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Need for Communitarian Ethics in Mathematics Teaching-Learning in Engineering Careers

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Abstract
This article presents some reflections on ethics in mathematics classes in engineering majors. We conceptualize ethics as the forms of relationship with the other or the otherness forms. Once the production and learning of mathematics are conceived as processual events that occur in concrete human practice, ethics is considered an inescapable element to consider, as the theory of objectification suggests. In the first part, this study addresses a brief contextualization of the relationship between mathematics teaching and learning and engineering from an

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ethical point of view. Then, an approach to Radford's theory of objectification and its ethical position is presented. In the third part, this study addresses an instrument design that allowed to explore preliminarily in a group of university mathematics professors the types of ethics applied in the classrooms. The fourth part of the article focuses on the analysis of the responses. Finally, we present some reflections and suggestions for future studies.

Keywords: collective learning; community ethics; obedience ethics; objectivation theory; subject; university mathematics.

Necesidad de una ética comunitaria en la enseñanza-aprendizaje de las matemáticas en carreras de ingeniería

Resumen

En este artículo presentamos algunas reflexiones acerca de la ética en las clases de matemáticas en carreras de ingeniería. Conceptualizamos la ética como las formas de relación con el otro, o formas de alteridad. Así que, desde el mismo momento en que la producción y el aprendizaje de las matemáticas se conciben como acontecimientos procesuales que ocurren en la práctica humana concreta, como sugiere la teoría de la objetivación, la ética resulta ser un elemento ineludible de considerar. En la primera parte abordamos una breve contextualización de la relación entre la enseñanza y el aprendizaje de las matemáticas y la ingeniería desde una mirada ética. Presentamos luego una aproximación a la teoría de la objetivación de Radford y planteamos su postura ética. Posteriormente abordamos, en la tercera parte de este artículo, el diseño de un instrumento que nos permite explorar preliminarmente con un grupo de profesores de matemáticas universitarias los tipos de ética que pueden estar operando en las aulas de clase. El análisis de las respuestas al instrumento lo abordamos en la cuarta parte del artículo y, finalmente, presentamos algunas reflexiones y sugerencias de estudios futuros.

Palabras clave: aprendizaje colectivo; ética comunitaria; ética de la obediencia; matemáticas universitarias; sujeto; teoría de la objetivación.

Necessidade de uma ética comunitária no ensino-aprendizagem da matemática nas carreiras de engenharia.

Resumo

Neste artigo apresentamos algumas reflexões sobre a ética nas aulas de matemática nas carreiras de engenharia. Conceituamos a ética como formas de relação com o outro, ou formas de alteridade. Assim, a partir do momento em que a produção e a aprendizagem da matemática são concebidas como eventos procedimentais que ocorrem na prática humana concreta, como sugere a teoria da objetivação, a ética se torna um elemento incontornável a ser considerado. Na primeira parte abordamos uma breve contextualização da relação entre o ensino e a aprendizagem da matemática e das engenharias numa perspectiva ética. Em seguida, apresentamos uma abordagem da teoria da objetivação de Radford e delineamos sua posição ética. Posteriormente, na terceira parte deste artigo, abordamos o desenho de um instrumento que nos permite explorar preliminarmente com um grupo de professores universitários de matemática os tipos de ética que podem estar operando em sala de aula. A análise das respostas ao instrumento é abordada na quarta parte do artigo e, por fim, apresentamos algumas reflexões e sugestões para estudos futuros.

Palavras-chave: aprendizagem coletiva; assunto; ética comunitária; ética da obediência; matemática da faculdade; teoria da objetivação.

I. INTRODUCTION

The public image and social meaning of mathematics are not subjects related to its teaching and learning. Considering the great emphasis of our culture on technology and science, it can constitute a *critical filter* to control the access of a considerable part of society to areas of advanced studies and jobs with high demand in these subjects [1]. It is not surprising that if we understand ethics as the form of otherness, i.e., the relation to the other [2], a debate is possible about the uncritically accepted fact according to which mathematics is beneficial. As Ernest [3] states, "a central problem with the ethics of mathematics and its teaching is that this discipline is taken for granted".

This problem is also present in engineering careers, specifically in mathematics (differential and integral calculus, differential equations, linear algebra) and physics classes. There is no doubt about the importance of knowledge in these areas of study in the academic training of engineers. Nonetheless, ethics has not been a topic of interest in mathematics education. "A conception of mathematics not as Platonic forms but as a human activity leads inevitably to the question of ethics" since mathematical activity necessarily implies a relationship between the individuals immersed in that activity [4].

However, we ask ourselves, in what sense is ethics relevant to teaching and learning mathematics in engineering careers? This question cannot be answered if we do not bring into the discussion the idea of the modern or postmodern Western school that considers the individual as its foundation and the foundation of the world. This fact is the historical figure of the contemporary ontology of the school that strips the human of its social, cultural, historical, and political determinations. Instead, we should be preaching about a subject as an *individual of necessity.*

When we talk about the self as an individual of necessity, we state that it is an entity that finds "outside itself [...] the conditions of agency, responsibility, and ethical subjectivity" [5]. We, humans, are primarily affected continuously by our context. In other words, the ethical dimension considered posits an image of humans "as fundamentally interdependent beings, whose passions and opinions are continually aroused, reinforced, and transformed by those of their fellow human beings" [6].

A conclusion to be drawn from this argument is that learning cannot be reduced to a problem of mental representations or cogitations but a problem of awareness. In this sense, we could point out that from an educational point of view, the problem to be faced is the creation of the conditions of possibility that allow us to continue thinking about new ways of otherness constituted in mathematical practices.

Consequently, we attempt to initiate a discussion and generate reflection on the forms of relationship with the other in university mathematics classes in engineering careers. For this purpose, in the first section, we address a brief ethical contextualization of the relationship between mathematics teaching and learning and engineering. In the second section, we present an approach to Radford's theory of objectification and its ethical dimension. Subsequently, we describe an instrument designed to inquire in a group of university mathematics teachers about the types of ethics that may be operating in the class. In the fourth section, we analyze the testimonies of the teachers who participated in this study. Finally, we provide a series of reflections and suggestions for future studies.

A. Mathematics Teaching and Learning and Engineering: A Necessary Relationship from an Ethical Perspective

Mathematics occupies a relevant place in the development of the culture of humanity because it creates a model of thought, fosters the capacity for abstraction, is a tool for modeling reality, and constitutes a fundamental language for science and technology [7]. As a human activity, mathematics is essentially a thinking activity instead of a routine or mechanism that machines can perform.

We cannot understand the relationship between mathematics and engineering without first reviewing what engineering is. Engineering can be considered a social science, basic science, design, and practical realization, which can be seen as the union, interpretation, and configuration of knowledge strongly oriented to problem-solving [8]. Furthermore, engineering is a discipline of knowledge application, which has an active component of both formal and factual sciences, whose purpose is to build a utility for the human race.

On the other hand, it is relevant to distinguish between mathematics as a discipline and the mathematics taught within a professional education cycle, in this case, engineering [1]. According to Bunge [9], mathematics is a science that does not deal with facts; its object is abstract. Engineering as an applied science takes advantage of mathematical and scientific concepts to create and transform the world and generate solutions for society even though its formative processes have remained static over time and have not adapted to technological development and the complexity of today's global problems [10]. In that sense, educational institutions that educate this type of professional must rethink the teaching of basic sciences, especially mathematics.

Decontextualization and abstraction of the programmatic contents, the neglect of the students' psycho-evolutionary moment, lack of daily praxis, and the use of a deductive, memoristic, and repetitive methodology are some reasons for the difficulty and lack of motivation of students toward mathematics. These actions repress creativity and originality in most cases and produce the rejection of sciences [11]. Instead, mathematics should be considered a profoundly changing and living structure constructed and discovered with its history and philosophy.

On the other hand, Rodriguez [12] argues that the teaching of science, especially mathematics, should generate disciplinary integration with the context. Capace [13] proposes an intriguing question: Does mathematics teaching respond to the new engineering challenges? Capace states that these problems do not lie in the students (skills and abilities); these difficulties remain in the traditional academic forms related to the mathematical contents dissociated from the use given by engineering professionals [13].

Some difficulties are associated with the way teachers attempt to conduct whole-class discussions, evidencing little ability to question students [14]. The transition from a teacher-centered to a learner-centered understanding of teaching requires recognition and awareness of the teacher's development as an individual connected to their social and cultural environment. In addition, a favorable environment of collaboration among colleagues is necessary so that mostly cooperative rather than competitive processes are favored [15]. Teachers must be allowed to rethink their actions, both in the classroom and outside of it, and how they can accept being permeated by their social, historical, and cultural context and their students [14].

Mathematics teaching-learning processes cannot be static or standardized. Shapira-Lishchinsky [16] suggests that the *emphasis on student* learning must overcome the mercantilist idea that the educational process meets only high-quality indicators, dismissing the idea of favoring ethical school environments.

B. An Approach to the Theory of Objectification and Its Ethical Considerations

The need to theoretically frame this study suggests making explicit some concepts from the theory of objectification (TO), which will serve as theoretical categories that allow us to interpret the reality of the university mathematics classroom, specifically about the nature of the ethical relationships that may be operating.

In the TO, knowledge is considered neither constructed nor transmitted but is found through social and collective processes of objectification. By *objectification processes*, the TO refers to those "active, embodied, discursive, symbolic, and material processes through which students encounter, notice, and become critically acquainted with historically and culturally constituted systems of thought, reflection, and action" [17].

The processes of subjectification, for their part, refer to the idea according to Radford [17] as "human beings are always unfinished life projects, subjects in perpetual creation [...] they are the processes of incessant creation of the subject, of continuous creation of a singular historical and cultural subject". A first effect is that the TO proposes a conceptualization of learning even though the individual is fundamentally present. A second effect is that the actions of objectification and subjectification are in a dialectical relationship. One does not occur without the other [18].

In its ontological sense, this kind of activity is, as Marx [19] suggested, a "form of life". As individuals manifest their life, so they are what they coincide. Therefore, with their production, both with what they produce and how they construct it. Thus, it is possible to affirm that individuals depend on the material conditions of their production. In this specific and concrete activity, it is not possible to avoid the forms of relation with others, i.e., ethical relationships.

Radford and Lasprilla [4] argue that from the very moment that the production and learning of mathematics are conceived as processual events that occur in concrete human practice, ethics becomes an unavoidable element to be considered from the perspective of the TO. Therefore, it is sensible to ask ourselves, *what kind of ethics can we foster in the classroom? And is it coherent with the educational project that frames the theory of objectification?* The TO attempts to respond to this challenge called “community ethics.” These authors propose that: For the TO, the interaction fostered in the classroom is based on communitarian ethics. [...]. This theory also seeks to create an openness toward the other, exercise solidarity, create a sense of belonging, and develop a critical conscience. These elements are concretely manifested through commitment, responsibility, and care for others [4].

This search for community ethics, centered on three vectors —responsibility, commitment to others, and care for the other—, would be appropriate to progressively abandon those pedagogical models in which individuality and alienation prevail. These three vectors come to configure the essential structure of subjectivity. According to Radford [2] *Responsibility* appears as the union, nexus, bonding, connection, and link with the other, which is expressed in the response we make to the call of the other [...]. *Commitment to other*s is the promise and implementation to do everything possible. [...]. *Caring for the other* [...] is a way of being with another [...]. Although caring for the other opens up the possibility of seeing ourselves in the other, of recognizing our vulnerability in the other's.

Ethics is based on a non-essentialist conception of the person (teacher, students). An idea of the individual is based on a relationship of otherness and is grounded in the other [20]. From the TO, we seek ethics based on the reflexive and critical constitution of "human capacities" (e.g., will, love, cooperation, solidarity). In these capacities, human relations in their historical-cultural contexts are confirmed [19].

As suggested by Vergel and Miranda [18], through this type of relational ethics, we could favor non-alienating forms of human cooperation in which individuals feel that they can and should express themselves. It is precisely under these circumstances that the individuals (students and teachers) have the possibility of affirming themselves in the social and cultural world.

II. Methodology

In the framework of this discussion, we have inquired, through a structured interview with a group of university professors who guide mathematics classes, about the ideas that may emerge about the ethics operating in the classroom. This question considers the relation and interaction among the students as a key aspect of the characterization of the ethics that may be used.

The selected group of teachers is part of the Civil Engineering program at a public university in the city of Bogota (Colombia). We opted for a case study based on the idea that "it provides a unique example of real people in real situations allowing readers to understand ideas more clearly than simply presenting them with abstract theories or principles" [21]. In this way, the teachers' testimonies assume a leading role when responding to the instrument designed for this purpose.

The selection criteria for teachers (coded as D1, D2, and D3) are threefold. First, they are professors who have overseen higher mathematics courses. The second selection criterion consisted of recognizing their academic trajectory and vast experience in guiding these university courses, and the third criterion was their consent to participate with their responses in this study.

Due to the health emergency caused by COVID-19, the questionnaire was sent by e-mail to the three teachers with their prior consent to participate. This agreement was discussed through different conversations with the teachers via Meet. To go even deeper into the three cases, we held dialogues with each of the teachers at separate times, in which we contextualized the purposes of the study. After specifying that the instrument was not intended to evaluate their professional performance since we only sought to deeply understand aspects associated with the nature of social interactions in university mathematics classes, the professors agreed to collaborate by responding to the instrument. Table 1 shows the instrument designed.

Table 1. Instrument that inquires about ethical aspects in the university mathematics class.

Dear Professor: *The questions below are part of a study in mathematics education in the framework of college mathematics in engineering majors. The questions are not intended to evaluate your professional performance, only to learn more deeply about the types of social interaction in university mathematics classrooms. We thank you for responding concretely and with the necessary details.* *Q1. What aspects do you observe and privilege when students work in groups to solve a mathematical problem?* *Q2. What characteristics of social interaction do you identify when students work in groups to solve a mathematical problem?* *P3. Briefly describe how you proceed when developing a college mathematics class. If you wish, select a mathematical topic or process to exemplify how you develop the session.* *P4. Considering the context of a series of class sessions on a college math topic, what indicators would show that students are learning the subject matter?*

The questions that make up the instrument are based on the idea that ethics is considered the form of relationship with the other, the form of otherness [4]. From the perspective of the TO, the ethical dimension makes the collection process more than a process carried out by a simple agglomerate of subjects linked by contractual relationships that are ultimately defined in terms of self-benefit.

The pertinence of the nature of the questions resides in the fact that mathematics is seen as an activity to practice *with others*. Thus, its quality depends on an ethic that does not allow a deep interactive action with others. This study considers that students do not relate to university mathematics only in cognitive terms; they also relate through and with their emotions [22]; therefore, it is proposed that mathematics should be seen as a relational and affective process [4].

III. RESULTS

The inquiry with the three university teachers (D1, D2, and D3) allowed us, through their testimonies, to understand the conceptions they had about social interactions. Also, to identify the way they saw learning in the mathematics class. The following grid presents the systematization of the teachers' answers to questions P1, P2, P3, and P4 that we formulated. These answers have been transcribed. The acronym RP1D1 means response to question P1 by teacher D1; RP2D3 means response to question P2 by teacher D3; RP3D2 means response to the question P3 by teacher D3.

Table 2. Systematization of the teachers' responses to D1, D2, and D3.

P1 What aspects do you observe and privilege when students work in groups to solve a mathematical problem?	**RP1D1** Reading comprehension, knowing how to relate it to what has been learned, mathematical analysis, ability to generalize or adapt if hypotheses are changed, justification, ability to use different types of representation.
	RP1D2 Leadership: Leads the group and guides the respective members to obtain the best solutions to the proposed exercises. Organization: Organizes and poses solution algorithms to the proposed exercises, relating them to their professional environment. Rigorousness: Rigorously presents the reliability of the solution of proposed mathematical problems using the learned concepts efficiently.
	RP1D3 Collaboration: Students share tasks and investigate to find the correct solution to the problem. Dedication: Students in a workgroup dedicate time to solve the problem.
P2 What characteristics of social interaction do you identify when students work in groups to solve a mathematical problem?	**RP2D1** It depends on the cultural context. For example, in Colombia, in some groups (the majority): absence of communicative competencies (mathematics) and difficulty explaining to their peers the development that followed their work. They present a low level of syntax to communicate what they want. Low self-esteem (they say to themselves, "I am a fool", "I am not good for this", and others). Fear of bullying. Aggressive communication that leads to a blockage, i.e., non-assertive communication. Apprehension or "laziness" to challenges. Dispersion. Individualism. Communication is done to distribute the work they do individually, but they do not give feedback to each other; there is no teamwork. Indifference. In other groups (minority): Commitment. Students comment on their points of view, interact constantly, and draw conclusions; in other words, they complement each other (feedback) and thus do teamwork. Assertive communication. In Chile or Argentina, I find more solidarity, empathy, and, therefore, teamwork.
	RP2D2 Affectivity: The way students attend to or accept the concepts presented by other members. Effectiveness: The way students present possible solutions to the proposed problems.
	RP2D3 Leadership: When a group member leads and organizes the group to achieve the best resolution of the problem posed. Cooperation: All the group members care about their group's development and good participation.
	RP3D1 I start by opening a space to ask questions on previous topics or previous exercises. That is a space that I also use when there is time to empathize with the students and create an empathetic environment. I contextualize the students: If the topic is theoretical, I explain where it leads to in the future, the importance of

P3 Briefly describe how you proceed in developing a college mathematics class. If you wish, select a mathematical topic or process to exemplify how you proceed in the development of the session.	understanding it, and what comes later, theoretically or practically speaking. If the topic is an application, I expose a situation and ask questions they want to answer with the acquired knowledge of the topic. Then, I begin to present the subject matter leaving a moment of reflection, asking if everything is fine, to know if I need to go back a little and, depending on the topic, I start asking questions that indicate to me they understood what was explained. When I finish the subject matter, I resort to simple examples and then to the exercises. At the time of the task, I leave a prudent time for them to read the statement, and then I ask them what the data or hypothesis of the exercise are and what they must answer. Once these questions have been discussed among everyone and I am sure the statement is well understood, I give more time for them to try to find or at least draw a "map" of the solution or where to start the exercise. Then, I solve it and give room for all the questions. Depending on the level of the students, I increase the complexity of the problems. I like to play with different representations of the same subject. I leave exercises for home, which are not handed out; they are different from the conventional ones in the books, but in which key ideas are stimulated and developed in the deepening and interrelation of the topics of the same subject or even when it applies to others. Finally, I tell them or ask how they would ask about something else with the same information of the exercise or modifications, or if they manage to establish a connection or similarity with another area they know.
	RP3D2 In this case, I believe you are requesting a lesson plan.
	RP3D3 I prepare in advance the topic to be developed in the class. For this, I make a presentation in Scientific Workplace. This presentation is explained during the session. In addition, examples of the subject are presented, and I develop them. Then, I establish exercises for students to solve, and a volunteer is asked to go to the board and write how it was solved. To verify and correct before the course the mistakes as well as the successes. After each topic seen in class, I leave a series of exercises for the students to develop and ask questions in the following session.
P4 Considering the context of a series of class sessions on a college math topic, what indicators would show that students are learning the topic?	**RP4D1** Students have intuition or know how to justify a proposition (e.g., by asking true/false questions) in some application contexts, related contexts, and parallel contexts. They can make diagrams of what they have learned, i.e., are able to see the big picture and make a summary of what is being learned or provide "feedback." They can make different representations of what they have learned, e.g., equations vs. graphs vs. tables, etcetera, and switch from one to another. They propose new alternatives to justify or establish relationships between different events, approaches, and why not, between diverse topics.

	RP4D2 Demonstrates ability and organizes the concepts studied to present solution methods to the proposed exercises. Demonstrates ability to differentiate the different concepts studied and relate them to other areas of knowledge. Suggests alternatives to elaborate algorithms to check the solutions to the proposed exercises. Collaborates actively in the resolution of the proposed exercises when working as a team, favoring the academic discipline of the group.
	RP4D3 Curiosity: Students start looking for extra exercises to those proposed and ask about the solution they made. Research: Students care about investigating more about the topics presented and provide input. Collaboration: During the development of the classes, the student is very active and participates continuously in class.

A. Analytical Considerations on the Answers to Question P1

In relation to question P1, the answers of the three teachers have a common element: There is an emphasis on the production of mathematical knowledge, as evident in the answer offered by D1.

In fact, the idea of "leadership" stated by teacher D2 appears linked to an instrumental emphasis of the activity, the student "leads the group and guides the respective members to obtain the best solutions to the proposed exercises." From the perspective of the TO, this conception of group work, and activity in general, is reductive since even when we accept that cultural knowledge is revealed to the consciousness of the subjects through the teaching-learning action, this activity is not only a generator of knowledge but also of subjectivities. Mathematics, its production, and its teaching-learning can only be understood as *relational and affective processes*.

Moreover, the idea of *collaboration* and *dedication* conceived by D3 emphasizes a utilitarian view of activity in mathematics. As suggested by the TO, action is much more than this instrumentalist view in that activity is a relational space in which teacher and students work and think together in what Hegel [23] called the *simple work*. It is through the joint activity that knowledge appears in the classroom, through action, perception, symbols, artifacts, gestures, and language, in a similar way and with a similar aesthetic force.

B. Analytical Considerations on the Answers to Question P2

Concerning question P2, the teachers' testimonies evidence an emphasis on the coordination of actions to achieve an end. For example, the answers given by teacher D1 emphasize the need to develop communicative competencies in mathematics. As he states, there is a "Lack of communicative competencies [...]; difficulty in explaining to their classmates the development that followed their work." In addition, D1 expresses concern regarding the nature of the interaction and the difficulties they usually encounter, as he states that students present low self-esteem when it comes to solving some problems, their fear of bullying or non-assertive communication, there is a lack of teamwork, and apathy with their classmates.

It is also important to highlight here the concern expressed by this teacher concerning the individualistic idea of group work, an aspect that Radford has recurrently pointed out since the TO: In the new case, monad, what is observed in the classroom is not *an* activity, but as many activities as students, in which each student performs theirs. If there are *n* students in the class, each student e_i performs their activity a_i. The mathematics classroom is the sum $\sum e_i$ of its monads, and what happens in a mathematics lesson is a collection $\{a_i\}$ of individual actions [24]. The testimony of D1 brings to light a type of ethics according to which the forms of otherness have a historical, cultural, and material origin that refract fluid and antagonistic visions and conceptions of the world and what good living can come to mean.

On the other hand, in the answer given by teacher D2, a relevant aspect of the ethical dimension as we conceive it in the TO is visible, such as *"affectivity"*, which for this teacher is understood as *"How students attend or accept the concepts presented by the other members."* However, we can glimpse an idea of the student as an *individual entity to disciplinary knowledge. This conception* is reinforced by the second part of his answer, "Effectiveness: How they present possible solutions to the proposed problems", since the student is conceived as a general entity in the appropriation of knowledge; the student appears, as Piaget would later say, as an *epistemic individual.*

Teacher D3 emphasizes *"leadership,"* understood as "when a group member takes the lead in the group organization to achieve the best resolution of the problem." The idea of leadership appears in this context subordinated to a utilitarian and instrumental view of activity and social interaction. The Vygotskyan category of "zone of proximal development" states that interaction with others and the teacher plays a crucial role in learning [25].

From the TO perspective, the problem is that social, cultural, and historical elements cannot be considered instrumentally in the students' learning; on the contrary, these elements are a constitutive part of how we think of the world in which we come to know it [26] [27]. Moreover, the idea of *cooperation* in D3's answer, *"when all the members of the group care about the development and good participation of their group,"* offers a romantic view of social interaction, in that the group can function according to previously fixed lines of conduct but disregards the aspect of knowledge production.

C. Analytical Considerations on the Answers Given to Question P3

Question P3 briefly described how teachers proceeded in developing a college mathematics class. Even though teacher D2 does not offer many clues since he points out that *"In this case, I think you are asking for a lesson plan..."* It is possible to affirm that the traditional conception of the lesson plan suggests following a kind of script that preferably is not subject to drastic changes.

On the other hand, in the responses offered by teachers D1 and D3, one can see what Radford [24] has called *maximum pedagogical guidance*, which operates in a very similar way to traditional teaching. In this case, the teacher controls the production and circulation of ideas in the classroom and only allows the student minimal and insignificant participation, e.g., calling students to the board, asking short questions, etcetera.

Moreover, it is possible to appreciate a model called *"teaching by modeling"* [24]. In this method, the teacher "models" the solution to the problem for the students. In other words, the teacher starts by showing the students how to do things (e.g., how to solve a new problem). In this model, the teacher tends to disappear progressively and thus gradually leaves the responsibility to the student, falling back into a type of traditional teaching-learning, seated in an ethic of obedience. The relationship between teacher and student is one of submission and compliance.

D. Analytical Considerations on the Answers Given to Question P4

According to question P4, there is a common element in the answers given by D1, D2, and D3. This indicator of learning a mathematical subject matter or process is based on knowledge production.

For example, D1 states that it is relevant that students can overview a general panorama of the topic learnt. D2 positions that it is possible to evidence the students' learning when they can differentiate concepts and suggest alternative solutions. Teacher D3 expresses that when students are curious and want to go deeper, those are signals that they are learning.

Although D3 also puts forward an idea of collaboration according to which "During the development of the classes the student is very active and participates continuously in class", it is not clear what the nature of the participation is, for example, if there is an interest in understanding the signs of frustration of another classmate and responds to the presence of the other [20]. Concerning this same aspect, teacher D2 states that an indicator of mathematical learning is that the student *"Actively collaborates in the resolution of the proposed exercises."* On the one hand, there is no specific idea of the development of subjectivity [28]; and what this teacher alludes to about *"works in a team favoring the academic discipline of the group"* seems to be related again to the instrumentalist idea of group work.

Concerning the analytical considerations we have raised about the responses offered by the teachers, we can add that learning is seen as an attribute of the student. As Radford [24] points out, "there is a socio-educational discourse that assigns a *reality* to the idea of learning as a phenomenon that happens (or not) to someone, to *the student*." It is possible to point out that students learn when they can answer the questions asked *autonomously*. In this case, autonomy is taken as a criterion for learning.

In this sense, the idea of seeing education as a process centered on developing the competencies necessary to function adequately in *market intelligence* [2]. That intelligence is when some produce and others consume. An economy where capital produces more capital and conceives the student as "competent" human capital [2]; that is to say, a human who acquires in the university what is needed to enter the world of technology, production, and consumption, becomes relevant. Our position is that universities (and schools) cannot be reduced to agencies in which students are technically prepared to position themselves in the labor world.

Finally, and in general, the answers offered by teachers to the questions P3 and P4 suggest an idea of the student as an entity that thinks "naturally" in specific ways [24]. In this sense, we can understand that the teacher's job is to guide the student. In other words, the student is being conceived as a mere *psychological entity*, a "cognitive individual" [26]; "as if he/she carried in his/her head a little box with ideas and representations of the world" [24]. However, we cannot ignore that the world is full of cultural-historical conceptualizations that embrace us as individuals.

IV. Conclusions

In this paper, we initiated a discussion concerning the type of ethics that may be operating in the teaching-learning activity of mathematics in the university context of engineering careers. This study intended to offer an exploratory approach based on data from a structured interview with three university teachers who guide mathematics classes in a public university in the city of Bogotá (Colombia). Despite the limits of our study, it seems relevant to raise some reflections that could eventually be appropriate for further research.

We understand, then, that university mathematical activity implies a relationship between those subjects immersed in such activity and a relationship of legitimization of disciplinary contents. Ethics is an unavoidable discussion in any educational method due to the teaching-learning activity's relational, human, and affective components.

We propose our analysis of the responses offered by the three university teachers under study based on our investigation of the theory of objectification and its Levinian ethical approach. According to this theory, human relationships occur within the framework of an activity, which is supported by two axes: the forms of knowledge circulation and the forms of human collaboration [22]. The analyses carried out allow us to affirm that, in general, the teachers' actions suggest that students adhere to an ethic where the relationship to otherness is alienating, an ethic of the oppressor and the oppressed [29].

The analyses carried out on the teachers' answers also show that the teacher figure, in general, appears on the scene of the mathematics class as the possessor of knowledge and power. On the other hand, students are conceived as entities submissive to teachers and their knowledge. The Freirean category of *being present* [30] is weakened given the nature of the relationship.

To Freire [30], becoming a presence in the world is a process of tension [24], argues, "It is not only to reach a place, but it is also to *appear,* it is *to erupt* in the social world through a *dialectical* movement between culture and the individual." Historically speaking, it seems natural that students appear subordinate to the teachers' actions, a fact that decisively influences their alienation. Radford's research, although associated with elementary school, can be considered for the case of university education and specifically for the problem that involves our study on the types of ethics that may be operating in mathematics classes.

It has been observed a tendency on the part of students to hold on to the relationship of attachment to the teacher and the considerable difficulty they have in taking a critical look at their work. This construction of the submissive and alienated student is not an invention of the student but a historical construction that the society in which the school is immersed carries out daily through a series of devices that have been naturalized over time [28].

The teachers' responses, in general, suggest that students work in individualistic ways, and in most of them, there is a kind of resistance to collaborating, perhaps due to the individualistic and selfish idea that Western education has promoted. As Radford [28] rightly puts it, "students tend to mobilize different ethics, based on principles of self-interest." Student competence is a dynamic and evolving outcome of the students' engagement with their conceptual and material environment.

Consequently, we want to see the student and the teacher not through the lens of psychology that perceives them as *established individuals* and as the origins of cognition or as Kantian substantial individuals. On the contrary, we should see them as "historical and cultural subjects that are constituted daily and jointly in the classroom in the teaching-learning activity" [24]. As Fromm [31] argues, "man varies in the course of history; he develops, transforms himself; as makes history, he is his product."

Several questions remain from the analytical reflections we have made. Let us mention only a few of them:

- What conditions would have to be created so that in a university mathematics seminar, we move from an ethic of a struggle for recognition and domination to an ethic understood as a dialogue of voices where participants are heard, listened to, considered, and responded to?
- What pedagogical actions and strategies could lead to modifying the forms of collaboration and human interaction in university mathematics students in engineering careers so that they come to rest on a communitarian ethics?
- How could we approach the dynamics of the mathematics classroom to recover the historical-cultural dimension and conceive the classroom as a space that bears social relations and produces non-alienating learning?

Undoubtedly, these are still open questions that require research and reflection but make us think of the activity of teaching-learning mathematics in engineering careers as an ethical event or, as we have suggested in the title of this article, as *community-oriented relational ethics*.

AUTHORS' CONTRIBUTION

César Augusto García-Ubaque: Research, Supervision, Methodology, Validation, Writing - Orginal Draft, Writing - Review and editing.

Rodolfo Vergel: Conceptualization, Methodology, Data curation, Formal analysis, Research, Writing - Review and editing.

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