Pre-service teachers' perceptions of the professional attributes of future physics teachers

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Abstract. We present here results of a study of longitudinal character, which sought to follow a group of future physics teachers of a State University in São Paulo, in Brazil, from the beginning until the conclusion of the teacher training course. The main objective was to understand how the research outcomes have been introduced or interfering in the education of these future teachers. In order to do that, we analyzed the possible variations in their imaginaries of aspects related to a possible 'good teacher' and the 'evaluation of learning'. Data collection was carried out through questionnaires that were administered annually. The data were treated through Discourse Analysis, originated by Pêcheux and developed in Brazil by Orlandi and other researchers. Among the results obtained, we have noted the strength and impact that the course and its pedagogical project have on the students, and that the conditions of discourse production were fundamental for the change in their imaginaries regarding those themes.

1. Introduction

Research in Science Teaching has expanded significantly; in Brazil, we can confirm this growth with the large academic output that results from the progressive increase in the number of postgraduate programmes in this area. These productions enrich the scientific events and favour the development of the research in the field, highlighting trends and gaps [1]. The results have shown promising paths in the search for solutions to the main problems in the area. However, this amount of production does not reach the classroom, for several reasons [2]. Causing future teachers to interact with research results, since their initial training, is one of the goals in order to bridge this gap.

In this way, this research had as its focus the study Physics undergraduates' representations, from admission to university through the conclusion of the programme, with respect to aspects such as scientific knowledge, the teaching of science, and the process of constitution of teaching knowledge. The objective was to analyse possible variations on these aspects during the training period and to verify how the research was being introduced or already interfering in the initial education of teachers, in the case of Physics.

The study involved a sample of physics students from a Brazilian public university, who were admitted in 2014 and should have completed the course by the end of 2017. The theoretical basis of this study is grounded on the work of authors who study teacher education, particularly how academic production interferes with initial or continuing teacher education.

In this paper we deal with aspects related to "learning assessment" from the perspective adopted by Luckesi [3], [4] and Hoffmann [5], and the possible "good teacher".

From an ethnographic study, developed by Cunha [6], which followed the daily routine of "good teachers" in the classroom, Cunha identifies several skills that make a "good teacher" and bring them together into five groups:

- Organization of the context of the lesson (HO): the teacher explains the purpose of the study, locates the content historically, establishes content relations with other areas of knowledge, uses verbal devices to point out fundamental questions, presents the lesson script and reference materials;
- Stimulus to student participation (HI): formulate questions, value dialogue, engage the student to ask questions, transfer inquiries from one student to another or class, use words of positive reinforcement, and listen to students' everyday experiences;
- Treatment of teaching material (HT): makes academic language accessible, uses analogies, links theory and practice, uses examples and uses research results;
- Variation of stimulus (HE): uses audiovisual resources, worries about instilling doubt, moves around in the room and stimulates divergence and creativity;
- Use of language (HL): use of appropriate terminologies, audible voice, adoption of varied voice intonation and sense of humour in dealing with students.

2. Methodology

For the constitution of the data, the research took on a qualitative approach, in the sense defined by André [7] and Flick [8]. The data were obtained through questionnaires, involving a sample of undergraduate Physics students, preparing to become high school teachers.

Four data collection events took place every year for four consecutive years. The first occurred in March 2014, when the undergraduates entered university, in the course "Methodology and Practice of Teaching Physics I". The other questionnaires were administered at the beginning of 2015, 2016 and 2017, in the courses "Methodology and Practice of Teaching Physics" III and V, and "Didactics for Science", taught in the first semester of each year.

The questions in the questionnaire were repeated annually, except in the first questionnaire, when there was an interest in investigating the personal and academic profile of each undergraduate in addition to the questions that would provide the main material for the analysis.

The sample has diminished in size due to some students' failing courses or having chosen to follow the BSc. This is because students choose, after admission, whether to follow the teacher education track or the baccalaureate.

Initially, 49 students participated in the first data collection; in the second year, this number fell to 11; in the third data collection, eight students responded the survey; and in the last questionnaire only three students in the initial sample participated. At the end of the four-year period, only one participant was graduating within the anticipated time.

Although this decrease seems a very pertinent fact, it is consistent with previous research carried out by Kussuda [9], who, in his work, showed the drop-out rate in this Physics programme in the same University.

The imaginary of the future teachers during the initial training course was analysed using an analytical device based on the Discourse Analysis studies developed in France by Michel Pêcheux and, in Brazil, by Orlandi and other researchers.

The main characteristic of this type of data analysis is the focus on promoting reflection on the interpretation, that is, it shows the impossibility of having a direct access to meanings. In this type of analysis, the main goal is to understand how an object leads subjects to make sense of it and what is the importance of those senses [10], that according to Gadet and Hak (??) [11] "every discursive process supposes the existence of imaginary formations".

From this perspective, we highlight a general overview of the research on learning assessment and the good teacher, and discuss the main results achieved.

3. Discourse production conditions

The utterances where collected during the courses "Methodology and Practice of Teaching Physics" I, III, V, and "Didactics for Science". These courses belong in axis two, called "The Formation of Didactic-Pedagogical Knowledge of the Physics Teacher – an integrative axis in the programme", in the curriculum of the undergraduate programme analysed.

The programme's pedagogical project includes two other axes: axis one, shared with the Bachelor's Degree in Materials Physics, which deals with the specific contents of Physics, and axis three, which covers philosophical, historical, political, economic, sociological and anthropological aspects related to science and its impacts on classroom teaching.

4. Analysis

The profiles of these future physics teachers were analyzed in previous studies [12], [13]. Thus, we can observe that the three licensees who participated sequentially in all data collection surveys, come from regular high schools of the private network and, during their graduation, participated in some extension or research project.

In this sense, by knowing the profile of these students, it is possible to build a bridge between the identification of the subject and their discursive productions, thus identifying the connections of meanings in their discourses.

In this context, there is a power relation, since the student ends up taking on a role as author of the discourse, and the researcher the role of reader, analyst. Even if the researchers made it clear that the answers given to the questionnaires would not be considered in the course evaluations, the students, by mechanism of anticipation, try to meet the "expectations" of the researchers. We thus understand the need to carry out an interview with the subjects who have reached the final stage of the study, which has not yet been done. Thus, this analysis corresponds only to the answers given by these subjects to the four questionnaires that have been administered.

To analyse the answers of the undergraduates to the question related to the "good teacher", an analytical device was developed based on Cunha [6].

First Student:
- 2014: *[...] The one concerned in the understanding and assimilation of this content by the student and also try to awaken the interest of the student in his course. In addition, he must have a professional attitude, be ethical, towards his students and colleagues.*
- 2015: *[...] An exemplary teacher is one who - with his didactics, his manner (personal characteristics) - can transmit the content and even stimulate the student to seek more knowledge.*
- 2016: *A dedicated teacher, concerned with adapting to different situations based on theoretical assumptions.*
- 2017: *An exemplary teacher is one who has a repertoire of methodologies and knows, through reflection, the right moment to apply [...]*

The first student presents in his speech, in the first two years, that the good teacher must have HI and HT, according to Cunha [6]. That good teacher is concerned not only with the students' understanding, but also with their participation in the classroom. In the third year, in his speech, there appear HO and HT, which correspond to a teacher who knows different teaching tools and considers theoretical contributions. In the last year, all the skills that make a good teacher are evident in his discourse.

Second Student:
- 2014: *A teacher who can explain his subject matter in a way that the students understand.*
- 2015: *A teacher who can expand the content and the students can learn the subject.*
- 2016: *A teacher who has a command of the subject, has a good didactic, arouses student interest in the study of topics.*
- 2017: *Taking theory into account, he would be able to explain better the subject in a way that most students would be able to understand, question and bring that knowledge to their lives.*

The second student initially cites HL, in which the teacher needs clarity in his explanations. In the second year, he lists HL and HT, that is, the teacher needs to have greater knowledge of the content. The following year he mentions HI, HT and HE. Finally, in the last questionnaire, HI, HT and HL feature in his speech, that is, a teacher who cares about the context in which students are inserted.

Third Student:
- 2014: *A teacher who likes what he does and knows how to play this role correctly. He deals with each situation in a coherent way.*
- 2015: *In my view an exemplary teacher is one who has knowledge of what is being transposed and possibly has a positive return, uses teaching, has dynamic classes that propose to the student the chance to use his critical sense, classes that offer development including social, a teacher who always searches for news, references etc.*
- 2016: *I have in mind that an exemplary teacher would have as work tools their methodologies for support, scientific background, knowledge of what must be transmitted and how it should be transmitted, know how to evaluate and exercise critical thinking in the classroom.*
- 2017: *An exemplary teacher in my view is one that aims at the well-being of the student and his learning, seeking within his academic and personal training different ways to help the student in his comprehension.*

The last student, in the first questionnaire, evidences HO, approaching the notion of a teacher who knows how to adapt to different situations. In the following two years, HO, HI, HT and HE are present in his speech, making clear the idea of a teacher who knows several methodologies and teaching tools and also seeks to awaken students' critical thinking. Finally, in the last year, it is possible to find in his discourse skills HO, HI and HE. It is clear in his discursive production that an "exemplary teacher" should be concerned with the students' well-being and learning.

When investigating aspects of Learning Assessment, the works of Luckesi [3], [4] and Hoffmann [5] have been used as theoretical grounding. From this perspective, we have analysed the question: "What is the meaning of "test" (evaluation) for you?". Here are the answers provided by the students:

First Student:
- 2014: *The test [...] should not be a method of "bulldozing" the student. Besides evaluating how much the learner has learned, it can evaluate where the teacher can readjust the class [...]*
- 2015: *Evaluation is an extremely interesting time for the teacher to analyse himself. A coherent test shows whether the content has been assimilated or not [...]*
- 2016: *Evaluation is the moment that the teacher should use to guide the following classes. Evaluation, if done correctly, will serve as a diagnosis of the student and his understanding.*
- 2017: *Evaluation is a very important moment in the teaching and learning process [...] It is a moment of evaluation of the teacher himself, his methodologies and their effectiveness.*

In the first three years, the undergraduate understands evaluation as summative, that is, it is evident in his discourse that evaluation has the function of rating student success and that, with evaluation, the teacher can detect problems to be corrected later. In the last year of the course, the student constructs his discourse based on the perspective of a continuous evaluation, highlighting the importance of evaluation in the teaching and learning processes.

Apparently, the student is familiar with the theory of continuous assessment, but he still cannot clearly understand how to use that in the classroom.

Second Student:
- 2014: *A way to see what the learner has learned and what has prevented learning, or what the learner has not understood.*
- 2015: *A way to see what the student has learned.*
- 2016: *A way to see what the learner has learned, what was not very clear to him (and somehow manage to come back and explain again to the student).*

- 2017: *Evaluating the content that the learner has learned and what has remained in deficit, the traditional models of evaluation are deferred.*

The second student writes in the four questionnaires the phrase "a way to see what the learner has learned", which makes his conception of summative evaluation clear. He understands evaluation as only a way to rate student learning and detect possible problems that are supposed to be corrected later.

In the last questionnaire, he shows that the traditional evaluation models are out of date; however, despite having this conviction, the licensee does not yet have a broad understanding of the evaluation models nor how to use them.

Third student:
- 2014: *The evaluation for me is relative; it has the function of evaluating, measuring, what you have learned. However, there are several ways to demonstrate the content understood.*
- 2015: *Continuous evaluation would be ideal because we can evaluate the student throughout the course and not just at a given moment [...]*
- 2016: *A moment like others in which the student can use the knowledge acquired* [...]
- 2017: *[...] measure students' knowledge. This is most effective when carried out on a continuous basis, in order to detect deficiencies in time and help them with these issues.*

The last student analysed has, in the first questionnaire, a summative evaluation view, since he makes it clear that the function of evaluation is to "measure" what a student has learned, that is, only to rate the student's learning. In the next three questionnaires, the constant use of the word "continuous" in his speech worthy of attention; he makes the importance of continuous evaluation clear. Because it allows for a procedural follow-up on student development besides being part of the teaching and learning processes.

Still in the third data collection, it can be noted in his speech that evaluation concerns both the student and the teacher, since it allows for reflection on the teaching practice.

5. Final Considerations

The results show that it was the conditions of discourse production (language, institution and imaginary formations) that provoked changes in students' imaginary in relation to the evaluation and to the possible "good teacher". By understanding the university as a social institution, it was in this context that the material conditions of production of students' speech were constituted. If it were not for these conditions (the student talking about the assessment and discussing the characteristics of a 'good teacher' in an undergraduate course in Physics), the imaginary of these students would not change, because the subject of the discourse establishes relations with their real conditions of existence, the context, through the imaginary formations that govern that discourse.

Although there is some resistance to the evaluation of learning, a favourable movement has also been identified in the adoption of new methodologies and in the understanding of the future teachers that traditional practices are out of date and need adjustments. This demonstrates the strength and impact that the physics programme (pedagogical project, syllabus structure and courses dealing with evaluation) has on these students

6. References

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