Becoming a Math Instructor for Engineering Students: Self-formation Through Professional Practice

Sibeli de Oliveira Schneider, Tufts University

Sibeli Schneider is a Ph.D. student in Mechanical Engineering at Tufts University. Her work focuses on teaching and learning in undergraduate engineering courses. She holds a Master's degree in Education and a Bachelor's degree in Civil Engineering from the Federal University of Rio Grande do Sul (UFRGS), Brazil.

Sergio Roberto Kieling Franco, Universidade Federal Do Rio Grande Do Sul

Dr. Sergio Franco is Professor in the School of Education at the Federal University of Rio Grande do Sul (UFRGS), Brazil, where he also serves as a faculty member in the Graduate Programs in Education and Informatics in Education. He has held several academic and public leadership roles, including as Director of Distance Education Policies at the Brazilian Ministry of Education (MEC) and as member of Brazil's National Education Council. Currently, he is a member of MEC's National Commission for the Evaluation of Higher Education and also of the State Council of Education of Rio Grande do Sul. His research focuses on distance education, teaching and learning, and higher education.

Becoming a Math Instructor for Engineering Students: Self-formation Through Professional Practice

Abstract

Background: This empirical research brief presents a subset of findings from a study conducted at a Brazilian federal university [1]. It focuses on instructors' ongoing self-formation practices, examining how outstanding mathematics instructors frame their practices and themselves when teaching undergraduate engineering students. When Pepin, Biehler & Gueudet looked at the state-of-the-art crossing mathematics and engineering education, they noted that "current practices of instructors have not yet been comprehensively investigated" [2, p. 182], a step toward innovation in the field. In this study, we identify teaching practices related to self-formation based on instructors' self-perceptions, that is, what these professors intentionally do to become better teachers.
Methods: Data were collected in stages. First, a survey with undergraduate engineering students plus an interview with the dean helped identify three outstanding professors from the department of mathematics in a Brazilian federal university. Being outstanding here means that, among the 40 professors affiliated instructors of the department, they are the ones engineering students seek out and recommend to their peers. Interview transcripts were analyzed via qualitative descriptive coding methods, and results were validated through member checking.
Results: This study highlights ongoing self-formation practices emerging from participants' self-perceptions. The practices include: (i) dialogue: they are all concerned in having an environment where students feel safe to ask questions, their main resource to achieve this is their constant invitation to dialogue; (ii) reflection after each class considering how to improve future ones; (iii) writing and continuously refining lesson plans and lecture notes; (iv) modeling their own practices after teachers they had admired as students; (v) conveying strong command of the content.
Final Considerations: This paper presents only a subset of the practices identified in the interviews, focusing specifically on ongoing self-formation practices. The findings point to pedagogical approaches that are barely investigated in the intersection of mathematics and undergraduate engineering education. Dialogue, for example, is a foundation of Freire's pedagogy [3] and has been widely studied in the context of adult education. Here, however, we provide evidence of its relevance in large engineering classes. Sharing these ongoing self-formation practices helps illuminate current teaching realities and supports immediate improvements. Future research could examine how instructors' self-perceptions relate to students' learning experiences.

Introduction

While engineering education research has produced a robust body of evidence supporting advanced instructional approaches, their translation into widespread teaching practice remains limited [4]. In mathematics courses required by engineering curricula, the situation is even more concerning, as instructors' current practices remain insufficiently documented. A recent review of the state of the art at the intersection of mathematics and engineering education noted that "current practices of instructors have not yet been comprehensively investigated" [2, p. 182]. Without such an understanding of existing practices and their contexts, efforts to translate

educational research into instructional change remain fragile; establishing this understanding is therefore a necessary step toward informed and contextualized change [4], [5]. This study addresses this gap by focusing on ongoing self-formation practices among instructors teaching mathematics in engineering programs.

In this paper, we claim that mathematics instructors willing to improve their own practice could immediately apply existing teaching practices and have a substantial impact on engineering students' learning experiences. Evidence for this claim comes from interviews we conducted with three outstanding mathematics instructors who teach service courses for engineering departments. These interviews aimed to identify teaching practices as articulated through outstanding instructors' own reflections and perspectives. A survey with undergraduate engineering students and an interview with the dean of the mathematics department helped us identify the participants in this research.

In this context, this paper presents a subset of findings from the study aforementioned, which took place at a Brazilian federal university [1]. Although the original study was designed to investigate teaching practices related to content development, the piece we focus on concerns findings about how the selected participants—three outstanding mathematics instructors—develop their teaching through ongoing self-formation, an outcome that inductively emerged during the analysis process. Whereas the larger study was grounded by Piaget's theoretical framework [6], [7], [8], [9], the results we share in this paper were closer to dialogical and reflective pedagogical principles as discussed by Freire [3], [10], [11], which provided a conceptual lens for making sense of the data collected. In short, the findings we share focus on what these professors intentionally do, while faculty practitioners, to develop themselves as teachers, and how these practices can be understood through the lens of Freire's dialogical and reflective framework. We hope to encourage those who aim to improve their own practice with feasible and immediately applied teaching practices.

Research Questions

This study aims to describe and understand the teaching practices of outstanding mathematics instructors who teach service courses to undergraduate engineering students. In particular, it seeks to examine the practices that support these instructors' ongoing development as teachers *while they act as teachers*. Adopting an interpretive perspective, the study explores how existing literature can help to understand the findings.

Therefore, the following research questions guided our work:

- What teaching practices do outstanding mathematics instructors use to support their ongoing development as teachers of engineering students?

- How can these practices be interpreted and discussed in light of existing literature?

Theoretical Framework

This study is grounded in an interpretive perspective [12] that seeks to understand teaching practices of mathematics instructors who teach mathematics courses to undergraduate engineering students. To make sense of the teaching practices identified in the analysis, particularly those related to instructors' ongoing self-formation, we draw primarily on Paulo Freire's dialogical and reflective pedagogy [3], [10], [11]. Freire's work offers conceptual resources that support interpreting teaching not as the transmission of content, but as a relational and reflective practice in which teaching and learning are inseparable.

Freire explains that critical teaching "involves a dynamic and dialectical movement between 'doing' and 'reflecting on doing'" [10, p. 43]. Reflection, then, emerges from practice and returns to it, informing subsequent pedagogical decisions and allowing the continuous improvement of teaching practice. This movement can be understood as action–reflection–action, a term that captures the circular and ongoing nature of this process. As an activity inherent to the work of educators committed to their practice, action–reflection–action is not limited to specific teaching contexts; it applies whether one teaches in a rural school or at a university [10]. The notion of action–reflection–action thus provides a lens for understanding some practices identified in this study not as isolated strategies, but as part of an ongoing process of professional becoming.

Dialogue occupies a central place in Freire's pedagogy and is understood not simply as conversational exchange, but as a condition for learning and teaching. For Freire, dialogue creates the conditions for mutual learning [3]. This perspective supports interpreting the instructor's efforts to invite questions, attend to students' language, and remain responsive to feedback as practices through which teachers position themselves simultaneously as educators and learners. In this sense, dialogue becomes a mechanism through which instructors gain access to information about students' understanding and, in turn, refine their own teaching.

Freire's work also emphasizes the ethical and affective dimensions of teaching, including care, responsibility, commitment to students' learning, all grounded in love. Teaching, in this framework, is a human practice that involves uncertainty, curiosity, and openness to being transformed by the educational encounter [10], [11]. Within this perspective, practices such as demonstrating expertise, revisiting instructional plans, and supporting students' confidence can be understood not as expressions of authority, but as a way of supporting students' belief in the possibility of learning or even in their own agency, particularly in contexts where students may experience insecurity or self-doubt, as mathematics matters [11].

Freire's framework allowed this study to articulate how reflective and dialogical practices can be enacted in mathematics courses within engineering curricula, supporting both teaching and learning processes for instructors and students. In this sense, Freire's pedagogy functions as an interpretive lens that helps us understand how teachers' practices can support their own professional development. At this point, it is worth noting that Professor Ira Shor also contributed to our framework, particularly through his conversations with Paulo Freire, one of the most cited references in this study [11]. We resonate with Shor's argument that "Teachers face too many classes, too many students, too much administrative control, so the need for something that works in class stands out stronger than the apparent need for theory" [11, p. 2].

That is what motivates this study: to connect educational research to the concrete realities of classroom practice and, therefore, to cultivate hope for viable and humanized pedagogical practices for both students and teachers, even within a discipline as exact as mathematics.

Methods[1]

The small number of participants (i.e., three) allowed researchers to conduct an in-depth analysis, supporting a qualitative approach. The exploratory nature of the study reflects its aim to investigate instructional practices that remain underexplored in the literature. Data analysis was grounded in interpretive and descriptive approaches aimed at understanding existing instructional practices as situated within teachers' contexts and perspectives. Mixed methods supported participant selection and data collection. The study was designed to document and interpret instructors' practices rather than to evaluate or intervene in them, aligning with a diagnostic and exploratory research purpose [5].

Participants

The goal of the first stage was to identify instructors, perceived by both students and academic leadership, as outstanding in teaching mathematics to engineering students. Three faculty members were selected from a pool of 40 mathematics faculty who worked on campus. Thus, data for participant selection were collected through two sources: (1) an online survey administered to undergraduate engineering students from different majors and (2) an in-person interview with the dean of the mathematics department.

Between late July and mid-August 2023, the survey gathered responses from students enrolled in 13 of the 16 engineering majors offered by the university at that time. Students were asked to identify instructors they considered outstanding during their engineering trajectories while taking Calculus I, Calculus II, Linear Algebra, or Differential Equations. The survey presented a list of all 40 instructors affiliated with the mathematics department at that time.

Because the engineering program spans five years and instructors teaching service courses may vary across semesters, the survey intentionally included all faculty members affiliated with the department, regardless of whether they were teaching those courses during the semester of data collection. For example, a senior student might have taken Calculus with an instructor who was not lecturing that course at the time of the survey but remained affiliated with the department.

When completing the survey, students could indicate instructors they had as official course instructors, as well as instructors they had heard about or whose classes they had observed without being formally enrolled. Given the high rates of course repetition in these subjects, it was plausible that some students had interacted with more than one instructor for the same course. At the time the survey was launched, eight instructors were teaching Calculus I, fourteen were teaching Calculus II, ten were teaching Linear Algebra, and five were teaching Differential Equations, illustrating the range of instructional exposure students could experience.

[1] The project was reviewed and approved by the university's Research Ethics Committee, the Brazilian equivalent of an Institutional Review Board (IRB) in the United States. Should the paper be accepted, details of the ethics approval will be provided in the final paper to preserve the anonymity of this draft.

The survey yielded 156 valid responses. Instructors were ranked according to the number of times they were identified as outstanding, both by individual course and overall. Three instructors clearly stood out, accounting for approximately 43% of the valid responses, while the remaining 57% were distributed among the other 37 instructors.

In parallel, an interview with the mathematics department dean was conducted in person and guided by the question: “Which faculty members are engineering students most likely to seek out when enrolling in service courses offered by the department?” The three instructors most frequently identified in the student survey were also named by the dean. This overlap was considered sufficient to designate these instructors as outstanding. To preserve anonymity, they are referred to as P1, P2, and P3.

Interviews

Between late October and early December 2023, semi-structured interviews were conducted with each participant. P1 requested an online interview, conducted from his home, to ensure privacy and minimize interruptions. Interviews with P2 and P3 were conducted in person in their university offices. Each interview lasted approximately one hour.

The interview protocol aimed to explore participants’ trajectories as teachers, their perceptions of their own formation, and the teaching practices embedded in their daily routines. Although the broader study was not initially designed to focus on ongoing self-formation practices, this category of findings emerged during the analysis process. Relevant questions from the interview protocol that contributed to this focus included, but were not limited to: “How do you prepare for your lectures?”, “What actions do you take when you notice that students are not following?”, and “What do you expect when you enter the classroom?”

In January 2024, after the interviews had been transcribed, coded, and analytically summarized, a member-checking process was conducted through brief follow-up interviews with each participant. These meetings were conducted in person in the participants’ offices and lasted no longer than 20 minutes. All participants confirmed the accuracy of the descriptions and interpretations presented.

Data Analysis

Interview data were transcribed and analyzed through an inductive coding process [13]. The analysis culminated in descriptive accounts of what we interpreted as participants’ teaching practices. Quotes from interview transcripts were freely translated from Portuguese to English by the first author, who conducted the interviews.

The initial analytical framework guiding the broader study was informed mainly by Piaget’s theoretical contributions, particularly given their relevance to mathematics education [14]. We hypothesized that his work could offer conceptual support for interpreting how instructors organize mathematical content, structure classroom routines, and sequence instructional activities. However, during the analysis, additional practices emerged that reflected participants’

concerns with their own teaching development and with students' learning experiences and well-being. These practices were not anticipated in the original research design but came into focus during the analysis. To make sense of this set of practices later categorized as related to participants' ongoing self-formation, Freire's dialogical and reflective pedagogical framework provided an interpretive lens. Although not imposed *a priori*, this connection emerged due to the researchers' engagement with the data and familiarity with Freire's work.

Therefore, our descriptions allow us to highlight three key findings. First, we show how theory and practice were interpreted in tandem, one informing the other, even though participants did not report intentionally applying specific pedagogical theories in their daily teaching. In fact, P1 explained that while authors such as Piaget and Freire were studied and considered important, they were not used as explicit references in classroom practice. Rather, their influence was indirect, emerging from "all the knowledge that has been produced." As he put it, "I would never say, 'today I'm going to give a Piagetian lecture' or 'today I'm going to apply Paulo Freire.'" Second, we illustrate how the practices under discussion appeared in the interviews. Third, we discuss how other instructors may benefit from what the professors shared.

Results & Discussion

The following subsections present participants' ongoing self-formation practices coded from interview transcripts. Each subsection combines empirical description, supported by evidence from interview data, with interpretation through Freire's theoretical framework.

Self-Formation Practice 1: Dialogue

According to Freire, dialogue happens within a humble and loving territory. It supports and is supported by the dialogic condition of being a teacher-student working with student-teachers, since "Whoever teaches learns in the act of teaching, and whoever learns teaches in the act of learning" [5, p. 31]. Dialogue is a common and strong practice shared among all participants, and it seems to have two main purposes: i) creating an environment where students feel safe to ask questions and look for support; ii) getting honest feedback about their own teaching with a view toward improvement. Are students learning in their classes? Are their teachings effective?

Talking specifically about the beginning of each semester, P1 described his expectation that "a dialogue can always happen", and that "students receive us well, then a sense of sync happens, and we can talk to them and they realize that they can trust us, and we are there to have an interchange, that we are not opponents". Similarly, P2 highlighted that remembering and using students' names supports the construction of a more personal relationship, making students feel more comfortable asking questions. P3, in turn, described his effort to use a language closer to that of his students, which he understands as a way of positioning himself as someone "they can talk to." Together, these accounts support our claim that dialogue is intentionally used as a pedagogical tool to foster a safe and trusting learning environment.

Once dialogue is established, instructors become attentive to feedback from students, whether explicit or implicit. Through questions, comments, and other cues, established dialogue provides instructors with information that supports more informed, in-the-moment decisions about how

the class should proceed. As P3 explained, “the fact that I talk to them… I already have a sample of what is happening, and then I can keep my lecture, redirect it, go back, or go slower.” In this way, dialogue functions as a tool for eliciting feedback on teaching practices and adjusting instructional plans. This process requires instructors to position themselves as learners, open to interpreting students’ responses and questions, while students, even if unintentionally, come to occupy a teaching role by offering insights into the effectiveness of instructional practice. In this sense, “The teacher is no longer merely the-one-who-teaches, but one who is himself taught in dialogue with the students, who in turn while being taught also teach” [5, p.80]. Finally, it is worth noting that these dialogical practices are enacted by instructors identified by students and academic leadership as outstanding, suggesting that dialogue operates not merely as a normative pedagogical ideal, but as a practice associated with effective and valued teaching.

Self-Formation Practice 2: Action-Reflection-Action

The action–reflection–action process, as conceptualized by Freire, emphasizes that critical reflection on present or past practice enables the improvement of future practice, as he explains: “Thinking critically about practice, of today or yesterday, makes possible the improvement of tomorrow’s practice” [5, p. 41]. The participants have established intentional routines of reflecting on their teaching practices. P2 explained that she deliberately reflects on the questions raised during class, how she responded to them, and whether she was satisfied with those responses. Based on this reflection, she may open the next class with a recall or a different explanation, in an effort to reach students with comfort and confidence: “Today is a new day, let’s understand it again to keep going well.”

P1 made it very clear that one “should never [enter a class] with excessive confidence (…) even if I had lectured that content other times, it is always good to recall.” When he notices that a particular explanation has generated confusion, he reflects on how to improve it. What enables P1 to notice such confusion, beyond students’ facial expressions, are students’ questions, encouraged by the dialogical environment he intentionally cultivates, where students feel safe to communicate their needs. Together, these accounts illustrate action-reflection-action as an ongoing and intentional practice through which instructors continuously reshape their teaching, reinforcing their commitment as educators.

Self-Formation Practice 3: Writing out Class Plans by Hand

One practical tool that helps professors reflect on their classes is writing and revisiting class notes. All three participants planned and organized their lectures by writing out their class plans by hand. P1 and P2 review their notes before each class, while P3 writes new ones while consulting previous notes. After finishing a lecture, they might annotate which examples were not clear or which parts went well.

The value of this practice lies primarily in its intentionality: being as prepared as possible for the lecture and keeping track of what is working and what should be improved. For class notes to achieve this purpose, they must be revisited, regardless of how many times the same lecture has been taught. While one might assume that senior instructors no longer need to review lectures they have taught many times, the participants’ accounts suggest otherwise. As an expression of

ongoing self-formation and closely connected to the action-reflection-action cycle [10], this practice applies independently of seniority. Rather than reducing the need for reflection, experience appears to deepen instructors' commitment to revisiting, refining, and improving their teaching.

In this sense, regularly writing and reviewing class notes emerges as a feasible and transferable practice for instructors who aspire to remain responsive, reflective, and committed educators in changing educational contexts. From an interpretive perspective, this practice can be understood as resembling a form of reflective journaling, in which instructors systematically document, revisit, and make sense of their teaching experiences. Such practices can support teachers' self-awareness and change-oriented reflection, contributing to their ongoing professional development and self-formation [15].

Self-Formation Practice 4: Conveying Expertise

Directly connected to the point above, a common concern shared by our participants is the importance they attribute to conveying expertise. In other words, they emphasize communicating to students that they have a strong command of the content. P1 explained that when students perceive the instructor as confused about the subject matter, they may question their own ability to learn it. This concern is particularly relevant in mathematics courses for engineers, where, according to P2, students often feel insecure about their prior knowledge. For these instructors, therefore, demonstrating expertise is directly connected to student learning, as it helps students recognize that the content is indeed learnable.

In his conversation with Professor Ira Shor, Paulo Freire noted that when a student believes something is possible to be learned, this belief can itself be a form of liberation: "some students came to me and told me that the classes made them feel more free. They used to say to me, Paulo, now I know that I can learn!" [8, p. 27]. P2's observations resonate with this idea, as she noted: "to be able to understand, first they need to recognize they can do it, right?". And that is a claim we make here: one of the central tasks in teaching mathematics to undergraduate engineering students is to foster students' self-assurance in their ability to learn. As P2 explained, "My role would be to frame it [the content] in a way that makes them believe they can get it."

Self-Formation Practice 5: Inspiration by Their Own Teachers

Although there have been ongoing efforts to address this issue, formal pedagogical preparation is still largely absent from the educational pathways of university instructors [16]. This reality also applies to P1, P2, and P3: all reported having received no practical instruction on how to teach during their academic training. This absence reinforces the importance of becoming a teacher through practice, a central aspect of the teaching practices discussed in this paper. Within this context, one way instructors navigate this lack of formal preparation is by modeling their own practices after teachers they admired as students, a process already discussed in the teaching and learning literature [17], [18].

All three participants recalled specific teachers who marked their academic trajectories and continue to inspire their teaching today. These inspirations include tangible and observable

aspects of teaching, such as the organization of the board (P1, P2), which they associated with clear use of space, visual clarity, logical organization of written explanations, and a visible sequencing of mathematical reasoning. At the same time, it is important to acknowledge that "Teaching is a human act" [5, p. 65], and that being human also entails subjectivity, a reminder of the limits of reducing teaching to prescriptive or purely technical guidelines. Thus, they also referred to more explicitly subjective dimensions of the profession, such as enthusiasm for the subject matter (P3), or the teacher's ability to foster in students the sense that they were deducing the next step themselves (P1, P2).

Final considerations

Illuminating current teaching practices in mathematics courses required by engineering curricula and relating them to well-established theories or contemporary research constitutes a key diagnostic step for advancing this teaching field. This does not imply, however, that improvement cannot occur in the absence of such documentation. Rather, it highlights the value of making existing practices visible and explicit, as this clarity can inform both future research and intentional pedagogical development.

In this study, we identified and described five teaching practices that emerged as central to the work of three outstanding mathematics instructors at a Brazilian federal university who taught mathematics courses for engineering programs. Using an interpretive and descriptive qualitative approach and interviews transcript analysis, the study focused on understanding these instructors' teaching practices related to their ongoing self-formation. The findings showed that these instructors demonstrated a strong sense of responsibility toward students' learning and positioned themselves as educators engaged in the work of teaching (and learning), beyond their role as researchers.

Taken together, the practices described (i.e., dialogue, action-reflection-action, writing out class plans by hand, conveying expertise, and inspiration by their own teachers) highlight ways in which instructors support students' learning while simultaneously fostering their own professional development. These practices are not presented as prescriptions or universal solutions, but as situated strategies that emerged from reflective engagement with teaching. Their relevance lies precisely in offering insights that may inform the work of other mathematics and engineering instructors interested in improving their teaching practices.

From an interpretive standpoint, the practices identified in this study resonate strongly with principles long discussed in Paulo Freire's work, particularly the notions of dialogue, action-reflection-action, and the inseparability of teaching and learning. Importantly, these principles were enacted by the participants without explicit reference to Freirean pedagogy, suggesting that such theoretical frameworks can be embodied in practice even when they are not consciously adopted. This alignment reinforces the idea that reflective and dialogical teaching practices are not merely theoretical ideals, but lived pedagogical possibilities.

Finally, this study underscores the need for further research that documents and examines existing teaching practices related to other realms of teaching, such as content development or assessment. Future studies might explore how such practices evolve over time, or how they are

perceived by students. By continuing to make teaching practices visible and analyzable, engineering education research can more effectively bridge the gap between educational theory and classroom practice.

Acknowledgements

We are grateful to the three instructors who participated in this study and generously shared their time and insights. We also thank Dr. Kristen Wendell and her research group for their feedback on the draft of this paper. Furthermore, we thank the reviewers for their contributions to this final version. This research was supported by the National Council for Scientific and Technological Development (CNPq, Brazil), which granted a fellowship to the first author during her master's program, enabling the development of this work. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the CNPq.

References

[1] S. de Oliveira Schneider, "A didática de professores-destaque em disciplinas iniciais dos cursos de engenharia," Universidade Federal do Rio Grande do Sul, Porto Alegre, 2024. [Online]. Available: https://lume.ufrgs.br/handle/10183/272030

[2] B. Pepin, R. Biehler, and G. Gueudet, "Mathematics in Engineering Education: a Review of the Recent Literature with a View towards Innovative Practices," Int. J. Res. Undergrad. Math. Educ., vol. 7, no. 2, pp. 163–188, Jul. 2021, doi: 10.1007/s40753-021-00139-8.

[3] P. Freire, Pedagogy of the oppressed: 30th Anniversary Edition, 30th anniversary edition. New York: Bloomsbury Publishing, 2014.

[4] A. Brooks, J. Knowles, E. Clement, P. Shekhar, and S. Brown, "Are All 'EBIPs' Created Equal? An Exploration of Engineering Faculty Adoption of Nine Evidence-Based Instructional Practices," in 2023 ASEE Annual Conference & Exposition Proceedings, Baltimore , Maryland: ASEE Conferences, Jun. 2023, p. 42287. doi: 10.18260/1-2--42287.

[5] J. A. Maxwell, Qualitative Research Design: An Interactive Approach, 3rd ed. Sage, 2013.

[6] J. Piaget, "A Epistemologia Genética," in Os Pensadores: Piaget, V. Civita, Ed., São Paulo: Abril Cultura, 1978.

[7] J. Piaget, Estudos Sociológicos. Rio de Janeiro: Forense, 1973.

[8] J. Piaget and P. Gréco, Aprendizagem e conhecimento. Rio de Janeiro: Freitas Bastos, 1974.

[9] B. Inhelder, M. Bovet, and H. Sinclair, Aprendizagem e estruturas do conhecimento. São Paulo: Saraiva, 1977.

[10] P. Freire, Pedagogy of freedom: ethics, democracy, and civic courage. in Critical perspectives series. Lanham: Rowman & Littlefield, 1998.

[11] I. Shor and P. Freire, A pedagogy for liberation: dialogues on transforming education. South Hadley, Mass: Bergin and Garvey, 1987.

[12] S. Gasson, "Rigor In Grounded Theory Research: An Interpretive Perspective on Generating Theory From Qualitative Field Studies," in *The handbook of information systems research*, IGI Global Scientific Publishing, 2004, pp. 79–102.

[13] D. R. Thomas, "A General Inductive Approach for Analyzing Qualitative Evaluation Data," Am. J. Eval., vol. 27, no. 2, pp. 237–246, Jun. 2006, doi: 10.1177/1098214005283748.

[14] M. A. Simon, R. Tzur, K. Heinz, and M. Kinzel, “Explicating a Mechanism for Conceptual Learning: Elaborating the Construct of Reflective Abstraction,” vol. 35, no. 5, pp. 305–329, 2004.
[15] M. Mavric and B. Medic, “The Use of Reflective Journals in Professional Development,” J. Posit. Sch. Psychol., vol. 6, no. 2, pp. 3803–3807, 2022.
[16] T. E. Robinson and W. C. Hope, “Teaching in higher education: Is there a need for training in pedagogy in graduate degree programs?,” Res. High. Educ. J., vol. 21, 2013, [Online]. Available: https://files.eric.ed.gov/fulltext/EJ1064657.pdf
[17] M. G. Arroyo, Ofício de mestre: imagens e auto-imagens. Petrópolis: Vozes, 2007.
[18] L. R. de C. Ribeiro, Radiografia de uma aula em engenharia. São Carlos: EduFSCar, 2008.