OTHER THEMES

The Pedagogical Formation of Teacher Engineers of EPTNM

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ABSTRACT – The Pedagogical Formation of Teacher Engineers of EPTNM. This work aims to analyze the pedagogical formation of teachers engineers who work in Technical Vocational Education of High School Level (EPTNM). Interviews had been conducted with eight teacher engineers who work in the EPTNM and who have done any course of pedagogical formation at any *campi* of the IFMG or the CEFET-MG. The results indicated that the interviewed teachers sought pedagogical formation in university graduate courses (teacher training) and specialization courses (*lato sensu* postgraduate studies) only after graduating from engineering courses. In conclusion, the pedagogical formation has a transforming potential in the way of performing and thinking of the teachers, and it is quite relevant to the formation of the teacher engineer.
Keywords: **Pedagogical Formation. Teacher Engineers. Technical Vocational Education of High School Level (EPTNM).**

RESUMO – A Formação Pedagógica de Professores Engenheiros da EPTNM. Este trabalho tem como objetivo analisar a formação pedagógica dos professores engenheiros que atuam na Educação Profissional Técnica de Nível Médio (EPTNM). Foram realizadas entrevistas com oito professores engenheiros que atuam na EPTNM e que realizaram algum curso de formação pedagógica de diversos *campi* do IFMG e do CEFET-MG. Os resultados apontaram que os professores entrevistados buscaram a formação pedagógica em cursos de graduação (licenciatura) e especialização (pós-graduação *lato sensu*) somente após se formarem em cursos de engenharia. Concluiu-se que a formação pedagógica tem um potencial transformador da forma de agir e de pensar do docente e é bastante relevante para a formação do professor engenheiro.
Palavras-chave: **Formação Pedagógica. Professores Engenheiros. Educação Profissional Técnica de Nível Médio.**

Introduction

Engineering has played an important role throughout the development of our society and has evolved along with advances in science and technology. It has been present since Ancient Era, as in the construction of the pyramids in Egypt and in the creation of the steam engine, to the present day, as in modern airplanes, buildings, weapons, automation systems, etc.

For Bazzo and Pereira (2006, p. 70) "[...] modern engineering is one that is characterized by a strong application of scientific knowledge to the solution of problems", but, in addition to scientific knowledge, it can be said that it is also characterized by the application of social, cultural, political and economic knowledge. Modern engineering differs from the engineering of the past in its projects by the application of laws, theories, scientific knowledge, among others, and no longer depends exclusively on people's empirical knowledge. The engineer is the professional who will use the knowledge and techniques of engineering, in a creative way, to solve problems in society.

The university graduate engineering courses train engineers to work in several areas: food, mechanics, electrical, production, among others; based mainly on the following contents: "Administration and Economics; Algorithms and Programming; Materials science; Environmental Sciences; Electricity; Statistic; Graphic expression; Transport Phenomena; Physics; Computing; Math; Solid mechanics; Scientific and Technological Methodology; and Chemistry" (Brasil, 2019a, p. 44).

Among the various professional career options that an engineer can pursue, some choose a teaching career in Vocational and Technological Education courses (EPT), according to Costa (2017, p. 270), probably, "[...] because the profession does not have a legal requirement for specific training". Thus, selection processes and public civil service exam for those in the engineering area who require some training for teaching are rare.

The case is that engineers are not previously prepared at graduation to perform such activity, as bachelors in engineering, unlike teaching degrees, do not focus on pedagogical training and teaching. Pinto and Oliveira (2012, p. 4) point out that "[...] in undergraduate courses there is no concern with training teachers. The goal is training for professional practice and teaching has never been considered curricularly as a professional possibility for the engineer". In areas such as natural sciences and engineering, there is no culture of pedagogical training; technical knowledge is prioritized (Silva; Faria; Almeida, 2016).

Resolution CNE/CES nº 2, of April 24, 2019 - which establishes the National Curriculum Guidelines (DCNs) for the University Graduate Course in Engineering, that "[...] must be observed by Higher Education Institutions (IES) in the organization, development and evaluation of the Engineering course within the scope of the Higher Education Systems in the country" (Brasil, 2019a, p. 43) – contributes to this situation, as it does not predict aspects related to teaching in the profile and

expected competencies of graduates of engineering courses. Rezende (2020, p. 63) highlights that "[...] the competencies provided for in this legislation must be improved and deepened so that there is the construction of the knowledge necessary for teaching".

Although engineering professors usually prioritize, in the continuity of their studies and in their research, the specific knowledge of their initial training, it is known that there are already engineering professors who recognize the importance of pedagogical training for the exercise of their profession and seek to acquire it in teacher training courses. As highlighted by Pimenta (2005, p. 24) "[...] there is a recognition that to know how to teach, experience and specific knowledge are not enough, but pedagogical and didactic knowledge are necessary".

Based on the hypothesis that engineering professors, at some point in their teaching career, seek to carry out a pedagogical training and in order to better understand the training of engineering professors and their role as teachers, the research question is: what is the pedagogical formation of engineering professors who work in Technical Vocational Education of High School Level (EPTNM) at the Instituto Federal de Educação, Ciência e Tecnologia de Minas Gerais (IFMG) and at the Centro Federal de Educação Tecnológica de Minas Gerais (CEFET-MG)[1]?

To answer this research question, the following general objective was defined: to analyze the pedagogical formation of engineering professors who work at EPTNM; as well as the specific objectives: to identify the formative curriculums of the teachers investigated, to know the pedagogical formation of the engineering teachers at EPTNM, and to draw a diagnosis between the formative curriculum and the pedagogical formation of the engineer teacher.

The choice for the pedagogical training of engineering professors at EPTNM as an object of research is due to its relevance to the training and teaching performance of teachers, especially for teachers who did not have this initial training in their graduation, such as engineers. In addition, it is necessary to disseminate and discuss data on teacher education, in order to understand where we are and what can and should be improved in formative courses. According to Nóvoa (2009, p. 45), there has been a lack of dedication of "[...] more time to the communication and discussion of concrete experiences in the training of teachers existing in several universities of reference" and, in particular, to the training of teachers of the EPTNM, because "[...] the non-perception of Vocational Education (EP) teachers as education professionals is reinforced, at a second level, by the lack of studies on the subject" (Gariglio; Burnier, 2014, p. 940).

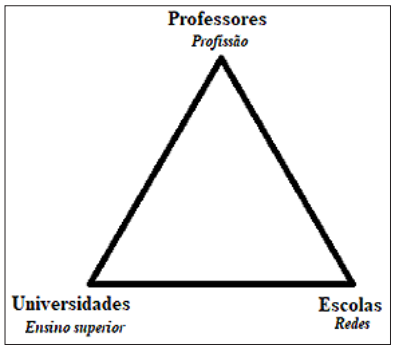
Still, this research is important for revealing several issues related to the training of teachers who work in professional education, because, as Machado argues (2019, p. 212), "[...] There is a range of issues lacking research, the results of which can contribute to the advancement of understanding of the limits and the limitations of teacher formation processes for working in professional education courses in Brazil and their institutionalization".

Pedagogical Knowledge and Teacher Education

Nóvoa (2019), reflecting on teacher education, signals the importance of thinking about teacher training based on the profession itself, since it is the experience brought by the teachers themselves, from their daily work and contact with students that will serve as a basis for the renewal and construction of new knowledge. Another important aspect for teacher education and for the strengthening of the profession is the exchange of experiences and information among teachers. It is through the division of knowledge among teachers that it becomes possible to find solutions to improve pedagogical practice (Nóvoa, 2019).

Figure 1 demonstrates the formation triangle, prepared by Nóvoa (2019). The author argues that, for the century in which we live, it is necessary to rebuild the environment for teacher education. The key to this reconstruction would be linked to the union of the three vertices of the triangle – Universities, Teachers and Schools – which together have a transforming potential for teacher education.

Figure 1 – Formation triangle



Note Subtitle: Teachers - *Profession* (Professores - *Profissão*) / Schools - *Networks* (Escolas - *Redes*) / Universities - *University education* (Universidades - *Ensino superior*)
Source: Nóvoa (2019, p. 7).

It is at the university that systematized, intellectual and scientific knowledge is found, with space for critical thinking. The school is the space that is linked to the teaching practice and the accomplishment of teaching, that is, to "being a teacher". To connect these two loose ends and form the triangle, teachers are the central point of the triad; it is where the training potential is, and where it is possible to unite the theory coming from universities with the practice carried out in schools (Nóvoa, 2019).

For Imbernón (2012), it is necessary to seek new paths for teacher education, approaching the formation of innovative practices with the use of forms of unlearning, so that learning can be resumed, with the objective of teaching transformation and not training. Thus, a more dialogic format is sought to build a space in which one can speak, but also in which one can listen, that is, a less individualistic and more collective formation.

Resolution CNE/CP No. 2, of December 20, 2019 (Brasil, 2019b), in its Art. 5, establishes the foundations that must be adopted in teacher training courses. It appears that, for this Resolution, teacher training is based on three main foundations: a solid basic training, the relationship between pedagogical theories and practices and the use of previous knowledge (Brasil, 2019b).

Of these foundations, the furthest from the initial training of the teacher engineer is the association between theories and pedagogical practices; therefore, this foundation can be worked on with greater emphasis in teacher training courses offered to these professionals. According to Costa and Malta (2018, p. 220) "[...] to be a teacher it is necessary, urgent and fundamental to know the studies in the field of education and adjacent. It is not enough to learn from practice, as every educator needs to reflect on and understand the relationship established between theory and practice".

According to Moura (2008), the teacher formation in the areas of engineering, law, medicine and other university careers, apart from the degrees in teacher training, goes through two moments. The first one is linked to specific training at graduation, in which knowledge can be deepened in postgraduate studies, mainly *stricto sensu*, and the second in a didactic-political-pedagogical training.

Pedagogical training for teacher engineers can occur through continuing education courses for teachers, who "[...] should not only deal with technique and content, but to promote pedagogical changes and lead to the improvement of teachers towards the personal and professional development of the community" (Gorzoni; Davis, 2017, p. 1402). Continuing education can be understood as training that is subsequent to the initial training of the professional and that takes place in courses with specific training actions, in specific spaces, based on also specific demands (Dalben, 2004).

Pimenta (2005) warns that continuing education courses for teachers, in which the teaching and pedagogical practice is not addressed in their contexts, will have little chance of success in improving teaching performance, since it will not be possible to transform new knowledge into new practices. Also the courses in which a transmitting training prevails, based on outdated theories, distant from the teachers' school reality and their competences, are doomed to failure in the process of teaching transformation (Imbernón, 2012).

In continuing education as a teacher, it is essential that he/she critically reflects on his/her teaching performance, because it is only through reflection on his/her way of acting and doing that this professional will be able to improve his/her teaching practice. The permanent training of teachers only becomes possible when he/she consciously recognizes himself/herself as an unfinished and unaccomplished being (Freire, 1996).

Resolution CNE/CEB nº 6, of September 20, 2012 (Brasil, 2012), points out as a possibility of pedagogical training the *lato sensu* postgraduate course with a pedagogical nature, and the teacher training

courses for graduated and non-licensed for teaching for those who have been approved in public civil service exam or who are in effective teaching practice:

> Art. 40 Initial formation for teaching in Technical Vocational Education of High School Level is carried out in university graduate courses and teaching course programs or other forms, in accordance with the legislation and with specific norms defined by the National Education Council. [...]
> § 2º For non-licensed graduated teachers who are effectively exercising the teaching profession or who have been approved in public civil service exam are guaranteed the right to participate or have their professional knowledge recognized in processes aimed at pedagogical training or certification of teaching experience, which may be considered equivalent to degrees in teacher training:
> I - exceptionally, in the form of a *lato sensu* postgraduate course with a pedagogical nature, in which the course conclusion work is, preferably, an intervention project related to teaching practice; [...]
> III - in the form of a second degree, different from their original degree, which will qualify them for teaching (Brasil, 2012, p. 12).

Pedagogical training should lead teachers to reflect on their teaching practice, placing this practice as a starting point and an arrival point, because only by reflecting on their current actions will they be able to modify them and constitute a new know-how, after all, "[...] the specificity of pedagogical training, both initial and continuous, is not to reflect on what you are going to do, nor on what you should do, but on what you really do" (Houssaye, 1995[2] *apud* Pimenta, 2005, p. 26). Therefore, reflection on teaching practice is a fundamental part of the pedagogical training of teachers, and this reflection must be allied with the approach of pedagogical theories, because only with the integration between theory and practice will it be possible to fully train the teacher, according to the foundations defined in Art. 5 of Resolution CNE/CP No. 2, of December 20, 2019 (Brasil, 2019b). Nóvoa (2017) corroborates this thought by basing teacher training in an integrated way, involved in theoretical moments, in the disciplines and sciences of education, and in practical moments, which make it possible to discover new issues to be studied through research and reflection.

Pedagogical training can help in the formation of identity as a teacher, as highlighted by Pimenta (2005, p. 18): "[...] identity is a historically situated construction process". Today's teacher is not the same as in the past; the characteristics of the profession have been changing, since it is influenced by the impositions/demands imposed by society. According to Pimenta (2005), one of the great challenges of teacher training courses is to make the teacher see himself more and more as a teacher, that is, to collaborate in the construction of the teacher's identity.

Pedagogical training courses can contribute to the development and improvement of pedagogical knowledge, which significantly help the teacher in teaching practice. In addition, such training courses can help in the construction of teachers aware of their role as people who can transform other people, so that they can act in a critical and reflective way during the training of their students, collaborating for the formation of autonomous citizens, as from scientific, pedagogical and cultural knowledge. According to Urbanetz (2011), the critical and reflective teacher is "[...] the one who, when reflecting on their practice, will be able to understand it, adapt it to the reality of their students, and transform it" (Urbanetz, 2011, p. 107).

Pedagogical knowledge integrates the knowledge necessary for teacher training, making up a significant part of this knowledge. Pedagogical knowledge can be worked from different sources in pedagogical training, as pointed out by Nóvoa (2017):

> As for pedagogical knowledge, it is certain that it plays an important role in training, but it is not to be confused with professional teaching knowledge. Simply put, it consists of three groups of disciplines: i) those with a psychological root, on the knowledge of children and young people, cognition and learning; ii) those related to social contexts, history and educational policies; iii) methodologies and didactics. A fourth, more recent group includes the disciplines of research or reflection on the production of knowledge (Nóvoa, 2017, p. 1126).

Pedagogical training must provide for the updating of the teaching methods used by teachers, so that they are efficient and suitable for the teaching level, as indicated by the United Nations Educational, Scientific and Cultural Organization (Unesco, 1974[3] apud Machado, 2019, p. 209): "[...] it must be designed in such a way that the future teacher becomes aware of the essentially creative nature of his profession and does not mechanically apply, throughout his career, the techniques learned during his initial training".

The National Education Council, in Art. 21 of Resolution CNE/CP No. 2, of December 20, 2019 (Brasil, 2019b), defines the minimum workload for pedagogical training courses for graduated people who are not licensed to teach and who wish to be enabled to teach school subjects in Educação Básica[4] related to his/her area of initial training, subdividing the minimum workload of these courses into two groups, in which different skills must be worked on. The first group should address professional competencies related to the dimensions of professional knowledge, professional practice and professional engagement. In the second group, aspects related to teaching pedagogical practice should be worked on. It is noteworthy that these courses can only be offered by Higher Education Institutions that already have degree in teacher training courses in the intended qualification.

> Art. 21. In the case of non-licensed graduated ones, qualification for teaching will take place in a course intended for

> Pedagogical Formation, which must be carried out with a basic workload of 760 (seven hundred and sixty) hours with the format and the following distribution:
> I - Group I: 360 (three hundred and sixty) hours for the development of professional skills integrated into the three dimensions contained in the BNC-Formação, established by this Resolution.
> II - Group II: 400 (four hundred) hours for pedagogical practice in the area or in the curricular component.
> Single paragraph. The pedagogical formation course for non-licensed graduated ones may be offered by a Higher Education institution as long as they teach a recognized degree in teacher training course and with satisfactory evaluation by the MEC in the intended qualification, without the issuance of new authorizing acts (Brasil, 2019b, p. 10).

Pedagogical training courses are expected to develop knowledge and skills, attitudes and values that help in the execution of teaching activities, enabling the continuous construction of teaching know-how, based on the challenges that teaching imposes in everyday school life (Pimenta, 2005). It is also expected that critical and reflective teachers will be trained, capable of reinventing themselves in the face of career changes, of making assertive decisions, of self-assessment and of knowing how to interact with the different subjects of the school environment.

Methodology

Initially, a literature review was carried out (Mazzotti; Gewandsznajder, 1999), from which we sought to build a theoretical framework to support the research. According to Rampazzo (2005, p. 53), "[...] any kind of research, in any area, presupposes and requires a previous bibliographic research, either to survey the situation of the question, or for theoretical foundations, or even to justify the limits and contributions of the research itself". At the end of the theoretical part of the research, the field research was carried out.

Research Context and Participants

The IFMG and CEFET-MG were used as the research locus. The institutions were chosen as an empirical field of research because both have an expressive number of teacher engineers working in EPTNM (Dias; Freitas; Moraes, 2020). In addition, the chosen institutions are public and offer high quality education, free of charge, to their students. The research participants were teacher engineers who work in EPTNM and who have taken a pedagogical formation course.

In this research, 8 workers were randomly selected for participation: 4 teachers from CEFET-MG and 4 from IFMG. Initially, contact was made by e-mail with the various course coordinators, department heads and sub-heads of the various CEFET-MG and IFMG campuses, through the e-mail available on the institutions' website, so that they

could indicate teachers with the desired profile for this research and their respective e-mail contacts. From the responses, a list was generated for each institution with the possible participants, based on which a random draw of 4 participants from each institution was made. Then, contact was made by e-mail with the possible participants drawn, in which an invitation was made to participate in the research.

The participants who took part in this research belong to the Belo Horizonte campi (*campi* I and II) and Curvelo, from CEFET-MG; and from Bambuí, Governador Valadares and Sabará *campi*, from the IFMG.

It should be noted that this research involved human beings, so it followed the ethical aspects indicated in the guidelines for research with human beings, determined by the Resolution of the Conselho Nacional de Saúde (CNS) No. CNS Resolution No. 510, of April 7, 2016 (Brasil, 2016), and by the Circular Letter of the Comissão Nacional de Ética em Pesquisa (CONEP) No. 2, of February 24, 2021 (Brasil, 2021).

The project was submitted to the Comitê de Ética em Pesquisa (CEP) of CEFET-MG, via Plataforma Brasil, for approval, and activities involving human beings only started after the project was approved by the CEP. The researchers obtained authorization from the institutions to carry out the research.

Data Collection and Analysis

This work had as its research object the pedagogical formation of teacher engineers in EPTNM, which is why a qualitative approach was adopted, to seek knowledge from the point of view of the investigated subjects, inserted in their social context (Lüdke; André, 2018).

The interview was the data collection instrument used. This technique has the great advantage of obtaining the desired information immediately and also allows the interviewer the possibility of better clarifying any answer given by the interviewee during the interview itself, which makes it a robust instrument for data collection in qualitative research, making it possible to cover issues in more depth, which would not be possible with other data collection instruments, as stated by Mazzotti and Gewandsznajder (1999, p. 168): "[…] the interview allows dealing with complex topics that could hardly be investigated adequately through questionnaires, exploring them in depth".

After the data collection phase, through interviews, data analysis was carried out, using as a basis the content analysis proposed by Bardin (2016), based on categorical analysis. Content analysis is a form of communication analysis, in which the meanings of the content of messages are sought, according to their context, and can be defined as "[…] a set of communication analysis techniques that use systematic procedures and message content description objectives" (Bardin, 2016, p. 44).

The Formative Curriculum and the Pedagogical Formation of Teacher Engineers

The courses taken by each research participant, the institution where the courses were held and the year of completion can be seen in Table 1.

Table 1 – Formative Curriculum of Participants, by Academic Degree

Identification	EPTNM	University graduate	Postgraduate studies		
			Lato sensu	*Stricto sensu*	
			Specialization	Master's degree	Doctorate degree
Teacher 1 (T1)	Electronics Technician (CEFET-MG) 2003	Metallurgical and Materials Engineering (UFMG) 2008	Teaching (IFMG) 2020	Materials Engineering (UFOP) 2011	Metallurgical and Mining Engineering (UFMG) 2017
Teacher 2 (T2)	- Data Processing Technician (POLIMIG) 2002 - Mechanical Technician (SENAI) 2002	Control and Automation Engineering (PUC-MG) 2007	- Project Management (FGV) 2013 - Teaching (IFMG) 2020 - Professional and Technological Education (UNINA) 2021	Electrical Engineering (UFMG) 2017	–
Teacher 3 (T3)	Electronics Technician (CEFET-MG) 2003	- Electrical Engineering (UFMG) 2011 - Maths Teacher Training Course (FAVENI) 2021	–	Electrical Engineering (UFMG) 2017	–
Teacher 4 (T4)	–	Civil Engineering (UEMG) 2015 - Maths Teacher Training Course (UNIFRAN) 2017	Geotechnics (FCV) 2018	–	–
Teacher 5 (T5)	Electronics Technician (CEFET-MG) 2005	Electronic and Telecommunications Engineering (PUC-MG) 2012	Teaching in Vocational and Technological Education (SENAI CETIQ) 2014	–	–
Teacher 6 (T6)	Accounting Technician (IMACO) 1978	- Electrical engineering (PUC-MG) 1986 - University Degree in Pedagogical Training (CEFET-MG) 1996	Management (CEFET-MG) 1998	Technology (CEFET-MG) 2001	Science Teaching (UNICSUL) 2014

Teacher 7 (T7)	Surveying Technician (IFSC) 2018	Civil Engineering (UFU) 2010	- University Teaching (UFU) 2016 - Finance and Business Strategies (UFU) 2011	Civil Engineering (UFU) 2016	–
Teacher 8 (T8)	Electrical Technician (ETFMG) 1978	Electrical Engineering (PUC-MG) 1985	Teacher training (CEFET-MG) 2012	Electrical Engineering (UFMG) 2002	–

Source: Prepared by the authors, based on research data.

Analyzing Table 1, it is observed that only Professor 4 does not have training at EPTNM and that, among the teachers who have this training, Professor 7 was the only one who did not attend EPTNM as the first academic formation and only Professor 2 carried out two trainings in EPTNM courses. As for higher education, it was found that all teachers initially graduated in Engineering and that teachers who have a second degree also took teacher training courses. All the investigated teachers have postgraduate studies course (*lato sensu* and/or *stricto sensu*), and most of the professors who took master's and/or doctorate degree courses continued their studies in the area of Engineering. When comparing the degree of academic formation of the interviewed teachers from the IFMG (T1 to T4) and CEFET-MG (T5 and T8), it can be seen that they are identical, with 1 (25%) with specialization, 2 with a master's degree (50 %) and 1 (25%) with a doctorate degree.

When the professors were asked the following question: "during your engineering degree, did you take any discipline focused on pedagogical training?", all of them reported that they did not attend. The statements of T7 and T3 exemplify the answers:

> No, I didn't and I didn't even know it existed. And look, I was a student who took classes in another courses: for example, I was studying Civil Engineering and I have studied two subjects in college in the Geography course; I studied Cartography and also Environmental Planning, not to mention the elective subjects [...] I did all this and didn't know it existed (T7).
>
> No. [...] There was a part of the course where we had to study some subjects of free education, so we could choose to do anything, but there was no direction for this [...] It was possible to take any subject of the many courses at the college (T3).

This situation reveals that there is no concern, on the part of some educational institutions, during the training of the engineer in his university graduate degree, to prepare him minimally for teaching, even knowing that this may be a professional activity that he can exercise. In the reports of T7 and T3, it can still be seen that there is a lack of guidance in relation to students of engineering courses regarding the possibility of becoming professors in the future, which is a problem, because, even in the curriculum the course does not contain any college subject of this type - as Professor 2 also informs: "none, [...] in the curriculum there was none" –, the engineering course student could seek this for-

mation in elective/optional subjects in other college courses, but only if they received guidance on this issue and if it was in their interest".

In seeking to understand whether the teachers participating in the research considered pedagogical training necessary for the engineer, it was observed that most of them declared that pedagogical training is essential for the engineer who wants to be a teacher, as can be seen in the arguments of T4, T5 and T7:

> I think so. I think not just for people in the engineering field, I consider any professor in any specific field, whether engineering, law, medicine, whatever. When you become a teacher, it is important to seek pedagogical training because [...] Teaching is a very complicated activity. Talking about learning is very complicated and it doesn't mean that because you are an engineer, you are prepared to work as a teacher [...] (T5).
> [...] We go for the gift and the ability, but I don't think that should happen. The teacher had to be trained to enter a classroom to teach (T7).
> [...] This pedagogical part makes a lot of difference in the teacher's didactics. I realize that each teacher has a different didactics, but when you don't know and don't have a pedagogical training, you don't work didactically [...] You arrive to teach your class, transmit the content, transfer it in a way that you believe everyone is understanding, but is everyone really understanding? [...] (T4).

Teacher 5's report shows how complex the teacher's activity is, since he must provide learning to different students, and how engineers are not ready for teaching, even though they have graduated from a higher level course such as engineering. Teachers 4 and 7, on the other hand, address the issue of how the lack of pedagogical training can harm the lives of students and teachers, because when the teacher does not have this formation, he acts according to his intuition and with what he thinks it is right, but that way he has less chance of success in promoting student learning, because he didn't have the necessary formation to act as a teacher. These testimonies reinforce how pedagogical training is essential for the teacher engineer. Thus, the idea that it is possible to learn to be a teacher only through professional practice cannot be accepted, as Urbanetz (2011, p. 107) also states: "[...] it is no longer possible to accept the concept of a reflective teacher emptied of content, whose training would result from reflection on their practice, without rigorous theoretical training, both in the specific area and in the pedagogical area".

Table 2 highlights the pedagogical training course carried out by each participant, as well as the modality in which it was offered, its workload and its duration.

Table 2 – Pedagogical Training Course carried out by each Research Participant

Identification	Pedagogical training course	Teaching modality	Workload	Course completion period
Teacher 1	*Lato sensu* postgraduate course in Teaching	Distance learning	360h	2019-2020
Teacher 2	*Lato sensu* postgraduate course in Teaching *Lato sensu* postgraduate degree in Professional and Technological Education	Distance learning Distance learning	360h 450h	2020-2020 2020-2021
Teacher 3	Maths Teacher Training Course	Distance learning	1160h	2020-2021
Teacher 4	Maths Teacher Training Course	Semipresencial	1200h	2016-2017
Teacher 5	*Lato sensu* postgraduate degree in Teaching in Vocational and Technological Education	Semipresential	420h	2013-2014
Teacher 6	Teacher Training Course	Presential	960h	1996-1996
Teacher 7	*Lato sensu* postgraduate course in University Teaching	Presential	400h	2016-2016
Teacher 8	*Lato sensu* postgraduate course in Teacher Training	Presential	360h	2010-2012

Source: Prepared by the authors (2021), based on research data.

The courses carried out were offered in distance learning, presential or semipresential modalities. The minimum course load is 360h and the maximum is 1200h. The teacher training courses that were carried out have a much higher workload when compared to the *lato sensu* postgraduate specialization courses carried out. Teacher 2 was the only one who carried out two pedagogical training courses. Most (62.5%) of the teachers sought pedagogical training in specialization courses (*lato sensu* postgraduate).

It was identified that, during the pedagogical training courses carried out by the research participants, subjects/themes such as critical student training, teacher socio-educational performance, inclusion, educational psychology, teaching and learning, teaching methodologies, history of EPTNM, evaluation, relationship between teacher and student, didactics, teaching practice, among others. All these subjects/themes are very relevant to teacher training and are well aligned with what Machado (2019, p. 209) indicates: "[...] pedagogical formation must therefore include basic instruction, psychology classes on the age groups to which the education will be directed and a complete preparation for the use of modern methods of teaching technical and professional subjects".

When investigating whether the pedagogical training course brought any significant change to the teachers, it was noticed that most of the interviewed teachers had some positive change in their teaching practice and/or in the way they see education. These changes occurred,

for example, in the teaching-learning process, in the way of thinking about the evaluation process, in the teacher's didactics, etc.

> It has changed [...] instead of giving importance only to the content, I started to give importance to the student's learning [...] This was from the course, where I paid attention to knowing how to listen to the student, about trusting the ability of the student, since many teachers do not trust (T8).
> It made me reflect a lot, I would say, especially in the evaluation part, it was something I say, it was the biggest change in my behavior as a teacher [...] (T2).
> The course made me look at the education area in a way that I didn't have, precisely this theoretical look, which I didn't have until then. [...] (T5).

In the cases of the few teachers participating in the research who reported that there was no change related to their work as a teacher after having taken the pedagogical training course, it is common to have the fact that the courses these teachers took were very theoretical, in which no relationship between theory and practice was stimulated, or, when it was stimulated, this relationship would have taken place in a very superficial way, which may be one of the causes to justify why these courses have not caused any significant change. Pimenta (2005), regarding such courses, states that:

> These programs have been shown to be inefficient in altering teaching practice and, consequently, situations of school failure, as they do not take the teaching and pedagogical practice at school in their contexts. By not placing them as the starting point and the arrival point of training, they end up only illustrating the teacher individually, not allowing him/her to articulate and translate new knowledge into new practices (Pimenta, 2005, p. 16).

Pedagogical training courses that are purely theoretical do not encourage the transformation of what was seen during training into practical applications, as expressed by some teachers:

> No... Nothing! I don't think so, because it wasn't an applicable class, it wasn't an applicable thing, it was a very theoretical thing. I confess that the course served more to understand the minds of my fellow pedagogos[5] who work at the school; to understand how they think than for me to apply in my teaching practice (T1).
> I have a hard time taking that into my discipline. Sometimes I even see this in other disciplines, so talking to one and the other I realize that it can be done one way or another, but I find it difficult to distance myself from my subject and manage to think wow, it fits here [...] (T7).

According to Freire (1996), the teacher will only have the ability to improve their teaching performance if they critically reflect on their teaching practice. So, by not incorporating the practical experiences of teachers into the pedagogical training courses, the relationship between the knowledge of pedagogy and teaching practice becomes difficult, that is, that is, the action of reflection on what is done in comparison with pedagogical theories is inhibited, which could result in the construction of pedagogical knowledge by teachers (Pimenta, 2005).

According to Imbernón (2012, p. 45), "[…] the permanent training of teachers would have to facilitate practical-theoretical reflection on their own practice, through the analysis of reality, understanding, interpretation and intervention on this practice", thus, teachers, when confronting the theory with their own teaching practice, would not simply accept the theories presented, but, in a process of reflection and discussion, would build their knowledge, as can be seen in the report of Teacher 5:

> Almost everyone who took the course was already a teacher and there was a lot of this discussion of counterpoint between theories/texts and practical experience within the classroom [...] this was a reason for discussion [...] I remember that many teachers sometimes questioned the validity of some theory, because in practice it was different; in practice sometimes it wouldn't work that way. I remember that we had these kind of reflections (T5).

Nóvoa (2009) goes even further in terms of the use of practical references in training courses, analyzing that "[…] Teacher formation would gain a lot if it were preferably organized around specific situations, such as school failure, school problems or educational action programs" (Nóvoa, 2009, p. 34). By bringing issues of day-to-day teaching to the training courses, teachers are brought closer to the school environment, which is their main place of action, and, through these practical situations, it would be possible to work on the relationship between theory and practice, because, despite starting from practical cases, these can only be adequately resolved with the foundation of theory, so these moments of reflection on theory and practice would induce teachers to build knowledge.

> I had a teacher who took a lot of her stuff from the classroom for us to analyze, [...] she and another teacher who also took materials for us to discuss, to analyze situations that they themselves had experienced and it that helped a lot in our formation (T6).

A second fact that may have influenced the fact that the pedagogical training course did not bring changes to a minority of the investigated teachers is that some of these engineering teachers have difficulties in accepting help from pedagogy, since, as Araújo (2008) states, teachers who do not fully recognize themselves as teachers present a very strong opposition to the contributions of pedagogy. The report of T7 expresses this resistance:

> There is a thing called active methodology, then you start to think 'what is this thing?', 'what are these people inventing now?' […] It's annoying because we're going to do training on active methodology and they don't use an active methodology in it. A lot of professors sit down to be able to do pedagogical training, and learn how to give a cool class and people come to do boring things and then I think 'I'm never going to take this anywhere' […].

Finally, another fact that may have influenced the pedagogical training course not to bring changes to a minority of the investigated

teachers may have been the lack of interest and dedication during the course, on the part of some of these teachers. Something that can be seen in the exposition of T3:

> Well, to tell you the truth… I did it like that, very superficially and I didn't learn anything to be honest, you know? So I think I used that thought of getting the certificate right there and it's ok. It was my choice, really (laughs), the course had a lot of theoretical material, I can't say it was either good or bad, you know? … Do you know why? I didn't study hard; I had to do a lot of things, so I did it with as little effort as possible, you know?

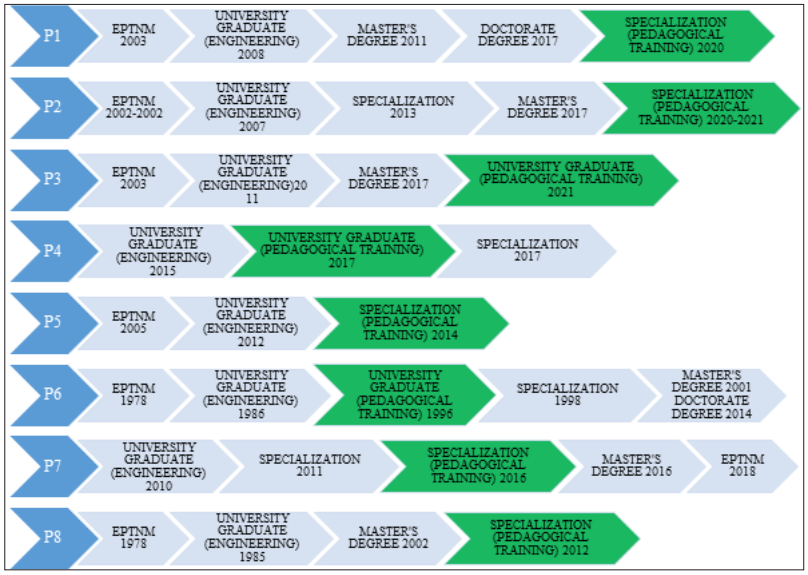
The teachers participating in the research give several suggestions for improvement for the pedagogical training courses, such as: exploring more the practice-theory relationship, improving the way of verifying student learning, contextualizing the theories presented, etc.

> I think that people need to apply more [...] and then I think, for example, if we had pedagogical training developed by teachers who have training in the area, teachers who have this more continuous training, supported by pedagogos, to bring these experiences to us, I think it would be better […] (T7).
> The people who designed the pedagogical training are people from the education area, of course, and they focused a lot on presenting the concepts and focused little on how we could apply that in the classroom [...] practical part; they were more theoretical than practical content [...] (T2).
> It would be something like this, some way of monitoring the way students learn, you know why, the way it is [...] the teacher makes the material, puts it there, and puts a questionnaire to evaluate, to see what is being learned and what is not [...] (T3).

Professor 7 cites the participation of teachers in the process of elaborating these courses as an improvement for pedagogical training courses, which is in line with the thinking of Nóvoa (2009, p. 36), who says that: "[…] Teacher education must move 'within' the profession, that is, it must be based on the acquisition of a professional culture, giving more experienced teachers a central role in the formation of younger ones". By bringing teachers with extensive teaching experience to participate, together with other education professionals, in the process of designing pedagogical training courses, they will be able to contribute to bringing the theories and concepts presented in the course closer to the reality of the classroom, as they have the experience of teaching activity. It is as Nóvoa (2009) brings, when he says that it is necessary to return teacher training to the teachers themselves, because training only makes sense when it is based on the profession itself.

Figure 2 shows the formative curriculum of each teacher in chronological order, showing the degree of courses taken and the year of completion of each course, highlighting the pedagogical training carried out by each participant.

Figure 2 – Participants' Formative Curriculum, in chronological order



Source: Prepared by the authors, based on research data.

From Figure 2, it is possible to state that all the teachers interviewed graduated from engineering courses as their first degree in higher education; that is, all of them only completed their pedagogical training after graduating in engineering. In addition, it is observed that the pedagogical training was carried out in the format of university graduate course (teacher training) and specialization courses (*lato sensu* postgraduate studies) and even teachers who had already taken master's and/or doctorate degrees also sought pedagogical training, which is in line with what had already been signaled by Masetto (1998): there is almost no concern with the pedagogical formation of students of the different master's and doctoral courses in the country.

Final Considerations

The formative curriculum of the investigated teachers involves formation in high school and higher level courses (undergraduate and postgraduate ones). Among the teachers interviewed, only one of them did not have the training at the EPTNM, and among those who have the training at the EPTNM, practically all of them had this training as their first academic training. All the research participants have degrees in engineering and some also have training in university graduate courses as a second degree. It was also identified that all the teachers interviewed have graduated in postgraduate courses (*lato sensu* and/or *stricto sensu*), and most of the master's or doctoral courses taken by these professors were in the area of engineering.

Research participants sought pedagogical formation in university graduate courses (Mathematics; Teacher Training) and specialization

(Teaching; EPT; Teaching at EPT; University Teaching; Teacher Training), which were offered in the modalities of distance learning, semi-presential or face-to-face ones and had workloads that ranged from 360h to 1200h. It was reported that, in these training courses, subjects/themes such as: the relationship between student and teacher, critical formation of the student, didactics, evaluation, teaching methodologies, teaching practice, psychology of education, history of EPTNM - among other very important subjects for teacher formation - were studied.

Pedagogical training caused significant changes for most of the engineer teachers interviewed, positively modifying the way they think and see the formation and education process, their way of teaching and evaluating, the teaching methodologies used, the relationship with students, among other aspects of teaching.

In the case of the few teachers who underwent pedagogical training and reported that they did not undergo any changes after this training, it was noticed that the courses taken by these teachers were very theoretical; in addition, it was also noticed that, in some of these cases, the teachers showed a strong resistance to the pedagogy contributions and/or demonstrated that they had no interest or dedication during the courses, which are the possible reasons why changes have not occurred for this minority of teachers. Thus, it appears that there is still room for improvement in pedagogical training courses, and the teachers participating in the research suggested several improvements, such as relating practice more to theory, involving teachers with formation and teaching experience, increase collaborative participation with other education professionals in the course design process, improve student learning assessment, etc.

It was diagnosed that, during the formative curriculum of the teacher engineers interviewed, all of them had graduated in engineering as their first higher education course and, only after they graduated as engineers, they sought pedagogical training - university graduate courses (teacher training) and specialization courses (*lato sensu* postgraduate studies). It is noteworthy that even professors who had already graduated from doctoral and/or master's degrees also sought pedagogical formation.

It is concluded that pedagogical formation has a transforming potential for the teacher's way of acting and thinking, being able to improve several aspects of teaching performance and leaving the teacher better prepared to face the challenges of the classroom and the difficulties that arise in the everyday life of the teaching career and, therefore, pedagogical formation is very relevant for the training of teacher engineers.

This research was limited to investigating teacher engineers who work at EPTNM and who have taken a pedagogical training course in two public education institutions of the federal network, in the state of Minas Gerais. Thus, it is pointed out as a suggestion for future research the coverage of other educational institutions belonging to the Federal Network of Professional, Scientific and Technological Educa-

tion (RFEPCT), not only from the state of Minas Gerais, but also from other locations in the country, as well as private educational institutions. Thus, it would be possible to have a broader view of the pedagogical training of teacher engineers from different institutions and regions of the country.

Finally, the investigation on the pedagogical training of teacher engineers, who work at other levels and in different teaching modalities of the EPTNM, can be a source of future works, in which it would be possible to compare whether there is any difference between the pedagogical formation of teacher engineers of these teaching levels and modalities and that of EPTNM engineering teachers[6].

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Notes

1 Translate Note (T. N.): We prefer not to translate abbreviations contained in official documents in the country context, refering to Brazilian public policies. We therefore chose to allow the reader to understand their meaning not by inference from English words that do not have the same meaning. This was chosen with the following abbreviations: Educação Profissional Técnica de Nível Médio (EPTNM) referring to Technical Vocational Education of High School Level; Educação Profissional e Tecnológica (EPT) and Educação Profissional (EP) referring to Vocational and Technological Education courses; Rede Federal de Educação Profissional Científica e Tecnológica (RFEPCT) referring to Federal Network of Scientific and Technological Professional Education; Base Nacional Comum para Formação de professores da educação básica (BNC-Formação) referring to the common national base for basic education teachers formation; Instituições de Ensino Superior (IES) referring to Higher education institutions; Conselho Nacional de Saúde (CNS) referring to National Health Council; Comissão de Ética em Pesquisa (CEP) referring to Public Ethics Commission and Ministério da Educação (MEC) referring to Ministry of Education.

2 HOUSSAYE, Jean. Une illusion pédagogique? *Cahiers Pédagogiques*, Paris, n. 334, p. 28-31, 1995.

3 UNESCO. United Nations Educational, Scientific and Cultural Organization. *La formation des professeurs d'enseignement technique et professionnel*. Paris: Les Presses de l'Unesco, 1974.

4 T. N.: In Brazil, in comparison with the American model, Educação Básica refers to: Educação Infantil (Kindergarten), to anos iniciais do Ensino Fundamental (Elementary School), to Anos finais do Ensino Fundamental (Middle School) and Ensino Médio (High School). Therefore, we use to translate Ensino Fundamental as Elementary and Middle Schools and we do not translate Educação Básica, keeping the use of the term in Portuguese.

5 T. N.: We do not translate Pedagogia as "Pedagogy", keeping the term in Portuguese, considering that, in Brazil, the Pedagogia course allows the exercise of teaching in Educação Infantil and Anos iniciais do Ensino Fundamental. In the American system, the Bachelors or Master's Degree in Early Childhood

and Elementary Education is a training requirement for acting in Kindergarten and Elementary School. Following the same reasoning, we do not translate *pedagogos* as "educators with diploma in teaching", also keeping the term in Portuguese.

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