BOARD # 252: IRES: Undergraduate Engineering Students Intercultural Communication Competence Before and After Participation in a 12-week International Research Experience in the Czech Republic

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Introduction

Undergraduate research is a high-impact educational practice [1] that provides opportunities for students to develop their research and technical skills, network with other students/professors, raise their awareness of graduate studies, and understand the social context of research. While undergraduate students are often able to participate in research at their own institution or nationally in the US (through available Research Experiences for Undergraduates sites) there are also international opportunities for research, with recent programs providing research experiences in Japan [2], Germany [3], and Columbia [4] (to name a few).

International opportunities allow students to network with foreign-born students/professors, learn about different countries and cultures, and learn new perspectives on how professionals from other countries approach research. This is incredibly important for American students preparing for the STEM workforce as they are expected to work and collaborate with foreign-born professionals throughout their careers. In the US, foreign-born workers accounted for 19% of the STEM workforce in 2019 and represent 45% of the subset of STEM workers (i.e. mathematical and computer scientists, physical scientists, life scientists, social scientists, and engineers) with doctoral degrees in 2019 [5]. Therefore, American engineers who transition to industry or pursue graduate research are likely to work directly with foreign-born professionals. It is then incredibly important for students to develop the intercultural communication competence to work effectively with persons from other countries and cultures. A component of intercultural communication competence is intercultural sensitivity, which Chen and Starosta describe as a person's "ability to develop a positive emotion towards understanding and appreciating cultural differences that promotes appropriate and effective behavior in intercultural communication" [6].

It is hypothesized that participating in international research under the mentorship of foreign-born faculty will increase the intercultural sensitivity of undergraduate students, but there are few studies that have evaluated this hypothesis in undergraduate engineering populations. To advance knowledge on this topic, an International Research Experiences for Undergraduates (IRES) site in the Czech Republic [7,8] integrated the International Sensitivity Scale (ISS) [6] into the evaluation activities of the programs second-cohort of participants (8 undergraduate engineering/computer science students). This work provides an overview of the elements in the IRES site, students responses to the ISS before and after their participation, and analysis/discussion of which factors had changes before and after the program.

Summary of IRES Program Activities

The second cohort (N=8) of participants were recruited from the population of electrical engineering, computer engineering, and computer science undergraduate students enrolled in (or recently completed) sophomore level electrical circuits courses at the University of Alabama (UA). Six of the participants identified as women (63%) with three identifying as men (37%). A

total of 88% of participants identified as white and one-participant identified as more than one race (Asian and white).

After recruitment, participating students completed a prep-course meeting weekly with the program coordinator for 2-hours over 15 weeks in the spring semester prior to their summer research. Classes were to prepare students for their summer research by introducing fractional calculus, fractional circuits, design methodologies, approximation techniques, and design tools (MATLAB, LTSpice). Additionally, this course provided activities and discussions to support students in their international travel (e.g., passport & medical requirements, currency, food culture, inter-city and inter-country buses/trains) and collaboration with international faculty (e.g., communication strategies, project requirements, documentation requirements).

After the prep-class, students travelled with the program coordinator to Brno in the Czech Republic to begin their 12-week international research experiences. On arrival in Brno, participants were housed on campus at BUT in the student dormitories. Dormitories were shared accommodations with each IRES participant sharing space with a current BUT student. This shared accommodation was intentional to facilitate interactions with students beyond the IRES cohort. Once on campus the BUT coordinator provided an orientation to the students to introduce them to campus, research labs, research mentors, and activities for them to pursue in Brno. After the orientation students met with the BUT mentors to establish expectations for the summer and the launch of their projects. The BUT mentors were all professors from the Faculty of Electrical Engineering and Communication at BUT (in either the Department of Radio Electronics or Department of Telecommunications). Students were provided access to an electronics laboratory on campus as their shared research space. For research activities, participants were expected to spend 40 hours per week working to meet the goals of their specific research and met at least weekly with their BUT faculty mentors.

The program coordinator remained in Brno for four weeks with the second cohort to transition students into their projects and establish the relationships with their BUT mentors. During this period the cohort and coordinator participated in social/cultural activities in the Czech Republic [8].

Student Assessments of ICC Before and After IRES

To evaluate the impact that participation in the IRES program had on the participants, they were asked to complete the ISS [6] during their first week in the pre- travel program and on their last day in the Czech Republic after their 12-weeks of summer research. This represents approximately 7 months between completing the pre- and post-surveys.

The survey is a set of 24 statements that respondents are asked to rate their level of agreement or disagreement using a 5-point Likert scale (1- Strongly Disagree to 5-Strongly Agree), was administered online. The individual questions (organized by factor) and the mean values from the pre- and post-program assessments are given in Table 1. Overall, 88% of the second year participants completed the surveys at both timepoints. Using the mean scores, overall values for each factor and the survey overall are computed to compare the differences. Note that those items with an asterisks (*) were reverse coded before being reported in Table 1. Using this scale, higher scores indicate a higher level of sensitivity in intercultural interaction.

Table 1. Pre- and post-program average scores for the 24 Likert scale items (1- Strongly Disagree to 5-Strongly Agree) of the ISS survey. Note that items with an astericks (*) are reverse coded.

Question	Pre (N = 8)	Post (N = 7)	Diff
Interaction Engagement	**23.63**	**26.44**	**2.81**
1. I enjoy interacting with people from different cultures	4.25	4.43	0.18
11. I tend to wait before forming an impression of culturally-distinct counterparts.	4.00	4.29	0.29
13. I am open-minded to people from different cultures	4.25	4.86	0.61
21. I often give positive responses to my culturally-different counterpart during our interaction.	3.75	4.43	0.68
23. I often show my culturally distinct counterpart my understanding through verbal or nonverbal cues.	3.63	4.00	0.37
24. I have a feeling of enjoyment towards differences between my culturally-distinct counterpart and me.	3.75	4.43	0.68
Respect for Cultural Differences	**15.63**	**15.28**	**-0.35**
*2. I think people from other cultures are narrow minded	4.25	4.57	0.32
*7. I don't like to be with people from different cultures	4.75	4.71	-0.04
*18. I would not accept opinions of people from different cultures.	4.75	4.57	-0.18
20. I think my culture is better than other cultures.	1.88	1.43	-0.45
Interaction Confidence	**15.64**	**18.14**	**2.50**
3. I am pretty sure of myself in interacting with people from different cultures	2.75	4.57	1.82
*4. I find it very hard to talk in front of people from different cultures	3.63	3.57	-0.05
5. I always know what to say when interacting with people from different cultures	2.38	2.29	-0.09
6. I can as sociable as I want to be when interacting with people from different cultures	4.00	4.14	0.14
10. I feel confident when interacting with people from different cultures	2.88	3.57	0.69
Interaction Enjoyment	**20.64**	**22.03**	**1.39**
8. I respect the values of people from different cultures	4.63	4.57	-0.06
*9. I get upset easily when interacting with people from different cultures	4.38	4.86	0.48
*12. I often get discouraged when I am with people from different cultures	4.13	4.43	0.30
*15. I often feel useless when interacting with people from different cultures.	3.25	4.17	0.92
16. I respect the ways people from different cultures behave.	4.25	4.00	-0.25
Interaction Attentiveness	**14.39**	**15.15**	**0.75**
14. I am very observant when interacting with people from different cultures.	3.25	3.71	0.46
17. I try to obtain as much information as possible when interacting with people from different cultures.	3.88	4.00	0.12
19. I am sensitive to my culturally-distinct counterpart's subtle meanings during our interaction.	3.13	2.86	-0.27
*22. I avoid those situations where I will have to deal with culturally-distinct persons.	4.13	4.57	0.44
Total Score	**89.93**	**97.03**	**7.10**

Overall, students mean ISS scores increased from 89.93 to 97.03 after their participation in the IRES program suggesting their 12-weeks of research under the mentorship of Czech professors, interacting with non-US students on campus/dormitories, and navigating daily living as foreigner increased their sensitivity in intercultural interaction. The factors that contributed the most to this

increase were *Interaction Engagement* (+2.81), *Interaction Confidence* (+2.50), and *Interaction Enjoyment* (+1.39), with little/no contributions from the *Respect for Cultural Differences* (-0.35) and *Interaction Attentiveness* (+0.75).

The individual statements with the greatest increase between pre and post responses were: "I am pretty sure of myself in interacting with people from different cultures" (+1.82), "I often feel useless when interacting with people from different cultures" (+0.92 when reverse coded, indicating greater disagreement with this statement). These differences support that the students felt greater confidence in interacting with people from different cultures after being in the program.

These results support that participating in this specific international research experience in the Czech Republic did increase the intercultural sensitivity of the undergraduate engineering students (from electrical, computer, and computer science majors). This trend was also reported by Davila et. al who measured the ISS of engineering students participating in summer research at the University of Puerto-Rico at Mayaguez [9].   Davila et. al reported statistically significant improvements in all factors (or constructs) except for interaction attentiveness after 6-weeks of summer research in Puerto-Rico [9]. The cohort in this study did not have a major difference in *interaction attentiveness*, which may be attributed to the technical focus of communication training provided to this group of engineers. This training emphasized using formal vs. colloquial language in speaking and writing to prevent miscommunication and always following up on meetings with written records for review/approval; not on evaluating the subtle nuances of communication (though this could be in interesting site of future research to identify those differences and how to train students to be aware of them).

Selection bias may be the source of the limited differences in the *Respect for Cultural Differences* scores of the cohort in this study.   This group of participants self-selected to apply to an international research program, indicating their interest and willingness to engage with other cultures. This is reflected in the Table 1 values indicating very high agreement with statements for this factor, which may be the cause for the similar scores at both timepoints.

An important limitation to note is that the data presented here is from a small set of students from a homogonous group (in terms of education, age, and race). While results support that the research experiences in the Czech Republic did improve this groups interaction engagement, enjoyment, and confidence further data from a more diverse population (both in education and race) is needed. Further, the results of the ISS do not provide specific insight on what aspects of the program contributed to the increases in each factor (e.g. interactions with research mentors, interactions with students on campus, length of time in foreign country, types of activities in foreign country, etc.). Future research should incorporate further questions about these program elements and participant experiences to help identify the most impactful program elements to support the design of future international research experiences.

Summary

The cohort of 8 undergraduate electrical/computer engineering and computer science students in this IRES program reported increases in the *Interaction Engagement, Interaction Confidence,* and *Interaction Enjoyment* factors of their intercultural competency assessment based on pre-

and post-program values after 12-weeks of research in the Czech Republic. This supports that this international research experience, while focused on a technical topic (fractional-order circuits and systems) positively increased the intercultural sensitivity of this cohort. This supports that international research experiences can increase the intercultural sensitivity of U.S. engineering students, which is important for their future careers in industry or academia which will require significant interactions with foreign-born STEM professions from different countries and cultures.

Acknowledgements

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