A Pilot Program to Foreground Innovation and Research Through the Lens of Communities of Practice in Engineering Education

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***Abstract*– In this Work-in-progress (WIP) paper, we present the background, conceptual framework, and preliminary results of an ongoing faculty development at a Chilean regional university. The program focuses on developing innovation and research competencies among the College of Engineering faculty by forming and supporting a community of practice that brings together members with diverse expertise and experience levels. Although preliminary, analysis of early surveys and interviews suggests that the initiative is favoring participant faculty's professional growth. However, further analyses of changes in practice, research outputs, and institutional uptakes remain to be examined as the program progresses. This ongoing experience contributes to discussions on advancing inquiry, collaboration, and innovation through faculty development programs.**

***Keywords*- engineering education, community of practice, faculty development, research competencies, innovation.**

I. Introduction

Increasing the capacities of engineering faculty to develop innovation and research in engineering education is a multifaceted challenge for any higher education organization. It requires considering academics' specific interests, positions, and professional trajectories, as well as the complexities of higher education systems, to create sustainable faculty development programs [1], [2]. From a sociocultural perspective of professional disciplines [3], the model of communities of practice addresses these elements by promoting collaboration and mutual engagement among people who share a domain and common goals [4], [5].

In this work-in-progress paper, we report advances in a pilot program aimed at developing innovation and research competencies in engineering education faculty through the formation of a community of practice. Educational innovation often refers to implementing changes in teaching practice, while educational research refers to the systematic inquiry that examines, documents, and produces transferable knowledge from those innovations. By considering the need to advance evidence-based innovation in classrooms [6], [7], the program design offers tools to develop scholarship on innovation within the nurturing space of collective learning fostered by a community of practice.

As the program has recently started and completed a first cycle of community-of-practice meetings, the paper presents the program structure, the research design for tracing its progress, and preliminary results characterizing the participants and their reflections on their development through engagement in the community of practice. The research questions addressed in the paper are:

1. What are the participants' experiences and perceptions of their research competencies at the beginning of the program?
2. How is the program impacting participants' self-perception of research competencies and professional development?

II. Conceptual Framework

A. Communities of Practice

Contextualized within a sociocultural understanding of learning (c.f. [8], [9]), the concept of community of practice stems from Lave and Wenger's seminal work on situated learning [4]. In that work, authors advocate for a "theory of social practice in which learning is viewed as an aspect of all activity" (p. 37–38). Without giving details on the definition of the construct, they highlight the role of communities of practice in learning and focus on the implications of becoming a participant in such communities. In other words, communities of practice negotiate meanings and build knowledge through apprenticeship relationships, in which newcomers start with peripheral legitimate participation but increase their expertise in the community by exposure and collaboration with other members. In this context, "As an aspect of social practice, learning involves the whole person; it implies not only a relation to specific activities but a relation to social communities—it implies becoming a full participant, a member" [4, p. 53]. Later, Wenger [10] would define communities of practice as those in which participants engage mutually on common issues, negotiate participation in joint enterprises, and share a repertoire of cultural tools and dynamic practices.

According to Buysse, communities of practice can bridge research and practice in education by underpinning two central tenets of the framework: experience situates knowledge, and the shared critical reflection on experiences enables learning and experience understanding [11]. Given its collaborative, social, and practical vision of learning, the approach has been recognized as valuable for innovation and research development in engineering education [6], [12].

Multiple professional development programs and research initiatives have adopted it as a framework in STEM and particularly in engineering [5], [13], [14], [15], [16], [17]. These studies agree on the benefits of communities of practice for

deepening disciplinary participation and professional growth among participants.

B. Development of Research Competencies

The development of research competencies among engineering faculty is a multidimensional process that involves technical and methodological skills, as well as motivational, ethical, and institutional dimensions. Buendía-Arias and colleagues [18] identify critical gaps in faculty research formation, including self-efficacy, reflective practice, and technology-mediated inquiry, and highlight the uneven development of these competencies even within structured programs. At the institutional level, Torres Delgado and Hernández-Gress [19] found that while engineering faculty tend to reach consolidated levels in teaching and ethics, competencies related to knowledge production and innovation consistently remain at initial stages. These findings suggest that sustainable faculty development requires structured environments where research competencies can be practiced, reflected upon, and gradually consolidated, conditions that communities of practice are particularly well-suited to provide.

II. The Faculty Development Program

The program described here is an initiative of the College of Engineering at a regional university in Chile. It has been developed in the context of a multi-year, government-funded project aimed to improve the college's indicators in different areas, such as research, entrepreneurship and innovation, and curriculum development. The program addresses the need to improve research and innovation competencies among faculty members who are more dedicated to instruction and have less experience in disciplinary research, but is open to any academic, regardless of their level of experience with teaching and research. It builds on and expands previous literature by deliberately bringing together instructors whose primary identity has been teaching with colleagues who hold consolidated disciplinary research trajectories to leverage synergies. Additionally, the dynamics of the community of practice intend to surface and address the tensions between teaching, disciplinary research, and educational research that often constrain scholarly engagement in engineering.

The program considers three main phases. First, the involvement of faculty in a two-session workshop focused on practical methods and actions to translate classroom or curricular innovation into research. Second, participants were invited to join a community of practice that began with a cycle of weekly meetings over the summer centered on the preparation of research proposals for implementation in the following academic year. Third, members of the community of practice hold monthly meetings while working in small research teams to implement their research proposals and write publications and grant proposals. In all phases, faculty are mentored and supported as they get to know each other and engage in meaningful collaboration. We are currently starting the third phase of the program.

IV. Method

The study of the faculty development program follows a case study research design [20], [21]. Accordingly, it includes diverse data collection methods that allow for data triangulation across sources. The main research question of the study is: *How might participants grow as engineering education researchers through their engagement in the community of practice?* In this work-in-progress paper, we address two sub-questions: (1) What are the participants' experiences and perceptions of their research competencies at the beginning of the program? (2) How is the program impacting participants' self-perception of research competencies and professional development?

A. Participants

After an open call to faculty in the different engineering departments of the college, a group of 21 academics attended the initial workshop. A fraction of that group continued in the cycle of meetings over the summer that created the community of practice. See Figure 1 for details on program participation and initial data collection instruments.

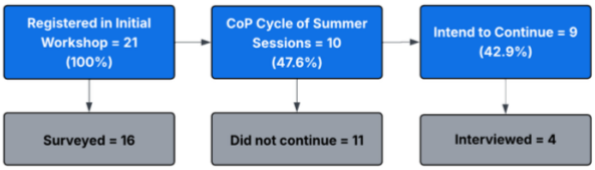

Fig. 1 Participation in the program
Note. CoP: Community of Practice

B. Data Collection

The case study design includes collecting multiple data sources through different phases of the program: participants' artifacts created in the faculty development workshop and community of practice meetings, surveys, semi-structured interviews, ethnographic observational notes, and recordings of the community of practice sessions.

In this paper, we report the data collected in two instruments: an initial survey and a first round of follow-up interviews with a subset of the participants.

The *initial survey* focused on participants' self-assessment of research competencies. It aimed to identify the levels of confidence, preparedness, and institutional conditions that participants perceived they had to begin or advance in educational research at the time they started the professional development. The instrument was designed based on the literature on research competencies [18], [19], is a Likert-type self-perception scale (1 = Strongly Disagree to 5 = Strongly Agree), and was self-administered before the first workshop session. It included 24 items distributed across six dimensions (see Table I). 16 participants answered the survey.

TABLE I
Categories in Survey

Category	Description	Items
1. Research Self-Confidence and Self-Efficacy	It assesses teachers' perceptions of their ability to initiate projects, formulate questions, analyze data, and communicate results	5

2. Methodological Skills	It measures the level of technical preparation regarding the research process, its stages, and the critical evaluation of studies	3
3. Digital Competencies Applied to Research	It explores the use of technological tools to manage literature, collect data, and disseminate results.	4
4. Motivation and Interest in Educational Research	It examines the desire to conduct research, the assessment of its impact on teaching practice, and interest in academic collaboration	4
5. Institutional Barriers and Support	It captures perceptions regarding the availability of time, resources, institutional support, and opportunities for collaboration.	4
6. Research Ethics and Responsibility	It addresses knowledge of ethical standards, informed consent, confidentiality, and considerations of equity and diversity	4

The *semi-structured interviews* were conducted at the end of the summer community-of-practice meetings with four volunteers. Interviews focused on participants' experiences with educational research and innovation before starting in the community of practice, and their perception of professional development in educational research after their engagement so far in the program. Each one lasted between 30 and 40 minutes and was conducted on Zoom.

C. Data Analysis

The research design includes analysis protocols that follow standard procedures of case study research (e.g., [20]). This implies first analyzing the qualitative and quantitative data collected from each data source separately, and second comparing and triangulating information across sources to identify patterns. For the qualitative data (analysis of artifacts, field notes, recordings, and interviews), we will create an eclectic codebook [22] that will include initial inductive and in vivo codes, their second-level aggregation through axial coding, and the categorization of patterns within and across the data. For quantitative data (survey), we will use descriptive statistics first and inferential statistics once we can compare data across different applications of the instrument. For example, we plan to reapply the initial survey at the end and conduct a t-test to observe gains in participants' perceptions of research competencies. The data reported in this paper have been analyzed following these processes in a preliminary stage. For the qualitative data, in particular, we have generated initial inductive and in vivo codes from the four interviews and used them to identify recurring themes reported in Section V, but the preliminary patterns will be refined in advanced levels of triangulation as additional data become available throughout the program.

V. Preliminary Findings

A. Participants' Perceptions on Competencies and Educational Research Before the Program

To answer the first research question, we analyzed the initial survey, which gives us a baseline of the assets and needs of faculty members who started engagement in the faculty development (n=16). For space constraints, we chose to report the results of seven items, representative of the six dimensions of the survey (see Figure 2).

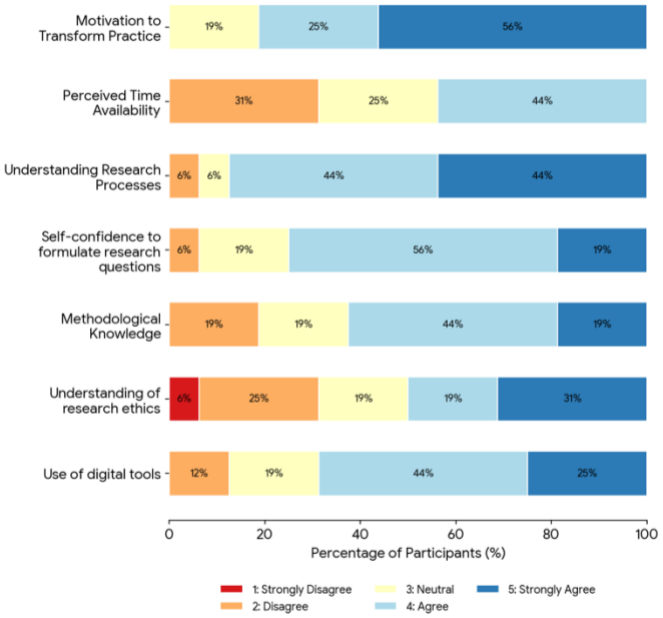

Fig. 2 Excerpt of initial survey results (n=16)

In general, the frequency distribution reveals a highly motivated group with some confidence in their research abilities and shared constraints. Specifically, 81% of academics agreed or strongly agreed they are motivated to transform their teaching practice through research (dimension 4; M = 4.38, SD = 0.81). Furthermore, participants expressed high confidence in understanding general research processes (dimension 2; M = 4.25, SD = 1.06) and formulating relevant questions (dimension 1; M = 4.00, SD = 1.15). On the same token, more than two-thirds of the participants surveyed seem to manage digital tools for research (dimension 3; M=3.81, SD=0.981). However, significant gaps emerged regarding the specific execution of educational research. Nearly 40% of the cohort reported neutral or disagreeing stances regarding their ability to effectively apply diverse research methodologies (dimension 2; M = 3.50, SD = 1.21). The most prominent barrier identified was perceived time availability, with 56% of participants expressing neutrality or disagreement when asked if they had the time to dedicate to research activities (dimension 5; M = 3.12, SD = 1.02). Similarly, 31% of the surveyed indicated knowledge and understanding of basic ethical norms for educational research—a 50% if we include those with a neutral stance (dimension 6; M=3.44, SD=1.365).

The survey results indicated the need for supporting participants' development of research competencies. They also justify implementing a community of practice that foregrounds collaborative learning among professionals with varying levels of expertise.

B. Participants' Perceptions of Gains and Professional Development Once in the Program

With the purpose of following up on the impact of the first cycle of meetings of the newly formed community of practice, we interviewed some volunteers (4). The questions were drawn from the initial survey and focused on the interviewees' experiences and perspectives after participating in the ongoing faculty development.

The interviewees (three women and a man) come from different engineering subdisciplines and have different levels of experience in teaching and research in higher education. The youngest has been working at the institution for 3 years, has not taught before, but has 15 years of research experience, and is the only interviewee with a doctorate. The other three faculty members have at least 20 years of experience at the institution, with extensive experience in administration and teaching, but some in research.

Across the interviews, we identified common themes, with nuances in participants' perspectives.

1) Greater takeaways: despite the interviewees' wealth of experience, all agree that the program has contributed to their learning and development as educational researchers. Main takeaways are the discovery of a new teaching or assessment approach that they would like to implement in their classroom, the learning of a technique that would help them to systematize the way they do pedagogical innovations, and the understanding of other perspectives through the ideas and experiences shared by peers in the community.

The interviews also showed participants' awareness of their learning needs. One of the participants highlighted how teaching and research on teaching are not always valued in engineering, and though engineers know that they are not primarily educators, in the program he sees how he needs to learn specific terminology:

> And here's the thing—I can relate to this statement as well: engineers have a certain arrogance, and I've experienced it firsthand. Many engineers think that just because they know a law by heart, they're lawyers. And they forget about the terminology, the spirit of the law. The same thing happens in teaching. There's no point in memorizing the terms if I lack the knowledge of the core of that learning to really understand…and to do that, I need to learn about teaching (Victor).

2) *Benefits of the community*: participants agreed that working on the community of practice has several benefits for their professional development as researchers and educators: learning from other ideas, collaborating with people with different perspectives and common goals, engaging with diverse colleagues, and feeling the pressure of committing to "doing well" in front of their peers. During the sessions, all participants shared their progress in their work and received feedback from peers and mentors in a safe environment. One interviewee shared that what she likes more is the welcoming environment of the community:

> I get the feeling that a lot of the time, when we're invited to a workshop with "research" in the title, people tend to back off or withdraw because we might not feel up to the task—since we're not researchers. And you have that mindset, like, "Damn, I don't have a PhD, so I can't be a researcher." And that's exactly why we were there—well, I think there were a few who did have a doctorate, but we all showed the humility of not knowing what was going on, of wanting to learn (Maria).

3) *Common motivations for engagement*: as the initial survey showed, participants are highly motivated to do educational research. In particular, interviewees agreed that their main motivation for engaging in the program is their interest in teaching and learning, and their desire to develop scholarship that nurtures their practice:

> And [presenting] at education conferences—which I actually find appealing. I mean, it's not really my field; I didn't study education, but I still find it really interesting, engaging, and important because we're at a crossroads right now, at a pivotal moment that will shape our future to some extent, as teachers (Bea)

> To be honest with you, it's not about my career, because—let's be real—research in this area has been promoted, and many universities are promoting it as a way to address gaps in existing career development. No, I'm past that stage; I'm already a tenured professor, and my career is established. So, this is really about…The area I want to focus on is teaching (Victor).

4) Competency growth: one of the interview questions specifically asked for their self-assessment of research competencies, asking whether they have improved in anything since starting the program. In general, the interviewees agreed that they had grown in at least half of the competencies asked (a subset from the survey). The competencies in which they agreed there was more growth were those related to creating a research proposal, recognizing a problem, and designing and applying an intervention. Half of them also reported growth in their abilities to collaborate with others in research projects.

5) Constrains to advance research: diverse limitations were recognized by the interviewees as affecting their engagement with research. As in the initial survey, participants agreed that time is a limitation to advancing independent research. Also, particularly in relation to educational research, one of the participants mentioned that the cultural perception of educational research as inferior to disciplinary research is an important barrier to pursuing scholarship centered on teaching and learning. Another participant mentioned how insecurities regarding what could be worthy of publication have affected her previous engagement in the field, and the program has helped her to see this differently:

> Someone in another institution told me, "I did a game, and I'm going to publish it." I was like, "Wow? It seems boring". I don't know, I felt like, well, they were just publishing things you do all the time in classes, but you don't usually go out of your way to publish them. You know what I mean? So, faculty have that same feeling. And then you say, "But if this is publishable, let's do it," and they're like, "No, is that publishable? No, that's so embarrassing"…So, it's like we need that motivation … and to say maybe, if you put it that way, "What are we going to do with this? It's not worth publishing, but if we shift the focus, if we look closely and analyze these results, compare them with this, then yes, we can publish it." (Judy)

6) *Expectations and support needed*: finally, the interview also sought to understand the future support that

participants foresaw for their constructive engagement in the community of practice. All of the interviewees agreed that they needed tutoring to help them keep working on practical things, receive support with what they need to learn more (such as technicalities, as Victor shared), and assist them in writing that concretizes their efforts in publications and research proposals.

VI. Discussion and Future Work

The data discussed in this work-in-progress paper represent a preliminary approach to understanding participants' perspectives at the beginning of this faculty development program. As our program is in progress, it only offers a snapshot of the participants' stances, an important element to contextualize efforts and understand expected changes during the program. Importantly, the relational aspects of the community of practice implemented in the program seem to have preliminary effects on participants' learning, engagement in research, and interactions with their peers.

However, these findings also have limitations. As they rely on self-perceptions, they do not yet allow us to establish whether these self-reported gains translate into changes in research and innovation practices, the generation of scholarly outputs, or the transformation of institutional dynamics. We therefore frame these early outcomes as evidence of engagement and emerging dispositions, rather than of consolidated transformation, and we treat the program's long-term impact as an open empirical question. We expect that regular engagement in community-of-practice meetings, along with the implementation of research activities, will enable participants to further develop their research competencies and confidence in pursuing educational research. We also expect that the collaboration and mentoring promoted in the program will help participants to feel supported in their efforts and mitigate the effects of external constraints. Our research design will allow us to understand how learning and professional development unfold as the program advances during the year to finally examine whether and how participation in the community of practice translates into observable shifts in faculty's scholarly trajectories.

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References

[1] N. Emery, J. M. Maher, and D. Ebert-May, "Studying Professional Development as Part of the Complex Ecosystem of STEM Higher Education," *Innov. High. Educ.*, vol. 44, no. 6, pp. 469–479, 2019, doi: 10.1007/s10755-019-09475-9.

[2] National Research Council, S. R. Singer, N. Nielsen, and H. A. Schweingruber, Eds., *Discipline-based education research: understanding and improving learning in undergraduate science and engineering*. Washington, D.C: The National Academies Press, 2012.

[3] C. Bazerman and J. Paradis, Eds., *Textual dynamics of the professions : Historical and contemporary studies of writing in professional communities*. Madison, Wis: University of Wisconsin Press, 1991.

[4] J. Lave and E. Wenger, *Situated learning: Legitimate peripheral participation*. Cambridge University Press, 1991.

[5] S. Fincher and J. Tenenberg, "Using Theory to Inform Capacity-Building: Bootstrapping Communities of Practice in Computer Science Education Research," *J. Eng. Educ.*, vol. 95, no. 4, pp. 265–277, Oct. 2006, doi: 10.1002/j.2168-9830.2006.tb00902.x.

[6] M. Borrego and C. Henderson, "Increasing the Use of Evidence-Based Teaching in STEM Higher Education: A Comparison of Eight Change Strategies," *J. Eng. Educ.*, vol. 103, no. 2, pp. 220–252, Apr. 2014, doi: 10.1002/jee.20040.

[7] G. Herman, L. Hahn, and M. West, "Sustaining Innovation in Engineering Education through Faculty Communities," in *2016 ASEE Annual Conference & Exposition Proceedings*, New Orleans, Louisiana: ASEE Conferences, Jun. 2016, p. 25993. doi: 10.18260/p.25993.

[8] L. S. (Lev S. Vygotsky, *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press, 1978.

[9] J. V. Wertsch, *Voices of the mind: Sociocultural approach to mediated action*. Cambridge, United States: Harvard University Press, 1993.

[10] E. Wenger, *Communities of practice: learning, meaning and identity*. in Learning in doing. Cambridge New York Port Melbourne [etc.]: Cambridge University Press, 2002.

[11] V. Buysse, K. L. Sparkman, and P. W. Wesley, "Communities of Practice: Connecting What We Know with What We Do," *Except. Child.*, vol. 69, no. 3, pp. 263–277, Apr. 2003, doi: 10.1177/001440290306900301.

[12] A. Johri and B. M. Olds, "Situated Engineering Learning: Bridging Engineering Education Research and the Learning Sciences," *J. Eng. Educ.*, vol. 100, no. 1, pp. 151–185, Jan. 2011, doi: 10.1002/j.2168-9830.2011.tb00007.x.

[13] M. Quezada-Espinoza, M. E. Truyol, J. F. Calderon, A. Dominguez, and G. Zavala, "Building Research Capacity in Engineering Education: Insights from a Faculty Development Program," in *2024 World Engineering Education Forum - Global Engineering Deans Council (WEEF-GEDC)*, Sydney, Australia: IEEE, Dec. 2024, pp. 1–9. doi: 10.1109/WEEF-GEDC63419.2024.10854956.

[14] L. J. Anthony, M. F. Palius, C. A. Maher, and P. V. Moghe, "Using Discourse Analysis to Study a Cross-Disciplinary Learning Community: Insights from an IGERT Training Program," *J. Eng. Educ.*, vol. 96, no. 2, pp. 141–156, Apr. 2007, doi: 10.1002/j.2168-9830.2007.tb00924.x.

[15] M. C. Ayar and B. Yalvac, "An ethnographic study of an engineering community: Mentoring as a tacit rule and its implications for how people learn," *J. Eng. Educ.*, vol. 111, no. 2, pp. 400–419, Apr. 2022, doi: 10.1002/jee.20454.

[16] M. D. Koretsky, S. B. Nolen, J. Galisky, H. Auby, and L. S. Grundy, "Progression from the mean: Cultivating instructors' unique trajectories of practice using educational technology," *J. Eng. Educ.*, vol. 113, no. 2, pp. 330–359, Apr. 2024, doi: 10.1002/jee.20586.

[17] S. Bernstein-Sierra and A. Kezar, "Identifying and Overcoming Challenges in STEM Reform: a Study of four National STEM Reform Communities of Practice," *Innov. High. Educ.*, vol. 42, no. 5–6, pp. 407–420, Dec. 2017, doi: 10.1007/s10755-017-9395-x.

[18] X. P. Buendía-Arias, L. C. Zambrano-Castillo, E. A. Insuasty, X. P. Buendía-Arias, L. C. Zambrano-Castillo, and E. A. Insuasty, "El desarrollo de competencias investigativas de los docentes en formación en el contexto de la práctica pedagógica," *Folios*, no. 47, pp. 179–195, Jun. 2018.

[19] G. Torres Delgado and N. Hernández-Gress, "Research Professors' Self-Assessment of Competencies".

[20] R. K. Yin, *Case study research and applications: Design and methods*, Sixth. SAGE Publications, 2018.

[21] S. B. Merriam, *Qualitative research and case study applications in education. Revised and expanded from "Case study research in education."* San Francisco, CA: Jossey-Bass Publishers, 1998.

[22] J. Saldaña, *The coding manual for qualitative researchers*, 3E [Third edition]. Los Angeles ; London: SAGE, 2016.