ON LINE PROFESSIONAL COMMUNITY DEVELOPMENT AND COLLABORATIVE DISCOURSE IN GEOMETRY [1]

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In professional development, attention to both collaboration and critical thinking in the various interactive socialization processes of teaching practices should be essential strategic elements in a formative environment. This study presents contributions from the teleinteractive dynamic established in a virtual environment for the critical development of the professional content knowledge of the mathematics teacher.

INTRODUCTION AND BACKGROUND

We believe that technological mediation - through ICT[2] – has a crucial influence on the comprehensive development of domains of Professional Content Knowledge (PCK) in mathematics (Escudero and Sánchez, 2002). But how can criticality be developed in teachers' actions? Is it possible to get to reach a level of development with metacognitive characteristics in continuing education courses?

Within this frame, our aim is to ascertain how teachers use their own linguistic and cultural capital critically (Blanton, 1998) in a short course through the Internet: *(1)* by describing and analyzing how teleinteractive collaborative (Wood, 2001) communication develops (NCTM, 2001), in different communicative spaces, and *(2)* by reflecting about critical aspects of PCK.

In the realm of teacher thinking, we consider that critical reasoning (Kuhn, 1999) is a personal process built over a long period of time. It has aspects of a nature that is *declarative* (metacognitive realm), *procedural* (strategic) and *of principles* (epistemologic). In such a process we have considered the four teaching actions concerning criticality (Smyth, 1991) in relation to teaching – *descriptive, inspirational, confronting, reconstructive* - all of which do take place and develop in the course of the dynamic. We started from the knowledge originated in the teacher (Llinares, 1998, 2000). We considered affective aspects of the use of teachers' knowledge in the teaching situation, their professional perspectives, self knowledge and the development of criticality. We consider that there are three aspects- *geometric, strategic-interpretive and affective-attitudinal* - of PCK at work on an on-line course. In the *geometric* aspect there are the teachers' meanings and reflections about the process of thinking mathematically. As aspects of *strategic-interpretive* knowledge, we have considered the reflections on learning, instruction and interactive processes. As *affective-attitudinal* aspect, we have considered attitudes regarding both the teachers' and the students' own learning, awareness and socioculturization, flexibility, judgment, fairness and values in teaching.

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[2] Information and Communication Technologies (ICT)

METHODOLOGY

Our virtual geometric environment was structured around 6 hipertextual axes: **(a)** the activity that forces the teachers to review their own knowledge on geometry and professional activity, **(b)** observation of the role that everyday life plays in the different geometric activities, **(c)** reconstruction of cognitive processes of students in class, **(d)** determining the material for each subject, **(e)** organized summary of contents, and **(f)** continuous evaluation. The geometric content was developed in eight units (flat areas and forms, spatial relations, geometric constructions, angles, symmetry, similarities and reasoning).

A group of mathematics teachers worked on a 50 hour Internet Course over six months using a range of online interactive tools: e-mail, geometric "authentic" tasks, self-regulation inquiries at the end of each lesson, discussion forum and distributed chats. The focus of this research was to analyze written mathematical communication in deferred or real time (Giménez and Bairral, 2001). Thus, semi-structured interviews, text writings and videotaped experiences of teachers' classrooms were used to recognize changes-in-action in geometry by means of their a-synchronous productions.

Two case studies were conducted. In this study we are applying a semantic analysis on them using Webs of virtual interaction (Giménez, Rosich and Bairral, 2001). The first case stems from the information obtained in the course of the pilot study (2000) and the other one uses the information inherent to the development of the second course (2001). For the ***presentation of data*** we have: **(1)** selected among the teachers' contributions in different communicative spaces; **(2)** coded characteristic elements that are representative within the contributions; **(3)** exemplified and analyzed the contributions *(a)* by identifying and describing actions of criticality, *(b)* by analyzing other elements in course of critical reasoning (Kuhn, 1999), and *(c)* by identifying aspects (Llinares, 2000) of PCK; and **(4)** confronted the process in function of what has been observed (discussion forum, chats, ICQ messages, various tasks, e-mail, questionnaires and the researcher's diary).

RESULTS

In order to explain the characteristics of the observed reasoning, we are basically using the discourse of one of the teachers (figure 1) to explain our observations and results. See, as an example, how Joana uses a metaphor to emphasize that changing the shape means changing paradigms, thus showing some traits that are characteristic of a *reconstructive action of criticality* (Smyth, 1991). We refer to PCK elements comprehensively (Joana step 3b) by pointing out the following aspects: *geometric* (analyzing, structures, valuing communicative processes), *strategic-interpretive* (by attributing values, questioning and exemplifying about daily life, mathematics aspect and mathematics task) and *affective-attitudinal* (enhancing the negotiation of meanings). As for the *geometric* aspect, we stress a greater awareness on the use of models and content integration. With regard to the *strategic-interpretive* aspect, we observed an involvement and discussion on the part of teachers regarding their own approaches and their contribution to their mates' approaches.

Joana (forum 3): ¨What **type of activities** can we propose to divert the focus of definitions to the understanding of the concept? **Integration** between the different branches of mathematics have to be given a priority. For **example**, how about working on the concept of area by associating it to the factorizing of a number?...¨

Regarding the *affective-attitudinal* aspect, we stress an open vision regarding the teaching-learning process of the teachers themselves and that of their students; no unnatural recalling of memories and the reflection about episodes in relation to their own personal-professional history as well as the importance of all this on the teachers' professional practice. See Carla's text.

> ¨*I have been a* **teacher for 25 years**. *For me, these 6 months of course count as 6 years. I feel like an ¨old friend¨*. **I have** *often found myself discussing certain contents with my colleagues and remembering you,* **I feel like writing to you to talk about it**. *I don't feel embarrassed talking about my doubts and I feel safe with your directions¨ (15th August 2001, by e-mail)*

The development of a virtual teachers' professional development community in geometry was revealed by enabling for a collaborative discourse with the following characteristics: (a) constant expressions of respect and trust among all participants, (b) open expliciting of ideas and principles and personal knowledge as well as exchange of experiences about the practice, (c) dialogic immersion of the researcher in the group enhancing and incorporating teachers' contributions on the site (http//www.ufrrj.br/institutos/ie/geometria/), as well as other strategies, and (d) acknowledgment of a critical teleinteractive dynamic that favored -through a good thought provoking participation from the tutor- cognitive unbalance among the teachers and enabled a process of personal commitment and critical thinking with signs of PCK improvement.

Joana (forum 7): ¨In unit 5 **I answered** the 1st[a] question, but **I am still in trouble** about filling in the chart. I have been doing a good deal of thinking about it today. At first I thought about giving a quick answer, but I just won't. **I want to make a more careful** analysis of the activities and concepts involved. I keep thinking, and **what do you people think**?

The flexibility of virtual work dynamic favors the constant negotiation of meanings (Horvath and Lehrer, 2000) with teleinteractions continually sustained or reconstructed in each specific educational context. So it is that, at a discussion forum (Joana step 4) there is some reflection on the cognitive process situated in the task proposed and the teacher even gets to set forth to the group her need for personal geometry study. Besides, an analysis on the communicative nodes in the debate interaction showed that even contents of a metacognitive nature are shared:

Ana (final questionnaire by e-mail): ¨**I really** liked to participate in that way. I remember having considered Antonio's statement as being rather traditional or conservative, I don't know for sure. At school **we are often alienated** from what is going on around us, and we often don't challenge what happens. And **in our mathematics classes we** sometimes miss the chance to see the world in a more open way

Steps 1 - 2: *Interview3 (I3) -* teacher comparing geometric tasks

¨... Shape influences the way we are hanging a picture, etc. That's a <u>very</u> <u>interesting</u> <u>thing</u> <u>to</u> <u>explore</u> <u>and</u> <u>discuss</u>, for instance the shape of boxes. <u>What</u> <u>shapes</u> <u>do</u> <u>boxes</u> <u>usually</u> <u>come</u> <u>in?</u> They are parallelepiped. That's very usual. <u>Does</u> <u>this</u> <u>happen</u> <u>by</u> <u>chance?</u> No, that's for things to fit in better, <u>more</u> <u>adequately</u>. So, when we try to change, <u>it's</u> <u>not</u> <u>just</u> <u>a</u> <u>matter</u> of changing the shape, we're <u>changing</u> <u>the</u> <u>paradigm</u>.

Step 3 a: Identifying and describing critical actions (Smyth, 1991)

Reconstructive action: reflecting on what I consider important, pedagogically, what could make a difference if changes were to be introduced in teaching.

Step 3 b: Analyzing elements in the process of critical reasoning (Kuhn, 1999)
Declarative: it attributes values, discusses, plans

Identifies Principles: it compares what is real and day to day life, it negotiates meanings.

Step 3 c: Identifying aspects of professional content

Geometric: it analyzes structure, it values communicative processes.

 Strategic-Interpretive: it attributes values, it challenges and exemplifies about what is daily life, what is mathematical, and about mathematical task.

Step 4: Confronting and analyzing the process

Forum8: "I think that my difficulty in responding to task 2 is in the way it was set out. As a matter of fact, that's a comment that I think is worth doing, The tasks that are being proposed here in this course have an interesting way, different from the usual, which is often: question and answer. That is also new to me..."

Figure 1. Example of part of the analysis of teacher Joana's discourse

A constantly activated feedback process was promoted. It emphasized different professional aspects in different discursive spaces: **e-mail** (it fosters more discussion with regard to individuals or small groups, the researcher acts according to the teacher's request and has a local control over the process, the teacher transforms the tasks hypertextually, teleinteraction is temporarily unlimited); **chat** (joint reflection with an

action triggering a more immediate response, better controlled by the researcher); **questionnaires** (personal information, integration and attention to evaluation processes); **discussion forum** (space for greater integration, identification of the interaction aspects used, it acknowledges the value of social and motivational components, value of unit contents and communicative spaces, space allowing for a more flexible response over time, where the researcher has a global and local control of the process, need to trust the group in order to contribute collectively, socialization and sustained discussion of the practice); **informative links** (identification of curricular elements that favor integration, distributed knowledge over the development of tasks); **interview** (reasoning located in the task, immersion provoked and conducted by the researcher); **ICQ messages** (expounding and clarifying personal doubts and other professional exchanges); **experience narratives** (development of situated knowledge and, regarding context, attention to cognitive processes and to the complexity of the educational process).

Besides, teleinteractions could be grouped in four key formative moments (Goffree and Oonk, 2001): *(1)* sensitivity and prior acknowledgment of the team members, *(2)* acceptance and trust for the teaching negotiation, *(3)* critical adaptation and accommodation of practical knowledge, and *(4)* collaboration and awareness regarding theoretical orientation.

Initially, plenty of descriptive directions were given and a cooperative contact was made.

> (Joana, mail C5.2): ¨ **textbooks** gives a static view of angles and what **I liked about the activities is that they talked about** a dynamic view of angles, when they speak about opening. **But books** talk like that because later, they are going to talk about figures, polygons and although **those angles can be larger or smaller depending on the figures**...in the figure it is static.¨

The attempts at reflection are always related to very concrete situations (Llinares, 2000), even when the difficulties presented are centered in strategic elements about the learning process.

> (Antonio, Ev1a-c) [about difficulty in geometry] break the learning pace through formulae and memorization by heart on the part of students and **introduce the content through** studies where they would have to build their own knowledge, even if it had to be guided. [complement] **The reason for** breaking the teaching method the students were used to, is that the group isn't mine, since I am working as a counsellor. I asked the teacher of the group for some extra time and permission to be able to elaborate with them a little studying along with teacher Cámara's activities [facility]. After breaking the ice with the students in connection with the new subject, **I felt that** learning happened in a natural way.

In phase, or moment, 3, there are plenty of elements of confrontation and critical adaptation of professional knowledge. At this moment the teachers reason and discuss about their issues, or their colleagues'. There are also traits of reconstructive inclusions in their PCK.

> (Joana, interview 40) ¨... Discussing with students why these shapes appear so little. I think that this is **a discussion that has to be made, because** there, you are talking about a geometrical aspect, I mean, because why is it that something, a room shaped like a circle, why is it less functional? **You get to have a different architecture**¨.

And they get to express their process of situated professional development critically, with their discourse supported by examples of their geometry-in-practice performance.

> (Antonio, questionnaire S4 nº 6.1c): [following a researcher's suggestion] ¨As for the towns being aligned, the first answer **may be**, because the airport at the middle point would be in the smaller town, **no problems**. **It meets the demands** of the question, doesn't it? For the second, **I think that** if it is equidistant from the 3 towns, it doesn't make sense to have them aligned, does it?¨

Teacher's cooperation when establishing relations between events and facts in the process of working in the environment and the awareness towards a theoretical orientation of a local character, in which the different practices and personal experiences gain importance, are examples of professional discourse at formative moment 4:

> (Antonio, interview162): ¨...**When I asked** these questions, **I was really** in doubt: **do I have to** set forth a question for the student to notice some properties before using the software or for him to start dragging [stress] directly in the program and find out? **Because one thing is** letting the student work with the CABRI in these matters and him/her starting, deducting [stress], to draw a vertex, stretch a segment **to see** what is going on there¨

In this teleinteractive process, PCK develops with the use of professional knowledge situated in concrete situations in teaching. It is constructed by integrating characteristics of discourse and interactive processes in each discursive space; and it is a distributed knowledge, that is to say, it is managed hypertextually and personally by the teachers themselves. It can be continually socialized in each communicative space of the environment or in another formative context along the process of professional development.

CONCLUSIONS

It is not only the use of the ICT that will bring about improvements in the educational process, but rather the way in which they are integrated in the formational scenario and how an adequate use for them is developed that will serve the needs of certain approaches in teaching-learning. The communication among teachers that was established as a linguistic capital from the different communicative spaces and the different interactive processes in the constitution and consolidation of a ***collaborative professional discourse community*** have been noteworthy characteristics of the set up environment.

Virtual environment, in spite of presenting a course with restricted features and limited in time, revealed important for an attitude that would boost the teachers' work and awaken the need in teachers for a constant investment in their careers. The availability and multiplicity of tasks and suggestions (reading of articles, possible projects etc.) constituted a unique trait of the environment, allowing to involve each teacher in studies of personal interest in which the professional time devoted to action and reflection was significantly considered. Inter-subjective teleinteractions and professional knowledge shared in the course of the tasks of the environment allowed us to perceive a potential of the virtual environment to integrate, from the personal interests of the people involved, elements that were initially external to the environment (other books, other teachers, links

to Webs, participation in events, etc.), which substantially enriched the PCK development process in all teachers.

Formative moments enabled us to ascertain that in the dynamic of virtual work, PCK: *(a)* develops with the use of professional knowledge situated in concrete situations in the teaching process, *(b)* is constructed integrating the characteristics of discourse and the interactive processes in each discursive space; and *(c)* is a distributed knowledge, that is to say, managed hypertextually and personally by the teachers themselves, as they can be continuously socialized in each communicative space in the environment or another formative context along the process of professional development. In spite of all this, we have to admit that the possibilities for in depth critical thinking with theoretical contrast are not easy in a short virtual course like the one that was carried about.

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