The role of theories in and for the awareness of practice: A case of teaching calculus at University.

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Introduction

This paper presents an investigation on how reflecting and discussing about one's practice can contribute towards a professional development of calculus professors. Our interest was on investigating how theories can be used to help studying about practice; to explore and raise ideas that may help the process of professional development of the involved professors.

A doctoral student P1, and his advisor, PO, carried on this work in Sao Paulo, Brazil. The participants were calculus professors, talking about their lessons about Reimann Integral during 17 meetings, after 10 meetings, one of the professors was no longer in the same university so the following meetings happened virtually on MSN. Ten meetings took place in a room at P1's university and were taped and transcribed, the MSN chat was saved in different files. Three main episodes were described and analyzed but for the purpose of this conference we will focus on the episode about the discussions that were raised on what is and how to characterize concept?.

A brief comment about our framework

It was proposed elsewhere (Bolite Frant et all 2004, 2005) that an articulation of both language and embodiment theories could help in analyzing discourse, and for this study, we used them here not only to analyze the dialogues during the meetings but also as a trigger to the dialogues.

Based on the Argumentation theory proposed by Perelman, Rabello de Castro and Bolite Frant elaborated the Argumentation Strategy Model - ASM as an alternative for discourse analysis, in order to interpret meaning production based on the arguments found in the discourse rather than on the words. The context of the enunciation is crucial to understand what is said, why it is said and how a speaker says it. In previous work (Bolite Frant 2001), we affirm that the process of making sense for mathematical objects, in classrooms, is similar to the process of making sense for ordinary objects in our daily life. Also, when teacher or peer is engaged in a dialogue, arguments are always there, one is trying to convence other about his/her own ideas, and during this conversation one is changing or defending his/her

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assumptions. We found that sometimes a student answer has more to do with the fact that she wants to agree with the teacher to receive a better grade with him than to the her understanding of what she is answering or even to show that may the teacher got the wrong answer. Also, since language has social constraints, a person enunciation may present implicit. Moreover if language was based on explicit enunciation everybody would understand everything, not only math, and we know that it does not happen at least most of the time. Since the implicit may be intentionally or not, the two theories should be used. Because ASM deals with intentionally implicit, when a person does not say something due to social rules, and Embodiment theory –ET deals more with unintentionally implicit.

For Lakoff and Johnson (1980) most of our conceptual system is metaphoric by nature, and most of our thinking is not conscious. Here the idea is not a Freudian one about unconscious but the fact that our thinking, usually, is unconscious. Lakoff and Nunez (2000) in their book, Where Mathematics Comes From, discuss about conceptual metaphor, a cognitive mechanism that preserves inferences made on a source domain to a target domain. Fauconnier and Turner (2003) building on this theory proposed another cognitive mechanism called conceptual blending[2], which in our view is more suitable for analyzing complex and sophisticated mathematical objects.

We also assume, as Lins 2004, that professional knowledge should be seen as a whole, there is no gap between content and pedagogical knowledge while teaching in classrooms. Teachers have to act on the spot relying within an integrated repertoire.

Meetings- Invitation and participation

Before entering the episode, we would like to give a flavor of the meetings and how they began. To start this study, P1 invited his colleagues to participate and help him by telling them that his doctoral work would focus on investigating his own practice because he was not happy with his students' difficulties and the way he was handling them. Moreover, since he started reflecting by himself and did not advance much he thought that maybe if they start discussing about his practice they could bring their own expertise on teaching Reimann integral and this way may help him and the others to improve their teaching.

[2] For a deeper discussion see Fauconnier and Turner book The Way We Think, also www.marktuerner.org

P1 enunciation reveals his intentions, he would be leading the first meetings but only because he was the one who proposed them. Immediately the others felt very comfortable to participate because the way the invitation was done and also because they shared the concerns about teaching and learning integral.

For the first meeting, P1 brought separately an activity and students written work about it, some articles about the theories were produced in order to better share with all participants P1 ideas.

For each meeting, P1 prepared and brought materials and he was joined by P2, who after a month or so taped his own class and brought to discuss with the group. And P3 talk (sic) more on the MSN than in the beginning, and also proposed tasks for some of them.

Both types of meetings constituted a rich environment for the debate, all happened in a very respectful way, with all of the participants willing to be together and to discuss about their practices. For example, we can see on the enunciation of P3 at the tenth meeting.

> … It is the first time that I am participate in a meeting among teachers/professors, but a meeting, let's say it, is not a pedagogical meeting isn't it, a meeting that actually works, and I think that it is it that is missing in any level of instruction, this exchange and share of experiences, I think without constraints , without being ashamed of saying something because others' judgment or whatever… you know, this never happens because we fear, a feet behind, fearing to show that you know less or more than the others, this didn't happen here, it has been very transparent and I feel it is fruitful for us in participating in this. (M10, P3)

Theories helping to reflect about concept in practice

After watching the videos from the first meetings, P1 and PO saw that "concept" was a frequent theme for the participants. We will give here a few examples

> P2-I like to start teaching integral starting using students intuition's and then defining with all rigor….
> P3- … students only value the formulas but then they loose the concept.
> P2- the definition of integral is a concept even more sophisticated than this one.
> P1- This is the concept that I will define later.

PO asked P1 what is a concept for you? So P1 read about it on Rosch (1999) and Lakoff and Johnson(1999). On the 12^{tnd} meeting he started by asking their attention for the many times that they talked about concepts.

The two other professors said that it was the first time they paid attention to this fact, moreover they start talking about the complexity that was neglected all times. Because for them a metaphor Concept Is Definition was very unconscious since they had their masters in mathematics and for a mathematician a concept is its definition. Then he shared the original articles he read as well as his own reflection about them with the group..

On the 16th meeting, this issue came again. Part of the discussions were revisited and we had different enunciations.

P2 I had never thought about this before, the theories helped a lot to think… while in my classroom yesterday I was trying to see the metaphors my students and I were using…yes, it's the student who builds…even if it's different from what I expect…he builds.

From our analysis we would like to emphasize that two conceptual metaphors for concept, besides the concept is definition, could be stated: The umbrella and the quilt

Concept is Definition shows that the source domain is the definition, that is static, does not change, is independent from who used it, is closed in itself then the target domain, the concept would have the same characteristics. After reading and discussing the articles about concepts and revisited their own enunciations the participants found that if they changed their ideas, the students also were capable of change and increase their own repertoire about integral.

Also, we found out that in the first meetings intuition was regarded as is something poor, that an instructor should move fast for the concept in order to be loyal to mathematics rigor.

After the 12th meeting, intuition was seen as the first source domain and that could lead to a definition that is acceptable for a mathematics community, for the purpose of teaching it at University level, and the two other metaphors were pointed for discussion.

While doing our last analysis but without time, yet, to discussed with P2 and P3, another interpretation was raised, a conceptual blending[3] rather than a metaphor can help us understand better this issue. A mathematical concept is a conceptual blending of two mental spaces, intuition and personal concept.

Some considerations

The meetings were a unique opportunity to reflect and share about each one practices. The theories helped to develop new ways of looking to old practice because they provoke the participants to pursue a direction that was not thought before.

It is worth pointing that it is not easy to change thoughts that are embodied in each person, since most of the time inferences are done automatically, unconsciously. But in this group, any time one said something one of the others, sometimes even the speaker, brought up an awareness of what was being said and a discussion took place.

After a week of the doctoral defense P2 and P3 asked for our gathering again on MSN. It was not the object of this study but it open for further investigating about community of practice/learning. In this study we saw that a community is not built because one says so but there is a need for leadership in the first moment in order to gather people, also one should not confound leadership with authority. P1 was always one of the group.

Bibliography

Ball et al, 2005, A theory of mathematical Knowledge for Teaching. ICMI 15 Aguas de Lyndoia.

Bolite Frant (2001) Tecnologia, Corpo e Linguagem, Simpósio Brasileiro de Psicologia da Educação Matemática

Bolite Frant et al. (2004) Reclaiming visualization: when seeing does not imply looking. TSG 28, ICME 10, Denmark http://www.icme-organisers.dk/tsg28

Castro and Frant (2002) Argumentação e Educação Matemática. Boletim Gepem n 40, pp 53-68

Fauconnier and Turner (2003) The Way we think. Basic Books ISBN 0465087868

ICMI Study 15, strand II – papers

Lakoff and Johnson (1980) Metaphors we live by.

Lakoff, G. y Núñez, R. (2000). Where mathematics comes from: How the embodied mind brings mathematics into being. New York: Basic Books

Lins, R. 2005. Categories of everyday life as elements organizing math teacher education. ICMI Study 15.

[3] By the time of ICMI we should bring an extend article about our framework, for now due to size constraints it was not possible to contemplate it within the depth we desired.

Mometti, A. Reflexão sobre a Prática: Argumentos e Metáforas no discurso de um grupo de Professores de Calculo. Tese de Doutorado. São Paulo: PUC/SP. 2007.