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Pedagogical practices of physics teachers from the Catatumbo region, Colombia

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Abstract. Pedagogical practice allows teachers to focus their attention on three types of knowledge: disciplinary knowledge: what do I know, pedagogical knowledge: how do I communicate what I know, and academic knowledge: how do I transform myself with what I know? Thus, the teacher has the capacity to transform not only his or her students, but to transform himself or herself in the process. In this sense, the research aims to characterize the pedagogical practice of physics teachers in educational institutions located in the “Catatumbo, Colombia”, a region characterized by high levels of violence and very specific social situations; it also aims to determine the influence of training at the master's level of the Francisco de Paula Santander University on teachers working in the area of physics. The research, framed in the mixed paradigm, allows the realization of univariate and multivariate analysis of variables inherent to the process of training and professional action of master teachers, as well as the categorization of their experiences resulting from the application of knowledge obtained throughout their studies in their professional practice and training in different areas of knowledge, emphasizing the practices, laboratories and teaching strategies used in the training of students by physics teachers.

1. Introduction

The teaching of physics is a discipline that is part of the academic training of teachers both in the specific aspects of physical science and its didactics and the pedagogical practices involved. The physics teacher, in basic and secondary education, must generate training spaces that motivate the student to interact with the environment, to perform laboratory practices and, consequently, to develop his or her own culture in which the student appropriates his or her knowledge, projects it to the environment and understands the reality explained by both static and dynamic physics, in such a way that they achieve significant learning and develop their criticality [1,2]. Based on this, the pedagogical practice is constituted in a scenario, where the teacher has at his disposal all those elements proper to his academic and personal personality, from the academic, what is related to his disciplinary and didactic knowledge, as well as the pedagogical that allows him to reflect on the strengths and weaknesses of his work in the classroom in search not only of the transformation of his students, but of transforming himself based on his knowledge [3].

The “Universidad Francisco de Paula Santander (UFPS), Colombia”, in its institutional educational project, favors a critical dialogical pedagogical model [4,5] which, in turn, founds two master's degree programs in education: The master's degree in pedagogical practice and the master's degree in mathematical education, from which teacher training is based in order to develop specific pedagogical models, curricular and didactic designs around the strengthening of the creative thinking of their students. From the beginning of the program, the teacher proposes a research project in which he



involves his disciplinary knowledge with pedagogical training in order to generate meaningful learning spaces in his students. This project is carried out in several phases, which involve both the teacher's own knowledge and the description of his or her students in their socio-economic environment so that, based on the specificity of their training, they can generate learning strategies specific to their discipline.

In this sense, the master's degree in pedagogical practice has among its training purposes: to foster critical pedagogical thinking and dialogue with participants; to generate processes of interdisciplinary research, on problems relevant to the training function; to foster change in pedagogical practices and to interpret assessment systems through strategies consistent with the discipline it teaches. Its curriculum is structured in three training axes: pedagogical training and pedagogical practice, research training and in-depth training. The research is structured in the following lines, in which the different degree works are assigned and developed: academic training and pedagogical practice, communication and education, science teaching.

On the other hand, the master's degree in mathematics education has among its training purposes: to enhance the entrepreneurial initiative of teachers by exploring and using the potential and competitive advantages that each can develop, in a perspective of insertion and with the application of new knowledge and technologies; to train human talent for its growth and incorporation into various value-added opportunities, which the education sector needs, integrating specific skills, pedagogical practices, teaching strategies strengthened in the field and local development; to incorporate new information and communication technologies as a tool for teaching mathematics and physics. Its curriculum is structured in four training axes: pedagogical, disciplinary, science teaching and pedagogical research. The research is structured in the following lines, in which the different degree works are assigned and developed: applied mathematics and physics; applied pedagogy; science, technology and innovation, and science teaching. As part of its educational and social commitment and in order to train teachers of basic and secondary education working in the area of "Catatumbo" in the department of Norte de Santander, Colombia, the UFPS establishes an incentive consisting of a partial exemption of half the value of their tuition with a consideration consisting of conducting research, which in turn is their thesis, whose purpose is to understand, explain or solve social and educational problems in this area.

The present research aims to determine the influence of the University on these pedagogical practices as a result of the process of training teachers in "Catatumbo, Colombia". The teachers in "Catatumbo" responded favorably to this incentive and that is how 406 teachers have been enrolled to date (278 in master's degree in pedagogical practice and 128 in master's degree in mathematical education). Several of them have already graduated and the results of their research have been presented at national and international academic events and are being published in indexed journals of recognized tradition. The region of "Catatumbo" is located in the north of the department of Norte de Santander, Colombia, it comprises about half of the territory, 11 municipalities that make up 19% of the population of the department. It has been characterized by an armed conflict for several decades, and Ramírez should be consulted in order to describe it from the point of view of the Colombian military [6]. The "Departamento Administrativo Nacional de Estadística (DANE), Colombia", estimates that 69% of campesinos and indigenous people living in rural areas of "Catatumbo" suffer from some type of vital need. In this area there are an estimated 20000 students and over 1000 teachers distributed among the 42 educational institutions, according to data from the departmental education secretariat.

Most of the teachers who are doing their master's studies at UFPS do not have a proprietary appointment and are awaiting the call for tenders, for the time being their appointment is on an interim basis. Teachers enrolled in master's degree programs at UFPS are distributed as follows, according to their undergraduate degree: in the master's degree in pedagogical practice 8% are physicists or graduates in physics, 12% are mathematicians or graduates in mathematics, 40% are graduates in pedagogy and human sciences, 15% are engineers, 9% are from administrative areas and 16% from other areas; in the master's degree in mathematical education 32% are mathematicians or graduates in mathematics, 15% are physicists or graduates in physics, 5% are graduates in pedagogy and human sciences, 23% are engineers, 10% from administrative areas and 15% from other areas.

The final objective of the research involves characterizing the population of teachers in “Catatumbo, Colombia”, who are doing their master's degree at UFPS, describing the context in which they work, identifying their pedagogical practice and the change that has been generated in their educational work as a result of the training process at the master's degree.

2. Methodology

The study is part of the multi-method modality [7] using open-ended surveys, in-depth interviews and documentary analysis of the theses presented [8]. Univariate and multivariate statistical methods are applied to data analysis [9,10]. In order to obtain valid results, a stratified random sample [11] of teachers enrolled in master's degree programs is selected to achieve 90% confidence with a margin of error of no more than 5%. Stratification is done by proportional affixing, by graduate academic program and by undergraduate degree. The sample is made up of 167 teachers, 114 for the master's degree in pedagogical practice and 53 for the master's degree in mathematical education.

Proportionate affixing was used to ensure the participation of teachers from each training area in the study. Thus, 9 physics teachers in the master's degree in pedagogical practice and 8 in the master's degree in mathematical education are included in the sample. The survey is the same for all in order to establish comparisons based on multivariate data analysis, but the interviews are conducted differently according to the professional training of the teacher. Based on the selected teachers, we inquired about their perception of knowledge, science, education, pedagogical practice, didactics, teaching and learning. The information was collected by means of an open-ended survey and, based on the answers given, the modalities of each of the variables analyzed were established to posteriori. Interviews and documentary analysis were carried out through a selection of program graduates for convenience. The information is processed for all the participants in the study; however, the design allows for the analysis of both the whole and each modality of the control variable academic training of the master. In this document, general results are presented, but emphasis is placed on those provided by teachers with training in physics and those with a degree in physics [12,13].

3. Results

The open-ended survey allows for the identification of trends among teachers, based on their area of training, but at the same time, it is possible to describe their views on each of the answers given. Figure 1 shows the correspondence between the different modalities of the variables analyzed, which constitutes the basis for the analysis of teachers' perceptions of different aspects related to concepts of education, science and learning. Six variables were analyzed: teachers' professional training, as a control variable and, as study variables, the perception of didactics, knowledge, pedagogical practice, pedagogy and science. Multiple correspondence analysis makes it possible to identify three groups.

A first group made up of physicists and physics graduates understands didactics as a science of imparting knowledge, knowledge as an accumulation of knowledge, pedagogical practice associating it with the activity carried out in class, pedagogy is a science of education and science associates it with the study of phenomena. A second group made up of engineers, mathematicians and graduates in mathematics and professionals in administration, do not have a specific perception of didactics, they associate knowledge with learning, they conceive of pedagogical practice as the work of teachers, they consider pedagogy as the art of education, and science as a body of knowledge. A third group, made up of graduates in education and human sciences and professionals in other disciplines, relates didactics with teaching practice and perceives it as a way of acquiring knowledge, knowledge is attributed to mental processes, pedagogy is associated with the work done by teachers and science as the acquisition of knowledge.

In general terms, with respect to knowledge, 46% consider it to be the result of a learning process that originates in the mind, the rest assume the knowledge as an accumulation of knowledge. Science is considered a collection of knowledge by 32% of teachers, 12% consider it a way of acquiring knowledge and 66% relate it to the study of phenomena. Didactics is understood as a science that allows the imparting of knowledge by 78% and as a methodological strategy for teaching by the rest of the students.

Teaching is understood by teachers as the process developed by the teacher to bring knowledge to their students, it is also understood as the permanent orientation of the teacher to his or her disciples. Learning is identified as a mental process that occurs in the student as a result of the work of the teacher and the student himself.

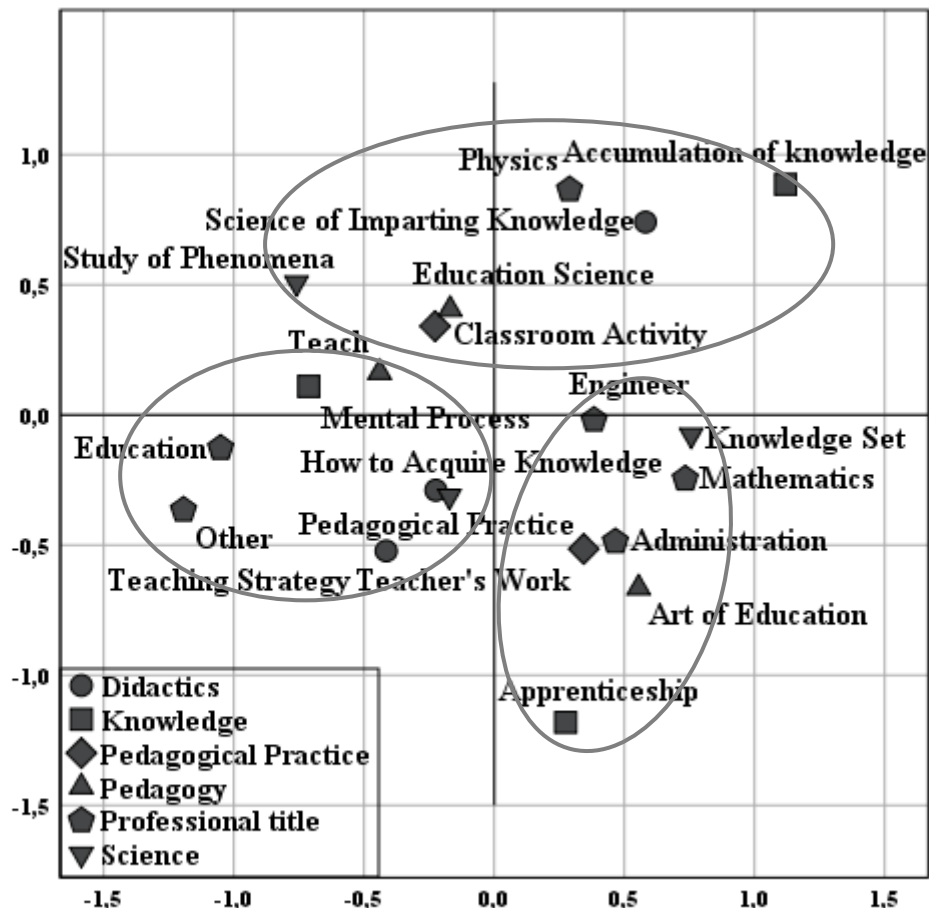


Figure 1. Perception of pedagogical aspects.

On the other hand, as a result of the interviews, it can be established that teachers in master's degree courses consider that the generation of problematic experiences and situations that require analysis, as well as the formulation of problems that go beyond disciplines and demand innovative approaches with the participation of teachers from different areas of knowledge, is what leads students to achieve significant learning.

Pedagogical practices can be classified into two categories: one category is made up of those considered expository, such as the master class, the lecture, the interrogation, the demonstration, the guided discussion, the problematic teaching, the case study and the didactic laboratories. The other category is made up of practices that lead to a deepening of knowledge such as the seminar, the discussion, the field practices, the playful practices and the dramatization.

4. Discussion

Physics teachers have opted for the construction of didactic material for the development of laboratories that strengthen the learning of physics and therefore skills in the study of mechanical and dynamic physics at the high school level in the "Catatumbo" region. In the interviews, the teachers expressed the difficulties associated with the cultural factors of the inhabitants of the region, which leads to a lack of attention by the students in the training and acquisition of knowledge. They also state that the learning

achieved in their training process has allowed them to develop special didactics for the motivation of the students, to involve evaluation models that not only allow them to verify the fulfilment of goals, but also propitiate learning.

Teachers in master's degree programs, particularly those with training in physics, mathematics, and a bachelor's degree in physics or mathematics, stated in interviews the need to establish pedagogical models that foster mathematical logical intelligence, spatial location, reading comprehension, the ability to express ideas and to argue for results as part of the development of potentialities and skills, and the achievement of meaningful learning. The opinions of physics teachers advancing the master's degree coincide with Maldonado [14] in that the approach and strategies designed by the teacher for teaching physics are related to generating good levels of creativity in students; however, it is important to establish divisions between the academic research of students and that of teachers [15] so that the former is concerned with strengthening the learning process while the latter is concerned with understanding the student and designing didactic strategies for teaching physics in conjunction with pedagogy and teaching practices.

Physicists and teachers of physics identify with the philosophical theory of intellectualism, a philosophical current that emerges as a response to the antagonism of the confrontation between empiricism and rationalism. It seeks to reconcile the two theories by forming a third that complements them by accepting that there are universally valid judgments and that these can be achieved through experience, since they coincide in affirming that knowledge resides in intelligence, in reason, but requires empirical work for its generation. The pedagogical practice is constituted as an ally to establish didactic strategies and knowledge formation in students and teachers.

5. Conclusions

Students with training in physics and mathematics from the UFPS master's degree courses in pedagogical practice and mathematical education show significant changes in the development of their pedagogical practices in the exercise of their teaching work. In particular, they perceive the formation of knowledge as a mental process but based on empirical aspects through the combination of theory and practice by incorporating the knowledge of the discipline to processes generated in their environment, thus achieving that the student generates a significant learning

The pedagogical practices developed by physics teachers are quite related to those developed by teachers of biological sciences and chemistry, since they agree in accepting that experimentation is required as empirical learning that complements the mental process that leads to specific knowledge of the area. In a region like that of "Catatumbo, Colombia", with specific social and cultural phenomena together with the conditions of violence and the lack of resources, teachers must awaken their creativity to generate field practices that complement theoretical training, especially in physics and related disciplines.

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