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# Affective and interactive suitability indicators: an experience in physics from the onto-semiotic approach

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**Abstract.** The purpose of this research was to propose theoretical elements for the description of the students' attitudes in the teaching of differential calculus and its applications to physics from the onto-semiotic approach in the affective and interactional suitability. The design of this research with a complementary approach of qualitative and quantitative methods, with predominance of the first one, under the interpretative paradigm. The field modality and a quasi-experimental design to evaluate the applicability of the concepts of differential calculus. The collection techniques were: first, the semi-structured interview, in order to guarantee the depth and density of the information so that it converges in an emerging system of meanings and categories; second, the application of a questionnaire to evaluate the cognitive capacity of students under the onto-semiotic and traditional approach; third, observation through surveys. The findings lead to an instructional process through which mathematical concepts are taught efficiently, the student's role is valued as being assertive, autonomous, and responsible, while the teacher contributes to the development of emotional support by increasing the student's motivation, self-confidence, and interest in learning mathematics.

## 1. Introduction

The traditional approach is still practiced in many high school and university classrooms; one of the reasons for this has to do with the conception that learning mathematics is judged only as a final, finished product, which is transmitted using a book full of model exercises to solve. Under this conception, the basic teaching strategy is repetition, which, however, does not guarantee learning. The study of mathematics cannot be separated from the socio-cultural development of humanity; progress in this area over time has had a great influence on the transformation of society, since mathematics is at the base of numerous scientific and technological developments whose ultimate goal is social progress [1].

At certain times and in certain situations, society hinders or obstructs the development of new forms of thought, either because of attachment to established and well-valued traditions and points of view, or because of fear of innovation and change, or because of a lack of means, materials and knowledge, which accompany the transformations of a state of things [2]. This circumstance applies to all areas of social life, including, of course, the field of education. This is why resistance to change is frequent, even when it is known that certain theoretical models and inadequate educational practices have limitations that could be overcome, or at least improved, through the implementation of didactic innovations [3]. Thus, traditional approaches to teaching that employ methods such as memorization, repetition and the monitoring of protocols that do not focus on the true understanding of concepts, procedures and, more seriously, do not provide clear criteria for the interpretation of results and their use for practical

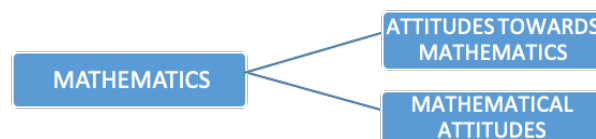


purposes, remain entrenched in many spaces.

Two categories of beliefs then emerge which influence math students. Beliefs about mathematics and student beliefs, the first category is characterized by the minor influence of the affective component because it is scarce, but they constitute an important part of the environment in which affection is developed; the second category refers to the relationship of the student and the teacher with mathematics in which there is a strong influence of the affective component, where beliefs related to confidence, self-concept and the reason for school success and failure are evident. These beliefs are closely related to the notion of metacognition and self-consciousness [4,5].

The representation and evaluation of oneself and the attributional patterns of successes and failures with which the student faces learning are some of the main aspects that determine the affective and emotional dimension of school learning [6]. The student then attributes his successes and failures to internal and controllable factors and not to external and uncontrollable factors, thus avoiding low self-esteem and negative attitudes towards his learning [7]. Self-confidence plays an important role in the process of teaching and learning mathematics [7,8], refers to confidence in the willingness and ability to want to learn mathematics has an essential role for students in their mathematical achievement.

Attitude is understood as an evaluative predisposition (*i.e.*, positive or negative) that determines personal intentions and influences behavior. It consists of three components: a cognitive component that manifests itself in the beliefs underlying that attitude, an affective component that manifests itself in the feelings of acceptance or rejection of the task or matter, and an intentional component or tendency towards a certain type of behavior. On the Figure 1 presents this definition [9,10], which is of a general nature and is valid for any type of activity, whatever its purpose.



**Figure 1.** The object of mathematics - categories.

The present proposal focuses on finding theoretical or conceptual, epistemological and didactic problems in students of I and II semester of business administration; considering the different aspects of the concept of derivative, the geometrical-visual, the algebraic-manipulative and the formal; therefore, the following question is posed.

What theoretical-practical conceptions do students have about differential calculus? Do these acquired conceptions bring them closer to the concept of function, limit, continuity and derivative? How would the ontosemiotic approach benefit the construction of knowledge in differential calculus? What attitudinal factors influence the learning process of the concepts of function, limit, continuity and derivative of the students of the Universidad Francisco de Paula Santander, Colombia. To try to answer the respective research question; the objective is presented below: To describe students' attitudes about affective and interactional appropriateness based on teaching practice in the teaching of the basic concepts of differential calculus.

## 2. Methodology

Descriptive research was used under the predominant qualitative approach with an interpretative paradigm; the design of the proposal was based on field research using information collection sources in the population such as questionnaires and interviews which were two written tests aimed at students; a semi-structured interview script aimed at teachers, since the study is qualitative - descriptive in order to make a comparison with the two instruments used; and thus obtain objective conclusions from this study.

This research used probability sampling which is defined as a subset where all elements of the population have the same probability of being chosen; using in the first stage a pilot test of 3 questions, applied to 15 students of the first semester of differential calculus. The sample size was composed of

forty-six students (46) I and II semester of the University Francisco de Paula Santander, San Jose de Cúcuta, Colombia.

First, teachers in the area of differential calculus were interviewed in order to know the beliefs and conceptions about the mathematics teaching models they use in their educational practices. The interview was characterized by a semi-structured script consisting of nineteen questions. Students were divided into two groups A (control) and B (experimental) of twenty-three students each; a Likert-type instrument was applied to the attitudinal group B (experimental) based on the ontosemiotic approach in the affective and interactional dimensions consisting of twenty-one questions with a duration of one hour.

### 3. Results

The following are the analyses and interpretation of the results taking into account the research question, the objective set and the methodology applied to the present proposal in order to identify which attitudinal factors influence the teaching of differential calculus under the onto-semiotic approach. The attitudes of students, a dimension expressed mainly through calculus apathy, the following quotation is an example: From the beginning we are afraid that it is mathematics: for we create a disposition, and in the face of this disposition I would think that there is no process that is before us.

According to this testimony, a majority of the teachers of the discipline could be contributing to generate some aversion and fear towards mathematics. However, the participants stated that it is also possible to find an active subject [11], provided that the teacher shows various ways and resources to learn, which implies stimulating the search for information from different sources and provoking discussion so that students can draw conclusions and take positions, which is evidenced when one of the interviewees points out: I believe that we should be free, in that sense it is also in conditioning the student to only one book and even one author because we are conditioning him to only one way of presenting knowledge and I believe that the student should be free that is to say he should review different positions particularly. In this sense, participation in class is fundamental.

#### 3.1. Affective and interactional suitability

Figure 2 shows the subcategory affective ability, based on two components the first interests and needs of students through student motivation for learning, incentives given to the student and individual differences and the second attitudes of students through apathy to calculation, class participation and active subject in the classroom.

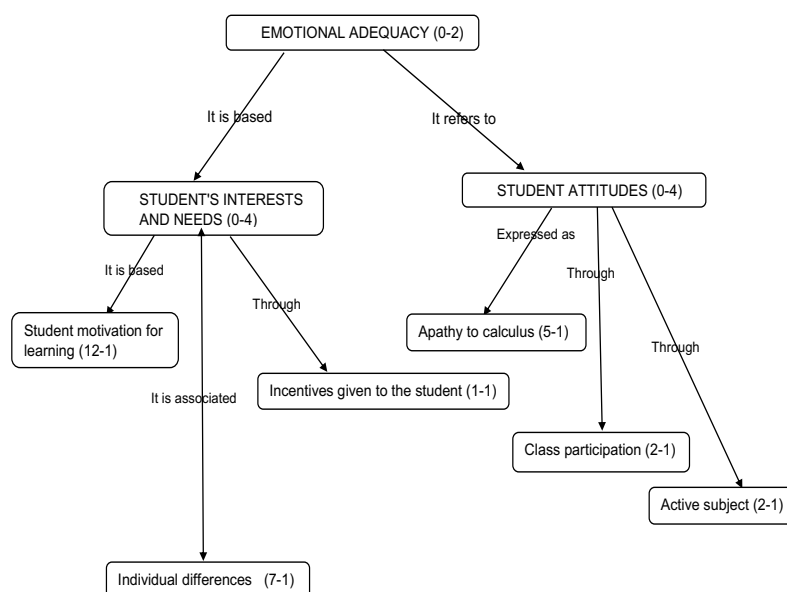


Figure 2. Affective suitability.

The design of mathematical instruction processes with high affective competence requires the teacher's knowledge and understanding of the role of the affective dimension (interests, needs, attitudes, emotions) in mathematical learning, as well as competence in creating learning environments that are of interest to the student [12,13]. The teacher should be aware that if the student has more or less stable affective competence, positive interactions in the cognitive domain would be achieved during the learning process in the classroom. The resolution of any mathematical problem is associated with an affective situation for the subject involved, who puts into play not only operational and discursive practices to give an answer to the problem, but also mobilizes beliefs, attitudes, emotions or values that condition to a greater or lesser extent and in different ways the cognitive response required [14].

The interactive proficiency assessment was only carried out with group B (experimental), since it was the one applied in the framework of the onto-semiotic approach. With regard to the results, it should be noted that more than 90% of the students agree that the teacher clearly explains the basic concepts and approximately 85% consider that the teacher provides an introduction to the study of the basic concepts. Other positive aspects of teachers that stand out for the vast majority of students (95%) are related to encouraging responsibility in students through activities and assessments and monitoring student learning progress (87%). Among the aspects questioned by the students are the low competence related to conflict resolution among students, seeking to reach consensus (expressed by 47% of the group) and 21% who think that teachers do not favor dialogue and communication.

On the other hand, Table 1 shows the items related to emotional adequacy. It should be noted that all students think that their teachers promote participation in class and more than 80% consider positive the actions of the teacher aimed at the approach of situations (exercises, applications) where the usefulness of the basic concepts of differential calculus in daily life is reflected. Approximately 21% of students questioned whether their teachers promoted their self-esteem by positively strengthening their attitude and approximately 18% also questioned the validity of the arguments given, through answers, conjectures and responses.

**Table 1.** Distribution of items related to affective suitability.

		Disagreeing	Neither agree nor disagree	All right	I totally agree
They propose situations (exercises, applications) where the usefulness of the basic concepts of differential calculus in everyday life is reflected	f	1	3	9	10
	%	4.3	13.0	39.1	43.5
Promotes student participation in class	f	0	0	13	10
	%	0.0	0.0	56.5	43.5
It promotes student's self-esteem by positively strengthening the attitude towards learning calculus	f	1	4	16	2
	%	4.3	17.4	69.6	8.7
The arguments given, through answers, conjectures and responses, are valid and convincing	f	0	4	15	4
	%	0.0	17.4	65.2	17.4
When I participate, my arguments and approaches are valued and contribute to finding solutions to the issues raised	f	0	7	9	7
	%	0.0	30.4	39.1	30.4
The contents provided by the subject differential calculus contribute to my socio-professional training	f	0	2	15	6
	%	0.0	8.7	65.2	26.1
I consider that the contents of differential calculus are related to other subjects and are interdisciplinary	f	2	11	9	1
	%	8.7	47.8	39.1	4.3

When evaluating their own performance, 87% of the students agree that the contents provided by the subject differential calculus contribute to their socio-professional training and 69% think that when they

participate, their arguments and approaches are valued and contribute to the search for solutions to the issues raised [15]. However, it is noteworthy that more than 55% of the students question the fact that the contents of differential calculus are related to other subjects and that they are interdisciplinary.

#### 4. Conclusions

Regarding the students' attitudes about affective and interactive suitability from the teaching practice, the Onto-semiotic Approach allowed, from a descriptive and explanatory analysis, to value the teacher's and student's point of view in a physics application class using the first and second criteria derived from the position function of an object. This analysis is necessary and useful in the teaching practice, valuing it as a didactic tool to carry out the different arguments in the classroom.

In mathematics education, the teaching of physics is considered a social activity where the interaction among students and between them and the teacher generates moments of academic reflection, thus achieving the construction of own knowledge achieving very high levels of understanding on the subject.

It can then be said that mathematics is influenced by emotions, despite its rigor, abstraction and formality. In this moment that Higher Education is going through, it would be a great success this reality where it intervenes in the process of learning the applications of physics in students, either in a facilitating way or presenting themselves as future and possible obstacles generating a positive or negative result in the process.

The emotional support must be presented in the classroom continuously at the moment when the teacher becomes an understanding mediator, flexible to the situations that arise in their students (staff), also at the moment when they show interest in the subject of physics using the dialogue to know what happens in their environment, their emotions, thoughts and decisions.

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