

Contradictions on the Process of Becoming a Physics Teacher

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Abstract: Our objective is to focus on contradictions of the process of learning and becoming a physics teacher. We undertook this research at undergraduate course called "Practices on Physics Teacher" addressed to third-year pre-services teachers. Data were gathered by recording classes and interviewing students. Using cultural-historical theoretical and analytical framework, we will point out macro and micro-levels contradictions of becoming a physics teacher.

Introduction

Physics Teacher Education in Brazil has been taking part in research agenda on Science Education for many years (Villani et al, 2009). However, it does not mean all themes have been investigated. Considering that, in this paper we present findings from a study conducted with the purpose to investigate Physics Teacher Education Program (PTEP) in which undergraduate students had to take their practicum in a High School. Using Cultural-Historical Activity Theory (CHAT), we will reveal some contradictions present on the process of learning and becoming physics teacher. Based on Engeström (1987)'s ideas we will point out two set of contradictions: (i) those present on macro-structure of activity; (ii) those present on micro-structure which are revealed by subjects' actions and speech.

Methodological Protocols

Our research is undertaken in course entitled *Practices on Physics Teaching* addressed to third-year undergraduate physics students (pre-service physics teachers) at a Brazilian public university. Events of lessons,- in which students and the professor gathered every fifteen days to discuss different sorts of topics in physics education,- and interviews were taken as our object of research.

Based on the qualitative methods we collected our data by videotaping classes at university, in which 75 people were involved and 70 hours of video were recorded. In the end of academic year, we interviewed 10 of those students (who accepted our invitation). Interviews followed a semi-structured protocol wherein questions were about: reasons of choosing a Physics (PTEP), their perceptions about how teachers should be educated, (early) teaching experience, solving problems during the practicum. Analysis is oriented event-based (TOBIN & RITCHIE, 2012), that is, we select events happened on the classes in which contradictions come out in order to understand what was going on at that moment.

Theoretical Framework

This research (design, methods and analysis) draws on the Cultural-Historical Activity Theory (CHAT) whose foundation emerged from Vygotsky's idea who argued the relationship between the subject and object is always mediated by instruments. Stating that Vygotsky "maintained the human beings are agents who react to and act upon mediating objects of the environment such as tools, signs, and instruments leading to an outcome" (Nussbaumer, 2009). Other elements were added to Vygotsky's idea by Leontiev (2009) such as the motive that orients the activity and conducts the guided action and automatic operations. Over the past two decades, Engeström (1987) proposed a complementation of these ideas when he introduced the community, rules and values, and division of labor as part of the human activity structure. These elements are underneath by either mediating the relation between subject and object or "reciprocally influence the achievement of the object and the final outcome" (Nussbaumer, 2009).

The arousal of *inner contradictions* is the consequence of this set of mediations within a complex human activity. For instance, Roth & Lee (2007, p. 203) say "activity systems harbor *inner* contradictions, which come with the coexistence of mutually exclusive elements". They also state "when inner contradictions are conscious, they become the primary driving forces that bring about change and development within and between activity systems. Generally overlooked is the fact that contradictions have to be historically accumulated inner contradictions, within the things themselves rather than more surface expressions of tensions, problems, conflicts, and breakdowns".

In this same perspective Engeström (1987)'s ideas of inner contradiction of human activity points out the cultural-historical aspect. He quoted "the basic internal contradiction of human activity is its *dual existence* as the total societal production *and* as one specific production among many. This means that any specific production must at the same be *independent of and subordinated to* the total societal production (...). Within the structure of any specific productive activity, the contradiction is renewed as the clash between *individual actions and the total activity system*." (p.52).

Discussions and Findings

These set of contradictions are related to the historical perspective of the activity system. According to Engeström (2001), "contradictions are not the same as problems or conflicts. Contradictions are historically accumulating structural tensions within and between activity systems". Considering that, for this paper we carried out our analysis by selecting events and characterizing them as our data in two general set of contradictions. From the video analysis, but mainly the interview, we are able to distinguish contradictions in two different levels, macro and micro, which are going to be defined in the following.

Contradictions at Macro-Levels

Therefore within Teacher Education activity system macro-level contradictions are: (i) attending to Physics Teaching Program does not mean to be a teacher; (ii) the locus for educating, physics department or school of education; (iii) theory and practice; (iv) conflicts between scientific carrier and teachership. For instance, we present below a fragment of one pre-service teacher's interview, in which he speaks about his choices so that is possible to highlight contradictions (i) and (iv):

Researcher: Tell me a little bit about your choices, I mean why did you choose a Physics Teacher Education Program? Have you always meant it?

Moises: Actually, in the very beginning I didn't want to pick this carrier [PTEP] I even didn't know what this carrier was as the majority of people who gets in here. I wanted engineering instead, mainly because of status of being an engineer or earning a good salary. (...) I realized my scores wouldn't be enough to apply to engineering so I thought what am I gonna do? I wondered to apply to maths and I did it, but I failed. Then I start wondering to apply to physics, but I didn't want to PTEP. I'd like to get in the scientific carrier. So I ended up in PTEP because of my scores, I mean I was afraid of not have enough and applied to PTEP.

Contradictions at Micro-Level: "I Don't Know to Be a Constructivist Teacher. I Guess I Will Be a Traditionalist One"

This is Igor's quote, one of pre-service teachers. By the time he exclaimed it, he had been asked to sketch a planning class about electromagnetism. It means he was working on a kind subject-matter should be taught at High School physics lessons and which strategies would be better to employ. Igor was involved in small group discussion and they struggled to figure out how to do that task. Following is Igor's transcription

Igor: I don't know how to be a constructivist teacher!

Student 2: such as Paulo Freire, Piaget?

Igor: Nop! I don't think Piaget is that constructivist ... and I don't know how to teach with Paulo Freire, but I know to do it in a class like STS. Do you know what is it? [he asks to student 2] Science, Technology and Society ... I think I am more, you know, traditionalist although.

The contradiction present in the Igor's quote is about being *and* not being, it means, mutually exclusive aspects of activity. Also, Igor reveals in his practice the contradictions "between *individual actions and the total system*" (Engeström, 1987, p. 52). In the other words, being either constructivist or traditionalist is his individual action so that to pursue one or another he has to follow specific rules. Rules are a socio-historic (collective) construction which makes subjects to belong to a specific group (of those who are constructivist or traditionalist, for instance). On the other hands, rules are related to the totality of the system. Then ways of (not) being is related to ways of belonging and so does to ways of becoming. We think these triple kinds of ways are what support human beings' practice. Hence Igor's case highlights exactly the micro-level contradictions. As a result a subject learns and becomes (a physics teacher) in a practice in which those layers (macro and micro) of activity are integrated to each other and in which contradictions come out.

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