

Board 382: Social and Cultural Activities Integrated into International Research Experiences for an Undergraduates Program 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), it is also possible for undergraduates to complete research internationally.

In addition to the domestic benefits of research experiences, this provides an opportunity to network with international students/professors, learn about a different country and culture, and learn new perspectives on how professionals from other countries approach research. In support of this mission our project team is coordinating an International Research Experiences for Students (IRES) site to provide summer research experiences for University of Alabama (UA) undergraduate students in the College of Engineering at the Brno University of Technology (BUT) in the Czech Republic. This collaboration leverages the unique concentration of faculty at BUT with active fractional-order circuits and systems research [2, 3, 4, 5].

Beyond research training the IRES site provides opportunities for social and cultural activities to enrich the student experience. As noted by Straub, social activities are an important aspect of undergraduate research experiences and serve to introduce participants to each other and get the group working well together [6]. The project coordinator (Freeborn) has also reported on the positive aspects of social and cultural activities in U.S. based REU sites he has coordinated [7].

While social and cultural activities were a feature of the first iteration of the IRES program, based on their previously noted importance for a successful program, a post-program survey of the first cohort (N=5) noted low satisfaction with the organized group activities and field trips [8]. This contrasted with strong ratings for the research aspects of the program reported in the same post-program survey. While not directly connected to the student's research activities, it is hypothesized that a greater focus on organized group activities will improve group dynamics and indirectly improve all program aspects. Further, a focus on group activities within an international program is expected to be even more important for participating students without access to their typical social and support structures. Therefore, to improve students' experiences in the program the second iteration included a greater emphasis on organized group activities increasing both the number and scope of events for students.

This work provides an overview of the social and cultural activities of the IRES site in the Czech Republic and student reports of satisfaction in both Year 1 and Year 2 to evaluate if the increased focus on group activities in Year 2 improved student experiences in the program. These details will inform the design and execution of the 3rd iteration of the IRES site and help other IRES coordinators identify approaches to integrating social and cultural activities to meet their own site goals.

Summary of IRES Program Activities



Students 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 UA. Recruitment at this level was required to ensure students had some familiarity with traditional circuits prior to their research focused on fractional-order circuits. After recruitment, participating students completed a prep-course at UA in the spring semester immediately before their summer research at BUT.

In the prep-course, participants met weekly with the program coordinator (Freeborn) for 2-hours over 15 weeks. 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 a living 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). Faculty were selected based on their active research related to fractional-order circuits and systems and their interest in mentoring undergraduate students. 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.

The program coordinator remained in Brno for three (Year 1) or four (Year 2) weeks 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 on weekends (Year 1/Year 2) and midweek (Year 2 only) in the Czech Republic. A summary of these activities for both project years is outlined in Table 1 (along with supporting photos from the Year 2 cohort to visualize these activities/locations).

Table 1. Cultural / social activities for Year 1 and Year 2 for pre-travel and initial 4 weeks of the summer program		
Timepoint	Year 1 (2022)	Year 2 (2023)
Pre-Travel	Tuscaloosa: Basic intro	Tuscaloosa: Basic intro, Ungame
Week 1		
	Brno: Spilberk Castle, Brno City Museum, 10-Z Bunker, Brno Ossuary	Brno: Spilberk Castle (above), Brno City Museum, 10-Z Bunker (above), Brno Ossuary
Week 2		
	Prague: Prague Castle, Old Town Square, Museum of Communism	Prague: Prague Castle (above), Old Town Square, Museum of Communism (above)
Week 3		
	N/A	Brno: Technical Museum of Brno (above) Lednice: Castle Lednice (above)

<p>Week 4</p>		
	<p>N/A</p>	<p>Brno: Central European Institute of Technology (CEITEC), Museum of Applied Arts</p>

In Year 1, the goals of these activities were to: **1)** increase students' knowledge about Czech culture/history and **2)** help them learn to navigate in Brno (using city transit) and in the Czech Republic (using the regional bus system). To try and meet these goals the group went to 7 cultural sites/museums in 2 cities (Brno and Prague) in the Czech Republic. It was expected time together traveling and the shared experiences at each location would establish a positive group dynamic, but the post-program surveys in Year 1 noted that this was not the case.

As reported previously [8], the program element with the lowest rating by the Year 1 participants was the group dynamics in the lab/project environment. We expect that interpersonal friction or conflict between participants may have strongly influenced their overall feelings regarding the program and motivated low scores for other items related to group dynamics (e.g., opportunities for social activities, organized group activities/field trips). This was supported by feedback from a participant in Year 1 to an open-ended question asking what they would change about the program. This participant noted:

- *"I wished there were more organized team building activities. It was honestly pathetic how easily we got mad at each other for different views or beliefs and then let that divide the group."*

To improve the group dynamics of the Year 2 cohort, additional team-building activities were added prior to traveling to Brno and further social/cultural activities were planned for the time in the Czech Republic.

Pre-Travel: In Year 1, it was assumed students in the prep-class would interact and start to form their cohort experience at UA. Unfortunately, students attended the class but did not interact at all outside of it. As a result, the first major social experience together as a group was the start of the international travel. In Year 2, to facilitate earlier social experiences between participants one class session was dedicated to the students playing the Ungame. The Ungame is a non-competitive conversation board game that utilizes subjective questions designed to promote interaction within groups. As reported by Pendelton and Leishman, this game can promote better understanding between groups by incorporating rules of proper listening techniques in a non-threatening environment that

can lead to understanding, and in most cases, ultimately result in sharing and communication [9]. For this in-class activity, students were paired and given 3 cards, taking turns to answer, listen, and learn about each other. After, new pairs were formed and the process was repeated until everyone had completed a round with all other participants.

Week 1/2: The cultural/social experiences in weeks 1/2 in the Czech Republic focused on learning about Brno and Prague and were the same for Years 1 and 2 (with specific details in Table 1). To increase impact of these activities in Year 2, participants were asked to write and submit a reflection to a guided "3-2-1" prompt. After the tour of Brno, this prompt was:

- *What were the 3 most interesting pieces of Czech culture or history you learned from these sites?*
- *What are 2 questions you have after these tours you would like to learn more about?*
- *Share 1 picture of an artifact or piece of art that you found most compelling and give a brief paragraph of its history (or the artist's biography).*

A similar prompt was provided after travel to Prague (and all other trips for the remainder of the summer). These reflections aimed to increase the active engagement of the students in the sites and history in which they were being immersed.

Week 3: An additional weekend trip was added in Year 2, with the group traveling from Brno to Lednice to tour Lednice Castle and its gardens. This provided an opportunity to learn more about Czech history and experience the Czech Republic outside of a large city center. This also required the use of the inter-city train system as a new experience for the students. Further, a mid-week trip to the Technical Museum of Brno was added to give them an opportunity to learn about the scientific contributions of the Czech Republic and provide a mid-week break from their focused research.

Week 4: Two mid-week trips were added in Year 2. First the group was provided a tour of the Central European Institute of Technology (CEITEC) fabrication facilities. This provided them an opportunity to learn how the fractional-order devices used in parts of the program were fabricated and learn about other types of research supported in Brno. Finally, the group visited the Museum of Applied Arts to learn more about arts and culture in the Czech Republic.

At the end of the 4th week, the program coordinator returned to the US and participants continued their research under the mentorship of the faculty in Brno for the remainder of the 12 weeks. In addition to the direct mentoring from the BUT faculty, each week participants had a virtual check-in (using the Zoom platform) with the coordinator. During check-ins students would outline accomplishments, challenges, and plans for the following week with an opportunity to get technical suggestions or insight on navigating relationships with their mentors. During the last week of the program, participants delivered 20-minute formal presentations to the participating BUT faculty group summarizing their summer research. This served as the final

culminating experience to close-out their time in Brno prior to their travel back to the United States.

Student Satisfaction with IRES Experience

To evaluate student satisfaction and perceptions of the IRES program, participants from both years were invited by the evaluation team at the Institute for Social Science Research (ISSR) to complete two online surveys. These surveys were completed before and after participants' summer research experience in Brno (referred to as pre/post surveys). The pre-summer survey provided information about expectations and a baseline for many of the post-summer questions. The end-of-summer survey was a comprehensive assessment of the students' experiences that included both close-ended and open-ended questions.

Students were asked to rate the IRES program overall on a scale from 1=Poor to 5=Excellent, with the distribution of answers for both years of the program provided in Table 2. While noted previously that Year 1 had a low, but still positive mean rating (3.40) of the program, overall the Year 2 rating was much higher (4.75). In fact, all Year 2 participants rated the program as very good or excellent.

Table 2. Rate the IRES Site program overall	1-Poor	2-Fair	3-Good	4-Very Good	5-Excellent	Mean
Year 1 Overall (n=5)	0	1	2	1	1	3.40
Year 2 Overall (n=8)	0	0	0	2	6	4.75

To further evaluate participants' level of satisfaction with the IRES experience they were asked to rate multiple aspects of the program using a five-point scale, where 1=Extremely dissatisfied and 5 = Extremely satisfied. These mean values for both Year 1 and 2 cohorts for 13 aspects of the program are given in Table 3.

Table 3. How satisfied are you with the following aspects of your IRES experience?	Year 1 Mean (n=5)	Year 2 Mean (n=8)
Research mentoring	4.40	4.13
Physical conditions in the lab/project environment	4.40	4.50
Research experience overall	4.20	4.38
International travel	4.20	4.88
Development of technical skills	4.20	4.50
IRES Site program overall	4.00	4.63
Research project topic	4.00	4.00
Relevance to career	4.00	4.00
Networking opportunities	3.80	4.25
Opportunities for social activities	3.20	4.62
Organized group activities/field trips	3.00	4.62
Bi-weekly seminars	3.00	4.50
Group dynamics in the lab/project environment	2.40	4.75

The bolded Year 2 values in Table 3 indicate aspects with higher satisfaction ratings by this cohort in comparison to the Year 1 cohort. Of the 13 program aspects, 10 were rated higher in

Year 2 than in Year 1. The largest increases were observed for the group dynamics in the lab/project (increase from 2.40 to 4.75), opportunities for group activities/field trips (3.00 to 4.62) and opportunities for social activities (3.20 to 4.62). This supports that the increased attention on team-building, social activities, and cultural activities had the intended effect on increasing students' satisfaction with these program elements. We believe this also influenced the higher ratings of satisfaction for most other aspects of the program. Only one aspect, research mentoring, had a lower rating in Year 2 than Year 1, but it still reflects high satisfaction in both years.

Student Assessments of Knowledge Before and After IRES

On the post-IRES survey, students were asked to report their current knowledge on a range of topics (focused on research activities and electrical circuits) and to *reassess* their prior knowledge at the beginning of the summer, using values of 1-Nothing to 5-Substantial amount. This approach aimed to provide a better estimate of what they had learned. Some studies have shown that novice learners tend to over-estimate their initial understanding of topics and having them reassess their prior understanding after a program gives a better estimate of how much they have learned [10, 11]. Table 4 presents the Year 1 and Year 2 means for participants' reassessment at the end of the summer of their pre-IRES knowledge and their assessment of their current knowledge after the IRES program.

Table 4: Participants' self-assessment of how much they knew about the following:

	Year 1 (n=5)			Year 2 (n=8)		
	Pre-IRES	Post-IRES	Mean Diff.	Pre-IRES	Post-IRES	Mean Diff.
Research process	2.2	3.8	1.6	2.8	4.1	1.3
Developing research questions	2.2	3.8	1.6	2.3	3.6	1.3
Designing a research study	2.0	3.4	1.4	2.0	3.5	1.5
Finding research articles	2.6	4.4	1.8	3.3	4.9	1.6
Preparing a research presentation	2.2	3.4	1.2	2.6	4.3	1.7
Interpreting research findings	2.2	4.2	2.0	2.8	4.0	1.2
Presenting research findings	2.6	4.2	1.6	2.5	4.0	1.5
Applying to graduate school	2.6	3.4	0.8	2.6	3.6	1.0
Ethics in science	2.4	3.6	1.0	2.5	3.5	1.0
Technical and scientific writing	2.6	3.4	1.0	2.5	3.5	1.0
Project management	2.4	2.8	0.4	2.9	3.8	0.9
Evaluating a research study	2.0	3.4	1.4	2.3	3.3	1.0
Fractional-order circuits and systems	1.8	3.8	2.0	1.0	4.3	3.3
Understanding how international collaborations work	1.4	3.4	2.0	1.6	4.3	2.7
Using MATLAB for visualizing data	2.6	4.4	1.8	2.4	4.5	2.1
Using MATLAB for solving circuits and systems equations	2.2	4.0	1.8	1.6	4.5	2.9
Using LTSpice for simulating electric circuits	3.2	4.2	1.0	2.1	3.9	1.8
Equipment to measure and test electric circuits	2.8	4.6	1.8	2.6	3.9	1.3
Czech Republic	1.4	3.6	2.2	1.6	4.3	2.7

Comparing the mean differences between Years 1 and 2, Year 2 participants reported greater gains in 10 of the 19 areas (with similar gains for the remainder). The increase in gains for the technical topics including fractional-order circuits and systems, using MATLAB, using LTSpice, and designing a research study suggest that the increased focus on social and cultural activities did not have any unintended adverse effects on the technical aspects of this program.

For further insight into their experiences, the post-IRES survey prompted participants to: Describe your positive feelings about the value/benefits of the program overall and to your career. The complete set of responses from the Year 2 participants' to this prompt is below:

- *"I enjoyed having a more independently-driven research project since it allowed me the opportunity to problem-solve and experience something closer to grad research than I had previously experienced."*
- *"I think it was a valuable use of my summer. I was happy with the quality and amount of work that was expected of me, and I learned a lot about the research process. It made me strongly consider grad school- before the summer, I wasn't nearly as confident in the value of grad school for my career path."*
- *"I think this program is a great starting point for my career. I do not think I will go into academia and especially not into computer science for this, but I think the paper on my CV with another mathematics paper is a great display of my wide skillset and knowledge. I also hope the international aspect will shine through to employers."*
- *"It taught me about what the process of research looks like and how to more effectively communicate with people I am working with. Also getting to see so many new places and meet different people."*
- *"The international network and communication skills that I created will stay with me and my career forever. This experience has taught me more than I expected, and I can truly say that this was the best summer of my life."*
- *"The program introduced me to working on engineering projects with international cooperation. It granted me an interesting project and problem to explore, and challenges to overcome."*
- *"The program is great for getting immersed in research. The mentors are open to working with you on a publication, which is useful for graduate school."*
- *"This opportunity helped me strengthen skills in electrical engineering that I previously hadn't used in internships. I also was pushed out of my comfort zone being in a new country with a small support system in said country."*

The Year 2 participants were also prompted to describe what they had learned about themselves during this experience. Below is the complete set of responses to this prompt:

- *"How much I enjoy conducting research and how I think I would enjoy grad school."*
- *"I enjoy traveling alone over traveling with a group."*
- *"I gained more confidence in myself. I was anxious about being in another country for such a long time. By the end of the program, those fears were gone, and I was fine traveling around on my own. It taught me that I'm more capable than I may think."*
- *"I learned that I am made for mathematics, not computer science. I can still hold a computer science job and enjoy that work, but it is not my area for personal fulfillment, just a good career."*

- *"I learned that I am quick to adjust and adapt to any situation, and I definitely think that I grew as a person in general. I also think I was able to be my true self around these people, which increased my confidence."*
- *"I learned that I do want to pursue a career in research."*
- *"I learned that I really enjoyed experiencing and learning new cultures, and meeting people from new cultures. I learned that I can work through all the phases of a research project to obtain an output."*
- *"I'm more independent and strong headed than I thought."*

Similar to the students' responses to these prompts in Year 1 [8], this second cohort expressed that they gained confidence in their technical abilities, their ability to contribute to research, and how to navigate working/living in a foreign country. These gains all align with goals of our program and support that the current activities are helping students to grow in those areas. None of the open-ended comments in the Year 2 surveys requested improvements to team-building or social aspects (in contrast to Year 1). This supports that the program revisions met their intended goal. Additionally, one participant even noted: **"I also think I was able to be my true self around these people, which increased my confidence,"** suggesting a positive group dynamic. While the Year 2 group dynamics are strongly influenced by the individual participants and not just the planned group activities, we believe the increased focus on social and cultural activities did contribute to the improvements in group dynamics for Year 2 of this program. These elements will be continued in the third iteration of this program.

Summary

The second cohort of our IRES program reported greater overall satisfaction with the program compared to the reported satisfaction of the first cohort. Based on the higher reported satisfaction with the group/lab dynamics, opportunities for social activities, and organized activities/field trips of the second cohort, the increased attention focused on team-building (using the Ungame as a pre-travel activity) and social/cultural activities appear to have contributed to these improvements. Continued focus on these program elements is recommended for future iterations and also for other international research programs aiming to improve their cohort dynamics and enrich participants' overall experience.

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References

- [1] G. Kuh, "High-impact educational practices: What they are, who has access to them, and why they matter," Association of American Colleges and Universities, 2008.

- [2] J. Koton, J. Dvorak, D. Kubanek, N. Herencsar, "Designing series of fractional-order elements," *Analog Integrated Circuits and Signal Processing*, vol. 106, no. 3, pp. 553-563, 2021.
- [3] J. Koton, D. Kubanek, J. Dvorak, N. Herencsar, "On systematic design of fractional-order element series," *Sensors*, vol. 21, no. 4, pp. 1203, 2021.
- [4] D. Kubanek, J. Koton, J. Jerabek, D. Andriukaitis, "(N+alpha)-order low-pass and high-pass filter transfer functions for non-cascade implementations approximating Butterworth response," *Fractional Calculus and Applied Analysis*, vol. 24, pp. 689-714, 2021.
- [5] L. Langhammer, R. Sotner, R. Theumer, "Various-order low-pass filter with the electronic change of its approximation," *Sensors*, vol. 23, no. 19, 8057, 2023.
- [6] J. Straub, "Research experiences for undergraduates social programs: a key ingredient for success," ASEE's Virtual Conf., 2020. doi: 10.18260/1-2--35149
- [7] T.J. Freeborn, M. Gosa, "Work-in-Progress: Social and Cultural Activities Integrated into an REU Site in the U.S. South," ASEE Annual Conf. & Expo, [Virtual], 2021. Available: <https://peer.asee.org/38218>
- [8] T.J. Freeborn, D. McCallum, S. Dunlap, "First cohort experiences during an international research experiences for undergraduates program focused on fractional-order circuits and systems," ASEE Ann. Conf. & Expo, Baltimore, U.S.A., 2023. Available: <https://peer.asee.org/42854>
- [9] R.K. Pendleton and T.R. Leishman, "Strategies for Improving Communication", *The Journal of Business Education*, vol. 60, no. 3, pp. 122-125, 1984. doi: 10.1080/00219444.1984.10533241
- [10] J. Kruger, D. Dunning, "Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments," *Journal of Personality and Social Psychology*, vol. 77, no. 6, pp. 1121-1134, 1999.
- [11] D. Boud, R. Lawson, D.G. Thompson, "Does student engagement in self-assessment calibrate their judgement over time?", *Assessment & Evaluation in Higher Education*, vol. 38, no. 8, 941-956, 2013.