ADVANCE: An investigation of the representation of female faculty candidates at Michigan Technological University

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Michigan Technological University

In the fall of 2008 Michigan Technological University was awarded a multi-year National Science Foundation ADVANCE grant entitled "Changing the Face of Michigan Tech". This research was supported by NSF grant No. 0820083. At the start of this project, the faculty complement at Michigan Tech was over 80% in Science, Technology, Engineering and Mathematics (STEM) in terms of disciplines, and prior to the ADVANCE initiatives only 12% of the full professors and faculty serving in leadership positions were female. One of the focus areas of this grant is to investigate the minority status of women faculty in the STEM fields by researching and implementing strategic ways to improve the recruitment of a diverse applicant pool, focusing on qualified female faculty candidates. As the ADVANCE project got underway, Michigan Tech also began recruiting for faculty positions hired in clusters by various topical areas in order to promote collaborative research endeavors across disciplines. This hiring agenda has been called the Strategic Faculty Hiring Initiative (SFHI). The driving research questions behind our project are: How can we increase the representation of women and minorities at Michigan Tech? Second, are women and minorities more strongly attracted to opportunities for collaborative, interdisciplinary scholarship (cluster-based) than to traditional departmental (replacement hire) positions?

In order to assess the gendered faculty climate at Michigan Tech and to determine areas for recruitment improvement, the "Applicant Survey" was developed (Appendix). This survey was designed and distributed in conjunction with the University Affirmative Programs Office and sent to all faculty applicants prior to initial screening and before interviewing. The survey was approved by Michigan Tech's Institutional Review Board (M0334).The Applicant Survey was voluntary and consisted of 20 questions meant to highlight various individual gender and race distinctions as well as the applicants' understanding of the position for which they applied, along with their desires for and impressions of the university's initial hiring processes. In this paper we will report on our findings and the impact of cluster-based strategic faculty hiring on our ability to increase the number of females in our applicant pool. The results of our analysis will lead to practical implications for improving the diversity of University faculty composition in STEM areas.

More than 1,700 applicant survey responses were collected over three academic years, i.e., 2008–09, 2009-10, and 2010-11. For purposes of this study, replacement hire respondents from non-STEM units were not considered, i.e., from the departments of Humanities, Visual and Performing Arts, Business, and Cognitive and Learning Sciences. Responses are provided only for applicants who indicated both gender and type of position (SFHI or replacement hire) for which the application was made. As shown in Table 1, the information from over 1,400 applicant survey responses was evaluated. It is important to note that the data for the 2008-09 academic year represents the full complement of SFHI applicants but only three of the replacement searches (from two academic units) due to being administered relatively late in the year. As the department replacement hire data contains far fewer responses, detailed comparisons between the SFHI and replacement hire responses were not conducted for this first year. Some of the questions for the 2009-10 survey were also slightly modified based on the responses to the first survey. Departmental replacement hires were aggregated, grouping all STEM searches performed across campus in the given year (Figures 1 and 2).

Table 1. 2008-2011 Total Numbers of STEM Respondents (SFHI and Replacement Hires) to Applicant Survey.

	2008-2009	2009-2010	2010-2011
Total STEM Applicants	**301**	**612**	**500**
Female	53	102	111
Male	223	510	389
(Gender Not Indicated)	(8)	(56)	(51)
Total SFHI	**153**	**297**	**209**
Female	24	36	39
Male	129	261	170
(Gender Not Indicated)	(0)	(2)	(1)
Replacement Hire	**123**	**315**	**291**
Female	29	66	72
Male	94	249	219
(Gender Not Indicated)	(25)	(129)	(117)
SFHI By Topic			
Computational Discovery-Female	24		
Computational Discovery-Male	129		
Health-Female		19	25
Energy- Female		17	14
Health-Male		128	79
Energy-Male		133	91
Open Rank Questions **(Strongly Agree or Agree)**			
Opportunities for Collaboration			
Female Replacement	26	51	58
Female SFHI	21	30	32
Male Replacement	72	218	146
Male SFHI	119	228	146
Spousal/Partner Accommodations			
Female Replacement	9	13	12
Female SFHI	9	13	17
Male Replacement	15	63	55
Male SFHI	27	92	65
Diverse Workplace			
Female Replacement	13	39	43
Female SFHI	16	27	30
Male Replacement	39	173	121
Male SFHI	84	191	139

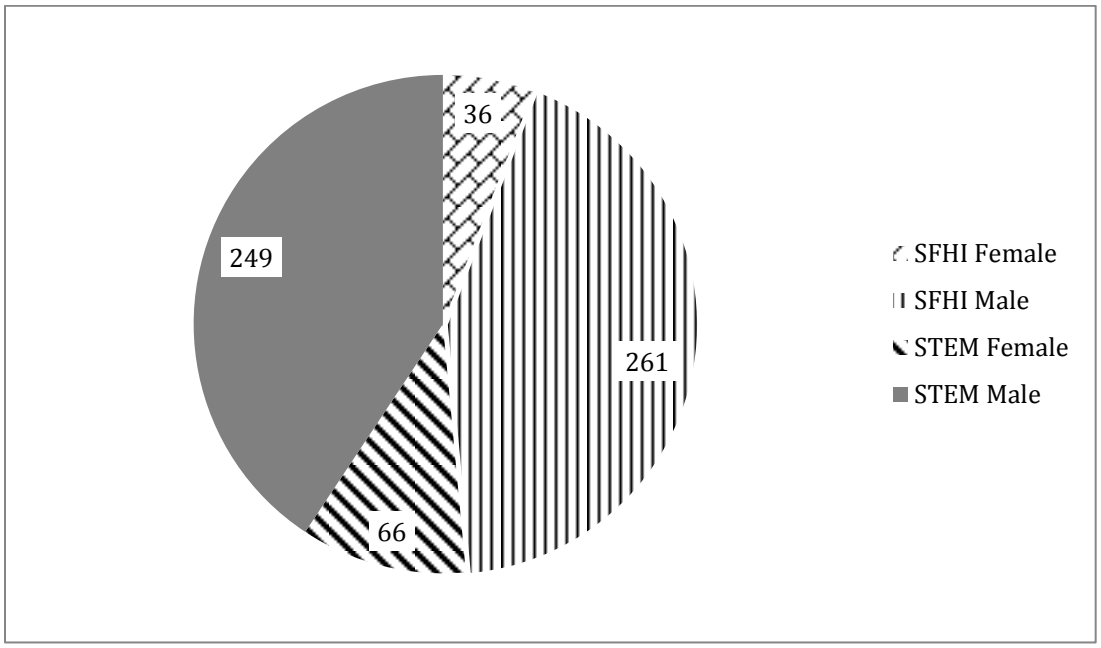


Figure 1. 2009-2010 SFHI vs. STEM Replacement Hire Applicant Survey Responses (n = 612)

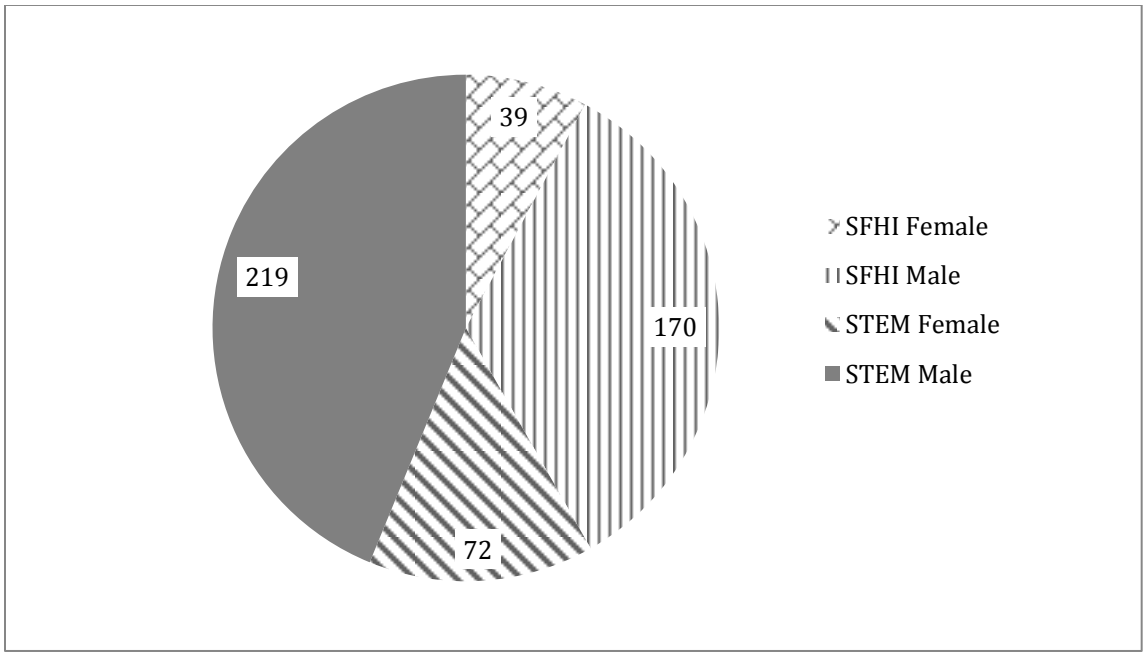


Figure 2. 2010-2011SFHI vs. STEM Replacement Hire Applicant Survey Responses (n=500).

The SFHI results are most informative if the specific interdisciplinary focus of the hiring initiative is considered in combination with the applicant data. The SFHI for 2008-09 focused on Computational Discovery (Figure 3). The percentage of female applicants was roughly 15%, not

surprising given the low representation of females in computing fields nationally, particularly in higher education fields.[1-5] The model often used to identify this negative trend is that of a "leaking pipeline".[3, 7] The pipeline model illustrates the gradual, but continuous, phenomenon of women exiting the STEM fields at key decision points or specific stages of career progression.[3] In most instances, it is presumed that these decisions are voluntary, and are the outcome of a wide range of factors[5]. The SFHI initiatives for the two subsequent years were divided between disciplines related to Energy and Health. It was anticipated that more females would apply to the Health SFHI since the initiative includes a number of disciplines considered more traditionally occupied by females[6]. However, the percentage of female applicants was only slightly higher than for the Energy-related fields (Figure 3).

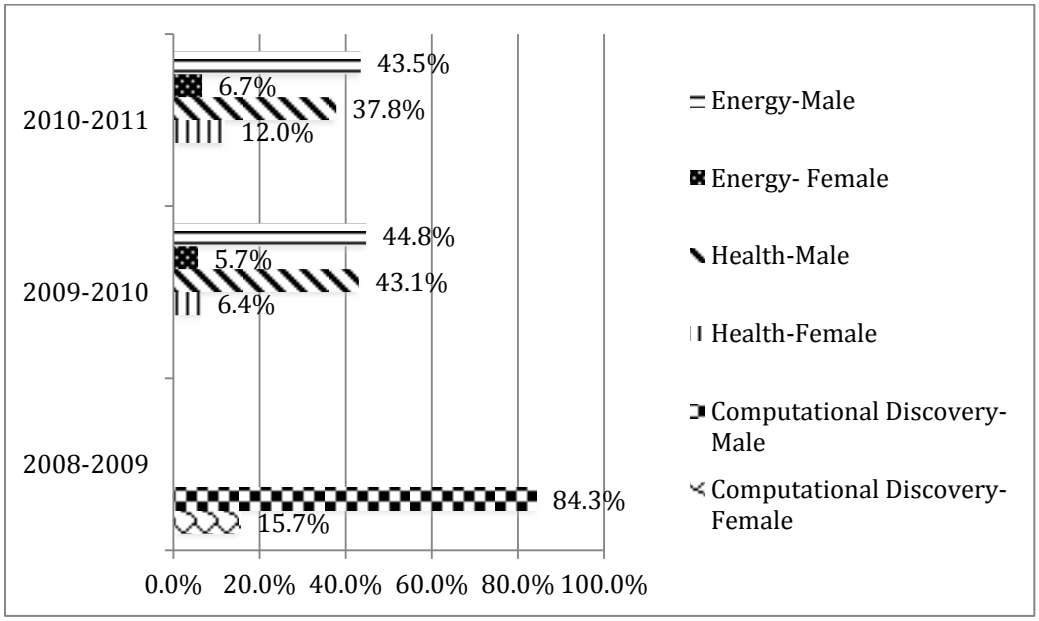


Figure 3. Applicant Respondents for SFHI Positions by Gender.
(Percentages based on total number of applicants who responded to survey and identified as applying for a Strategic Faculty Hiring Initiative position, see Table 1.)

All applicant groups reported high interests in teaching and interacting with undergraduate/graduate students (data not presented) and in opportunities for collaboration (Figure 4). However, the SFHI applicants, in general, were also more interested in the applied research focus of the positions compared to the replacement hire applicants (data not presented) The female SFHI candidates also indicated that they were more likely to consider working in a culturally diverse environment (Figure 5) with partner/spousal accommodation as compared to the female replacement hire respondents (Figure 6). ("Valued" for each of these concerns was determined by the respondents who selected "strongly agree" and "agree" from a 6 point Likert scale.) The data presented in Figures 4 – 6 represents the percentage of applicants who valued collaboration, diversity or partner accommodation; the original data are presented in Table 1. This trend also appears to some extent for the male SFHI vs. replacement hire respondents.

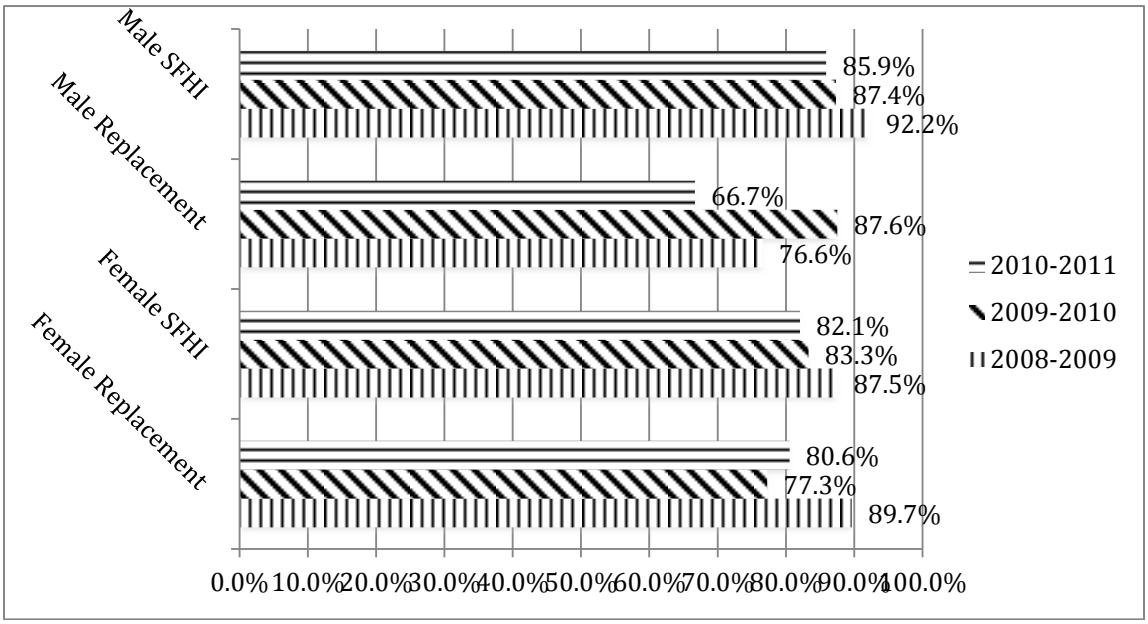


Figure 4. Applicants who valued opportunities for collaboration.
(Percentages for total respondents by gender; see Table 1 for corresponding number.
"Valued" = Response of Strongly Agree or Agree.)

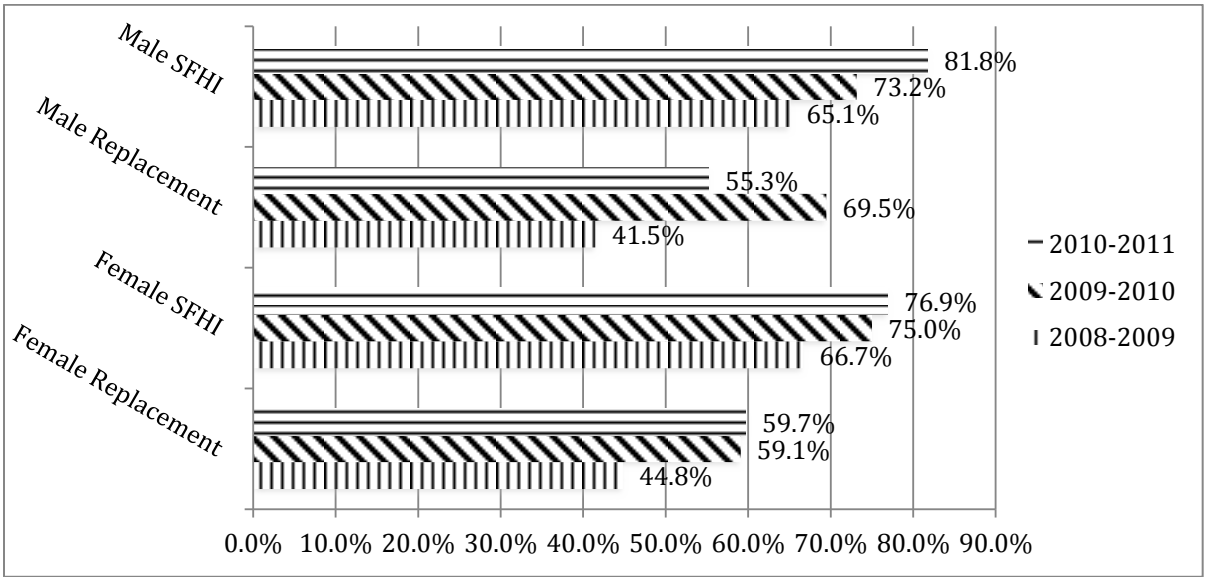


Figure 5. Applicants who valued diversity in the workplace.
(Percentages for total respondents by gender; see Table 1 for corresponding number.
"Valued" = Response of Strongly Agree or Agree.)

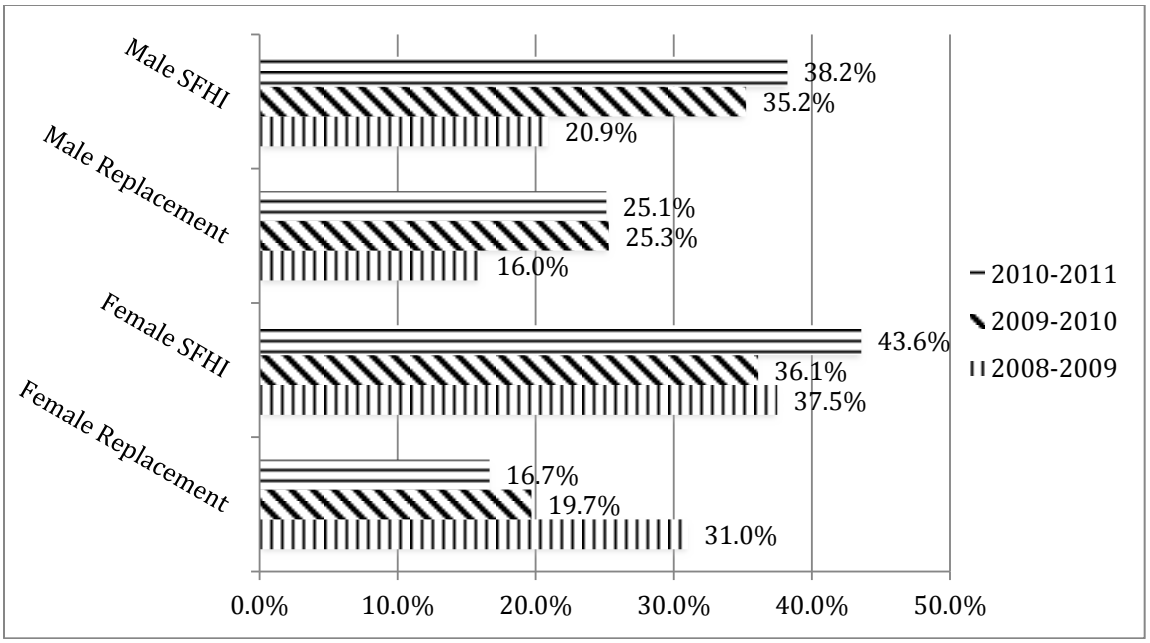


Figure 6. Applicants who valued partner accommodation.
(Percentages for total respondents by gender; see Table 1 for corresponding number. "Valued" = Response of Strongly Agree or Agree.)

Discussion

The preliminary results of this study support our original propositions regarding increasing diversity across the Michigan Tech faculty. As our results show, more females were attracted to hiring initiatives that included inter-disciplinary and multi-disciplinary opportunities than to traditional departmental replacement postings. In other words, the applicant pools for SFHI positions contained more females than the aggregated results of departmental faculty replacements. Female applicants from both pools indicated that collaboration with peers and teaching opportunities were of great interest. Of greater significance in this study, female SFHI applicants were also most interested in workplace diversity. Therefore, opportunities to enter a new organization or position as part of a cohort might be an attractive factor to consider for institutions attempting to increase the diversity of their faculty. Placement advertisements for SFHI-type postings should clearly communicate this unique opportunity.

The other characteristic that proved valuable to female SFHI applicants was partner/spousal accommodations. This result might be linked to the specific location of Michigan Tech. Realistically, there are few major employers in the surrounding geographical area, and employment is depressed throughout the region. The focus of applicants seeking assistance for their partners is becoming a critical consideration that must be addressed by the institution in order to attract and retain a diverse faculty.

Appendix: Applicant Survey (2010-2011) ADVANCE: Changing the Face of Michigan Tech

ADVANCE (2010-2011): Changing the Face of Michigan Tech

Michigan Tech Tenure-Track Faculty
Equal Employment Opportunity Self Disclosure Form and Applicant Survey

CONSENT TO PARTICIPATE IN RESEARCH

ADVANCE: Changing the Face of Michigan Tech

You are asked to participate in a research study conducted by Dr. Margaret Gale, through the Provost's Office at Michigan Technological University. This work is funded by the National Science Foundation. Your participation in this study is entirely voluntary. Please read the information below in its entirety before deciding whether or not to participate. This survey also contains information necessary for us to meet our federal Affirmative Action reporting requirements.

PURPOSE OF THE STUDY

This on-line survey of applicants for tenure-track faculty positions is being used to collect information that will aid us in attracting a more diverse applicant pool. We will also obtain the information necessary for us to meet our federal Affirmative Action reporting requirements.

PROCEDURES

If you volunteer to participate in this study, you will be asked to do the following things:

Respond to the questions in this survey to the best of your ability. Submit the survey once you have completed the questions you wish to answer.

POTENTIAL RISKS AND DISCOMFORTS

There are no anticipated direct or indirect risks or discomforts associated with participating in this study.

In the event of physical and/or mental injury resulting from participation in this research project, Michigan Technological University does not provide any medical, hospitalization or other insurance for participants in this research study, nor will Michigan Technological University provide any medical treatment or compensation for any injury sustained as a result of participation in this research study, except as required by law.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

There are no anticipated direct benefits to the participants in this study as a result of their participation.

It is anticipated that the results of this study will be used to attract a more diverse pool of candidates to tenure-track faculty positions at Michigan Tech. The results may also be disseminated to other institutions and therefore should broaden the representation of faculty from under-represented groups across the academy.

CONFIDENTIALITY

The information obtained from this survey will be collected by the Affirmative Action Office. Any information that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Information for those conducting this NSF-funded study will not be released until after the application process has been completed. Names and e-mail/IP addresses will not be connected to specific responses; all data will be pooled and used only in aggregate form.

Individuals from NSF and the Institutional Review Board may inspect these records. Should the data be published, no individual information will be disclosed.

ADVANCE (2010-2011): Changing the Face of Michigan Tech

PARTICIPATION AND WITHDRAWAL

You can choose whether or not to be in this study. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits to which you are otherwise entitled. You may also refuse to answer any questions you do not want to answer. There is no penalty if you withdraw from the study and you will not lose any benefits to which you are otherwise entitled.

IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about this research, please contact Ms. Chris Anderson, 104 Alumni House, 906-487-2474, or email csander@mtu.edu, Dr. Peg Gale, 121 Noblet Hall, 906-487-2352, or email mrgale@mtu.edu, Dr. Susan Bagley, 531 Dow Bldg, 906-487-2385, slbagley@mtu.edu, Dr. Bill Predebon, 808 ME-EM Bldg, 906-487-2551, or email wwpredeb@mtu.edu, or Lisa Watrous at lmwatrou@mtu.edu.

RIGHTS OF RESEARCH SUBJECTS

The Michigan Tech Institutional Review Board has reviewed this request to conduct this project. If you have any concerns about your rights in this study, please contact Joanne Polzien of the Michigan Tech-IRB at 906-487-2902 or email jpolzien@mtu.edu.

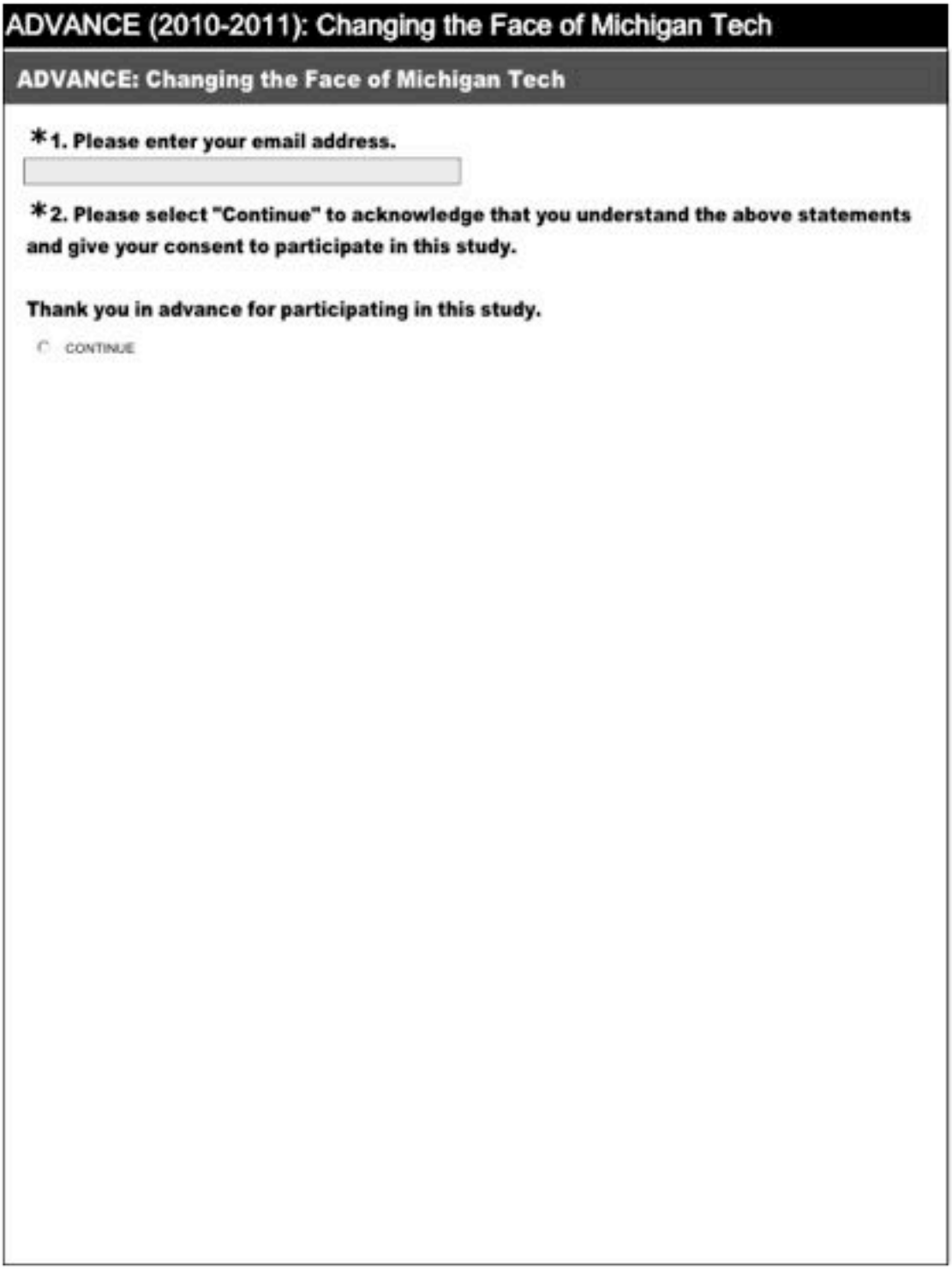
Once you have entered the survey, enter your e-mail address and select the CONTINUE button to acknowledge that you understand the above statements and give your consent to participate in this study.

Thank you in advance for participating in this study.

Date of IRB Approval: 9-15-2010

IRB Number: 0334

Project Expiration Date: 9-14-2011


ADVANCE (2010-2011): Changing the Face of Michigan Tech
ADVANCE: Changing the Face of Michigan Tech
*1. Please enter your email address.
*2. Please select "Continue" to acknowledge that you understand the above statements and give your consent to participate in this study.
Thank you in advance for participating in this study.
CONTINUE

ADVANCE (2010-2011): Changing the Face of Michigan Tech

Part I. Affirmative Programs Office Data

Michigan Technological University is an equal opportunity employer. In order to meet this commitment, it is necessary to collect information concerning applicants (Part I) in accordance with our federal Affirmative Action reporting requirements. Additionally, Michigan Tech continually strives to improve its processes for attracting quality applicants. To help us with this process, we ask that you complete the following brief survey (Part II). Answers provided to these additional questions will be used as part of a NSF-funded ADVANCE study.

Your response to this request is voluntary and refusal to provide it will not subject you to any adverse treatment. This survey is being administered and reviewed independently of those who review your application. The responses you provide will not be connected to your application.

3. Please enter your name (first, last).

4. Gender

- ○ Male
- ○ Female

5. Date of Birth

Please enter your date of birth. MM / DD / YYYY

6. Position applying for:

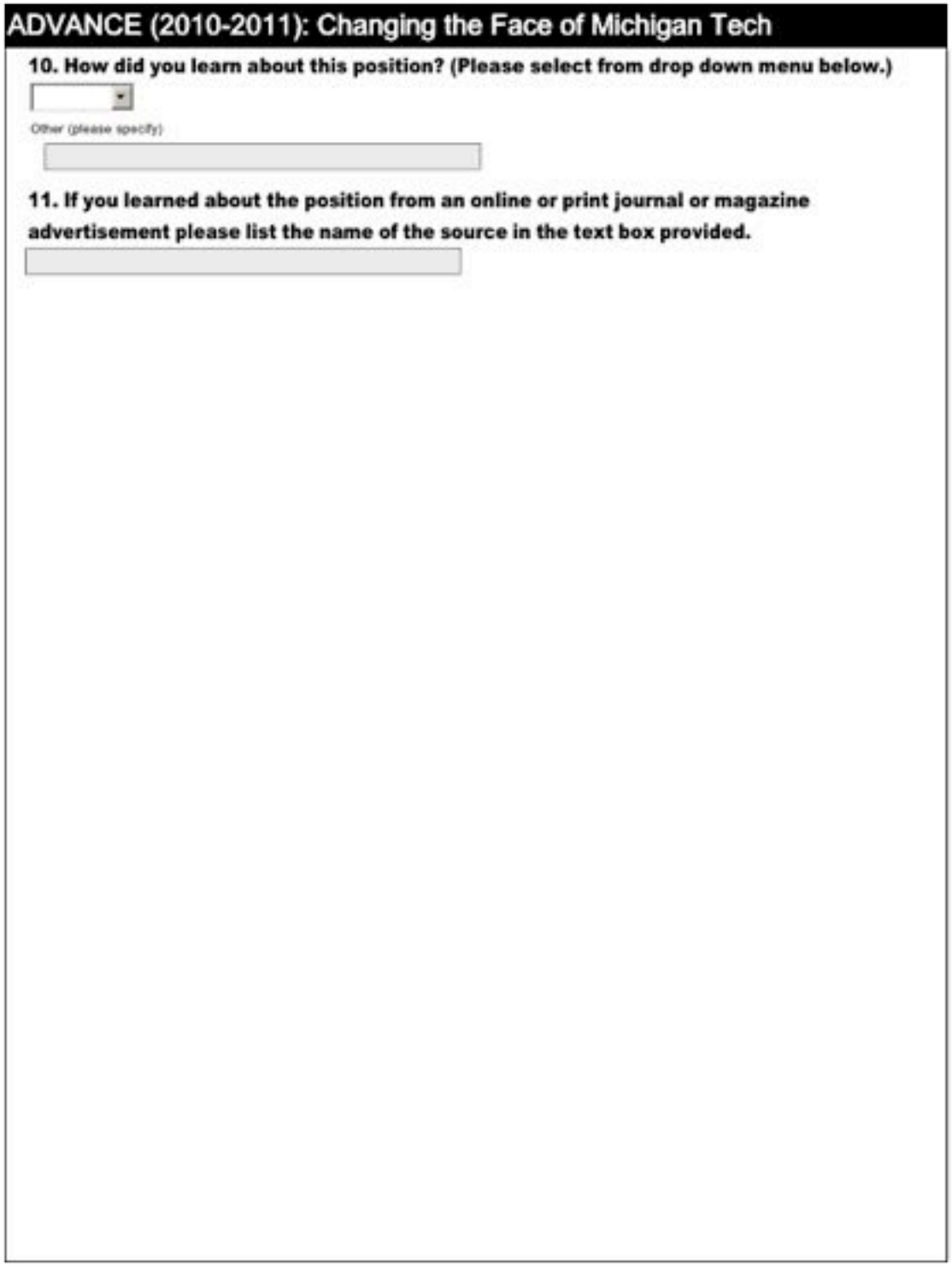
7. Department:

8. Ethnicity (optional)

- ○ Hispanic or Latino- A person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race
- ○ Not of Hispanic or Latino origin
- ○ None

9. Race- Select one or more (optional)

- ☐ American Indian or Alaskan Native- A person having origins in any of the original peoples of North and South America (including Central America), and who maintains cultural identification through tribal affiliation or community recognition.
- ☐ Black or African American - A person having origins in any of the Black racial groups of Africa.
- ☐ Asian - A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, for example, China, Cambodia, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
- ☐ Native American or Other Pacific Islander - A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
- ☐ White - A person having origins in any of the original peoples or Europe, North Africa, or the Middle East.


ADVANCE (2010-2011): Changing the Face of Michigan Tech
10. How did you learn about this position? (Please select from drop down menu below.)
Other (please specify)
11. If you learned about the position from an online or print journal or magazine advertisement please list the name of the source in the text box provided.

ADVANCE (2010-2011): Changing the Face of Michigan Tech

Part II. Specific Data for Advance Project

A. Background Information

12. U.S. citizen or permanent resident (green card)?

- Yes
- No

Other (please specify)

13. Is your application in response to a specific department/school's hiring opportunity?

- Yes (If yes, go to question 14)
- No (If no, go directly to question 15)

14. If you answered "Yes" to question 13 please indicate the specific department/schools to which you applied.

15. Is your application in response to a Strategic Faculty Hiring Initiative (SFHI) position?

- Yes- Energy
- Yes- Health
- No

16. For what type of position did you apply? (Please select position from drop down menu.)

Other (please specify)

17. What is your current academic rank/level? (Please select rank from drop down menu.)

Other (please specify)

ADVANCE (2010-2011): Changing the Face of Michigan Tech

B. Interest/Motivation

18. Evaluate the following elements that motivated you to apply for the position. I am interested in...

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
The high level of relevance and timeliness of this academic area/position	○	○	○	○	○	○
The applied research focus associated with this academic area/position	○	○	○	○	○	○
Opportunities for collaboration	○	○	○	○	○	○
Working in a culturally diverse environment	○	○	○	○	○	○
Spousal/partner accommodations & opportunities	○	○	○	○	○	○
The opportunity for teaching undergraduate students	○	○	○	○	○	○
Opportunities for working with graduate students	○	○	○	○	○	○

19. Please rank the following in order of importance to you in applying for this position, 1 being the least important and 6 being the most important.

	1	2	3	4	5	6
Multidisciplinary Research Opportunities	○	○	○	○	○	○
Opportunities for Collaboration	○	○	○	○	○	○
Job Description Matches Research & Teaching Interests	○	○	○	○	○	○
MTU Reputation	○	○	○	○	○	○
Working in a Culturally Diverse Environment	○	○	○	○	○	○
Location	○	○	○	○	○	○

20. Do you have any concerns/reservations about this position?

ADVANCE (2010-2011): Changing the Face of Michigan Tech

Thank you for your assistance in helping us enhance the quality of the application process at Michigan Technological University.

[1.] Ahuja, M.K. (2002). Women in the information technology profession: A literature review, synthesis, and research agenda. *European Journal of Information Systems*, 11, pp. 20-34.

[2.] Buche, M.W. (2006). Gender differences in defining ``technology'', in Eileen M. Trauth (Ed*.) Encyclopedia of Gender and Information Technology*, Hershey, PA: Idea Group Reference, pp. 528-534.

[3.] Camp, T. (1997). The incredible shrinking pipeline, *Communications of the ACM*, 40(10), pp. 103-110.

[4.] Denning, P.J., and McGettrick, A. (2005). Recentering Computer Science. *Communications of the ACM*, 48(11), pp. 15-19.

[5.] Fouad, N.A., and Singh, R. (2011). Stemming the tide: Why women leave engineering. Retrieved online October 5, 2011 at http://www.studyofwork.com/wp-content/uploads/2011/03/NSF_Women-Full-Report-0314.pdf .

[6.] Moen, P. and Chermack, K. (2005). Gender disparities in health: Strategic selection, careers, and cycles of control. *Journal of Gerontology, Series B,* 60B, pp. 99-108.

[7.] Woszczynski, A., Myers, M., and Beise, C. (2004) *Women in Information Technology, in Strategies for Managing IS/IT Personnel*, Eds. Magid Igbaria and Conrad Shayo, Hershey, PA: Idea Group Inc., pp. 165-193.

Biographical Information

LISA M.WATROUS, *PhD Candidate*, Michigan Technological University College of Arts & Sciences
Ms Watrous' PhD candidate in the Rhetoric and Technical Communication Program at Michigan Tech. Her areas of research interest attend to the intersection of language and oppression. She is also a research assistant on Michigan Tech's ADVANCE grant.

DR. MARI W. BUCHE, *Associate Professor,* Michigan Technological University School of Business and Economics
Dr. Buche's research is motivated by questions that investigate the radical impact of changes in technology and information systems on the professionals intimately involved in developing, implementing, and supporting those systems. She also considers the moderating effect of gender on theoretical outcomes.

DR. SUSAN T. BAGLEY, *Professor*, Michigan Technological University Biological Sciences
Dr. Bagley's research is focused on effecting systems-wide improvements in production of fuels and other materials using lignocellulosic biomass. She is a Co-PI on Michigan Tech's ADVANCE grant.

DR. JASON M. KEITH, *Professor, Director, and Earnest W. Deavenport Jr. Chair,* Mississippi State University Dave C. Swalm School of Chemical Engineering
Dr. Keith's research uses mathematical modeling to improve air quality and energy efficiency through the applied fields of reactor design and alternative energy. He has also spent time studying, evaluating and implementing faculty development programs. Prior to joining Mississippi State University, Keith was a faculty member at Michigan Technological University, most recently as an associate professor.

Learning Through Service: Student Motivations

Authors: Kristine Guzak, Ph.D. Student; Kurt Paterson, Ph.D., P.E.

1. Background

Over the last few years, concerns have escalated among many national organizations that technical expertise is no longer solely sufficient for the development of future engineers.[1-5] Additionally, in the United States engineering programs continue to struggle to attract students, especially women and minorities, despite decades of strategies to change these patterns.[6-9] Independent of these challenges, students have rapidly created extracurricular service efforts, of considerable note is the quick emergence of Engineers Without Borders chapters at more than 200 universities within eight years.[10] In some institutions, this service involvement has fueled the creation of courses and programs that offer Learning Through Service (LTS) which seems to attract a wider range of students to engineering. A growing body of evidence advocates that LTS may provide significant advantages to engineering students, but studies to date are quite limited.[11-15] As universities play catch-up to these trends, a fundamental question remains unexplored: *What motivates engineering students to be engaged in service?*

2. Objectives

This paper presents findings to the above question of student motivation from two LTS programs at Michigan Technological University: (1) iDesign, an international senior-level capstone design program, and (2) Peace Corp Master's International (PCMI), an international graduate-level research program. Until recently, little formal assessment data exists for either program at Michigan Tech. While anecdotal evidence regarding participant and program outcomes is compelling, questions have surfaced on specific gains (and costs) to participants as a result of choosing these international sustainable development program options instead of other possibilities. In order to promote overall sustainability of these programs, the readiness of, and potential challenges for, participants are crucial components to understand. The data analysis can provide invaluable information that could shape these programs and help lead to better comprehension of how to promote these programs to others, scale them effectively, or enhance their contributions for all stakeholders. In an effort to respond to these questions, a formal assessment program was designed and initial data acquired in the 2010-2011 academic year; this paper examines findings from this dataset.

3. Study Participants

Both international programs at Michigan Tech partner with rural economically-developing communities in other countries, and both position the students as technical experts within a multi-stakeholder partnership for engineering infrastructure design, construction, or enhancement. Additionally, each of the programs has on-campus preparation prior to international fieldwork, and end with engineering analysis and communication. The programs are further described below.

3.1 iDesign: Undergraduate Program

The undergraduate program cohort for the purposes of this study consists of 26 multi-disciplinary students with a wide range in backgrounds (e.g. work experiences, travel experiences, language proficiency, etc.). As part of the program, students participate in one semester of prep work (Spring), two weeks of fieldwork in the host community (Summer), and one semester of analysis and communication (Fall). As a complementary component to the preparatory work, students underwent a mixed methods assessment before international travel (March-April, 2011) and will complete it again after the fieldwork (November, 2011). Within the scope of this assessment the students are in the process of completing the fieldwork, thus limiting the data to information prior to their departure.

3.2 PCMI: Graduate Program

The graduate cohort consists of 14 masters students in civil or environmental engineering students from various backgrounds (e.g. undergraduate disciplines, travel experience, volunteer experience, etc.), although four students failed to complete the assessment beyond demographic information. As part of the program students participate in two semesters of preparatory work (coursework and informally through their learning community), twenty-seven months of fieldwork (including 3 months of training), and one semester of communication (thesis defense) upon returning from fieldwork. Similar to the undergraduate students, the graduate students underwent a mixed methods assessment at the start of the program (August, 2010), but also at the conclusion of their on-campus preparation (April, 2011) before the fieldwork; they will undergo the same assessment upon returning (various points in Fall, 2013). Our assessment protocol is a longitudinal one, following students from start to finish within their program, however, this paper focuses on the assessment program design and pre-fieldwork evaluation to date.

4. Assessment

The assessment program consists of five mixed methods: A.) motivations, B.) intercultural awareness, C.) sustainable engineering, D.) skills and attitudes, and E.) readiness,. As part of the overall study the following instruments were used in an effort to qualitatively and quantitatively assess a better understanding of knowledge, skills, attitudes, and identity of participants. Instruments B-E could have an impact on the narrative responses to instrument A (Motivations), so that instrument is completed first by each student cohort as early as administratively possible during the on-campus preparation phase of each program. The assessment program has been reviewed and approved for use by Michigan Tech's Institutional Review Board.

A. Motivations

Comparable to many international service programs, both programs within this study are options, and demanding ones at that, hence the stated question above

becomes especially relevant to the student, their team, and their host community. This paper focuses primarily on the motivations component of the mixed methods protocol, but connections to the other four instruments are presented where relevant. Student motivations are captured through an essay describing interest in participation, and indirectly through parts of the other four tools. The essay is motivated by a handout at a cohort meeting early in the program (for pre-assessment) and near the end of participation (post); task directions are general to give students a completely blank canvas for response:

Task: write a narrative, no more than one page at 12 point font, describing your motivations for wanting to participate in this program. Print out, staple to this cover sheet, and drop off.

As standard protocol, no names are allowed on returned responses, rather student's use a six-digit codename (first 2 letters of first name + first 2 letters of last name + 2 numbers from birth**day**) across all five instruments.[16]

Each motivations narrative essay was transcribed, then coded using qualitative data analysis software (HyperRESEARCH 3.0) bearing in mind the question: *Why are students interested in participating in these programs?*[17] Appendix A includes the list of codes created, including further explanations of each. Once the essays were coded they were then analyzed using a frequency reporting tool built into HyperRESEARCH. This dataset was examined using several filter options (all responses, by gender, class level, and intercultural experience). The findings of these analyses are discussed in the Results section below.

B. *Intercultural Development Inventory (IDI)*

Developed by the Intercultural Communication Institute, the IDI assesses intercultural competency and awareness.[18-19] The IDI is an online, 50-question instrument, which creates quantitative "scores" (perceived and actual intercultural development, among other information) based on participant responses to these Likert-scale questions. This information provides insight where the individual may lie on a development scale from ethnocentrism to ethnorelativism (stages: denial, defense, reversal, minimization, acceptance, and adaptation). The IDI suggests how well the participant might work with someone who has a different worldview, culture, and life experiences; while this is important for forecasting possible project partnership successes and challenges (and can inform preparation), it is also suggestive of the framework supporting a student's motivations for participation.

C. *Sustainable Engineering Assessment*

This assessment addresses how well prepared students are to work with global engineering problems. It is comprised of two components: (1) an open-ended case study based question to measure the understanding of sustainable engineering,

and (2) an online survey in which the motivations, self-efficacy, and mastery of sustainable engineering are addressed.[20-21] The case study reflection essay is administered with the whole cohort in a room, and handwritten over a period of 30-45 minutes. The online survey is comprised of 25 Likert-scale questions that are based in sub-groups examining self-efficacy, beliefs, and knowledge of sustainable engineering. This survey typically takes students approximately 10 minutes to complete. From this assessment a better understanding of the students, possible explanations of their sustainable engineering mindset in relation to international service, as well as the effectiveness of the programs in which they were involved can be examined.

D. Skills and Attitude Survey

An additional, internally created (but not validated) survey, the Skills and Attitude Survey, is a student self-assessment on knowledge and skills on international engineering work. This survey is comprised of 17 Likert-scale questions and elicits responses on program involvement, reasons for involvement, skills and knowledge gained, skills and knowledge to be improved, professional and personal outcomes influenced by participation, and forecasted next steps.

E. Readiness

The Readiness Indicator is a shortened version of the 45-item instrument used to promote global competency, the Miville-Guzman University-Diversity Scale (M-GUDS).[22] The readiness assessment, developed for international programs at Purdue University, is comprised of 20 questions utilizing a six-point Likert scale ranging from strongly agree to strongly disagree and has been used to examine the awareness and potential acceptance of cultural similarities and differences among engineering students.[15] This instrument was utilized as additional perspective on the motivations of students participating in the international programs being assessed, as well as to understand preparation effectiveness, and potential team and project partnership issues. The resulting information provides essential background information and further perspective to analyze the students' motivations.

5. Results

A. Motivations: General Findings

An overall frequency report of motivational codes was generated using HyperRESEARCH to better understand the male and female groupings, graduate and undergraduate programs, and three levels of international experience. In general, motivations for participation seem independent of class level, while gender or international experience have greater influence. The figures and tables below show the results of the code analyses of student motivation essays by experimental variable (gender, class, experience). Figure 1 shows the descriptive breakdown of all students in

both programs (n=36) for this investigation. The motivation analysis for all students, in the form of the eight most frequent codes (motivations for participation), is presented in Figure 1. See Appendix A for the list of all codes (motivations). While the top reason is outward-focused ("helping others"), the rest are self-focused professional and personal drivers.

Grouped differently, student motivations fall into two broad categories, idealistic and pragmatic. The top reasons presented by the first group include: wanting to make a difference, fulfilling engineering obligations to all of humanity, and understanding cultural diversity and how it influences the need for engineers. The second group typically state being motivated to: gain project management experience, leadership experience, or construction experience. A common statement was the desire to *do engineering that matters* to their community partners, but also to them as students. There was also a special pride in belonging to a tribe of fellow students similarly motivated to go above and beyond the required expectations for graduation. While these generalities provide an interesting first look, the remainder of the paper and presentation will provide more nuanced discoveries by gender, cultural experience, and academic level.

Additionally, a glance at the overall breakdown of the motivations of everyone involved in this study shows that there are three main motivations: helping others, personal goal, and desire to work abroad (see Appendix A for further code descriptions). A further examination of the entire group suggests that career goals, solving problems, new opportunities, hands on experience, and community need are also high motivators for students to become involved with international programs (Table 1). A further breakdown of the results can be found in a pie chart in Appendix B. As discussed within the remainder of this paper, this information can be used to encourage individual groups of students to increase the interest in these programs and continue to meet the needs of students.

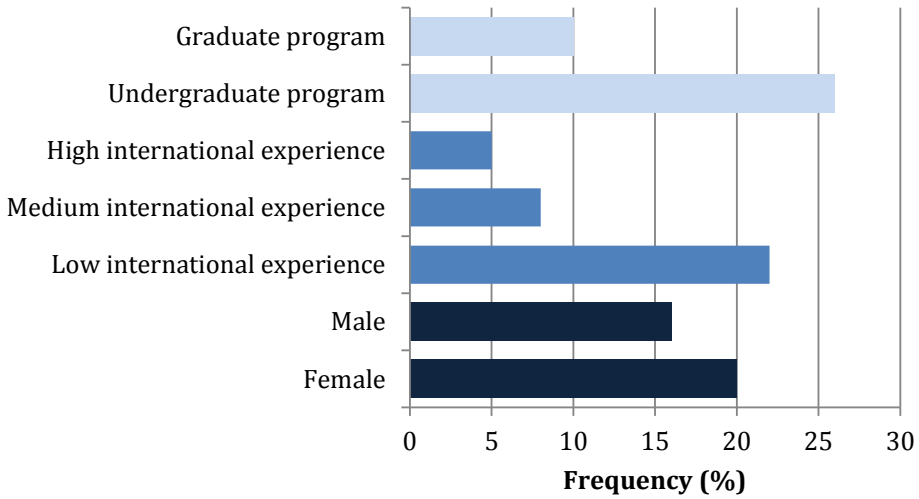


Figure 1. Student participant demographics in three categories: gender, prior international experience, and class level (n=36)

Table 1. Top motivation essay codes as response to reasons for participation in an international service program (n=234 code tags for 36 student essays)

Motivation (code)	Frequency
Helping others	15%
Personal goals	12%
Desire to work abroad	12%
Career goals	8%
Solving problems	6%
New opportunities	6%
Hands on experience	6%
Community need	6%

B. Motivations: Gender Influences

Despite decades of effort, the engineering field is still dominated by white men.[6,23-24] Intriguingly, LTS programs, especially international ones, are disproportionately comprised of women, typically 50%.[12-14,25] A better understanding of what is attracting (and retaining) females to these programs could create a pathway enabling universities to effectively create student bodies more representative of society. The evaluation of the gender-filtered code frequency reports effectively illuminate what attracts males and females to the two programs at Michigan Tech University; these are likely a representation of what could be seen at other universities in other programs similar to these, but a greater study pool will elevate the confidence of generalized findings. Figures 2 and 3 reveal demographic patterns by gender: a key finding is the female participation rate in both the undergraduate and graduate programs (54% and 71%, respectively); there is a strong interest in international programs from women, even though they tend to have less international experience than men in these programs (Figure 3). Further analysis of the motivations suggest that the top three reasons are exactly the same (but in slightly different order), although the break down for fourth and fifth reasons are different. Males and females alike agree that helping others, their desire to work abroad, and their own personal goal are the main three reasons that motivate them to participate in these programs. These top three reasons account for 40% of the motivation reasons mentioned by males and about 38% of those from females.

Due to the similarity of the responses for the top three reasons, the fourth and fifth ranked reasons (many reasons have tied for each place) were further examined. For the males these include alignment with career goals, the desire for a new opportunity, getting hands on experience and a desire for an unconventional job after graduation. For the females this includes the desire to help a community with their needs, career goal, the influence from a class they had taken (university or high school), and hands-on experience. Some similarities between males and females are evident in this second tier of reasons, but the few differences are noteworthy. Classes have an impact on females in a way that they do not for males, universities should work to attract women to these kinds of programs through positive classroom experiences (e.g. relating engineering practice to helping

communities). In general many men might be receptive to messaging about the professional value to be gained from these new and challenging experiences.

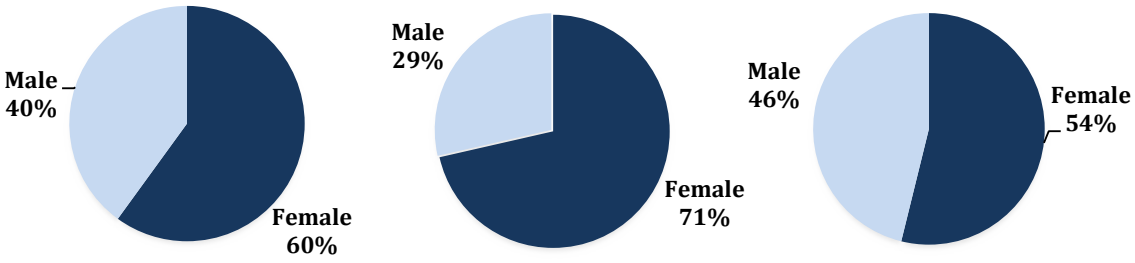


Figure 2. Gender breakdown for (left to right): all participants (n=40), graduate program (n=14; four women did not complete all aspects of assessment but are included here), and undergraduate program (n=26)

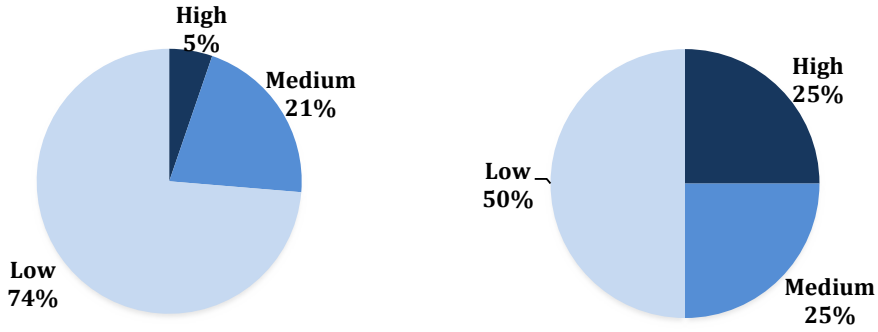


Figure 2. International experience for (left to right): all women (n=23) and all men (n=16). Low is 0 to 10 weeks, medium is 10 to 30 weeks, and high is greater than 30 weeks of living and traveling internationally.

Table 2. Top five motivations expressed by men and women; rank (frequency), n=234 code tags within 36 student essays

Motivation	Male Rank (frequency)	Female Rank (frequency)
Helping others	1 (16%)	1 (15%)
Personal goals	3 (10%)	2 (13%)
Desire to work abroad	2 (14%)	3 (10%)
Career goals	4 (8%)	4 (8%)
New opportunities	4 (8%)	
Desires unconventional job	5 (7%)	
Hands on experience	5 (7%)	5 (6%)
Community need		4 (8%)
Class influence		5 (6%)
Solving problems		5 (6%)

C. Motivations: Academic Level Influences

Statistics also reveal that fewer students are pursuing higher level degrees and that the majority finish their undergraduate program and go directly into the work force.[26-27] As part of the graduate program within this study, students have the option to pursue a higher level degree while gaining international experience. Understanding what the motivations are of the two levels of students might help encourage students to explore these experiences and continue their education at the graduate level. The motivations of each level of student were analyzed within this study and found that although the graduate program has lower numbers, it attracts a individuals with higher international experience (even normalized for age; data not shown). The same top three reasons as with males and females were found to be the case for undergraduates and graduates; they are motivated by helping others, their desire to work abroad, and their own personal goals.

Since the top reasons were insensitive to class level, the second tier reasons were further examined. Undergraduates were found to be motivated by their career aspirations whereas graduates were motivated by more intrinsic factors (the influence of a class, desire to solve pressing problems, interest in overcoming difficult struggles, the satisfaction associated with being part of a well-regarded program, and the interest in having an unconventional career). It is clear that the reasoning between these two levels require a very different approach in attracting more individuals to these programs. Graduate level students require evidence (based on their philosophical, moral, ethical views) that the program offers an opportunity to engineer a difference, whereas many undergraduates want to see the professional development advantages of participation. Graduate students need more complex incentives to continue their education than undergraduates do since their objectives are less career and more personal. Targeting graduate students in the classroom and appealing to their interests to show them that there are other options than simply getting a degree and joining the traditional work force is essential for expanding programs like these.

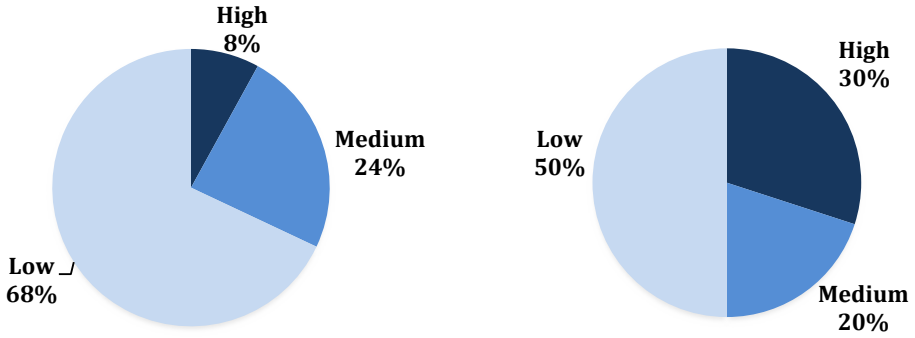


Figure 4. International experience for (left to right): all undergraduates (n=25) and all graduate students (n=10). Low is 0 to 10 weeks, medium is 10 to 30 weeks, and high is greater than 30 weeks of living and traveling internationally.

Table 4. Top four motivations expressed by undergraduate and graduate students; rank (frequency), n=234 code tags within 36 student essays

Motivation	Undergraduate rank (frequency)	Graduate rank (frequency)
Helping others	1 (17%)	2 (12%)
Personal goals	3 (10%)	1 (15%)
Desire to work abroad	2 (12%)	2 (12%)
Career goals	4 (9%)	
Desires unconventional job		4 (6%)
Class influence		3 (8%)
Solving problems		3 (8%)
Program reputation		4 (6%)
Personal struggle		4 (6%)

D. Motivations: Intercultural Experience Influences

Once students become involved with international programs it is often difficult to go back to their daily lives without craving more. Students who have previously had international opportunities were also analyzed to determine what their motivations were for becoming involved with each of these two programs. The hope was that gathering information about whether an additional international experience was enough to attract the student or if they had alternative motivations. Students were broken up into three categories for this category of analysis: low (0 to 10 weeks), medium (10 to 30 weeks) and high (above 30 weeks) international experience. The frequency results show these programs attract a fair amount from each level with the graduate program attracting more experienced students (see Figure 4 above; note that one undergraduate female did not answer this question). In fact the undergraduate program is the first international experience for 20% of the cohort (all graduate program students had at least two weeks of travel abroad prior to start). Some students are interested in sampling such experiences for the first time, many others are returning for more. If the experiences are positive (and challenging based on motivations listed by graduate students in Table 4, for example), the biggest hurdle is crafting first experiences, then a virtuous cycle of involvement can be catalyzed.

Similarly to previous sections, top reasons for all international experience levels are helping others, desire to work abroad, and personal goal. Yet further examination reveals a few interesting differences. Desire to help others decreases with experience, this may be rooted in an appreciation of the realities of development work (partnership oriented vs. "helping"). The most experienced students ranked a desire to work abroad most highly. From these preliminary observations it seems that new (less experienced) students may connect more with an "engineering philanthropy" goal, whereas experienced students are looking for "engineering development." Regardless of their mindset, encouraging students to become involved with these programs because of the opportunity to gain valuable experience should be attractive.

Table 5. Top three motivations expressed by students with low, medium, and high international experience; rank (frequency), n=234 code tags within 36 student essays

Motivation	Low rank (frequency)	Medium rank (frequency)	High rank (frequency)
Helping others	1 (17%)	1 (14%)	2 (13%)
Personal goals	2 (13%)	2 (10%)	3 (10%)
Desire to work abroad	3 (12%)	2 (10%)	1 (16%)
Career goals		1 (14%)	3 (10%)
Class influence		3 (8%)	
Hands-on experience			3 (10%)
Program reputation		3 (8%)	

Conclusions

The assessment strategy and its five instruments used to assess students within the undergraduate and graduate programs help to begin gathering information about what motivates students to participate in international programs like these. It is easy to over-generalize, exceptions always exist, but in general students are attracted for altruistic (helping) or pragmatic (experience) reasons; in general women and students with less experience are motivated by the former, men and students with more international experience the latter. In addition to determining what motivates students to participate in these programs the sustainability of these programs relies on consistent (or growing) student demand, the readiness of the participants, and the preparation resources needed. The motivations analyzed within this study can indicate where efforts should be focused to meet the needs of students to encourage their participation; a mixed message campaign would work best, targeting practical and idealistic outcomes. This preliminary assessment completed at Michigan Tech University will be continued to assess post-program attitudes, expanded to other similar international programs within the university, and offered to other universities, all with a desire to best practices in international programs and enhance the sustainability such programs.[28] The essential component to take away from this study is *what gets measured is what gets improved*: understanding student motivations benefits all involved.

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Biographic Information

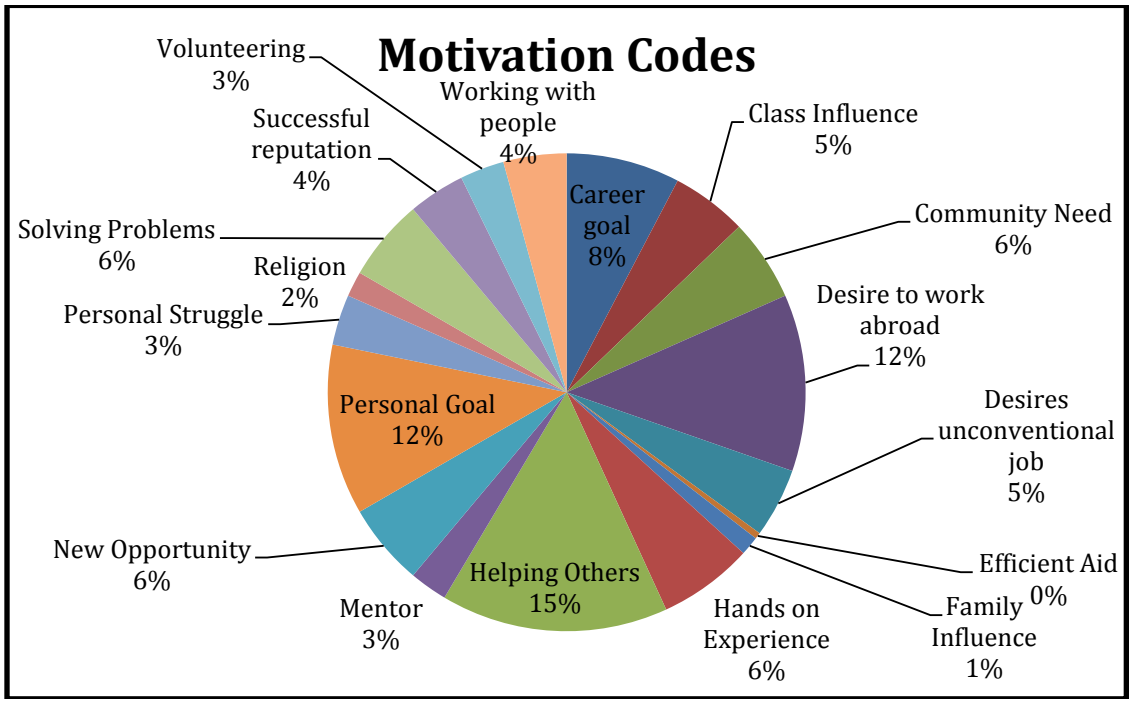
KURT PATERSON, Associate Professor of Civil and Environmental Engineering, is also a director of several international programs at the undergraduate and graduate levels. He strives to be an educational innovator, adding intriguing courses to the curriculum. He is PI/co-PI, on several large projects assessing the impacts of learning through service on students, faculty, and communities around the world.

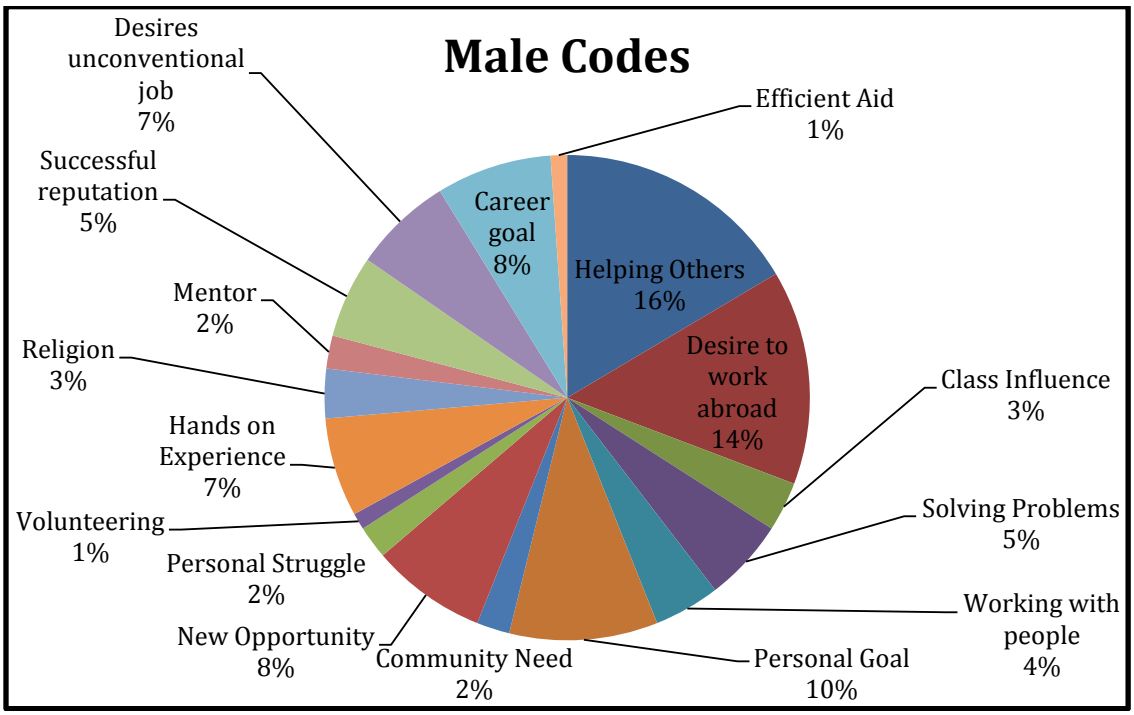
KRISTINE GUZAK is a Ph.D. student of Environmental Engineering at Michigan Technological University. She is the lead graduate student on a larger project assessing the impacts of learning through service on undergraduate students. Her research interests include Engineering Education with some focuses on international programs.

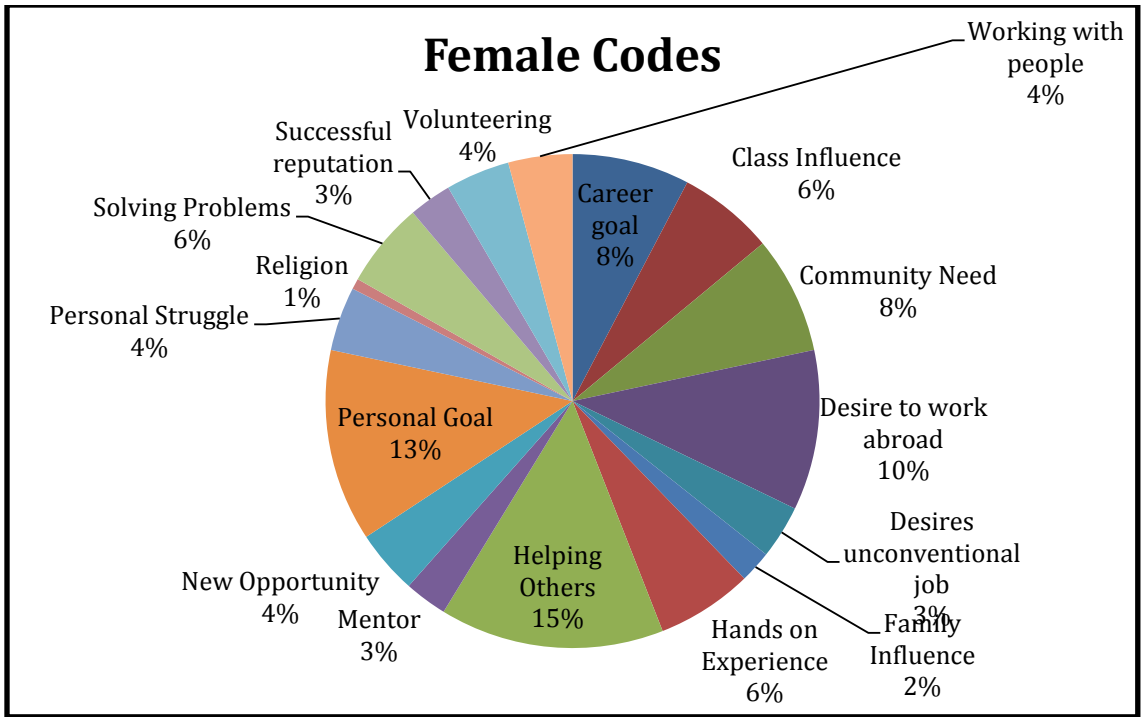
Appendix A: Code Descriptions

Career goal	Personal ambition, international experience will help with resume or other forms of career aspirations
Class influence	Within a class it was suggested that international experiences are beneficial
Community need	A desire to work with people to get them what they need as opposed to giving them what is thought they need
Desire to work abroad	Personal ambition to work outside of the United States
Desires unconventional job	Personal ambition to work in a setting that is atypical of the engineering 9 to 5 job
Efficient aid	A desire to work with the people to get them what they need even if this means not personally traveling
Family influence	Family members suggest the importance of international experiences
Hands on experience	A desire to use the material learned in class out in the field to solve real problems
Helping others	A desire to assist people other than oneself
Mentor	An outside source like a professor or advisor suggests that international experiences are useful
New opportunity	The prospect of experiencing something outside the ordinary
Personal goal	Individual ambition to do something internationally
Personal struggle	Individual problems one must overcome while working internationally
Religion	A religious belief impacts the desire to work abroad through the desire to help, teach, learn, etc.
Solving problems	A desire to work with circumstances to overcome obstacles others face
Successful reputation	The reputation of the international program precedes itself, encouraging students to participate
Volunteering	The desire to give one's time
Working with people	The desire to work with others to reach a common goal and learn from each other

Appendix B: Detailed Charts






Female Codes
Working with people 4%
Class Influence 6%
Community Need 8%
Desire to work abroad 10%
Desires unconventional job 3%
Family Influence 2%
Hands on Experience 6%
Helping Others 15%
Mentor 3%
New Opportunity 4%
Personal Goal 13%
Personal Struggle 4%
Religion 1%
Solving Problems 6%
Successful reputation 3%
Volunteering 4%
Career goal 8%