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In pursuit of strengthening graduate education in Engineering Education in Brazil

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Abstract: This Evidence-Based Practice presents the results of a study conducted with Brazilian engineering schools, aiming to identify viable paths for implementing a graduate education structure in Engineering Education in the country. The research was carried out within the context of the "Faculty Development" Working Group, linked to the Brazilian Association for Engineering Education (ABENGE). It involved the organization of a Targeted Session (TS) at the Brazilian Congress of Engineering Education (COBENGE 2024), the publication of its results in a book chapter, and, finally, the hosting of a meeting (COBENGE 2025) to develop strategies to be pursued.
Throughout these meetings, several successful experiences of graduate programs in Science, Technology, Engineering, and Mathematics (STEM) Education in Brazil were presented. There are only a few Higher Education Institutions (HEIs) that offer graduate programs specifically focused on this area, and these programs generally operate in isolation, without close collaboration among them.
On the other hand, the recent national curricular guidelines for engineering programs in Brazil highlight the need for faculty development and training for those teaching engineering courses. They also indicate the necessity of creating appropriate instruments for evaluating the work of these professors, which could form part of a faculty career advancement system.
During the Targeted Session held at the 52nd COBENGE (2024), researchers were invited to share their experiences in graduate-level training for engineering professors. The contributions were diverse, including accounts of teacher training courses, STEM graduate programs, regular graduate courses focused on Engineering Education, studies mapping publications in this area, and reports on outcomes achieved by students who participated in these initiatives.
At the 53rd COBENGE (2025), representatives from the institutions that had taken part in the previous year's session gathered to define strategic directions, which included: the creation of a certification process, within ABENGE, for existing graduate programs in Brazil aligned with Engineering Education (EE); encouraging the inclusion of engineering education courses within traditional engineering graduate programs; and ABENGE's support for the establishment of research groups, academic departments, and career paths in Engineering Education within engineering schools, inspired by international experiences.
As results, this work presents a clear overview of the current state of graduate programs in Engineering Education in Brazil and discusses prospects for strengthening a collaborative network of programs. In particular, it highlights the potential of international cooperation as a strategic pathway to foster joint graduate programs, academic mobility, and shared faculty development initiatives between Brazilian institutions and their international counterparts. Such collaboration may contribute to reducing regional asymmetries and to aligning the development of graduate education in Engineering Education in Brazil with global discussions and practices in the field.

Introduction

The purpose of this paper is to present pathways for consolidating graduate education in Engineering Education in Brazil, as well as to promote closer collaboration among faculty

members, researchers, and institutions that have this field as a focus of interest in their academic and professional activities.

In the international context, there are well-established and successful experiences in the field of Engineering Education, both in the United States, such as the case of Purdue University, and in other countries [1, 2]. Within this scenario, the role of the National Science Foundation (NSF) stands out, as it maintains a specific funding area dedicated to research in Engineering Education, with structured funding lines for projects in this field. In other continents, graduate programs focused on engineering, science, and technology education can also be identified. This study seeks to take these successful experiences as references to support the development and expansion of graduate education in Engineering Education, Science, and Technology in Brazil.

Importance of Graduate Education and Faculty Development: the Context of National Curricular Guidelines and Professional Programs

In Brazil, the institutionalization of research in the field of education has been consolidated within graduate education, particularly through the CAPES evaluation system (Coordination for the Improvement of Higher Education Personnel), since the early 2000s. The current National Curricular Guidelines (DCNs) for undergraduate engineering programs [3] explicitly reinforce the importance of education research in the context of Engineering Education by establishing that Higher Education Institutions (HEIs) offering stricto sensu graduate programs may "allocate workload, in accordance with the Program Pedagogical Project, to their own curricular activities articulated with research and extension."

It is worth emphasizing that the integration between research and extension is particularly relevant in professionally oriented graduate programs [6], as it enhances the dissemination of research results to society and increases the social impact of academic production.

Another central aspect highlighted by the DCNs [3] concerns the need to maintain a Faculty Development and Training Program within HEIs, "with a view to valuing teaching activities," grounded in conceptual and pedagogical mastery, including the use of active learning strategies and interdisciplinary practices. The guidelines also emphasize the importance of continuous faculty education and training and indicate the need to establish institutional mechanisms for faculty evaluation, particularly in the teaching dimension.

Taken together, these guidelines underscore the relevance of professional graduate programs in the field of Education as privileged spaces for the continuing development of engineering faculty. In this context, the mobilization of graduate programs and centers becomes strategic for promoting alignment among educational proposals capable of addressing the emerging demands arising from the DCNs. Therefore, bringing together the various actors involved in graduate education and fostering this debate constitutes a desirable and necessary action for strengthening the field of Engineering Education in Brazil.

Theoretical framework

The discussion on the consolidation of graduate education in Engineering Education in Brazil is grounded in different and complementary theoretical axes. These include: teacher education and the Science, Technology, and Society (STS) movement; engineering education, including challenges associated with the expansion of distance undergraduate programs; as well as STEM/STEAM education and its relationship with Science Education (These three dimensions are further detailed in Appendix A). Finally, institutional experiences in faculty professional development and pedagogical courses within engineering graduate programs are presented as relevant references for the field.

Faculty Professional Development at the Institutional Level

Faculty professional development in higher education has been promoted by various institutions as a strategy to enhance teaching and learning processes, particularly in engineering programs. Such initiatives often rely on approaches such as problem-based learning, project-based learning, and the use of active learning methodologies, aiming to foster student engagement and the development of professional competencies.

Institutional faculty development programs typically structure their formative actions through workshops, courses, and communities of practice, addressing topics such as active learning, pedagogical planning, assessment, and educational innovation. These experiences highlight the importance of systematic institutional policies for continuing professional development, aligned with program pedagogical projects and with the contemporary demands of Engineering Education.

Experience in Graduate Engineering Programs

Within graduate education, some Brazilian institutions have implemented programs and courses focused on the pedagogical preparation of master's and doctoral students in Engineering, with the aim of qualifying them for teaching in higher education. One such example is the University of São Paulo (USP) [14]. These initiatives generally combine pedagogical preparation activities with supervised teaching internships, contributing to the development of competencies related to the planning, implementation, and assessment of teaching and learning processes.

Such experiences include courses that address the foundations of Engineering Education, teaching methodologies, assessment, curriculum planning, the use of educational technologies, and academic production in the field. Evaluative studies of these courses indicate that even among graduate students who do not act directly as faculty members, there is recognition of the importance of pedagogical preparation for academic and professional careers. These findings reinforce the relevance of systematically including Engineering Education components in graduate programs, contributing to improved teaching quality and to the consolidation of the field in Brazil.

Methodology

This study is characterized as a qualitative investigation, grounded in the systematization of collective discussions and reflections conducted during two Targeted Sessions held at the 52nd

Brazilian Congress of Engineering Education (COBENGE 2024) and the 53rd Brazilian Congress of Engineering Education (COBENGE 2025). The information gathered during these sessions was articulated in this article based on previously defined guiding questions, which oriented the debates and the collective construction of knowledge.

For the organization and analysis of the empirical material, transcripts of the audio recordings from the Targeted Sessions were used, with the participants' consent. These records made it possible to identify, group, and systematize the main points raised by researchers and institutional representatives, as well as the convergences and divergences that emerged during the discussions.

Based on this systematization, the text was structured to present the knowledge produced through research and collective reflection, focusing on the concerns that motivated the organization of the sessions, particularly those related to the consolidation of graduate education in Engineering Education in Brazil and the definition of institutional strategies to strengthen the field.

Results and discussion

The discussions held during the Targeted Session at the 52nd COBENGE (2024) and further developed during the Working Group meeting at the 53rd COBENGE (2025) revealed a set of structural tensions related to the consolidation of graduate education in Engineering Education in Brazil. One of the central aspects identified concerns the social and institutional value attributed to graduate degrees in higher education. Master's and doctoral degrees are widely recognized as instruments for academic career advancement, particularly when pursued in so-called "hard" engineering areas directly associated with a faculty member's technical specialization.

Within this context, it was observed that pursuing graduate education focused on Engineering Education tends to be perceived as less attractive in terms of professional and institutional recognition. As discussed by the participants, many faculty members choose to pursue stricto sensu graduate degrees in specific engineering fields - even when their primary professional activity is teaching - rather than in areas focused on pedagogical and educational foundations. This choice was identified as one of the main barriers to the recognition and expansion of Engineering Education as a field within Brazilian universities.

At the same time, the discussions revealed the existence of a growing group of professionals interested in educational issues related to engineering education. This group is composed primarily of engineers, but also includes researchers from other fields who are dedicated to investigating and developing effective pedagogical practices in engineering programs. This diversity of profiles was identified as a strategic opportunity for strengthening the field, indicating potential for the expansion and consolidation of graduate programs in Engineering Education, provided that institutional articulation and formal recognition of the field are achieved.

It also became clear that existing initiatives in the country, although relevant, remain largely isolated and limited in scope. To date, no consolidated or widely recognized model of graduate education in Engineering Education has been identified; instead, there are individual or

institutional experiences that lack scale and national integration. This diagnosis reinforces the need for articulation among institutions and programs, a topic that was extensively discussed during the Working Group meeting.

A new and promising element highlighted in the discussions refers to the creation, in the second half of 2023, of a CAPES evaluation area dedicated to network-based professional programs associated with Basic Education [15], such as ProfMat and ProfFis. Participants indicated that this model could inspire the development of a similar proposal for Engineering Education, involving collaboration among multiple Higher Education Institutions and enabling faster and more equitable progress at the national level.

Institutional Changes in Engineering Schools

One of the central outcomes of the discussions concerns the need to institutionalize Engineering Education within universities through the creation of formal and recognized spaces within academic structures. The importance of institutionalized departments, centers, or research groups capable of housing and fostering scientific production and training in Engineering Education in a continuous and structured manner was emphasized.

International experiences, such as those observed at universities with a long-standing tradition in the field, were cited as references, demonstrating that the consolidation of Engineering Education is strongly associated with the existence of dedicated institutional structures that integrate research, faculty development, active learning methodologies, and engagement with industry. In such institutions, graduate-level education, including programs focused on Engineering Education and STEAM Education, constitutes an integral part of the academic strategy.

In the Brazilian context, the discussions indicated the existence of still incipient but relevant movements toward institutional recognition of the field. Recent initiatives involving the creation of interdisciplinary positions and academic areas related to Education were mentioned, signaling openness to the consolidation of Engineering Education as a legitimate field of research and training. These actions were interpreted as indicators that institutionalization is possible, provided it is supported by clear and long-term academic policies.

Support from Funding Agencies and Decision-Making Bodies

Another axis of discussion concerns the need for political and institutional articulation with the bodies responsible for the regulation and evaluation of graduate education in Brazil. Participants emphasized that the consolidation of Engineering Education as a graduate field requires coordinated action, led by institutions or associations with legitimacy and the capacity to engage in dialogue with organizations such as CAPES.

In this regard, a parallel was drawn with the process that led to the development and approval of the current National Curricular Guidelines for Engineering programs, which resulted from a collective and articulated effort among different stakeholders and achieved significant outcomes within a relatively short time frame. The discussions suggested that a similar strategy could be

adopted to raise awareness among relevant authorities about the need to recognize Engineering Education as a specific field of graduate training and research.

Faculty Development Experiences with Implications for Graduate Education

The discussions also highlighted successful faculty development experiences that may serve as references for the consolidation of graduate education in Engineering Education. One example cited concerns the pedagogical training requirements within the faculty career structure of the Federal Network of Professional, Scientific, and Technological Education, in which newly hired faculty members - regardless of holding master's or doctoral degrees - are required to complete complementary training in professional and technological education or related areas. This policy was identified as a relevant experience in valuing pedagogical preparation in higher education.

Another experience highlighted was that of professional graduate programs focused on faculty development with an emphasis on STEM, aimed at professionals from Engineering, Mathematics, Physics, Chemistry, and related fields. These programs were presented as examples of initiatives that integrate pedagogical training, teaching practice, and applied research, reinforcing the potential of professional graduate programs as a strategic pathway for strengthening Engineering Education in Brazil.

Final considerations

The discussions held during the Targeted Session at the 52nd COBENGE (2024) and further developed during the Working Group meeting at the 53rd COBENGE (2025) made it possible to construct a consistent overview of the challenges, potentials, and possible pathways for consolidating graduate education in Engineering Education in Brazil. The systematization of these reflections shows that, although relevant initiatives and successful experiences exist, the field is still in a process of structuring, requiring greater institutional articulation, formal recognition, and strategic actions in the medium and long term.

One central aspect concerns the need to identify, bring together, and articulate individuals, research groups, and institutions that share an interest in Engineering Education. The experiences presented throughout the sessions reveal the existence of individual, institutional, and context-specific efforts that have not yet evolved into a formalized, structured, and widely recognized graduate program. This scenario reinforces the importance of overcoming the fragmentation of existing initiatives and creating conditions for the collective construction of more robust and sustainable proposals.

In this sense, networking was identified as a fundamental strategy to leverage actions and promote the effective consolidation of graduate education in Engineering Education. Cooperation among institutions can expand the reach of existing experiences, reduce regional asymmetries, and accelerate the maturation of the field in Brazil. The discussions also highlighted the need for greater institutional boldness, as the institutions and actors involved in these debates have sufficient mobilization capacity to attract new stakeholders, influence academic agendas, and intervene more effectively in graduate education regulation and evaluation processes.

Another relevant direction concerns strengthening the international dimension of Engineering Education. Closer engagement with foreign institutions that have an established tradition in Engineering Education, Engineering Education research, or STEM/STEAM Education was identified as a strategic vector for the development of the field in Brazil. The establishment of international partnerships can foster the exchange of experiences, academic cooperation, faculty and student mobility, and the development of network-based graduate programs involving Brazilian and international institutions. This perspective aligns directly with the ASEE context by situating the Brazilian discussion within a global agenda for engineering faculty development and Engineering Education research.

Associated with this internationalization, the discussions raised the proposal of creating an international quality seal for graduate programs in Engineering Education, inspired by accreditation and certification models already consolidated in other fields and countries. This seal, structured at levels such as gold, silver, and bronze, could function as a mechanism for recognizing program maturity, academic quality, and alignment with previously defined criteria, such as scholarly production, institutional articulation, educational impact, pedagogical innovation, and international engagement. Such an initiative has the potential to promote continuous program improvement, enhance international visibility, and contribute to the consolidation of the field in Brazil and in partner countries.

As a practical outcome of the discussions, the creation of a specific Working Group focused on Graduate Education in Engineering Education and Technology within ABENGE was proposed. The formalization of this group, with approval from the association's board, could constitute a strategic space for continuing dialogue with CAPES and for leading national and international articulation initiatives. Among its potential responsibilities are the development of proposals for network-based graduate programs, the construction of reference frameworks for program certification and accreditation, and the strengthening of dialogue with international associations and institutions in the field.

In summary, the directions resulting from this work indicate that the consolidation of graduate education in Engineering Education in Brazil depends on a collective, articulated, and bold effort capable of integrating national initiatives, promoting international cooperation, and establishing innovative mechanisms for recognizing program quality. Such actions can make a decisive contribution to strengthening faculty development, research, and pedagogical innovation in Engineering, aligning the Brazilian context with contemporary international discussions and practices in the field.

An Integrative Effort to Strengthen Graduate Education

The final reflections also indicate that consolidating Engineering Education as a field of research and training requires an integrative effort across different areas of knowledge. When addressing the education of researchers in Science Education, it becomes essential to broaden the focus to include investigations into the teaching and learning processes of basic sciences within the context of engineering programs. Well-established programs in Physics, Chemistry, and

Mathematics Education, although highly relevant, still show limited systematic articulation with the specific demands of engineering education.

In this context, Engineering Education can play an articulating role by promoting dialogue among scientific, technological, and pedagogical fields and by contributing to the development of educational proposals that are more coherent with the National Curricular Guidelines and with contemporary challenges in engineering education. Strengthening graduate education in this field, therefore, depends on the ability to integrate knowledge, institutions, and actors within a collaborative perspective oriented toward improving the quality of engineering education in Brazil.

Within this horizon, articulation among areas, institutions, and countries reinforces the role of Engineering Education as an integrative field capable of engaging with international programs and contributing to the construction of shared quality reference frameworks. The consolidation of academic networks and international certification mechanisms can broaden the impact of these initiatives, strengthening graduate education and promoting the preparation of engineers more closely aligned with contemporary global challenges.

References

[1] SANTANA, A. L. M., de Deus Lopes, R. (2024). Using Real-World Problems and Project-Based Learning for Future Skill Development: An Approach to Connect Higher Education Students and Society Through User-Centered Design. In: Ehlers, UD., Eigbrecht, L. (eds) Creating the University of the Future. Zukunft der Hochschulbildung - Future Higher Education. Springer VS, Wiesbaden

[2] CARDOSO, J. R.; GRIMONI, J. A. B. - Introdução a Engenharia - Uma abordagem em ensino por competências, 2023;

[3] BRASIL. Ministério da Educação e Cultura. Conselho Nacional de Educação. Câmara de Educação Superior. Diretrizes Curriculares para os cursos de engenharia. Resolução CNE/CES nº 2, de 24 de abril de 2019. Disponível em: Acesso em: abr 2024.

[4] BRASIL. [Constituição (1988)]. Constituição da República Federativa do Brasil de 1988. Brasília, DF: Presidência da República, [2024]. Disponível em: www.planalto.gov.br. Acesso em: 18 jan. 2026.

[5] DELIZOICOV, D.; ANGOTTI, J. A. P.; PERNAMBUCO, M. M. Ensino de Ciências: fundamentos e métodos. 5 ed. São Paulo: Cortez, 2023.

[6] CYRINO, M. C. C. T; RIZZATTI, I, M; RÔÇAS, G. Os desafios da Área de Ensino: "é caminhando que se faz o caminho". Bolema, Rio Claro (SP), v. 37, n. 76, p.i-xvi, ago. 2023

[7] SASSERON, L. H.; MACHADO, V. F. Alfabetização científica na prática: Inovando a forma de ensinar Física. 1 ed. São Paulo: Editora Livraria da Física, 2017.

[8] CACHAPUZ, A. et al. A necessária renovação do ensino de Ciências. 3 ed. São Paulo: Cortez, 2011.

[9] ASSUMPÇÃO, G. S. et al. Current trends in Production Engineering Education: Active learning strategies. In: IJCIEOM 2020 International Joint Conference on Industrial Engineering and Operations Management, 2020, Rio de Janeiro. Anais eletrônicos […]. Rio de Janeiro: ABEPRO, 2020.

[10] ASSUMPÇÃO, G. S.; CASTRO, A. C.; CHRISPINO, A. Políticas Públicas em Educação Superior a Distância – Um estudo sobre a experiência do Consórcio Cederj. Ensaio: aval. pol. públ. Educ., Rio de Janeiro, v. 26, n. 99, p. 445-470, jun. 2018.

[11] BYBEE, R. W. The case for STEM education: challenges and opportunities. Arlington, Virginia: National Science Teachers Education, 2013.

[12] SILVA JUNIOR, J. M.; CORDEIRO, R. V. Steam education: características e reflexões acerca de uma proposta educacional ativa e interdisciplinar. Congresso Internacional de Educação e Tecnologias (CIET) e Encontro de pesquisadores em Educação e Tecnologia (EnPET), 2022.
[13] PUGLIESE, G. O. Stem Education – um panorama e sua relação com a educação brasileira. Currículo sem Fronteiras, v. 20, n. 1, p. 209-232, 2020.
[14] PRÓ-REITORIA de Pós-graduação da USP. O que é o PAE. 2024. Disponível em: https://www.prpg.usp.br/pt-br/pae/o-que-pae Acesso em: 7 ago. 2024.
[15] CIÊNCIAS E HUMANIDADES PARA A EDUCAÇÃO BÁSICA, 2024. Disponível em: https://www.gov.br/capes/pt-br/acesso-a-informacao/acoes-e-programas/avaliacao/sobre-a-avaliacao/areas-avaliacao/sobre-as-areas-de-avaliacao/prof-proeb. Acesso em: 18 nov. 2024.

APPENDIX A

Teacher Education and the Science, Technology, and Society (STS) Movement

Brazilian legislation grants universities autonomy in teacher education, particularly in science and technology, while maintaining the principle of the inseparability of teaching, research, and extension, as established in Article 207 of the Federal Constitution [4]. The National Common Curricular Base (BNCC) and the National Education Plan (PNE) provide guidelines for initial and continuing teacher education aimed at ensuring high-quality education for the challenges of the 21st century.

The National Curricular Guidelines for Continuing Teacher Education establish, in Article 3, that professional development should encompass competencies in three dimensions: knowledge, practice, and professional engagement. However, many teacher education programs still reproduce outdated practices and content, compromising teaching quality [5]. This gap is especially evident in science education, where improving teacher qualification requires structural and attitudinal changes in teacher education processes.

In this context, [7] argue that science teaching should move beyond content transmission, promoting a critical and participatory approach to scientific and technological issues and their relationships with society and the environment. Science education is thus central to teacher education, particularly in graduate programs, as it integrates educators into research. Research activity supports the socialization of scientific knowledge and fosters critical thinking, essential for understanding Science, Technology, and Society (STS) interactions [8].

Engineering Education in Brazil and the Expansion of Distance Learning Programs

The renewal of engineering programs has been observed in several countries over recent decades. In Brazil, this concern has intensified in recent years [9], particularly after the approval of the new National Curricular Guidelines for Engineering programs in 2019. These guidelines require programs to promote learning processes focused on students' intellectual autonomy, competency development, active learning methodologies, as well as institutional policies for student support and continuous faculty development [3].

This transformation is also linked to the expansion of educational models beyond traditional face-to-face instruction, including distance and hybrid engineering programs, which require coherent and specific didactic-pedagogical approaches.

The emergency remote teaching experience during the COVID-19 pandemic increased the visibility of distance education by exposing faculty and students to digitally mediated practices. However, distance education was already recognized as a legitimate modality in higher education before the pandemic [10]. This scenario highlights the need for faculty development and systematic research in Engineering Education addressing active learning, interdisciplinary practices, and the critical pedagogical use of educational technologies, since technology alone does not ensure improvements in educational processes.

STEM/STEAM Education

The STEM movement emerged in the United States in the 1990s in response to the growing demand for a qualified workforce in scientific and technological fields. STEM education faces major challenges, especially in integrating science, technology, engineering, and mathematics, which have traditionally been organized as separate disciplines. A key difficulty is incorporating technology and engineering into a context historically centered on mathematics and natural sciences, with emphasis on inquiry and problem solving [11].

In Brazil, STEM was introduced as an effort to promote more integrated curricula and contextualized pedagogical practices. Initiatives have sought to stimulate students' interest in scientific and technological careers, moving away from passive learning models. As highlighted by Silva Júnior and Cordeiro [12], STEM education encourages student protagonism, fostering autonomy, creativity, and curiosity in problem-solving situations.

These authors examine STEM/STEAM education from multiple perspectives. From a public policy standpoint, it responds to the demand for professionals in scientific, technological, and engineering fields and their impact on the economy. Methodologically, it emphasizes student-centered approaches, with teachers acting as mediators in learning based on challenges, projects, and prototype development. In engineering curricula aligned with the DCNs (2019), STEAM prioritizes competency development over strictly disciplinary structures and values interdisciplinarity through integrative projects and collaborative work.

Despite the significant growth in STEM/STEAM publications in recent years, [13] as cited in [12] warns that the movement has not yet consolidated as a dominant pedagogical practice in Brazil. The author notes that STEM should not be treated as a redemptive model, while recognizing its potential contributions to science education through the integration of technology and engineering.