A Decade of International Faculty Professional Development: Impacts of Faculty Collaboration, Cooperative Learning, and Community Building

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Sponsored by the CREATE National Energy Center

Abstract: This paper presents an analysis of the summative impact and lasting influence of ten years of faculty professional development efforts. Over the last decade, the CREATE National Energy Center, funded by the National Science Foundation Advanced Technological Division, has conducted four international faculty professional development projects focused on U.S. renewable energy technical educators (Australia/New Zealand-2013, Germany/Denmark-2014, Germany-2019, and Iceland-2024). These projects expanded participants' knowledge of global renewable energy advances, technologies, and policies, provided opportunities for collaboration and community-building, and allowed advancement of pedagogical strategies and practices for educating and deploying a green energy workforce. This paper utilizes a mixed methods approach, including survey methodology and participant interviews, to present an analysis of the extended impact of these professional development projects and their influence on participants' knowledge, teaching practices, curriculum development, and workforce technician preparation. The study also investigates the impacts of extended community engagement and peer collaboration as a vehicle for professional advancement.

Keywords: professional development, international, collaborative learning, faculty professional development, community of practice, engineering education, STEM education

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Introduction

The CREATE National Energy Center (CREATE) furthers the development of the skilled technical workforce required to evolve the nation's energy portfolio and ensure American competitiveness in the ever-evolving energy sector by supporting and empowering renewable energy technology educators and academic programs at both the college and high-school levels.

As part of this work, CREATE routinely investigates best practices in renewable energy education. One finding repeatedly presented was the successful approaches to renewable energy education and adoption that other countries were already implementing. In 2013, this discovery led CREATE to conduct an initial international faculty learning consortium that traveled to Australia/New Zealand and, in 2014, a second program to Germany/Denmark. Participant data and outputs indicated that the learning exchanges were successful in meeting their goals for educator professional development and increasing the robustness of energy technician educational programming.

Based on the successes of the first projects, in 2019, CREATE sent another faculty delegation to Germany to learn more about advances in energy storage and training. This project expanded the scope of renewable energy curricular and faculty development efforts, especially in the emerging area of energy storage, and further refined the international professional development model developed by CREATE. In 2024, a fourth consortium traveled to Iceland to study electric vehicles and their impacts on the grid, as well as Iceland's renewable energy infrastructure. In 2025, this group also visited Norway to compare electric vehicle policies and energy infrastructure between Iceland and Norway.

The goals of the learning exchanges were to provide participants with access to:

- Best practices in teaching methods, course content, certifications, articulation, and career pathways for renewable energy technicians both in the U.S. and abroad.
- Firsthand experience and fundamental baseline knowledge of international renewable energy practices and policies to support the globalization of courses, curricula and programs taught in the U.S.
- In-depth exposure to and discussion of national energy policy and its impact on renewable energy education in the host countries and in the U.S.
- A community of educators to share knowledge on U.S. & International energy policy, teaching methods, emerging technology and application for the U.S. workforce.

Participant involvement, collaboration, reflection, and data were collected before, during, and after travel and used to modify the professional development model and to better understand participants' knowledge gains, application, and dissemination. This paper will not go into depth on the professional development methodology but instead focus on long-term impacts; for more information on the international faculty exchange model and its evolution, please contact the paper authors.

Methods

Approach

Data regarding the summative impact and lasting influence of four faculty international professional development efforts spanning 10 years were collected primarily using a web-based survey, designed to align with survey research methodology best practices [1], [2]. Survey items captured participants' perceived value and long-term impacts of participation as related to participant teaching practices, knowledge gains, community leadership, and dissemination. Additional survey items collected data on participants' collaborations and ongoing connections.

For each of the four experiences, pre- and post-surveys collected data on immediate gains; an additional survey was administered eight months after the 2019 trip. These captured participant responses to similar survey items and focused on shorter-term gains and impacts; as this data will not be part of this analysis, these surveys will not be mentioned further.

Subjects

A total of twenty-nine individual participants have been involved in one or more of the international projects, for a total count of forty-six between all four completed projects. All participants were nominated by peers within industry and education and completed an extensive application, which was reviewed and approved by a panel of experts based on their expertise and their ability to share and disseminate knowledge gained abroad. The participants represent a wide range of renewable energy fields and disciplines, educational levels taught, genders, industries represented, and geographic areas across the nation. This includes: California, Colorado, Delaware, Florida, Illinois, Iowa, New York, Nevada, North Carolina, Oregon, Texas, and Wisconsin. These participants embody an accomplished, well-rounded group of energy educators across the country.

Instrument Design and Administration

The initial page of the instrument worked as a gatekeeper to ensure informed consent; respondents were presented with survey and project information and, after reviewing this information, provided the choice to either exit the survey or indicate consent. The following page utilized four items to collect demographic information about the respondent. The third page of the survey collected perceived impacts on pedagogical practices and curricular strategies, and the fourth page recorded perceived impacts on the respondents' professional development. The fifth of six requested pages requested information on dissemination, specifically the long-term impacts on the respondent's professional practices. The final page of the instrument collected data regarding ongoing peer connections and the results of any collaborations that arose from being connected to peers through these professional development opportunities. An exit page provided choices to opt in or out of being quoted in publication, whether they preferred to be consulted before being quoted, and if they were open to follow-up interviews if needed. Throughout the survey, Likert-like scales were utilized to collect interval and ratio-scaled data along with open-ended text items.

Responses were automatically aggregated prior to analysis to identify trends and the frequency of responses. For questions employing Likert scales, both the percentage of respondents selecting a given response and weighted averages were calculated to rank importance and facilitate interpretation of the results. Open text responses were analyzed independently by two reviewers, with conclusions then compared to discern emergent patterns and themes.

The survey was administered via SurveyMonkey from November 12 to November 26, 2025. An initial email invitation was sent to all 29 participants from the four trips; reminders to non-responders were sent on days 6 and 10. Just prior to closing the survey, non-completers received a personal message from the project lead encouraging them to provide their insights. The final response rate was 100% with all surveys completed in full.

Results

Reported Impacts on Teaching Practice and Curriculum

One of the desired outcomes of the international professional development projects was to positively impact post-travel teaching practices and curricular activities of the renewable energy educators who participated. Participants reported additions and changes to their courses and pedagogy that indicate that the experience did impact their teaching and curricular work. In terms of instructional content, 83% of the participants reported incorporating international perspectives into their courses, 65% created new lectures, 54% created new units or modules in their existing courses, and 50% reported developing new written materials; additionally, 26% reported creating and conducting entirely new courses as a result of their participation. In terms of teaching practice, 48% adopted new pedagogical techniques after being exposed to new methods abroad, while 41% encouraged students to pursue international educational experiences. Fourteen percent also took on sponsorship of student-based international activities. These types of instructional and curricular changes and improvements demonstrate some of the impacts of these professional development opportunities on the teaching and curricular activities of the participants (see Table 1).

Table 1. Perceived Impacts on Teaching Practice (N=26)

How has participation impacted your teaching practice?	
Incorporated or increased the international perspective in courses	83%
Developed new course lectures	65%
Developed new course units or modules	54%
Developed new written course materials	50%
Adopted new instructional techniques	48%
Referred students to pursue international opportunities	41%
Developed entirely new courses	26%
Sponsored student international activities (trips, conferences, etc.)	14%
Connected my classroom to international speakers	9%

Fourteen participants shared additional impacts on their teaching and curricular development practices by responding to an open-text item requesting this information. Responses tended to cluster around three topics: improved teaching (10), improvements to courses or programs (7), and increased awareness of emerging trends and developing technologies (3).

Comments about pedagogical changes that occurred due to international exposure included statements such as *"it caused me to recreate lessons and do more to teach systems-level thinking,"* which was described elsewhere as framing lessons through a systems lens to highlight the impacts of energy policies on a variety of issues, including migration, agriculture, and urban planning. Another respondent expressed a similar

sentiment, noting, *"I now embed leading questions, focusing on the positive and negative aspects of it; how does a change in one area impact the change of the entire process."* Other changes were attributed by participants to being exposed to different ways of teaching renewable energy technologies while traveling; several summarized these changes, stating that *"the trips abroad changed how I view workforce education"* and that *"both the German and Icelandic experiences have broadened my view of how technician training can be accomplished."*

Comments around impacts on teaching practice also included several comments noting the value of obtaining firsthand insights regarding international trends and practices that the educator-participants were able to share with students. Example of these comments included statements such as *"I now have direct experience providing an international context for many of the topics I teach," "I was able to see it for real and bring that back to the students,"* and finally one noting that, as the instructor, they are now able to provide *"concrete, real-world examples for my students…this makes information more real to them and can create important connections to others."* It is clear that for these participants, the international experience presented an opportunity to improve their teaching skills and how they taught these topics.

The second grouping of open-text responses concerned changes made to curriculum and courses. An example of these types of comments include one participant noting that, post-travel, they *"reorganized our electro-mechanical technology program to be more responsive to numerous industries"* after observing core curricular models abroad that were designed to serve multiple sectors, and another stating that *"I expanded my lecture and teaching materials through the education I gained from visits to facilities making use of renewable energy in Australia, New Zealand, Germany, and Denmark."* While the impacts on teaching practice and course content overlap slightly, participant comments indicate that the experiences allowed for positive change in both.

The third cluster of open text responses noted that the experiences provided the participant with an increased awareness of technological advances and industry trends, especially where other countries have exceeded the U.S. in development and implementation, and allowed them to infuse this information into their programs. An example of this type of comment from a participant shared that the experience *"enabled me to get informed about forthcoming changes in the marketplace, to adapt our academic programming, and to plan for the necessary lab equipment, tools, and resources to make sure out school stayed current."* This is but one example of how the international study tours impacted what was being taught in the programs run by participants.

From both the quantitative and qualitative data provided by the participants, it is clear that these professional development opportunities impacted the participants' teaching and curricular activities in numerous and meaningful ways.

Reported Impacts on Professional Development

A third desired outcome of the study trips was that participants would experience a perceived increase in their professional proficiency. A Likert-style survey item presented common types of professional capabilities targeted by professional development, including increased subject matter knowledge, deepened understanding of industry trends and issues, and improved professional networks; respondents were asked to indicate the perceived amount of impact the international experiences had on each. Twenty-five participants responded, with well over half reporting that they felt that they had "very much" gained an understanding of renewable energy policy abroad (88%), expanded their knowledge about energy technologies (80%) and new technologies (72%), and extended their professional network by connecting with their professional peers on the trips (76%). Fifty-six percent of the respondents noted that they were able to satisfy institutional professional development requirements, and 33% reported connecting professionally with international peers (see Table 2).

Table 2. Perceived Impacts on Overall Professional Development (N=25)

How has participation impacted your teaching practice?					
	Very Much	Somewhat	A little	Did not occur	Weighted Average
Developed an understanding of renewable energy policy outside the United States	88%	12%	0%	0%	3.88
Expanded my knowledge about energy technologies	80%	16%	4%	0%	3.76
Developed professional relationships with fellow participants	76%	12%	12%	0%	3.64
Gained knowledge about new or unique technologies	72%	24%	0%	0%	3.60
Fulfilled professional development expectations by my institution	56%	20%	0%	12%	2.96
Developed professional relationships with international peers	33%	25%	25%	13%	2.71
Influenced me to join related professional organizations	21%	0%	29%	42%	1.83

To learn more about the professional development gains participants attributed to their international experiences, an open-text response item asked respondents to share "one detailed example" of how participation impacted them as professionals. The twenty-one responses often included more than one observed gain, and clustered around several common themes, including cross-cultural insights and expanded awareness of international renewable energy policies and governance (14), increased technological knowledge (7), practical applications to their teaching practice (6), an extended professional network (4), and new professional opportunities (2).

Comparing and contrasting domestic renewable energy policies and practices with those observed and studied abroad was noted repeatedly as a direct benefit of the international opportunities. Respondents highlighted that, by observing the advancement of these efforts within a cultural context and learning firsthand about the policies that support these systems, they were able to understand better how these lessons might be applied domestically and felt encouraged to share professionally what they had learned, even outside their classrooms. One example of this is the participant who noted that *"analyzing the EV and EV charging infrastructure in Iceland provided insights into the challenges the US faces…the deployment serves to inform future efforts here."* Another commented that after observing demonstrations of integrated thermal energy storage opportunities in Germany, the participant utilized this knowledge to inform a regional project working with ten schools, remarking that this exposure allowed them *"to demonstrate the feasibility of German projects"* and to engage those institutions *"with thermal energy storage solutions that may advance them on a path towards energy efficiency, electrification and decarbonization."* One last example of the impact of the participants' ability to compare and contrast international and domestic policies and convey their expanded knowledge to others was the participant who shared that *"since learning firsthand about energy policy in another country, I am more confident discussing energy policy in an international context and have sought to broaden my understanding of international policies in countries beyond that in which I studied."* Gains in participant international, cultural, and policy awareness were key professional advances experienced by the participants.

Another category of response focused on gains in technical and sector-specific knowledge. Some participants noted that the professional development opportunities allowed them to observe and engage with technologies with which they had previously had no direct knowledge. For example, one commented

that *"for years I have been researching geothermal…this can only go so far, but to see the facilities and talk with the people who do this every day makes it real…it increases your knowledge from intermediate to advanced just by being able to talk with the people who are there, and by seeing what they are working on in real life."* Others commented that visiting and seeing advances such as energy-neutral commercial structures, high-efficiency insulation that allows hot water to travel great distances, the use of geothermal for heating and cooling, and observing how electrification is being advanced in these countries directly increased the participants' professional knowledge base.

There were more comments detailing how the international opportunities helped to advance their pedagogy and curricular work. One participant shared that they had adjusted their course content after a discussion in Iceland indicated foundational network knowledge. Several commented on the professional impact of a greater "*understanding of how the German technical college system implements apprenticeships and work-based learning,*" with one noting that they were able to *"share my experiences with colleagues and industry partnerships, which helped to reshape how my college viewed apprenticeships."* Another noted that *"my work has since become almost entirely focused on apprenticeships…the lessons I learned about how apprenticeships work in Germany has been invaluable to me as it showed me what was possible."*

Several participants highlighted the professional advancement made possible by the connections they made with their peers during and after travel, a specific metric discussed more fully in later segments. Lastly, several participants commented on additional professional opportunities that arose from being part of the international projects, such as successfully obtaining funding for their programs after learning more about grants and programs that could support these efforts, and through collaboration with both domestic and international peers.

Participant Dissemination

Another key measure of the impact of the international professional development projects is the extent to which participants disseminate the information, insights, and details acquired over the course of these experiences. Two metrics were used to analyze participant dissemination: the number of professional contacts with whom information from the experience was shared, and the frequency of the dissemination method. Both were derived from self-reported participant data.

For the first measure, participants were asked to estimate the number of contacts with whom they shared the observations and knowledge they gained through participation; not surprisingly, given that the participants were primarily educators, the largest group was comprised of students. This includes lectures, course materials, guest lectures, and any other means by which students were provided with information that arose from the participant involvement. A number of the participants have given lectures and presentations to various groups; educators or peers make up the next largest group of contacts, followed by groups external to higher education, including general community members, energy professionals, and business contacts. Smaller numbers of contacts were made with school administrators, government workers, and elected officials; however, the total number of contacts is still significant, especially in combination with the other estimated number of contacts (see Table 3).

Table 3. Participant Estimated Dissemination by Type of Contact (N=25)

	Average	Total Reported
Students	285	6,836
Educators	79	1,965
General Community Members	67	1,536
Energy Professionals	47	1,088
Business and Industry Contacts	28	673
School Administrators	9	233
Government or Regulatory Officials	8	192
Elected Officials	3	70

While the number of estimated contacts does suggest that the knowledge gained from these professional development opportunities was well distributed by participants, looking at the frequency of the types or

methods of dissemination tells us a little more about how. The most frequent type of dissemination, outside of teaching, was through informal discussions with educators and administrators at the participants' home institution; 72% of participants had three or more discussions with peers about the information they brought back from the study tours. Formal lectures or presentations to a variety of groups made up the next set of dissemination methods; the percentage of participants who gave these presentations three or more times which ranged from presentations to other educators (34%), institutional peers (29%), energy professionals (30%), government officials (12%), and even the general public (16%). Interestingly, only 12% of the participants utilized publications and journal articles three or more times to share acquired knowledge. Overall, participants clearly sought out and leveraged a range of dissemination methods to distribute the gains and spread the impacts of the international professional development projects (see Table 4).

Table 4. Participant Estimated Dissemination by Dissemination Method (N=24)

	5+ times	3-4 times	1-2 times	Plan to/ have not
Discussed with peers or administrators at my institution	56%	16%	28%	0%
Delivered presentations/lectures to other educators	13%	21%	38%	21%
Delivered presentations/lectures to faculty at my institution	8%	21%	33%	33%
Delivered presentations/lectures to energy professionals	17%	13%	25%	42%
Delivered presentations/lectures to my school administration	8%	13%	21%	46%
Delivered presentations/lectures to government or regulatory agencies	4%	8%	25%	55%
Delivered presentations/lectures to the general public or peers outside the U.S.	8%	8%	21%	59%
Disseminated via papers, journal articles, publications, etc.	8%	4%	13%	67%

When looking at the number of contacts and the methods by which these contacts occurred, it is clear that the growth that the participants experienced, both as professionals and as teachers, was shared widely and that professional outlets were routinely utilized to disseminate this knowledge.

Participant Collaboration & Community of Practice

A final objective of the projects was to create conditions favorable to collaborative knowledge building and peer networking. Towards this end, the pre-travel, during travel, and post-travel learning activities were anchored in social learning theory [3], [4], [5] and purposefully structured in such a way as to encourage the establishment of an informal community of practice [6] for the participating renewable energy educators. While the other objectives – positive impact on teaching practices and curriculum development, the expansion of subject matter expertise, the dissemination of acquired knowledge post-travel – provided visible results immediately after each trip [7], [8], [9], a study of results several years after travel reported that the two greatest takeaways were the impact on knowledge gained regarding unique technologies, and the development of relationships built with fellow participants [9]. This has been a continued theme echoed through surveys of past participants and analysis; comments from that 2020 study specifically included statements such as "CREATE has established an amazing community of renewable energy professionals. Interacting with my peers, and sharing common experiences has helped me to develop a professional network that spans the United States;" these were not uncommon. However, conducting a follow-up analysis to determine whether a lasting community had been formed required some time to elapse; at the time of this study, most subjects experienced direct participation between 6 and 12 years prior, so in addition to measuring impacts using the three previous criteria, this study also analyzes whether or not peer networking and collaboration have occurred over time.

The first item in this section of the survey sought to identify which aspects of the experiences participants felt had had lasting impacts on their professional practice and to what degree; this also allowed for the results suggested by the analysis of the initial three objectives to be reconfirmed. A Likert-like item queried participants about the perceived lasting impact of each of the various elements of the international professional development projects. All of the elements were seen as having a significant lasting impact by the majority of the participants, with the exception of "visiting cultural sites," which still had high marks (40% significant lasting impact, with 52% indicating some lasting impact). Based on the weighted averages, three elements tied for the most significant impact: working, traveling, and learning with peers, exposure to non-U.S. renewable energy deployment, and visiting international industry sites. Very close behind were three more elements of the projects, also with identical weighted averages; these included exposure to non-U.S. higher education structures and processes, visiting with non-U.S. policy makers, and exposure to new technologies. The final three elements, still with responses indicating strong lasting impacts, were interacting with non-U.S. citizens around the topic of renewable energy, interacting with international peers, and, as mentioned previously, visiting cultural sites (see Table 5).

Table 5. Perceived Lasting Impacts of Professional Development (N=25)

Which of the following has had a lasting impact on your professional practice?					
	Significant Lasting Impact	Some Lasting Impact	Little Lasting Impact	No Lasting Impact	Weighted Average
Working, traveling & learning with a cohort of renewable energy educator peers	88%	8%	0%	4%	3.80
Firsthand exposure to renewable energy deployment outside the U.S.	88%	4%	8%	0%	3.80
Visiting industry sites	84%	12%	4%	0%	3.80
Exposure to non-U.S. higher education structures, processes	64%	28%	4%	4%	3.52
Visiting with renewable energy policy makers outside the U.S.	64%	28%	4%	4%	3.52
Exposure to new technologies	52%	48%	0%	0%	3.52
Interacting with non-U.S. citizens and learning their opinions about renewable energy	63%	29%	4%	4%	3.50
Interacting with educator peers from outside the U.S.	52%	36%	12%	0%	3.40
Visiting cultural sites	40%	52%	8%	0%	3.32

The next survey question asked respondents whether or not the experience had led to "ongoing peer connections or a peer network". Fifty-six percent (15) responded yes, indicating that they have been professionally engaged over time with peers from their travels (see Table 6).

Table 6. Participants Reporting Ongoing Engagement with Peers (N=25)

Did your participation result in ongoing peer connections or a peer network?	
Yes	56%
No	44%

The fifteen respondents who indicated that the international experience had led to ongoing peer connections were asked to use an open-text item to describe the network that had resulted. Many spoke of connecting

informally with one another to share best practices, develop lab activities, share industry contacts, and bounce ideas off one another. As one participant explained, *"the network is loose in that there are no required meetings or activities, but the shared experiences and conversations over the course of the projects built a shared sense of purpose and support that are reinforced each time we see one another."* Another shared that *"as a teacher in a small technical program, I do not have a large group of faculty at my college who are engaged in similar subjects as me. But the peer group I've developed from these experiences has…given me a network of some of the most brilliant and talented teachers from across the country."*

Informal connections are, of course, part of the community of practice model and a mechanism for community members to engage and evolve their professional practice with one another. The authors were also interested in the concrete outcomes or outputs arising from collaborative networking among group members. The next question asked all respondents if the professional development experiences had led to any peer collaborations that "resulted in tangible outcomes." Sixty-four percent (16) responded yes to this prompt (see Table 7).

Table 7. Percentage of Peer Collaborations that Resulted in Tangible Outcomes (N=25)

Did your participation result in peer collaborations with tangible outcomes?	
Yes	64%
No	36%

As with the previous set of questions, an open-text item asked those responding "yes" to elaborate on the types of outcomes that these peer collaborations generated. Many mentioned joining together to present at conferences, including the NSF ATE PI meeting and the American Society for Engineering Education (ASEE). Others spoke of pursuing grant funding together, with one respondent noting that, in addition to being *"involved in multiple NSF and Department of Energy (DOE) grant projects with several of the participants from this experience,"* they have *"served as co-PIs on grants together."* Another shared that they *"continue to maintain connections with several of the educators I met on this trip in relation to my work to expand registered apprenticeship training in clean energy. They have helped me make connections to industry and have provided feedback on new national training standards that are being developed."* Another mentioned that several participants had worked together to arrange industry site tours in their region.

Co-developing educational materials and curricula was also mentioned as an outcome of peer collaborations that were begun during the international experiences. Several participants highlighted being involved in the creation and hosting of intensive summer student workshops, with one participant noting that, *"on the first trip to Germany, I spoke with one of my peers about co-hosting solar workshops. We just held our third workshop at his campus this past summer."* Another described course development, commenting that *"working with these colleagues, through many years, has led me to directly improve my battery technology course and a new course in EVSE [electric vehicle supply equipment], resulting in a finely tuned battery and energy course that is available to many other colleges. This fall at the PI conference, I met an instructor getting ready to teach their battery class for the very first time. I shared with them the entire course of labs, assignments, and assessments, many of which were directly developed from the information and peer collaborations initiated by these projects."* This informal yet deeply connected community of educators clearly continues to expand the impacts produced by the international professional development projects.

Discussion

While CREATE has analyzed formative and summative data regarding the activities and structure of each project to improve the experiences, this study sought to clarify the long-term impacts these professional development efforts have had, if any. The analysis of data collected for this study has shown that, for the majority of the participants, engaging in one or more of these projects has had long-term and significant benefits, specifically in the areas these efforts were intended to address. Below, we will discuss two key takeaways from this study: elements of effective international professional development and the growth of a community of practice.

Effective Professional Development

In previous papers, the leadership of these professional development opportunities has provided very specific insights and advice for structuring similar experiences, including learning activities that work in concert to create a collaborative, rigorous, and intensive experience for participants. In this paper, we have looked at the goals for educator professional development and found that, for the majority of the participants, these experiences provided them with such advancement. Many felt their teaching and courses were improved by the exposure to international green energy practices, advancements, and policy, as well as by the knowledge gained around workforce education and pedagogy in general. Many of the participants spoke of sharing their insights and the knowledge they obtained with others beyond their students, including, for some, a sense of advocacy after seeing firsthand how other countries were deploying renewable energy technologies. In reviewing and analyzing the participant data and comments, including online discourse records and web meetings [10], [11], [12], it was clear that participants uniformly felt their professional expertise, knowledge, and teaching skills were deepened and broadened by being involved in these structured experiences for professional development.

Growing a Community of Practice

A key outcome of the CREATE international professional development efforts has been the lasting connections between participants, especially those that have produced tangible outputs benefiting the community beyond the group that participated. Some of this may be attributed to the learning activities, which were crafted in alignment with social learning theory [3], [4] and based on the community of practice (CoP) model [5]. Participants were intentionally paired to complete small assignments, which encouraged connections and required at times to lead the group; these efforts mimicked the traditional CoP model of experts at the center with neophytes experiencing "legitimate peripheral participation" as they gain expertise and group acceptance [6]. Some of this connectiveness is likely also due to the participant selection process, which vetted potential attendees and mindfully created groups that were diverse in terms of demographics but also alike in their passion for teaching, renewable energy workforce preparation, the existing and emergent energy technologies, and who expressed an interest in learning more about how other countries are advancing green energy and educating their renewable energy workforce. Lastly, there are the professional benefits of connecting to one another that are inherent in any learning community; the comments shared by participants [13] and noted above illustrate the many ways these professionals have utilized connections that were made during the international project to improve their teaching, increase their knowledge, obtain sounding boards for ideas and strategies, and expand their professional activities into new areas including obtaining funding for grant-based work, developing new systems for renewable energy apprenticeships, and co-hosting student workshops. While not everyone on the trip had connections that persisted, the data shows that more did than not, and that the community of practice continues to connect the participants of these study trips.

Study Limitations

The 100% response rate to the survey invitation provided a fairly complete picture of how these efforts have fared over time, however a small number of respondents (7) were only involved with the most recent trip to Iceland in early 2024 and unable to discuss long-term gains; their feedback was included as relevant regarding professional improvements overall, and utilized to capture their experiences as part of the informal community of practice. More data will be collected from these subjects during subsequent studies of long-term impacts. Another limitation was a lack of data on the frequency and type of connections between participants within the CoP. This data would provide an excellent addition to this body of work, perhaps using social network analysis as a theoretical framework. Lastly, as detailed previously in the Subjects section, participants selected for the international programs were rigorously vetted. While the authors cannot substantiate, with data, that this initial selection process led to strong lasting impacts, we do suspect that the quality of participants was a factor.

Conclusion

Consistent with the studies and analyses conducted following each international professional development project, this study again demonstrates that international professional development events, when informed by learning theory and clear goals, can be extremely effective in deepening the technical knowledge of educators, in facilitating the incorporation of international trends and technological advances into curricula and instruction,

and in disseminating findings widely. This study, however, expands on those findings to demonstrate that over time, the impacts continue and expand, and that connections established between education professionals engaged in these efforts can continue well beyond travel to generate outcomes that further advance the field and the nature of renewal energy workforce education.

Acknowledgements. This work was supported by the National Science Foundation under DUE Grant Award # 2201631. Special thanks are extended to all for their help in facilitating this project.

Disclosures. The authors declare no conflicts of interest.

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