of Haiti. - Designing low-cost methods of repairing current Haitian houses.	- Recognized need to understand cultural differences. - Recognized need for credible sources to inform design decisions.	- Proactively managed team morale. - Recognized criticality of communication with project partner, given lack of access to users.	- Appreciation for vertical integration of team.
Evangelical Covenant Church	Cybercafé	- Designing a cybercafé for the purpose of educating teachers in LaMare, Haiti	- Recognized need to understand cultural differences.	- Adaptability to cultural situations.	- Appreciation for multiple disciplines of team.

Table 2: EPICS Projects and their Associated Global Competencies (discussed in the Themes section)

Habitat for Humanity (HFH) – Sustainable Housing through Affordable Design and Education (SHADE)

EPICS has partnered with the local affiliate of Habitat for Humanity (HFH) since 1998 and has delivered several projects to this partner. One of the active projects is the SHADE project which was started with support from the Ford Motor Company. EPICS developed a design for an energy-efficient and sustainable home for HFH, and this model home was built with support from a grant from Ford Motor Company. The project included the development of educational and training materials and systems for the local affiliate. The impact of this initial project was expanded to include training of HFH construction managers from across the state on sustainable

construction practices. The team has continued working together with HFH to assess the environmental, economic, and social impacts of changes in design and construction that stem from the recently revised standards for energy performance ratings. Furthermore, the team is designing the next generation of designs for sustainable building practices for HFH.

Specifically, in the fall semester of 2011, the team focused its efforts on (1) identifying such sustainable building practices, (2) analyzing comparative energy efficiency in current HFH housing and the model house designed by the team, and (3) developing educational materials for other HFH affiliates to construct energy-efficient housing across the state. Although this team has operated within a local context, they have shared a common course division with the Central Plateau team (described below). Such a setup has allowed for members of the SHADE team to have opportunities for peripheral participation in the Central Plateau project team and vice versa. As the team operated in a local context, they were able to frequently meet with their project partner.

Habitat for Humanity International (HFHI) – Central Plateau

The partnership with the local HFH affiliate led to a partnership with HFH's activities in Haiti. A second HFH team, the Central Plateau project team, partnered with the Habitat for Humanity International (HFHI) affiliate in Hinche, Haiti. This team operates with a similar focus as SHADE in identifying strategies for the construction of affordable housing. However, the stakeholders of this project's activity are the impoverished communities within the Central Plateau region of Haiti.

Specifically, in the fall semester of 2011, this team directed its focus on to (1) evaluating earthbag housing as a consideration for construction of HFHI houses, (2) identifying low-cost methods of repairing the roofs and foundations of existing Haitian houses, and (3) designing a method for providing clean water to the community within the Central Plateau. The team did not have direct access to the Haitian stakeholders through an international experience, but developed their understanding of the stakeholder population through observations and interviews captured by the two student project leaders in a trip to Haiti and discussion with the HFH Executive Director who regularly travelled to Haiti. The Executive Director spent extensive time in Haiti and represented the interests of the stakeholders, as well as Haitian citizens who lived in the local community.

Evangelical Covenant Church Missions Committee – Cybercafé

The Cybercafé project team partnered with the missions committee of the local Evangelical Covenant Church. This partner was selected as they had frequent access to the community in Haiti in the central plateau region of Haiti in the community of LaMare. LaMare is geographically near to the Haitian village working with the HFHI Central Plateau team, and consequently, the partnering church's mission committee coordinated their efforts with the local HFH affiliate.

In the spring semester 2011, the EPICS Cybercafé team collaborated with the partnering missions committee in order to improve the area's educational efforts for children and adults.

One of the teams focused on the development of a sustainable cybercafé for Haitian primary school teachers of LaMare, Haiti to receive educational training via online instructional tools. This project team intentionally partnered with the missions committee in order to provide the students with regular access to the stakeholders who were in this area. While this team included some members that had traveled to Haiti on short-term trips, they did not have direct access to the Haitian stakeholders. Moreover, no students traveled to Haiti to gather information for this project (in contrast to the Central Plateau project earlier described). Instead, they relied on the project partner to represent the Haitian stakeholders' interests as well as Haitian students connected to the university. The design of the cybercafé was completed in the form of a detailed design document and delivered to the project partners in this semester (Spring 2011).

Global Competency Themes

Student artifacts from each team were examined and analyzed with respect to the global competency dimensions: cognitive, behavioral, and attitudinal.[10] The results of the analysis are discussed around each of the psychological dimensions as seen across the three case studies.

Cognitive: "Knowledge of Cultural Differences"[10]

According to the SHADE team's design documentation, they understood, to a quantifiable degree, the economic constraints of their stakeholders (residents of HFH housing and HFH construction managers) and let this knowledge guide their recommendations to the local HFH affiliate. Although, in this team, the students did not significantly report the value of this knowledge in their reflections, the nature of this project immersed them into a noteworthy "knowledge of cultural difference."[10] Inherent in the scope of the project was the sustainability of their recommendations and how their posed energy efficiency solutions would impact society in general. The team was challenged to (1) assess the economic benefits of energy-efficient practices for homebuilders and homeowners and (2) develop tools to communicate this knowledge to HFH construction managers and homeowners. Such a challenge gave the team a clear opportunity to "work effectively with people who define problems differently than they do"[7] by reconciling the values of two culturally different stakeholder groups (HFH construction managers and homeowners) with their own understanding of the project.

The Central Plateau team exhibited a prominent focus understanding the culture of their stakeholders throughout the team members' reflections. As written by one student, "[The team] needed to get the perspective of the Haitian people in order to make our project successful." The project team regarded such understanding as not only necessary for proper technical specifications, most team members, as evidenced by their reflections, regarded their ability to understand their stakeholders' culture as an ethical imperative. As voiced by one student, "[t]he main ethical issue which (*sic*) I encountered was the issue of understanding the differences in the Haitian culture as opposed to the American culture. The last thing my team wanted to do was to offend those who would be benefitting from our potential house design."

Furthermore, the students on this team demonstrated an ardent concern for the credibility of information about their stakeholders. Some indicated that "the internet" was employed to understand the "Haitian culture" but implied or stated that such information was not necessarily

credible. Two incidents appeared to engender such skepticism on their initial research. The first was a poor design review where external reviewers conveyed, according to one student, that "[the] designs…were disconnected from the scope of [the] project." The second, more prominently mentioned, incident that produced skepticism was the information obtained by two members of the team on a four-day trip to obtain information from the project partner and other local stakeholders in Hinche, Haiti. The students, however, tended to not apply this same degree skepticism to the information obtained by the students on their information-gathering trip. The team seemed to regard the information gathered by the two students in Haiti as correct, one team member noting that "[i]f we had the information directly from the trip to Haiti at the beginning of the year, we probably would have been able to test our design which would have enhanced our experience in EPICS."

The Cybercafé team certainly recognized the need to understand cultural differences between them as the design team and their projects' Haitian stakeholders. However, rather than developing such understanding throughout the semester, some students claimed understanding before beginning the project. One student explicitly noted that, "[Upon coming into the team,] I understood cultural constraints and some of the potential complicating factors…in the education system." Another said that he "brought first hand Haiti experience to [the] group…[from previous] volunteer work." This second student's insight into Haiti appeared to be readily accepted by his teammates according to their reflections.

In addition to student experience in Haiti, the team also interviewed Haitians who lived in the local community of Purdue University. These interviews, reflected upon by one student, seemed to primarily focus on relevant technical dimensions of knowledge for the project, including a man from Haiti "who had set up a cyber café in Haiti before" as well as another individual who informed the team of the cost of materials. The team gained more cultural knowledge (as opposed to technical) from their American project partners, who had recently begun a long-term commitment to working in Haiti. One student reflects on this experience, stating, "Usually I am interacting directly with the people of [a given] country, so it was interesting to interact with other [US Citizens] and talk about the country's problems without actually being there."

Behavioral: "Flexibility and Adaptability to Cultural Settings"[10]

In the personal student reflections, much of the SHADE team seemed to direct much of their focus on their development of communication and teamwork skills when working across occupational cultures. The impetus for their focus on improving communication with their projects' stakeholders seemed to be related to incorrect assumptions made about them, which set the project team behind their planned schedule. As one student wrote,

> "[Something] that I would change [about the SHADE project] would be contacting HFH and the homeowner of the EPICS house earlier in the semester. There were pieces of information that we needed from these places to complete our deliverables, which we did not realize until later in the semester."

The noted need for communication with the project stakeholders (including the project partner) seems to be primarily related to better understanding the specifications of the project.

Members of the SHADE team further reflected on their development of teamwork skills, specifically being flexible and patient with one another. Several members reported "communication problems" among the team, but such incidents caused them to reflect on practices that could ameliorate the team's cohesiveness. For example, one student noted that "[w]orking with students on a team project has taught me to be more flexible and open to different ideas." Another student similarly reflects on his development of patience, elaborating that watching other teammates struggle with a task seemed to be "just time on the clock ticking away." He then continues that he was able to, through that process, "learn patience in the situation."

The HFHI Central Plateau project team demonstrated a prominent focus on adapting to changing specifications for their designs. Nearly every member implicitly or explicitly discussed the team adapting to evolving specifications as they better understood the stakeholder's context. One student articulates this sentiment, stating,

> "As a team we learned how to adapt to situational changes that affect the project…My ability to adapt progressed throughout the semester. At first I struggled with problems that I could not understand or see with my own eyes. As the semester went on I gradually learned how to deal with the uncertainty and find ways to adapt to the unknown."

Other reflections corroborate this student's sentiment by noting a major narrowing of the projects' scope throughout the semester. Students focus on behaviors that could have ameliorated their adjustment to this significant scope change, citing behaviors such as better long-term planning and communicating uncertainty to teaching assistants.

Given the team's understanding of Haiti, the Cybercafé team demonstrated some degree of adaptability with regard to their understanding of the Haitian culture. This adaptability manifested as refraining from allowing cultural judgment based on little information to affect decision making. Essentially, the team acknowledged that they had a limited cultural understanding of the stakeholder culture and should not be entrusted with critical decisions that might significantly affect the rural Haitian context of their project.

For example, one student recounted a time where they had learned about the expensive price of building materials in Haiti. Although the team believed that they should import materials from the United States, they refrained from incorporating this opinion in their design. Rather, they expressed their concern to the project partners, noting that "they would be making the final decision anyway."

Another student tells of a different example of the team exhibiting this same behavior of refraining from cultural judgment in their design:

> "The biggest ethical issue I encountered this semester was the potential of 'dehumanizing' the Haitians by some of the choices we made. … We … assumed that everything needed to be simplified because they wouldn't be able to use or

> understand the same things we do…We addressed the issue by avoiding making decisions. This helps first of all because it prevents us from making the wrong decision. It helps secondly because it allows the Haitians to be invested and have a voice in the project. This is quite possibly the greatest way to empower them."

It should be noted that, as mentioned in the first example, the team never entirely "avoid[ed] making decisions." Rather, they enrolled the project partner to make decisions that required cultural knowledge of Haiti.

Attitudinal: "Attitudes like Openness and Respect toward Other Cultures" [10]

Although students on the Central Plateau team seemingly developed a deeper appreciation for and openness to the Haitian culture, they did not explicitly mention this in their design documentation or student reflections. However, they did seem to note developing an appreciation for and openness to students in different classifications. As might be expected, one freshman student conveyed such appreciation to their upperclassmen team members, noting that she "came into the Habitat for Humanity EPICS team with little to no knowledge of construction terminology…However, [an upperclassmen student] was always quick to explain terms…with which I had not been familiar." Furthermore, another freshman student notes, "I learned a lot of professional engineering habits [from two seniors]." This appreciation is reciprocated, however, toward the freshman team members by one student who wrote:

> "Working with the underclassmen was a surprisingly refreshing and enlightening experience…[They] admittedly demonstrated a greater willingness to try new things and design creatively—attributes I had to borrow to formatively contribute to our project."

Such amiability among cultural tensions that imbued the vertical integration of the team might be explained by intentional efforts to engender such team cohesiveness. The project team leader documented deliberate out-of-class, social in order to foster a connection among the vertically-integrated Central Plateau team.

As with the Central Plateau team, students on the Cybercafé team developed a significant appreciation to the differences within their own team culture. Comprised of a variety disciplines, team members reflected on the multidisciplinary cohesiveness of the group. For example, a student from outside of engineering noted that "[a non-engineering student and an engineering student] showed me how to do a lot of technical research. I am computer literate, but I have never been exposed to many of the things we dealt with this semester." Moreover, this sentiment was reciprocated by an engineering major who said that "[w]hat I know now and what I knew at the beginning of the semester cannot be compared…I now know how to work with multiple disciplines…[and] how to be productive as a team."

Discussion and Conclusion

Among three cases, we certainly notice significant variations. For example, regard for the stakeholder's context appears to be higher in both the international Central Plateau and

Cybercafé teams than in the local SHADE team. However, the reasoning for this may or may not be related to the setting of the project's focus. One could pose an alternative explanation that the SHADE team's apparent internal team conflict elicited considerable reflection on the need for teamwork and communication rather than reflection on the stakeholder's culture. Moreover, while regard for the stakeholder culture was high in the internationally-focused projects, both the Central Plateau and Cybercafé teams, despite their concern for information quality, appear to have accepted certain forms of information with little or no questioning. Firsthand reports from students in both teams seemed to significantly influence the designs of both projects with little criticism from team members.

The limitations of this study prevent us from making strong conclusions about the variations across the three cases. In this particular study, we confined the bounds of exploration to be within one semester for each project. A richer exploration of each case would follow if we expanded the bounds of exploration to include the activity of the project teams across multiple semesters and included more sources of documentation to analyze (such as interviews, text from individual design notebooks). Moreover, in spite of our efforts to remain objective by examining text from documentation, the authors' affiliation with EPICS may impose a bias in our analysis of these cases.

However, even within our designated bounds, the similarities across the case studies appear to be more striking than the differences. Due to the authenticity of the service-learning experience provided by the EPICS program, students on both local and global project teams interact with wide variety of people in the course of the projects, including their stakeholders and their teammates. If we consider "global competency" to be characterized by the psychological dimensions of Table 2, then the data from these cases suggest that students, at some level, develop in their global competency through their experience in EPICS. Though we have posited EPICS a transitional experience to developing global competency (instead of an immersive experience), the nature of EPICS provides access to students that might not participate in an international experience. The development of such competency in "at home" programs such as EPICS provide engineering education with a broader range of solutions to engender global competency.

References

1. GlobalHUB - Newport Declaration (2008) Retrieved December 15, 2011, from http://globalhub.org/newportdeclaration.
2. Parkinson, A. (2007) Engineering Study Abroad Programs: Formats, Challenges, Best Practices, *Online Journal for Global Engineering Education*. 2 (2), Article 2. Available at: http://digitalcommons.uri.edu/ojgee/vol2/iss2/2
3. ABET Engineering Accreditation Commission (EAC). (2010). Criteria for Accrediting Engineering Programs: Effective for Evaluations During the 2011-2012 Accreditation Cycle. Baltimore, MD: ABET, Inc.
4. Shuman, L.J., Besterfield-Sacre, M., and McGourty, J. (2005). The ABET "Professional Skills" – Can They Be Taught? Can They Be Assessed? *Journal of Engineering Education*. 94(1), 41-55.
5. National Academy of Engineering (NAE). (2004). *The Engineer of 2020: Visions of Engineering in the New Century*. Washington, D.C.: The National Academies Press.

6. Duderstadt, J.J. (2008) *Engineering for a Changing World: A Roadmap to the Future of Engineering Practice, Research, and Education*. The Millenium Project: Ann Arbor, MI.
7. Downey, G. L., et al. (2006). The globally competent engineer: Working effectively with people who define problems differently. *Journal of Engineering Education*, 95(2): 107–22.
8. Lohmann, J.R., Rollins, H.A., Hoey, J.J. (2006) Defining, Developing and Assessing Global Competence in Engineers. *European Journal of Engineering Education*. 31(1):119-131.
9. Parkinson, A. (2009) The Rational for Developing Global Competence. *Online Journal for Global Engineering Education*. 4(2), Article 2. Available at: http://digitalcommons.uri.edu/ojgee/vol4/iss2/2
10. Jesiek, B.K., Shen, Y., and Haller, Y. (2012) Cross-Cultural Competence: A Comparative Assessment of Engineering Students. *International Journal of Engineering Education*. 28(1): 1-12 (in press)
11. Bielefeldt, A.; Paterson, K.; and Swan, C. (2010). Measuring the Value Added from Service Learning in Project-Based Engineering Education. *International Journal of Engineering Education*. 26(3): 535-546
12. Bringle, R.G. and Hatcher, J.A. (1996). Implementing Service Learning in Higher Education. *The Journal of Higher Education.* 67(2), 221-239
13. Lima, M. and Oakes, W.C. (2006). "Introduction." *Service-Learning: Engineering in Your Community*. Wildwood, MO: Great Lakes Press, Inc., 1-22.
14. Creswell, J.W. (2012). "Chapter 14: Ethnographic Designs." *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research.* Boston, MA: Pearson Education, 461-500