Physics teachers' initial education and professional performance: What do future teachers have to say?

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Abstract

This research deals with the discussion about Physics teachers' undergraduate education and professional performance related to the knowledge acquired during this initial education. More specifically, we try to answer questions like: How do future teachers evaluate the knowledge acquired during their initial education as in terms of specific knowledge as pedagogical knowledge? What are their formative needs and future expectatives about professional performance and the school teaching environment? Data was constituted from a sample of 26 future high school physics teachers, one semester long, that were taking the supervised curricular training in a undergraduate Physics education program (called Licenciatura in Brazil), in São Paulo State public university. Besides the final report of this training, future teachers were asked to answer a questionnaire aiming to take their conceptions about their initial education program, their formative needs, future professional expectatives and high school teaching environment. According to the future teachers, the program they were about to finish was satisfactory in terms of Physics specific contents; however, about the pedagogical content knowledge and the pedagogical practice, they showed to be unsatisfied and insecure. The majority of the questionnaire responses demonstrated that they feel lack of teaching experience. Moreover, teachers emphasize other factors related to the future professional performance: possible difficulties to deal with students' indiscipline, schools' bad physical structure, limited number of Physics classes in high school level, lack of didactical laboratories and also they seem to be frightened that the expertise teachers do not be collaborative with the new ones. In this sense, the research outcomes shows the necessity of discussions about questions involving teachers knowledge, related to either, the Physics conceptual domain and the pedagogical one, since it matters directly to future teachers professional performance. Discussions in this sense can also help evaluation and restructuration of programs designed to initial and continuous teachers' education.

Keywords: Physics teachers' initial education; Physics teachers' knowledge; Physics teachers' professional performance.

Resumen

Este documento se centra en la discusión sobre la formación del profesorado en física bajo el sesgo de la formación docente y las actividades profesionales con respecto a los conocimientos adquiridos durante la formación. Más específicamente intentarmos contestar cuestiones del tipo: ¿Cómo los profesores evalúan a los futuros profesores los conocimientos adquiridos en la formación docente, tanto en el conocimiento específico y la enseñanza? ¿Cuáles son sus necesidades de formación y aspiraciones de los resultados futuros y el contexto profesional de la enseñanza en las escuelas? Los datos fueron registrados con una muestra de 26 de los futuros profesores de física de la escuela secundaria, durante un semestre, durante el desarrollo de actividades extraescolares supervisadas, una licenciatura en física, una universidad pública en el Estado de São Paulo, Brasil. Al final del curso, los estudiantes dieron informe sobre el escenario, que también contenía un breve cuestionario para sondear sus opiniones sobre su formación inicial, las necesidades de formación, los deseos y el contexto futuro de la enseñanza en las escuelas. De acuerdo con las respuestas de los estudiantes, la Licenciatura en Física fue satisfactoria en cuanto a conocimiento de los maestros sobre el contenido específico de la física. Pero en el conocimiento de los contenidos educativos, lo que implica la enseñanza de la práctica pedagógica y el conocimiento, know-how, afirman insatisfacción e inseguridad. En cuanto a la falta de experiencia profesional experiencia en la enseñanza parece muy fuertemente en las respuestas de los estudiantes. Además, otros factores que parecen estar complicando para el ejercicio profesional se los alumnos problemáticos, la estructura física de la escuela, el número de clases de física (tiempo), la falta de laboratorios de enseñanza, la falta de cooperación por parte de los profesores con más experiencia, etc. Por lo tanto, es necesario debate en torno al tema del conocimiento de los maestros con respecto tanto en el ámbito conceptual y pedagógico, porque afectan directamente el

desempeño profesional de los futuros maestros, y las discusiones de este tipo pueden ayudar a la evaluación y reestructuración de los cursos y la formación la educación continua de los profesores.

Palabras clave: La formación inicial de profesores de Física; Conocimiento de los maestros; La práctica profesional.

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I. INTRODUCTION

The questions on teachers' knowledge have permeated the research in teacher education field in the last 20 years, being viewed as a research area itself, considering the volume of work carried out and diffused [1, 2, 11]. From the moment that Shulman [9] stated his thesis on the need to refocus research on the teacher for the analysis of their professional knowledge on the subject, the teachers' knowledge has been the source of numerous investigations.

According to Pacheco [7], regarding teaching as a professional activity, the teacher must be trained both, in basic skills (content) and in teaching skills. That is, when it comes to teacher knowledge, in most cases, knowing the content assumes particular value in relation to others. But for acting, the teacher needs not only the content, although its outstanding importance, but also the know how to teach this content. To be a teacher is not enough just to know the content, not enough to have talent or common sense, not enough just to follow your intuition or have experience, and yet not enough just to have culture, otherwise, we will have only a "craft without knowledge" [3]. For this author, the craft of being a teacher must consist of knowledge. Such knowledge should be built and deployed during the future teachers' initial education.

Moreover, we agree with Tardif [11], that no knowledge in itself is an alone trainer. To know something is not enough, we must also know how to teach. According to the author, "the teachers attend a change in the nature of his mastery: It deals with knowledge of procedures for the transmission of knowledge. Knowing is not enough; he/she has to know how to teach" (p. 44).

According to Shulman [10], the transformation of science content into school curriculum becomes a crucial point in educational research that focuses on the creation of teacher knowledge. For this author, the pedagogical content knowledge is a kind of knowledge that goes beyond the knowledge of matter, of subject, extending to the knowledge of the subject to be taught.

Furthermore, it guides the research on teacher knowledge upon the contents of teaching and learning, that is, the question of teachers knowledge on specific contents and upon the way these contents are tranformed into teaching.

To Guarnieri [5], teachers in early career experience several difficulties related to the performance in the classroom. Beginning teachers feel "very concerned about the question of what to teach and how to teach [...] how to select and organize learning contents, and distribute them on a school day, the procedures to use to convey the matter" (p. 14).

Despite the initial training did not present all the complexity of teacher education, when thought from the perspective of practical rationality, it is a time of extreme importance to the education process [6]. That is, when the teacher is prepared to begin teaching, since that learning continues throughout their careers.

According to Gil-Pérez and Carvalho [4], Science teachers do not only lack adequate training, but are not even aware of their short comings. In this sense, the study outlined here aroused our attention. That is, will our future teachers, particularly physics teachers, be aware of their needs? Also, how do future teachers assess knowledge acquired in teacher education program related to the specific knowledge as well to the pedagogical knowledge? What are their formative needs and aspirations upon future performance and teaching professional context in schools?

II. THE RESEARCH

This study is a qualitative research and makes part of a wider study, in which the goal was to accompany a group of future Physics teachers of high school (26) over a semester, during the development of activities from supervised curricular training inserted in education program in Physics, at a public university from São Paulo State, Brazil.

This monitoring was intended to verify the teacher knowledge mobilization in discursive interactive contexts of Physics teaching involving analogies. To turn it possible, all the classes taught by undergraduate students were observed, recorded and transcribed for later analysis.

At the final stage of training, undergraduates, as parte of the assessment rules, elaborated a report, which also contained a short questionnaire to survey their views about their training; both, in level of knowledge, and pedagogical needs, expectations on future performance and on teaching professional context in schools.

Even the report not being the central instrument for collecting data, it called us equal attention in reading the answers given by students to the questionnaire regarding the knowledge acquired during the training. According to it, we decided to use the questionnaire in the research as a characterizing element of future teachers, to identify who they are and what they think about their education.

However, due to space limitations, we are presenting here only the discussion from one of the questionnaire parts, which corresponds to teacher knowledge content obtained from initial education and future aspirations of these pre-service teachers. To interpret the speeches, emerged from the questionnaire, we preserved the integrity

and anonymity of participants. So, we identified them by using codes.

III. DATA INTERPRETATION

One of the questionnaire questions sought to determine, if the physics content taught during physics initial education was satisfatctory in order they become "good physics teacher".

Among the 26 undergraduates (100%), seven (27%) responded that the physics content, which they had during the undergraduate degree, was not enough for they be considered a "good physics teacher". But, the remaining 19 (73%) said they were satisfied and ready for acting. Some of the aspects that contributed to 19 (73%) of undergraduates said they were satisfied with the education received, as for the content, are related to the following factors: the scope of the curriculum, which is complete concerning the content; preparation to solve problems in physics, pohysics basic subjects related to work at teaching laboratories; consistent basis for autonomous learning of content not covered in the classroom; content in excess.

Some of the explanations given by seven (27%) undergraduates who considered education received, in terms of content knowledge, unsatisfactory were: the course as an undergraduate bachelor's program in disguise, absence of teacher during class time, lack of explanation from the teacher in classroom; kowledge approaches far from high school reality; fragmented contents in enviroment physics and technologies, lack of conceptual discussion; contents treated lightly.

Some of these undergraduate students emphasize, still, that the amount of hours dedicated to the disciplines of basic physics as insufficient, they should be expanded, so that, the treatment of the content would be more comprehensive, since certain subjects are seen as being very wide.

"Knowing the content", "master the subject," "have full conceptual domain of the subject", "know a lot of physics" are terms used by the majority of undergraduates by highlighting the specific content as essential for a teacher to be considered as a "good teacher". Coupled with this knowledge, the "good teacher" also needs to know treating and explaining the content in the classroom by linking it to other fields of knowledge, which are not necessarily the specifics, such as: history of Science, Science, technology, society and environment (STSE), that are often knowledge related to the field of teaching.

A_1: *You have to master the subject.*
A_2: [...] *conceptual domain*.
A_5: *First knowing the content, learning a little history of science and have teaching.*
A_7: [...] *A good teacher must master the content. Another thing which is vitally important: a good teacher should do in their classes is constantly relating contents to students' daily experiences.*
A_{25}: *Knowing physics very well, having teaching, so that students can understand it well, do experiments in class that lead they to think and make question, do the experiment relations with the content covered and the student's daily life; knowing how to begin treating a subject taking into account the students' spontaneous conceptions, to introduce the philosophy of science, a way of thinking, to question the science through formulating hypotheses; knowing the history of science in order to match the experiment analysis to the subject historical development, to be able to evaluate student's interest and participation, effort and learning, have a good relationship with students, and admit when you are wrong.*

Thus, from the 19 undergraduate students, eight emphasize the importance of knowing more than the content, it is also relevant to know how teaching this content. It means, the pedagogical content knowledge is so relevant as the content knowledge.

Therefore, for some o them, the dissatisfaction with the education emerges from the fact that they were not "prepared" to transform specific content into a "teachable content" in high school students level.

A_3: *It left much to be desired in method item, this is, subjects like Practice, Instrumentation and Teaching are currently uncorrelated. All these matters are always redundant in the "What should be done..." and not worry about "how it should be done" in a concrete and applicable not only as a dialectic. I consider that a serious flaw in my education.*
A_4: *I think, however, I can feel some difficulty to implement such content at high school level.*
A_6: *Due to the fact that it* [Physics] *was taught in a way that there was not the approach it should be treated a specific content at high school level; there was not taught accordingto the content [to be taught]at high school.*
A_9: *Regarding the methodology that should be used, or theories of learning, all part of this level is poor. All I know about theories of learning and other important issues, I learned by myself, studying for assessment to the Science Education Graduate Program.*
A_{10}: *There was a few classes directed toward the teaching and learning. I think I will have difficulties to teach only the superficialities and errors contained in textbooks.*
A_{16}: *Being a good teacher means not only having control over the content of the matter, but also knowing how to teach, how to evaluate, among others.*

However, even with a background in terms of knowledge contents and pedagogical contents deemed satisfactory, they believe that the teaching experience will help them to reduce possible failures of the initial education. This is the case, for example, of MRS, which states:

MRS: *The contents viewed along the graduation were very satisfactory for me to be a good teacher, because we saw the fundamental disciplines of Physics and Basic Education, essential to do a good job in school. However, there is many knowledge that only comes with years of*

teaching, facing many different situations and problems, keeping contact with other students and teachers.

In addition, specifically with respect to knowledge provided by the discipline of Physics Teaching Practice, which deserves detach by dealing with the approach of specific content under the bias of how working this content in the classroom, 100% of the undergraduates said they were satisfied with the way it was handled, despite the above statements are opposite. The undergraduates considerations regarding the knowledge provided by this discipline are below:

TABLE I. Students' answers upon the knowledge provided by teachers from the discipline Physics Teaching Practice.

Knowledge provided by teachers from Physics Teaching Practice
Discussion of relevant issues to teacher profession;
Establishment of a "bridge" with the educational setting;
Reflection on the content didactical transposition into a clear, understandable and meaningful content for students;
Reflection and discussion on content involving CTSA, scientific method and its implications, history and philosophy of Science, spontaneous conceptions;
Rethinking the teacher profession and their methodologies;
Contact to school reality and its relationship of teaching and learning, particularly the difficulties inherent to school environment;
Approaches of positive and negative experiences, enabling reflection on the teacher know-how knowledge.
Reflection on how to improve teaching and teaching capacity through research;

Despite the undergraduates detach the subject knowledge as primary in order to be a Physics "good teacher" and understanding that beyond this knowledge, knowing how teaching that content is also essential, undergraduates point out some difficulties that also would influence their professional practice. Among them, there are:

1) Regarding to the lack of teaching experience:

A_6: *I think my own lack of experience would be the biggest obstacle.*

A_7: *My inexperience is the main difficulty I have with the own act of teaching. There were very few opportunities to teach during the undergraduation.*

A_8: *The main difficulties that I would feel in teaching physics today is the lack of experience.*

A_{11}: *I think that my difficulty would be, in general, the lack of experience. The discipline offered practical teaching experience to prepare and teach classes to high school students, a task that there is no better way to dominate as time and experience acquired.*

A_{13}: *Maybe the initial lack of practice. I am convinced that no one goes out [the university] ready to teach* [...] *it is built slowly, during his/her career.*

A_{18}: *In the first place, it would be shyness, because I feel a little difficult, at begining, until knowing the class as a whole, I think the first lessons with a particular class would be a little difficult.*

2) In relation to security in konowing the content:

A_{18}: *Another thing would be a little insecure perhaps, be very careful in speaking to not teach students flawed concepts.*

A_{24}: *I understand that the knowledge gained in the undergraduation is enough to teach in high school, with reference to the physics content. But, it will be necessary a a good review of the matter before each class, since, at the end of the program, the basic physics concepts have being forgotten, since the programa gets deeper into the nebulous world of modern physics.*

3) Related to lack of pedagogical content:

A_3: *I have vocation to teach, but not the methodology. I have consistent technical education on the subject I teach in the classroom, but I recognize that I could pass it more effectively if I had the necessary teaching experience.*

A_2: *To understand what the students do not understand, or comprehend why the content of intellection is not presented, because it involves not only specific knowledge, but a lot of psychology and patience, as well as to be able to lead a conceptual discussion satisfactorily, without being obliged to flee to the famous incomprehensible equations.*

A_4: *One of the main difficulties that I might feel would be the implementation of the teaching content for the high school level.*

A_5: *In preparing a lesson.*

A_8: *Difficulty to carry out the didactic transposition efficiently, since the program does not have a subject that teaches us how implementing this teaching effectively.*

A_9: *I have already taught classes in high school, and the main difficulty I see is how to use modern methods to stimulate students to study and take an interest in science.*

A_{18}: *The way to prepare lessons.*

A_{19}: *This is my fourth year teaching and I have serious difficulties for preparing a series of lessons that makes students reflect on nature and analyze it, looking for explanations and models.*

4) Regarding to lack of structure (textbooks, Physics, other school personnel, curriculum, etc.):

A_{17}: *The main difficulty would be to develop practical classes at the laboratory, since most schools does not have structure and materials or even a laboratory, a space for these different classes.*

A_{19}: *Rejection by other professionals, often older, who have a mentality of "mechanistic-teaching".*

A_{20}: *The main barrier that I see, even without having yet taught, is the small number of physics classes per week: only two classes, one hour and twenty minutes. It is little time for lessons with discussion, in order to achieve a meaningful learning. One thing I fear is going into the degrading system that is installed inside schools, where students are seen as obstacles that must be endured every day to receive their salary at the beginning of the month.*

A_{24}: *You may find problems at the physical facilities the*

teacher generally have in state schools, in order to implant a new methodology of teaching, or experimentation, since many schools do not have laboratorios, or they are found in poor conditions.

IV. CONCLUSIONS

According to undergraduates' responses, one can conclude that the Physics teachers' initial education (undergraduate programs) satisfactorily provided future teachers regarding to specifi conten knowledge. However, in relation to the pedagogical content knowledge, which involves teaching the knowledge and the pedagogical practice, they claim dissatisfaction and insecurity, as if the program did not have prepared accordingly.

In research conducted with prospective chemistry teachers, Parga, Mora and Martínez [8] also found that most teachers in both, pre-service and in-service education consider the specific knowledge of chemistry as being critical to school planning but are unaware, or do not know, how to articulate history and epistemology of chemistry in their classes, characterizing also a non-curricular articulation of knowledge with pedagogical knowledge. Regarding the lack of professional experience, teaching experience appears very strongly in the undergraduate students' responses. Although the most positive assessment of the course, in the question on the professional activities, it is demonstrated that it represents the same uncertainty as the education received. In addition, other factors that seem to make more complex the professional performance would be, the students' misbehavior or indiscipline, the schools' physical structures, number of physics classes (time), lack of teaching laboratories, lack of cooperation from the more experienced teachers etc. Thus, we believe that it is necessary discussions surrounding the issue of teacher knowledge regarding both the conceptual and pedagogical domain, and how they can influence on the professional performance of future teachers. Moreover, these discussions can be valuable for the evaluation of initial education and continuing education teachers programs not only in physics but also in other similar sciences such as chemistry and biology, for example.

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