

# University teaching and learning of engineering student monitors<sup>1</sup>

## Docência universitária e aprendizagem de estudantes monitores de engenharia

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### ABSTRACT

Research with the objective of analyzing learning processes that are developed by monitors students studying calculus and analytical geometry in engineering courses and how these processes can enhance the constitution of university teaching from the perspective of historical-cultural theory. The data was produced through the application of questionnaires to students. The analyses indicated that the monitors reproduce the same class models as their teachers, that the main methodology used is still solving exercises, and that the didactic choices of both teachers and monitors are not well-founded and do not promote conceptual understanding. Fragilities in the integration between Basic and Higher Education are also analyzed, as well as failure of diagnoses to enhance teaching planning. All of these factors harm the development of teachers and students. The research proposes that training spaces be created suitable for learning and developmental didactics, as well as greater appreciation of monitoring.

**Keywords:** Historical-cultural theory; University teaching; Monitoring at the university; Developmental didactics.

### RESUMO

Pesquisa com o objetivo de analisar processos de aprendizagem que são desenvolvidos por estudantes monitores de cálculo e geometria analítica de cursos de engenharia e como esses processos podem potencializar a constituição da docência universitária na perspectiva da teoria histórico-cultural. Os dados foram produzidos por meio da aplicação de questionários aos estudantes. As análises indicaram que os monitores reproduzem os mesmos modelos de aula de seus professores, que a principal metodologia utilizada ainda é a resolução de exercícios, que as escolhas didáticas, tanto de professores quanto de monitores não são fundamentadas e não promovem a compreensão conceitual. Também é analisada fragilidade na integração entre Educação Básica e Superior, não consideração de fatores subjetivos que interferem na aprendizagem, além de ausência de diagnósticos para potencializar o planejamento de ensino. Todos esses fatores prejudicam o desenvolvimento de professores e estudantes. A pesquisa propõe que sejam criados espaços formativos adequados à aprendizagem e à didática desenvolvimental, bem como maior valorização da monitoria.

**Palavras-chave:** Teoria histórico-cultural; Docência universitária; Monitoria na universidade; Didática desenvolvimental.

<sup>1</sup> Research with funding from the Minas Gerais State Research Support Foundation – FAPEMIG and management of resources from the Uberaba Teaching and Research Foundation – FUNEPU. English version by Letícia Cristina de Sousa Dias. E-mail: [lecridias@gmail.com](mailto:lecridias@gmail.com).

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## 1 Introdução

The research aims to analyze, in the light of historical-cultural theory, learning processes that are developed by students studying calculus and analytical geometry in engineering courses and how these processes can enhance the constitution of university teaching. Learning in these disciplines was chosen to form the object of investigation due to the high failure rates in public and private engineering courses in the country.

According to Passos (2007), the high failure rates in these subjects have among their possible causes:

the absence of a monitoring program, reduced competition in the entrance exam [...], lack of interest on the part of students, lack of foundation (prior knowledge), insufficient workload, unavailability of books in the library, large number of students per room, teaching methodology to be desired, difficulties in the teacher-student relationship, among others. (PASSOS, 2007, p. 9).

This is an analysis that emphasizes general elements that impact the high failure rates in subjects, although it does not delve into the quality of the relationships that are established between teachers and students to implement the training process. In this sense, the present research proposes to analyze, based on data produced through questionnaires, the teacher-student and student-student interaction in engineering monitoring, indicating ways of establishing teaching and learning that contribute to mutual development.

It is believed that analyzes resulting from the learning processes developed by student monitors can contribute to engineering teachers having better theoretical-practical support for the didactic-pedagogical organization of their work. Considering that many engineering teachers do not have didactic-pedagogical training, whether initial, continuing and/or experience in teaching, it is believed that the analyzes resulting from the research can contribute to this training and also to the teaching performance in these courses.

The institution where the research was carried out is located in Uberaba, Minas Gerais. This is the Federal University of Triângulo Mineiro – UFTM, a university that has been offering engineering courses since 2010. The institution has existed since 1953, offering undergraduate courses in the health area and degree courses since 2009. The creation of engineering at the institution integrated the Support Program for Restructuring and Expansion Plans of Federal Universities – Reuni, developed by the Federal Government from 2007 onwards.

The theoretical framework for analyzing the student learning process is historical-cultural theory. This perspective understands that the subject constitutes himself in the world through cultural appropriation, in which he grasps cultural symbols at the same time that he also produces culture. The subject is understood as a social being who only produces his humanity in the relationship with others (VIGOTSKI, 2007). It is produced as such in activity, that is, in intentional action that aims to achieve a purpose (LEONTIEV, 1978).

In this understanding of man who produces himself actively, he anticipates his action by planning what he wants to achieve and evaluating whether he has achieved his goal. Especially in the school environment, this theoretical perspective has as its main objective to create conditions for learning knowledge historically produced by man, so that the subject develops considering the mediation of a developmental didactic organization, which promotes the development of subjects.

This process occurs in *obutchénie*, that is, in the interaction between students and teachers. “In this way, *obutchénie* [...] expresses the unity of action of both, with a focus on student learning that occurs in a process of collaboration with the teacher and other students.” (LONGAREZI, 2020, p. 4).

The use of the transliterated Russian term *obutchénie* is due to the lack of a word in the Portuguese language that expresses the dialectical unity of the action of teachers and students who act collaboratively to promote learning. This perspective of understanding the formative process, as a developing unit of

teachers and students, is a construct of historical-cultural theory, an object of study, research and analysis by national and international research groups, including the Group of Studies and Research in Didactics Developmental and Teaching Professionalization – GEPEDI<sup>3</sup>.

From the perspective of *obutchénie* and developmental or developmental didactics, the role of education is to create adequate conditions for the study of subjects, the latter of which can only be produced by the subject himself in his psyche.

In the specific case of psychic activity, this transformation cannot be a direct product of teaching, for this reason, developmental theory must be the appropriate organization of learning that creates the conditions for the emergence of this activity. (PUENTES, 2019, p. 37).

This is a training and education perspective that questions the traditional way in which schools are organized, especially to promote the learning of mathematics through the transmission of content and mechanical repetition of exercises, often without conceptual understanding.

In these cases, the teacher may present tendencies towards an alienated relationship when teaching. It is understood that, [...], school approvals may even occur, however they do not reveal the students' level of conceptual appropriation, whether empirical or theoretical. Such approvals do not always demonstrate what is expected from the content and form of teaching for development: to fully develop the student and promote conceptual appropriation at the theoretical level. Therefore, the inferences lead to the assumption that, faced with didactic inadequacy, students may present tendencies towards an alienated relationship in achieving “study”, as the actions, conditions, contents and form of this study process are not in correspondence. Knowledge, in these cases, ceases to operate as an instrument for expanding/developing one's capabilities. (FRANCO; LONGAREZI; MARCO, 2016, p. 128).

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<sup>3</sup> The group has existed since 2008 and is based at the Federal University of Uberlândia – UFU Brasil, being coordinated by professors: Andréa Maturano Longarezi and Roberto Valdés Puentes. It has numerous articles, books, collections already published in addition to the periodical *Obutchénie*. The author of this research is one of the members of the group.

The concept of learning from the perspective of historical-cultural theory and developmental didactics also confronts its hegemonic understanding resulting from traditional schools. Nuñez (2009) says that:

[...] learning is a social activity and not just an individual activity, as has been understood until now. It is an activity of production and reproduction of knowledge through which the child assimilates social modes of activity and interaction, and later, at school, the foundations of scientific knowledge, in conditions of guidance and social interaction. (NUÑEZ, 2009, p. 25).

In this learning concept, three important elements stand out: the social character, the activity category and the mediation category. Thus, not only the child, but also the university student must learn due to their characteristic of being active, conscious and guided by an objective endowed with intentionality, when the activity satisfies their cognitive needs and when the objective coincides with the motive (TALÍZINA, 1985). Your interaction with colleagues and teachers and, furthermore, your action with a specific object of study must result in transformations at a psychic and physical level, in addition to transformations in the object itself. This is how learning results are achieved.

According to Vygotski (2003, p. 5):

Learning is more than acquiring the ability to think; it is the acquisition of countless specific attitudes to think about a series of different things. Learning does not change our ability to focus attention, but it better develops numerous attitudes to focus attention on a series of things.

It is expected that the analyzes resulting from this investigation can contribute to the training of engineering teachers, considering the fact that in the country, *stricto sensu* training is the only necessary requirement for teaching in Higher Education, as provided for in article 66 of the Law on Guidelines and Bases for National Education, LDB 9.394/96: “Preparation for higher education teaching will take place at postgraduate level, primarily in master's and doctoral programs”. (BRAZIL, 1996).

The law is silent on specific requirements for university teacher training, since *stricto sensu* training in Brazil trains researchers, not always discussing concepts that underpin the teaching profession, much less addressing the need for specific training for this role. Arriving at university, as a university professor, often “gives birth” to a teaching professional overnight, who has spent years developing research in their specific field of training, which in most cases does not include teaching knowledge. Thus, as he arrives to work essentially as a teacher, he feels the impacts of the omission of the law that contributes to weakening and devaluing the profession, by not recognizing specific knowledge that could be developed.

In this way, there are university professors who face dilemmas when organizing their teaching activities didactically, often reproducing, in an alienated way, the models experienced while they were also students.

What happens when an engineer starts teaching, especially if he has not undergone an initial degree training process, is that the only resource he has is to seek to reproduce the teaching models he had in his experience as a student. These are the teacher's references that he brings from his training, and which are probably linked to the figure of other engineers, also without pedagogical training. And yet, inherent to the engineering training, is the characteristic of a compartmentalized and specialized training in exact sciences and technologies, without links or deepening of the human and social sciences, which makes it even more difficult to read and understand more globally the complex relationships that involve school, planning, didactics, evaluation, and the socio-cultural aspects of the educational process. For these professionals especially, pedagogical discussions will need to be brought in a way that leads them to reflect on teaching practice and establish effective action strategies given the role that the teacher must assume today. (BONILAURE, 2013, p. 3).

The situation is widespread and becomes naturalized in the university environment:

In most higher education institutions, including universities, although their professors have significant experience and even

years of studies in their specific areas, unpreparedness and even a lack of scientific knowledge of the teaching and learning process that they go through prevails. to be responsible from the moment they enter the classroom. (PIMENTA; ANASTASIOU, 2010, p. 37).

In didactic-training intervention research (DIAS DE SOUSA, 2016; DIAS DE SOUSA; LONGAREZI, 2018), carried out with undergraduate teachers, three references of teacher training-action were synthesized: memorized, empirical and praxis. They indicate how some teaching constitution processes weaken its praxis by detaching theories from practices, discussing theoretical principles not observed in practices and not investing in creativity to produce teaching performance and strengthen the profession.

The first [memorized reference] indicates that the teacher trainer resorts, in teaching and teaching, to memorizing theoretical principles and concepts related to the area of education present in teaching discourse that are not presented, coherently, in pedagogical practice. He says it, but often, he doesn't do what he says. The second [empirical] reference indicates the reproduction of class and teaching models in a naturalized way, without the necessary theoretical foundation for this. He does it, but he doesn't know why he does it. [...]. In addition to these, references to praxis were highlighted, those in which the theory-practice unit is aimed at materializing teaching: the trainer appropriates a concept, thinks about it, actively produces himself with it, also producing its organization didactics seeking greater coherence and intentionality. (DIAS DE SOUSA; LONGAREZI, 2018, p. 48).

Such references reveal that it is necessary to invest in the professional development of university teachers so that it is possible to overcome the still predominant dissociation between pedagogical theory and practice, in order to strengthen teaching praxis<sup>4</sup> and not reinforce, on the one hand, the reproduction of memorized pedagogical discourses, and on the other, the alienated reproduction of teaching models without theoretical-practical foundation.

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<sup>4</sup> For Sánchez Vásquez (2011), praxis is the movement of human thought that produces unity between theory and practice, enabling the transformation of subjects and the world. In this sense, it is not just a matter of thinking about a fact, theoretically, but producing awareness that allows for grounded, thoughtful and revolutionary practical action.



Although the absence and/or timidity of institutional actions and policies that support the didactic-pedagogical training of university teachers from all areas of knowledge still prevails, including teachers of engineering courses, the national curricular guidelines – DCNs for these courses, with effective from 2019, indicate concern regarding the fragility of teachers' pedagogical training, signaling the need to establish permanent teacher training and development programs in universities:

The undergraduate course in Engineering must maintain a permanent Training and Development Program for its teaching staff, with a view to valuing the teaching activity, greater involvement of teachers with the Pedagogical Project of the Course and its improvement in relation to the training proposal, contained in the Pedagogical Project, through the conceptual and pedagogical domain, which encompasses active teaching strategies, based on interdisciplinary practices, so that they assume a greater commitment to the development of the desired skills in graduates. (BRASIL, 2019, p. 6).

Even though the didactic orientation provided for in the DCNs<sup>5</sup> is different from the epistemological conception defended in this article, of a historical-cultural nature, there is an effort to propose alternatives to face the situation of lack of pedagogical training among engineering teachers. This is an important indication in the sense of valuing analyzes that result from the understanding of learning processes, which, in fact, contribute to teaching work.

Considering that education can promote the development of teachers and students, the understanding that teaching is produced in processes of imitation-creation is corroborated (DIAS DE SOUSA, 2016, 2018; VIGOTSKI, 2007). “The teacher, in order to develop, needs to imitate by creating and these two apparently contradictory dimensions bring together a dialectical unity in the constitution of his pedagogical praxis”. (DIAS DE SOUSA; LONGAREZI, 2018, p. 634-635). And beyond that:

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<sup>5</sup> The Resolution that establishes national curricular guidelines for undergraduate engineering courses defends training through the mastery of skills necessary for professional performance. It is an epistemology that values knowing how to do, not making clear the role of theory in this process.



[...] teacher training needs to be organized in such a way that it is cohesive content as method-content. This unity needs to be expressed in training with proposals for activities that provide opportunities for experiences with the concepts worked on, in a way that allows discussion and referral to teaching problems. This intentional organization of training must constitute a source of imitation-creation for the teacher so that his or her own production of teaching is possible. (DIAS DE SOUSA, 2018, p. 635-636).

In this sense, the training and didactic development of the teacher must occur as a dialectical unit, producing their praxis. Teaching materializes in the confrontation with real problems and needs in the field of teaching, which implies understanding that training needs to provide opportunities for the development of theoretical-conceptual<sup>6</sup> thinking about teaching, mediated by instruments, helping to guide and overcome the concrete situations expressed in the reality of the classroom.

Praxis is constituted in the experience of theory, in the creation of didactic possibilities based on it, understanding this movement as also constituting training. Therefore, the experience of theory must be intentional, present throughout the training process, not a solitary action by the teacher trainer after the theoretical abstractions, carried out separately, after training, already in the exercise of the teaching profession. (DIAS DE SOUSA, 2016, p. 10).

It is expected that the research analyzes will also contribute to the need to establish monitoring programs that do not reinforce a teaching model devoid of intentionality, without the foundation of educational theories that discuss didactic principles, psychopedagogical understanding of learning organization and an *obutchénie* possible. In this sense, the present investigation proposes this dialogue considering assumptions from historical-cultural theory and developmental didactics.

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<sup>6</sup> According to Puentes and Longarezi (2017), in the tradition of historical-cultural theory, theoretical thinking is a special type of superior mental capacity that can only be developed in the school environment through the formation of scientific concepts and mental actions. Concepts are “mental images” of a concrete object in its essential features. (GALPERIN, 2001).

## 2 Methodology

The methodological proposal is the development of research with a qualitative approach. According to Ludke and André (1986), it opposes an empiricist view of science, seeks interpretation instead of measurement, discovery instead of verification, values induction and assumes that facts and values are closely related, becoming A neutral stance by the researcher is unacceptable.

To develop the investigative process, the following research procedures were used: bibliographical review, document analysis and open-ended questionnaire applied to calculus and analytical geometry monitors of engineering courses at UFTM in the period from 2017 to 2021. The questionnaire “refers to It is a means of obtaining answers to questions using a formula that the informant fills in himself. [...] It contains a set of questions, all logically related to a central problem” (CERVO; BERVIAN, 2007, p. 53). In the research, the questionnaire aimed to understand the learning processes of the monitors: knowledge they consider necessary for learning, study strategies used, participation of subject teachers in the development of monitoring, difficulties and potential in learning the content.

A survey was carried out of the calculation and analytical geometry monitoring students of the engineering courses at UFTM in the period from 2017 to 2021, together with the sector that monitors the monitoring program in the institution's Dean's Office of Education, arriving at the number of forty-four student monitors. Of these, sixteen had already completed their courses. Contact with graduating students via institutional email was not possible for this reason, and these students were excluded from the total number. Of the twenty-eight students still with institutional ties, nineteen responded to the contact via email, three of which chose not to participate in the research. Thus, at the end of the survey, sixteen students agreed to participate in the research, responding to the questionnaire that was organized using the *googleforms* tool.

The institution understands monitoring as:

Teaching and learning modality that contributes to the integrated training of students in teaching, research and extension activities of undergraduate courses. It is understood as an instrument for improving teaching, through the establishment of new pedagogical practices and experiences that aim to strengthen the articulation between theory and practice. This is an activity carried out concomitantly with the teacher's work in the classroom, thus requiring a more active and collaborative participation of participants in the teaching-learning process. The monitoring work aims to contribute to the development of pedagogical competence and assist academics in understanding and producing knowledge. This is a formative teaching activity. For the monitor, it is a stimulus that requires commitment and responsibility. (UFTM, 2023).

The concept converges with the understanding of Araújo and Moreira (2005) on monitoring:

(...) extra-class activity, acts as a source of assistance, in order to overcome deficiencies in the knowledge necessary for the perfect understanding of course concepts, in a situation in which the student population assisted gains, qualitatively, as the monitor, for Being a member of the same category as the target population, has favorable conditions to become a motivational vector in the teaching-learning process. (ARAÚJO; MOREIRA, 2005, p. 2).

The questionnaire answered by the engineering monitoring students at UFTM sought to reveal the conditions under which the monitoring activity is carried out, in addition to seeking to understand how their own learning processes developed in understanding the concepts of the disciplines of calculus and analytical geometry.

The analyzes were carried out according to the principles of content analysis. According to Bardin (1977), content analysis identifies a set of techniques for analyzing the sources used in research. The techniques aim to organize systematic and objective procedures for describing the content of research sources, creating indicators that allow the inference of knowledge produced during the analyses. It takes place from three consecutive

moments: pre-analysis, exploration of the material and data processing: inference and interpretation.

In the pre-analysis, a “floating reading” of the data produced is carried out, at which point the outlining of hypotheses related to the research topic begins, based on the theoretical framework consulted. The second moment corresponds to the exploration of the material. It is the longest stage, in which the aim is to encode the raw data and organize it into units of meaning. Coding comprises a breakdown of themes, context units and recording units. This is the categorization phase, that is, defining a “kind of drawers or rubrics” that, according to the author, allow the classification of significant elements of research sources.

The third stage of content analysis refers to data processing, which includes inference and interpretation. At this point, the contents selected in the previous phases are in fact analyzed, in light of the theoretical references consulted.

### **3 What students say about their learning processes and their monitoring experiences**

This section aims to present the synthesis of the data, with the answers to the questionnaire applied to the research participants, related to their learning processes in the disciplines and the experiences developed in monitoring. After intense reading and analysis of the responses in their entirety and raw state, they were synthesized based on each question, maintaining the essence of what was answered by the monitors.

Regarding characterization, the research participants are essentially male, indicating that even with the increase in women's participation in the most different segments of social and productive life, including engineering training, this environment still concentrates more men. The characterization also indicates that the majority of participants completed Basic Education around 18 years of age. In this way, this is a public that did not interrupt its training with the arrival in Higher Education. Furthermore, there is a balanced proportion between monitors from the two disciplines investigated.

Regarding the process developed for learning the subject contents, the monitors' responses revealed: what is considered by them as essential knowledge for learning mathematics, the main form of study, difficulties in learning, learning successes, factors considered facilitators for learning, how they consider that the teacher can support learning and how they explain the high failure rates in subjects.

The majority of students indicate that they were guided by teachers on how to study. At the same time, they report having encountered difficulties in learning. The knowledge they consider essential for learning in the subjects refers to basic mathematics training, which leads to the inference that, perhaps, this knowledge has not been learned.

The main form of study reported is solving exercises, a traditional methodology that remains hegemonic and widely used to learn mathematics in both Basic and Higher Education. Regarding the reported difficulties in learning, the participants indicate that solving lists of exercises does not always help them understand the concepts, which leads to the inference that training through this methodology may not develop theoretical thinking, as proposed by the didactics for the development.

Other difficulties were indicated in the learning processes: the relationship with teachers based on pressure, demands, without understanding the training needs of students, without carrying out diagnoses, making it difficult to organize teaching coherently with needs that could be diagnosed.

Regarding students' success in learning, they are not qualified, as participants indicate difficulty in self-evaluating their learning. The only reference they have is external: the grade, the only reference they can cite to indicate achievement of learning objectives.

When asked about potential learning facilitators, they indicate experiencing a contradiction: even though they have difficulty evaluating what they have learned from solving exercise lists as the main study resource, they recognize this methodology as the most appropriate,

attributing the failure of those who are not approved subjects to individual issues such as lack of focus, motivation and lack of prior knowledge. They value as facilitators a teacher who talks more, is open to difficulties and also to interaction between the students themselves.

Asked about how teaching support for student learning can happen, they report the importance of the teacher making diagnoses so that it is possible to create the conditions for difficulties to be faced. Furthermore, they value individual service. A conflict remains: the doubt about the methodologies used, whether they are in fact the most effective.

Students also give their opinion on the high failure rates in the subjects of calculus and analytical geometry, indicating two main factors: the lack of prior knowledge and the vertical and distant relationship with teachers. Regarding the process developed in monitoring, the answers sought indications of how it occurs: intensity of demand for monitoring, recurring complaints among those who seek monitoring, study strategies used in monitoring, justifications for these choices, teachers' guidelines for developing monitoring and suggestions of institutional services that they consider could support the training of students.

Student monitors indicate that this activity is recognized in the institution as important support for students' training, and is constantly sought after by them. Those who seek monitoring explain their search with the following justifications: considering that they did not understand the teachers' explanations about the subject contents and considering that they have difficulty with the fundamentals of mathematics, in addition to difficulty in making sense of what they believe they know.

The student monitors reveal that they use the same teaching strategies as their teachers, that is, above all, the strategy of solving exercises. They also experiment with the use of video classes and technological tools. When asked about the reasons that led them to make these didactic choices, they have difficulty justifying their choices, which leads to the inference that they

carry out monitoring by reproducing models they experienced as students, without understanding the theoretical-practical basis of these choices.

This situation is confirmed when asked about the teachers' guidelines for carrying out the monitoring activity. They refer to specific guidelines such as time, appropriate place, dissemination and clarification of the moment, clearing doubts, but there is no reference to studies, for example, carried out in collaboration with subject teachers, on different didactic concepts and what underpins each of them, which could enable monitors to intentionally opt for a specific didactic organization.

Finally, research participants suggest several actions that can be developed at the institution to support learning and student retention. They can be summarized in three dimensions: a) curricular restructuring; b) didactic-pedagogical training of teachers and c) psycho-pedagogical support services for students.

#### **4 Possible analyzes for the development of teachers and students**

Analyzes emerged from the research data that can contribute to understanding the reality of calculus and analytical geometry classes in engineering courses, as well as contributing to understanding the reality of monitoring these disciplines in Higher Education. Such an understanding can also shed light on possibilities for establishing teaching and disciplines, especially those that contribute to the development of teachers and students. This perspective enhances the permanent transformation of consciousness, theoretical thinking, pedagogical praxis, creativity and autonomy of the subjects of the educational relationship. (DIAS DE SOUSA, 2016; DIAS DE SOUSA; LONGAREZI, 2018; PUENTES, 2019; PUENTES; LONGAREZI, 2017).

In the specific case of the teacher, according to the perspective of developmental didactics, his commitment, as responsible for the didactic-pedagogical organization, as being the “most capable subject of the educational relationship” (VIGOTSKI, 2007), it is the permanent search for favorable conditions for the emergence of psychic activity that promotes



learning (PUENTES, 2019). In this movement, it is up to him to know the student, his needs, his possibilities, make use of available studies and educational experiences to produce in his own way, in the imitation-creation unit (DIAS DE SOUSA, 2016), the pedagogical praxis with the subjects real and concrete.

The data reveal that the empirical character of calculus and analytical geometry classes remains hegemonic, based on the repetition of traditional models, especially the resolution of lists of exercises, in a teaching style that does not promote the understanding of concepts, as there is no correspondence between learning objectives, contents and foundations of didactic organization in the implementation of pedagogical practice (FRANCO; LONGAREZI; MARCO, 2016). This is what a student's response indicates: “[...] *I had a little difficulty understanding the concepts of products (scalar and vector). I consider that I learned backwards, that is, I started by solving the exercises and then understanding the logic*”.

In this sense, it is inferred that the main training reference for teachers is empirical (DIAS DE SOUSA, 2016), as there is no development of awareness of the theoretical-practical foundations of didactic choices: “*they do it, but they don't know why they do it*”, which weakens the production of pedagogical praxis. The class model: exposition of a mathematical definition, presentation of the demonstration of an exercise solution and fixation through the resolution of other exercises of the same type, traditional didactic organization of learning in mathematics remains.

The organization of the monitoring reflects and repeats the same practice as the classes in the subjects covered by this investigation: “*I solved exercises step by step together with the students*”, as reported by a research participant. In this way, the teaching choices of the monitors are not based on a set of specific theoretical-practical principles, also contributing to weakening the production of their pedagogical praxis, which should be strengthened as a space for experiencing theories, as a source of creation in them. founded. (DIAS DE SOUSA, 2016).

Thus, considering that monitoring revealed a practice based on the empirical, in the repetition of didactic models experienced in the disciplines, without understanding what didactically underpins the choices, there is a contradiction with the concept of monitoring defended by the research institution itself, which should contribute as “instrument for improving teaching through the establishment of new pedagogical practices and experiences that aim to strengthen the articulation between theory and practice” (UFTM, 2023).

Based on the responses of the monitors, monitoring was not observed as constituting fertile ground for the creation of new practices and pedagogical experiences built in collaboration with teachers and students, since from these data emerged the understanding of a reality that repeats the same pattern of class that students experience in their experiences in the disciplines: *“I always preferred to solve the exercises with the students”*, as mentioned by one of the monitors.

It is believed that in order for new knowledge in didactics for learning calculus and analytical geometry to be produced, especially from the perspective of developmental didactics, it is necessary to invest time and study in the collaborative training of teachers and student monitors. Without this, there is a risk of continuing to reproduce models, and, unfortunately, maintaining high levels of failure in these disciplines.

Another possible analysis that emerges from the research data is the understanding of the fragility in the integration between Basic School and Higher Education. There remains a distance between them, even though they are levels that participate in the organization of Brazilian formal education. (BRAZIL, 1996).

It is believed that the search for greater reciprocity and integration between these levels of education is fundamental for the mutual achievement of learning objectives in a collaborative way, considering the complaints reported by the monitors: *“the most frequent complaint is that the teacher was unable to explain the matter clearly”*; *“they didn’t understand where they*

*could use it and lacked understanding of functions”* and also: *“the most frequent questions were related to basic mathematics content”*. All complaints reveal fragility in the development of students' theoretical thinking (PUENTES; LONGAREZI, 2017), which should acquire centrality, both in Basic Education and Higher Education.

Such reciprocity and integration between levels of education should structure relationships, including adopting ways of evaluating this integration:

[...] if, on the one hand, the presence of the university in the interior municipalities enhances integration with basic education systems, enabling the fulfillment of their demands, by or however, there is a need to create systematized evaluation processes for the policy developed that include analysis and evaluation techniques for public policies [...] (REAL, 2015, p. 154).

The data produced with the investigation recurrently indicated the lack of prior knowledge of mathematics to understand the contents of calculation and analytical geometry: *“they don't know basic properties and operations”*; *“very difficult in basic operations and they were unable to interpret the exercise”* and also: *“they did not understand the content”*, which reinforces the need to invest in improving the integration between Basic Education and Higher Education, as a way of combating dichotomies and vertical relationships between teachers at both school levels.

It is believed that the dialogue and mutual commitment of legislators, public administrators, researchers and especially professionals from both levels of education, among other strategies to be considered in the elaboration, execution and evaluation of public policies for Brazilian education, promote advances towards alternatives that overcome diagnoses of failure in learning different content, especially mathematics:

The precariousness of children's learning in public schools is notorious, proven by official indices and surveys by international organizations. Many explanations referring to external factors

have been gathered, and they are important, since the educational phenomenon is multidetermined [...], but there has been no shortage of diagnoses in the attempt to identify, also, and especially, intra-school factors – organizational and pedagogical - didactics – which act on children's academic failure and affect the productivity of the education system as a whole. One of them is the professional performance of teachers in the initial years of elementary school. (LIBÂNEO, 2011, p. 14).

It is believed that, considering the investment in the integration between Basic and Higher Education, it is also necessary to invest in the valorization and professionalization of teaching, regardless of the level of its performance, in order to combat, in addition to possible vertical relationships, pure judgment and simple teaching practices that do not result in professional development. In this sense, it is necessary to give centrality to the essence of the teacher's work, that is, human training. This principle is fundamental, especially to produce meanings about the profession, which is experiencing increasingly alarming levels of teaching suffering and illness:

[...] the reasons for teaching work - aimed at the humanization of individuals, which relate school education to a greater ideal of people's development, give way, by leaps and bounds, to the specific and pragmatic purposes required for adaptive sociability, both from teachers and students. (MARTINS, 2018, p. 137).

Only by valuing everyone and investing in training for human development will it be possible to transform current structures, which are often closed, inflexible, rigid and based on mercantilist principles that have been eroding human motives for teaching, making meanings that could be produced in processes of collective and individual humanization:

I believe that facing the suffering of teachers demands a strong investment in training for resistance: resistance against the 'meaninglessness' of teaching work, resistance against mass certification; resistance against the violation of democratic rights and, above all, resistance against the conversion of school institutions into institutions destined for the uncritical execution

of policies limited to the interests of the bourgeois State. If such challenges can only be faced collectively, there is another challenge, and this is the responsibility of each teacher in particular: resisting the destruction of collective struggle mechanisms! (MARTINS, 2018, p. 140-141).

The difficulty expressed by the monitors in self-evaluating themselves, even when asked about their learning successes, is revealing of the fragility of training, which in both educational contexts: basic and higher education, has encountered difficulties in developing the humanity of the subjects, weakening the production of meanings about themselves, including with regard to the apprehension of mathematical concepts. This fragility is not only revealed with regard to knowing mathematical concepts, but also the difficulty of being able to evaluate difficulties, choose and seek alternatives to overcome them, in a more autonomous and conscious way.

Regarding subjective issues that affect the relationships between teachers and students, enhancing or not learning, they were observed in the research data, although they are not always considered to understand the training process in its entirety.

Thus, when we study learning as a general function outside the subject who learns, we are ignoring an essential constitutive moment of the learning process, defined by the meaning that this process has for the subject within the singular condition in which they find themselves inserted in their life trajectory. When we orient ourselves to study learning, considering the subjective condition of the subject who undertakes it, we have access to emotions generated in different spaces of their social life that appear in the classroom, constituting moments of meaning for the subject within that space, which is essential in understanding the emotions produced in learning (GONZÁLEZ REY, 2003, p.237).

The monitors mention their emotional issues as part of the difficulties they encounter when learning: *“the biggest problem I had with the subjects was related to the psychological. I didn’t perform well in tests and I didn’t*

*distribute my time assertively.*” In this sense, it is believed that they are equally important elements in the analysis of the educational process, considering that there is no possible neutrality in human relationships of any type, including relationships between teachers and students. Both produce emotions in the relationship such as affection, anger, fear, rejection, among others, which need to be considered in the didactic-pedagogical organization. That is why creating favorable conditions for learning from a developmental perspective is so complex. Such an organization must consider creating an environment of respect, trust and openness as a basis for learning, considering the real subjects.

And how is it possible to understand which teaching conditions can be more favorable for learning? One of the monitors interviewed indicated that it is necessary:

Understand the room you have in your hands, carry out periodic checks to map deficiencies and act on difficulties encountered. It is doable, but it is very difficult to apply. However, I believe it is extremely rewarding (research subject).

The monitor indicates diagnosis as an important tool for teaching work from the perspective of developmental didactics. “Diagnosing a given situation or reality within the scope of teaching is one of the most necessary didactic principles to direct a process that promotes development” (DIAS DE SOUSA, 2016, p.66), as it implies knowing the state of what is studied in a given moment, according to an objective, with a view to transforming reality in search of better results (ORAMAS; ZILBERSTEIN, 2003).

Despite this, based on the research data, teachers seem not to use the diagnosis to guide their teaching organization, and perhaps this does not happen due to the existence of high numbers of students per class, as indicated by a monitor: *“personalization teaching is hampered by the fact that the classrooms contain many students”*. This is a factor that also harms learning, because with the absence of diagnoses, planning becomes generic, disregarding the

particularities of real and concrete subjects. This lack of knowledge contributes to the difficulty of making didactic choices that are more appropriate to students' development zones (VIGOTSKI, 2007).

## **5 Final considerations**

The research made it possible to understand the learning processes that are developed by students studying calculus and analytical geometry on undergraduate engineering courses. In this sense, the data indicated what they think, their difficulties, their study strategies, relationships they establish with subject teachers, how they think about the university structure and how it can support student success and retention in graduation.

It is believed that the research results have much to contribute to engineering education, especially with the pedagogical training of university teachers from a developmental perspective. In this sense, based on the results, we propose the need to:

Creation of spaces and collectives of teachers interested in investing in training for university teaching. Such institutional actions and policies, to be developed and implemented with the participation of the subjects involved, cannot reproduce traditional training formats, in which the main strategy is a specific lecture on a certain topic or subject.

It is necessary to invest in training spaces in which it is possible to implement the imitation-creation unit (DIAS DE SOUSA, 2016): discuss theories, diverse teaching experiences that encourage and support the creation of alternatives to be implemented in the classroom, which will then be discussed, again, as part of a cyclical and permanent training movement. To achieve this, the training environment needs to be welcoming, generate a climate of trust and encourage creativity and development of teachers and students.

A new understanding of monitoring as a space for teaching, developed in collaboration between teacher and monitor, is also necessary. In this sense, monitors need to understand, minimize



In other words, theoretical-practical foundations that equip them to make well-founded and intentional didactic decisions. This process needs to happen in collaboration with subject teachers, in a movement that can enhance the development of both. Maintaining monitoring as an unintentional and punctual answer to questions contributes to the devaluation of teaching as a professional activity that demands solid and consistent knowledge in areas related to education.

With the research, it was possible to conclude that the pedagogical dimension of Higher Education institutions remains outside institutional policies, and/or limited to the individual efforts of teachers and other professionals concerned with the quality of training. Even with knowledge produced in the area of education, reality has changed little in this dimension, with the predominance of the reproduction of educational models that do not always consider psychopedagogical principles of human development, as well as historical and cultural time and the profiles of real subjects.

In this sense, it is concluded that the still predominant didactic organization, resulting from the traditional teaching model, has not contributed to the development of students' theoretical thinking, as well as to the development of their awareness of learning successes and difficulties to be overcome. Considering this understanding, the research proposes the urgency of questioning certainties about the teaching profession, which often hinder the development of teachers and students.

It is hoped that the research can be another instrument of reflection for teachers and other professionals who work in Higher Education. The calculus and analytical geometry student monitors indicated realities that deserve to be heard, constituting, in itself, a broad set of data that can provide new learning paths. May your reports be heard and welcomed. May it be possible to humanize man permanently. Its plastic capacity to learn and develop is unlimited and cannot be reduced to reproduction.

## Enseñanza universitaria y aprendizaje de estudiantes monitores de ingeniería

### RESUMEN

Investigación com el objetivo de analizar los procesos de aprendizaje que desarrollan los estudiantes de cálculo y geometría analítica en carreras de ingeniería y como estos procesos pueden potenciar la constitución de la enseñanza universitaria desde la perspectiva de la teoría histórico-cultural. Los datos se produjeron mediante la aplicación de cuestionarios a los estudiantes. Los análisis indicaron que los monitores reproducen los mismos modelos de clase que sus profesores, que la principal metodología utilizada sigue siendo la resolución de ejercicios y que las elecciones didácticas tanto de profesores como de monitores no están bien fundamentadas y no promueven la comprensión conceptual. También se analizan las fragilidades em la integración de factores subjetivos que interfieren em el aprendizaje, además de la falta de diagnósticos para mejorar la planificación de la enseñanza. Todos estos factores perjudican el desarrollo de profesores y estudiantes. La investigación propone crear espacios de formación adecuados para la didáctica del aprendizaje y el desarrollo, así como una mayor valorización del monitoria.

**Palabras clave:** Teoría histórico-cultural. Enseñanza universitaria. Monitoria em la universidad. Didáctica del desarrollo.

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Received in October 2023.  
Approved in December 2023.