Work in Progress - Development and Contribution to Students' Intercultural Skills: A Case Study of an International Collaborative Site

Yousef Jalali
Department of Engineering Education
Virginia Tech
Blacksburg, VA, USA
yousef@vt.edu

Rolf Mueller
Department of Mechanical Engineering
Virginia Tech
Blacksburg VA, USA
rolf.mueller@vt.edu

Vinod K. Lohani
Department of Engineering Education
Virginia Tech
Blacksburg, VA, USA
vlohani@vt.edu

Abstract— This work-in-progress research paper presents our experiences with a NSF-sponsored International Research Experiences for Undergraduates (IRES) program hosted by an a large land grant university in the United States. A major component of the program is implemented at an international laboratory in China The lab has been established in 2010 as a collaborative research platform, for a large land-grant university in the U.S. and a public comprehensive university, to study the biosonar sensing and flight of bats from an engineering perspective. The lab has pioneered work on the diversity and dynamics of the structures (noseleaves and ears) that bats use to emit and receive ultrasonic pulses In addition, the lab has hosted research experiences for international (primarily U.S.) students and collaborative BS/MS and MS/PhD educational programs. In the last two years, two cohorts of IRES scholars completed the 10-week IRES program. In addition to research and technical experiences, the IRES students participated in several field trips and seminars and were exposed to Chinese culture. To better understand the impact of the program, students were invited to complete pre- and post-program surveys and a post-program interview. The surveys included cultural intelligence assessment, Global Competency Activity, and Sojourn Readiness Assessment. In addition, students answered a few open-ended questions about their technical and cultural experiences. In this paper, we first explain the history of the lab and its research and educational contribution to date. Then, we describe the IRES program and program evaluation measures. Finally, we focus on the influence of the program on students' intercultural skills and present the assessment results.

I. Introduction

Higher education institutions have increasingly recognized the importance of developing intercultural skills. Class project, field trips, research experience and study abroad programs are among different means to expose students to different cultures and build intercultural skills. International experience may enhance students' awareness, attitudes, skills, and behaviors connected to different cultures and more broadly a diverse global society. A NSF-sponsored International Research Experiences for Undergraduates (IRES) program hosted by the Shandong University-Virginia Tech International Laboratory (SDU-VT Lab) in China is one such programs. The lab has been established in 2010 as a collaborative research platform between Virginia Tech in the U.S. and Shandong University in China, to study the biosonar sensing and flight of bats from an engineering perspective. The IRES program provides international research experience for students with the goal of improving a workforce of internationally competent professionals. In addition, the program aims to provide a platform to foster diverse research and technical experiences in the field of bioinspired science and technology. In a prior study, comparing this IRES program and another one that sends students to Australia, we found that participants from China program focus on global skills much more heavily in discussing their experiences [1]. Reflecting on findings in the previous study, in this paper we have made an attempt to better understand the influence of the program on students' intercultural skills.

There is no consensus about the terminology that can capture the meaning of these intercultural skills and traits. In the literature, different terms such as intercultural competence, global competence, or intercultural communication have been used [2-4]. Within engineering [5-7], the term global competence/competency is often used [1]. In this study, we use the term "intercultural competence" mainly because facilitating "intercultural" development has been listed as one of the major goals of the IRES program. First, we present a brief history of the lab and its research and educational contribution to date. Then, we describe the IRES program and different measures that were incorporated to evaluate the program. Finally, we focus the influence of the program on students' intercultural skills and present the assessment results.

II. International Lab: Background and Impact

The SDU-VT Lab has been established to enable interdisciplinary research between the life sciences and engineering. The lab is dedicated to the study of bats as model organisms for parsimonious sensing in natural environments (biosonar) as well as for the integration of sensing and flapping flight. China provides a great site for this work since the country is home to more than 100 different bat species, many of which have highly sophisticated biosonar systems that allow the animals to navigate and pursue their prey in complex natural environments [8]. The experimental facilities in the lab have been set up to allow for a quantitative analysis of bat biosonar and flight behaviors from an engineering perspective. Fig. 1 presents a view of the lab at Shandong University in China.

Fig. 1. Aisle view of the SDU-VT International Laboratory.

The lab's experimental capabilities have been focused on obtaining accurate and detailed three-dimensional models of structures that are important to the bats' biosonar and flight-related structures. This includes micro-computer tomography for small structures, photogrammetry for larger structures or entire bat specimens, as well as laser scanning for bat habitats (e.g., caves). For biosonar research, arrays of ultrasonic microphones have been established to reconstruct the emitted wavefields of bats that have been trained to sit on an experimental platform or fly inside a cylindrical flight tunnel. For better understanding of bat flight and its coordination with sonar sensing, a flight tunnel has been instrumented with more than 30 high-speed video cameras that allow three-dimensional tracking of landmark points placed on the bats. The experimental setup of microphone and camera array in the flight tunnel is shown in Fig 2.

The SDU-VT Lab has been staffed with Chinese graduate students (masters and PhD) as well as undergraduate students who are participating in a collaborative BS/MS education ("3+2") program between VT and Shandong University. Undergraduate students in this BS/MS program stay at Shandong University for their first three years and work as undergraduate research assistants in the lab during their third year. After three years at Shandong University, students in the program can apply for graduate admission to Virginia Tech in the form of an accelerated ("UG-G") program. Students have the option to send some of their course credits back to Shandong University to complete the requirements for their BS degrees. In addition, Virginia Tech students and faculty have travelled to the lab for one to three months, almost always in the summer. In a typical year, the lab has sent about eight undergraduate students to Virginia Tech and received 16 to 17 summer research visits from Virginia Tech undergraduate and graduate students as well as five to six visits from faculty.

In addition, collaborating students and faculty from other universities in the US and in Europe have visited the lab for joint research work. Because of the lab's unique combination of access to bat species with sophisticated biosonar systems as well as state-of-the-art experimental facilities and tools, substantial progress has been made towards understanding the function of bat biosonar. The lab has supported the application of numerical acoustics to the problem of ultrasonic beamforming in bats and has shown that bat biosonar beampatterns are characterized by a large degree of geometrical complexity in the form of frequency-dependent peaks and notches [9]. Research from the lab has shown that specific shape features of bat noseleaves (i.e., "megaphones" for ultrasonic emission) and ears such as half-open cavities [10] and flaps [11] affect the acoustic characteristics of these structures and can help the encoding of pertinent sensory information [12]. Digital shape models of outer ears from many different bat species have enabled the first large-scale analysis of the shapes of bat outer ears (pinna) across many different bat species[13]. The results of this work have shown that a large portion of the variability in these structures can be explained by virtue of a few simple dimensions. Finally, simultaneous recordings of bat biosonar behaviors with high-speed video cameras and ultrasonic microphones or microphone arrays have shown that the biosonar systems in some families of bats have a fast peripheral dynamics where the noseleaves [14] and pinna[15] undergo rapid shape changes. Numerical and information-theoretic analysis of these findings has demonstrated that these dynamic features result in the encoding of useful sensory information in the time domain [16,17].

The lab has supported the development of new techniques for the reconstruction of the kinematics of flying bats that based on high-speed computer vision that combined video recordings from many different viewing angles [18]. Data from these recordings has enabled detailed computational fluid dynamics of bat flight [19] that is currently being used to study the non-stationary aerodynamics of maneuvering flight in bats.

As was mentioned earlier, besides the scientific research and collaborative education programs, the lab has emphasized intercultural exchanges between students and faculty. To this end, summer programs for international visitors have included local and regional excursions to sights of cultural and historical significance as well as informal interactions between Chinese and international students.

III. IRES Program

Each year, five undergraduate and graduate students complete a 10-week summer research program. Applicants submit their resume, transcript, statement of interest, and two letters of recommendation. The major selection criteria are: (i)

students' academic performance, (ii) students' qualifications with the specifics of different research, and (iii) team diversity. The success rate is about 60 percent. It may be mentioned that in the first year only mechanical engineering students participated in the program, mainly because of limited recruitment time. All projects have a focus on using bats as a model for engineering; two subthemes are biosonar sensing and flapping flight.

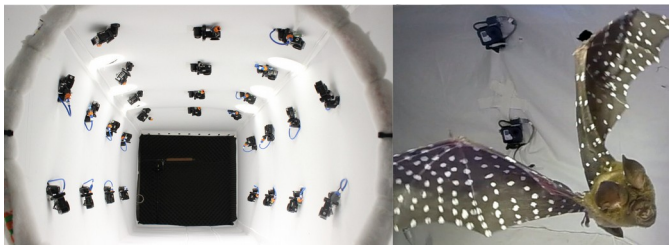

Fig. 2. The experimental setups – instrumented flight tunnel

The program begins with an orientation, where students spend one week at Virginia Tech to better understand logistics and their upcoming research and cultural experiences in China. Then, students spend eight weeks in China at the SDU-VT Lab, working on their respective projects. While in China, students participate in different seminars and field trips. Finally, they spend the last week in the U.S. preparing final reports in scientific format and developing presentations for a research symposium. All costs including travel and research supplies are covered by the NSF/IRES grant.

In order to evaluate the program and its goals including research and cultural skills, students complete pre- and post-program surveys and participate in a post-program interview. The surveys include cultural intelligence assessment [20], Global Competency Activity, and Sojourn Readiness Assessment [21]. In addition, students are asked to answer a few open-ended questions about their technical research experiences. These surveys are implemented by a faculty and graduate student from VT's Engineering Education Department and these persons are not engaged in the technical aspect of the project. As of 2019, with only ten students completed the program, it is still early to use advanced quantitative measures with statistical significance, to assess how successful the program has been in terms of quantitative measures and statistical significance.

IV. INTERCULTURAL COMPETENCE

As was mentioned earlier, students were invited to complete pre- and post-program surveys and participate in post-program interview. Rather than exploring a particular question or quantifying the effectiveness of the program, our intent in this paper is to examine how students describe their development of intercultural competence. Five students completed the IRES program in the second year in Summer 2018. The participants were two undergraduate students in mechanical engineering, one undergraduate student in biological systems engineering, and two graduate students in creative technologies.

We focus on interview questions that are developed to capture students' experiences; the complete interview protocol is given in the appendix. For example, we used the following interview questions to gain a better understanding of their development of intercultural competence:

- What cultural barriers did you encounter, if any?
- In what ways was this experience helpful to you professionally?
- What did you learn about culture?
- What was the best part of your international summer experience in China?
- How has the program changed or expanded your understanding of what it means to be a global engineer?
- What global engineering skills have you begun to develop?

The first author conducted and transcribed semi-structured interviews. Each interview took about 45 minutes. In general, we identified four major themes regarding students' experiences: development of open-mindedness, development of communication strategies, changes in perceptions about the world, and recognition of cultural differences.

Some students reflected on how as a result of this experience they have become more open to new situations. One student in describing her experience said:

"…it's definitely opened my mind, my future to travelling and seeing a different cultures and experiencing different ways of thinking and doing and so that has certainly [had] an influence on increasing my open-mindedness."

Another student said:

"…if you just working in other countries, places all over the world I mean, it's definitely important to have an open mind about things you go [to] in there, open mind about what the culture be like, what the people be like you know you can't really go… open to learning about what it's like there and adjusting yourself and how the working and things go, be prepared if you need for any barrier they could come up in the language…"

Another important category emerged from the data was development of communication strategies. Students reflected on effective means of communication in cross-cultural situations:

"Being able to communicate ideas that's something that I've started developing while I was there but I still don't have a complete understanding of how you can properly effectively communicate your emotions and the ideas that you have in your mind to the other person when the languages might not even have a proper? construction of that idea, that something that we start developing in our time there"

Another student demonstrated how he could reflect on improving his communication strategies:

"I think communication is definitely one of them again, language barrier if you are explaining something technical like I was working with [name] I would draw it out and being able to talk to him slowly and try to make it as concise as clear I could and I think that is something that I improved upon… bottom line, that's what you need to be able to communicate as an engineer, make any progress as an engineer, communication, and I really think I improved upon that… really being able to simplify the problem, and being able to simplify what you are communicating."

Some students reflected on their perceptions about the world and highlighted the existing stereotypes;

"I would say definitely improved my perception of the world, just being able to see people interact you know seeing on the bench you know people walk people watching you kind of see that everywhere different but at the same time we all kind of the same, see similarities between, interaction between people and can definitely, you watch somebody, yah, that person interacts a lot like one of my friend, I saw that a few times; I just heard somebody talking and the way using their hands as gesture reminded myself of friends back home."

Another students said:

"All the political stuff, it's not accurate representation of what the country is because the country is not government, government, it's people… I think that China was not what I previously thought and there was much more beautiful and the people much more friendly and helpful …"

Finally, students recognized the cultural differences and demonstrated respect and recognition of difference. One student in response to the question about cultural barriers clarified:

"I don't think there were barriers but I think there were just differences I don't think I would label them as barriers because they didn't, specifically restrict me or harm me from doing anything … but I don't think there were any barriers, I mean there were differences such as how people behave in public or how public workers there behave …"

Another student explained it in this way:

"I learned about culture; one thing I learned about culture is you have to respect culture and while you're being surrounded you sort of have to embrace it and immerse yourself in the culture, like in Chinese culture, realize that it's in China so everything is very Chinese you sort of have to not to lose your identity completely but you sort of have to embrace what is around and I think that is sort of a key thing when you're travelling abroad not just China but anywhere in the world you have to respect the culture, respect its people and embrace what's around you."

These results present a better picture in compare with what we observed in the previous study [1] in relation with intercultural competence. However, we still need to incorporate the results from different measures to both improve the quality of the research and gain a better understanding of students' experiences and overall influence of the program.

V. Summary

In this paper, we presented our experiences with development of an international laboratory in China and its educational and research contributions. In particular, we highlighted role of the lab in an NSF-sponsored IRES program that aims to provide a platform to foster both research and intercultural skills among graduate and undergraduate students. In this study, we focused on the influence of the program on students' intercultural skills, as one of the overarching goals of the IRES programs. Based on the post-program interviews, students overall demonstrated evidences about different components of intercultural competence, knowledge, skills, and attitudes [22]. We found four major themes: development of open-mindedness, development of communication strategies, changes in perceptions about the world, and recognition of cultural differences. As Downey, et al. [5] have highlighted in a highly cited work on the development of global competency of engineers, to have a meaningful learning of such skills, one needs to go beyond awareness and recognize global competency as learning to work with people who define problems differently. We hope that by combining qualitative and quantitative measures we may gain a better picture about the influence of the program, and not only shed light on the factors that affect students' experiences but also learn meaningful ways to better prepare students for similar international experiences.

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The experience from the IRES program in China has provided insights into how intercultural as well as interdisciplinary skills can be fostered within a short time. These insights could be used to design international research experiences for students that operate on a larger geographical scale and hence provide students with experiences that cover multiple cultures as well as scientific disciplines.

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APPENDIX

Welcome

- Introductions and overview of research goals.
- Overview of the interview process/IRB information
- Questions about the conversation/confidentiality

Interview Questions

1. What did you like about the program that you just completed?
2. What was the best part about your research experience internationally?
3. How was it different from your experience at Virginia Tech?
4. What difficulties did you encounter in research, if any?
5. How did your research experience influence your thinking about future career and graduate school plans?
6. What barriers did you encounter in travel, if any?
7. What cultural barriers did you encounter, if any?
8. In what ways was this experience helpful to you professionally?
9. What did you learn about culture?
10. What was the best part of your international summer experience in China?
11. How has the program changed or expanded your understanding of what it means to be a researcher?
    a. What research skills have you begun to develop?
12. How has the program changed or expanded your understanding of what it means to be a global engineer?
    a. What global engineering skills have you begun to develop?
13. For future, what would you like to change to improve IRES program?

Closure

1. Would you like to comment further on any dimension of your experience that we have not yet discussed or have considered insufficiently?
2. Is there anything I didn't ask you about that I should have?