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Mathematics Teacher Continuing Education: Fostering the Constitution of a Learning Network

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Abstract

This qualitative study analyzes log entries from a group of elementary school teachers aiming to understand how a collaborative learning network is set up during the continued development actions. The interpretive analysis revealed the following categories: Shared reflection, Learning, Trust, Reflection on practice, Experience Exchanging, Shared Goals and Commitment to the other, which show the features of collaborative work. Categories were analyzed using CHIC software which allowed for the relational analysis among them showing that development under this perspective can favor the practitioner's professional development by offering him opportunities to experience his role as a learner and a teacher simultaneously.

Keywords: professional development, collaborative work, learning networks.

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The paradigm for the 21st-century society brings the need to rethink education and the ways to teach and learn mathematics having as a focus the future practitioner who will work in synch with a globalized world, which has a number of different technological resources that require mastering knowledge, creativity, ethics and solidarity.

In this scenario, the teacher's role becomes evident because, being a mediator in the student's learning process he will have to review his practices, his mathematical knowledge and teaching strategies. This implies developing new knowledge and, hence, continued education for the mathematics teacher.

In Brazil, legislation makes it mandatory for children between 6 and 14[1] years of age to attend school, and this period is known as elementary school. The right to attend school is made available for the Brazilian population by means of federal, state and municipal schools. It is by attending them that Brazilian children have access to culture, mainly when they come from more impoverished segments of the society, since private schools provide for the families who are financially capable of paying for the costs. In short, there are two types of school: the public, free one, which offers elementary education for the population in general, in an inclusive, democratic perspective, and the private one, which provides for specific social and religious groups. It is worth noting that the majority of the Brazilian children and young adults attend public schools.

Taking into account Brazil's continental dimensions and the limited resources for education, two challenges are at stake: access to education and the quality of teaching-learning processes. The issue of access today can be considered as having been solved, but the greater challenge to promote quality, democratic teaching for public schools to provide for all kinds of students remains.

When one thinks about the quality of public education, a number of issues arise: the premises, management and human resources. With regard to the latter, the first resource to come to mind is the teacher as the key mediator between students and knowledge. Among elementary school teachers, when we focus our attention on the mathematics teacher, some issues emerge, such as: (1) how can a mathematics

teacher face the challenge to help build quality teaching in public schools? (2) With technological advances happening daily, how can the teacher keep up with them and use such innovations in the classroom? (3) How can the teacher prepare himself to deal with the challenges presented by this public school that provides for all kinds of students and teach mathematics there?

Such questions immediately evoke this teacher's continued education that should play a key role in the teaching career. How has continued education been performing? Developing processes in the continued education modality have been provided by teachers' individual initiatives, by the government's initiative, and by development projects linked to college researches in their mathematics education programs. When the teacher decides to pursue development individually, the courses sought are those to improve specific and/or teaching knowledge and specialization courses, while government's proposals include training, qualifying and workshops aiming at implementing public policies. Regarding college projects, the choices for development actions are, in their majority, oriented to understand the teacher's learning process, as well as the different development strategies.

One of the development strategies recently emphasized by many authors is the one which enables the teacher's professional development by taking into account his knowledge and a reflective and investigative attitude towards practice (Alarcão, 2001).

In Brazil, there are studies about continued education for mathematics teachers showing that group work, both at colleges and development centers and also at the school itself, develops collaborative attitudes among participants (Fiorentini, 2006; Lobo da Costa et al, 2011). Besides, learning *in* and *with* the group, can become a regular practice among teachers to share what they think and do regarding the teaching and learning of mathematics in the classroom, as well as to discuss issues related to social, political, cultural and economic aspects. Such aspects, albeit not specific to mathematics, are embedded in the educational action and can interfere both with the teacher's practice and students' learning.

This qualitative study analyzes log entries from a group of elementary school teachers aiming to understand how a collaborative learning network is set up during actions for continued development.

Professional Development and Collaborative Work

Studies have shown indicators that play a significant role in continued education processes and can lead to changes in teaching practices aiming at improving the quality of mathematics teaching. Such indicators emphasize the importance to create situations that allow for the teacher to have opportunities to reflect upon his own learning and his pedagogical practice so as to favor the perception by the individual of his own conceptions and pedagogical demeanor and the methodological strategies he uses in the classroom. (Pietropaolo et al, 2009).

Hence, many authors like Imbernón (2010), Prado and Valente (2002), Campos et al (2009) among others, underscore that continued development geared to professional development should include the classroom daily issues, and integrate contextualized actions so that the teacher can revisit his practice, reflect upon it and rebuild it.

> … the teacher's practical experience in the classroom should also be presented both as a study and reflective situation to the developing teacher. This situation allows for the teacher to put into practice the theoretical principles and, by doing so, notice the need to understand their relativity, considering the various elements at play in the teaching-learning process. (Prado, 2003, p. 41)

The continued education approach that prioritizes contextualized learning, and an investigative-reflective attitude from the teacher, requires a systematic follow up from the developer as the pedagogical mediator in the teacher's acting context. In this perspective, Lobo da Costa et al (2010), Prado (2006) underscore the importance of the developer's role to promote situations that will favor interactions among teachers so that a collaborative network can be built in which everyone learns and teaches with and to one another.

Collaborative work, as proposed by Fullan and Hargreaves (2000) is characterized by a number of features, of which we highlight: the attitudes and behaviors in the rapport among the teachers, which reveal trust, commitment, sharing of ideas, experience and doubts, as well as

the recognition both of the individual and of the group to which they belong.

However, it is important to emphasize that collaborative work is not immediately established among participants. According to Imbernón (2010):

> … collaborative work among teachers is not easy, as it is based on understanding education as a means to create spaces where both individual and group abilities can be developed, with dialog, from the analysis and discussion among all participants when exploring new concepts. (p.65)

Hence, a developing approach needs to intentionally develop strategies that favor collaboration as a practice built by group members. This is confirmed by what many researchers, such as Fiorentini et al (2002), have been finding as signs that collaborative work is essential for the professional development of teachers.

Professional development for us means, according to Ponte (1997), as being formed by all the actions performed by the teacher that lead to restructuring his pedagogical practice, based on reflection, action and new reflection. It is "a process of growing competencies in terms of teaching and non-teaching practices, in self-controlling his activities as an educator and as part of the school organization" (p. 44).

To enhance professional development, according to the author, it is important to consider both the collective and individual aspects, since such development is improved by collaborative contexts (institutional and associational, both formal and informal ones) where the teacher has the opportunity to interact with his peers.

One research in particular conducted by Lobo da Costa (2004) identified that collaborative work involved characteristics that were present in the development process, and were defined as the following categories: (C1) Shared reflection; (C2) Learning/ learning with each other; (C3) Teacher's actions; (C4) Development actions; (C5) Research about practice; (C6) Experience exchange; (C7) Representativeness of all participants' thoughts; (C8) Partnership; (C9) Shared goals; (C10) Commitment to the group; (C11) Trust, (C12) Voluntary participation; (C13) Dialog/interaction; (C14) Autonomy

development and (C15) Reflection on action.

It is worth noting that researchers such as Boavida and Ponte (2002) have also pointed out that collaborative work is an interesting option in continued education processes. For these authors, collaboration happens "in cases when a number of interveners work together, not in a hierarchical relation, but in an equal basis so as to have mutual help and common goals from which everyone can benefit" (p. 45). Collaborative work has the advantage of providing multiple views about the educational situation which in turn allows for the production of consistent, interpretative frames about the issue which was researched and studied.

When working in collaborative-nature groups, the relationship between developer-developee is upturned in such a way that the established belief that in a continued education process there is one developer, or team of developers, who work with a group of teachers promoting their development, is now replaced by the idea of forming a team of educators who work together with college researchers and/or institutions in charge of the projects, and teachers, in a relationship of mutual learning and developing (Lobo da Costa, 2006).

Another relevant issue refers to the conclusions drawn by the GT 7 meeting in the III SIPEM as presented in the Report (2007), which pointed that:

> Partnership, the pursuit to build collective knowledge, meets our present needs. School teachers, very frequently, have been acting like their students when receiving knowledge that is imposed and/or meaningless: they reject it. Developing proposals that are based on the transmission of knowledge – well-meant, but foreign to the local reality of each group of teachers – have proven to be irrelevant for decades. Together, school and university teachers reflect upon their own professional knowledge and give new meaning to their own professional development[3].

The GT7 emphasizes the importance of continued education projects whose focus is not only on increasing the teacher's mathematical knowledge, but which promote discussions of contents that relate to

classroom daily activities. They point out that establishing partnerships among mathematics educators at the universities and the schools is essential for the development of common knowledge, required by both the academic world and the school. In this regard, the group of Brazilian researchers has established indicators that are closer to those found in a worldwide context (Jaworski, 2001).

The research to which this article refers to is embedded in the *Programa Observatório da Educação* (Education Observatory Program, in English) whose focus is to involve academics with teachers working at elementary levels, having as a principle the development of work partnerships, closely linked to classroom reality. In other words, this partnership is made by the integration of two different types of knowledge: theory and practice.

Research scenario

The research which supports this article is embedded in the project "*Educação Continuada de Professores de Matemática do Ensino Fundamental e Médio: Constituição de um Núcleo de Estudos e Investigações sobre Processos Formativos*" (ECPMEFM)[4], linked to the Education Observatory Program. This program is funded by the Brazilian government whose goal is to improve the teaching and learning processes in public schools in the country and is developed together with universities. The project stimulates the academic community to develop action and research oriented to the needs of teacher development for teachers that work at elementary-level education.

The ECPMEFM project is being developed in a private university in São Paulo city by the mathematical education department, with a group of professors, master and doctoral students, who work and develop research together with teachers, engaged in mathematics teaching in public schools. The research and development project has as a goal to develop a continued education methodology for mathematics teachers working at elementary levels of education, and involves the creation of collaborative professional learning networks, so as to provide sustainability, deemed to be the project's underlying concept.

The project is under development and extends for four years, involving various groups of mathematics teachers at elementary schools in the city of São Paulo, and development actions are performed on-site at the university campus, using practical and theoretical activities related to mathematical concepts and their implications to the process of teaching and learning. The group reports and discusses practices developed by the teachers in the context of their classroom together with their students. The group uses a virtual learning environment - (AVA) specially customized for the project - to improve the interaction and dialog among participants for them to share ideas and experiences about each one's own learning experience in the project and in their practice teaching mathematics.

One of the guidelines for mathematics teachers' development in the ECPMEFM project is the constitution of collaborative groups between school and university teachers, among school teachers only, and between teachers and students. We seek to investigate to what extent such groups improve the professional development of the teachers involved. This is about using qualitative research, of a co-generating nature, as proposed by Greenwood and Levin (2000), that is, a particular kind of action-research that is developed by the partnership between researchers and teachers who create knowledge together. Both types of knowledge, the practical and the academic, are key for the research development. Continued development is designed through a number of strategic actions linked to contextualizing learning and building a collaborative network among peers, including the possibilities of virtual interactions as one way to allow for recording in writing the participants' reflective logs (Prado, 2003; Bairral, 2003; Lobo da Costa et al, 2008).

This is the scenario in which the present study was developed. The goal was to understand how a collaborative learning network is set up during continued development actions. For that, we analyzed data collected from the first group of participants in the project, which included thirty elementary school teachers working at the public school network in São Paulo.

The development actions performed with this group aimed to:

- Approach contents based on the official mathematics syllabus of the state of São Paulo, starting at Sequences and followed by Plane

Geometry.

- Develop activities involving: narratives, identification of teachers' expectations and demands, as well as life histories and reflection upon their own learning.
- Discuss the purposes of mathematical education.
- Discuss issues related to practices performed at the schools with the students and the theories studied, as well as reflections and studies carried out in the classroom.

As for data collection, one of the strategies used at ECPMEFM project was to request, after one school-term interaction with the group, that a reflexive log be produced. The log was individually written and made available in the virtual environment used as a support for development actions.

The reflexive log was a key element for data collection for two main reasons. First, because it enables the teacher to register his learning path in such a way that he can reflect and become aware of what he experienced with the group in this process of reconstitution. Second, to take developers and researchers to know the actions, reactions, feelings, impressions, interpretations, explanations, hypotheses and concerns in the experiences lived by the group of teachers and also to redirect future development actions.

The log entries analysis was interpretative and used as categories the characteristics found in the research conducted by Lobo da Costa (2004), previously mentioned. Besides this interpretative analysis of the entries, a statistics treatment was applied to the categories using the software CHIC, 2004 (Coercive and Hierarchical Implication Classification) which allows us to have an overview of similarities and variable classes mapped on the hierarchical levels of a tree.

From these indicators, we identified and analyzed the categories that were present in the entries made available in the virtual environment, which came from the participating teachers' reflexive logs.

Results

The interpretative analysis of the logs stored in the AVA, showed the following characteristics of collaborative work:

Code	Category	Description
C1	**Shared reflection**	Reports expressing thoughts and queries to the group.
C2	**Learning/Learning with each other**	Reports stating own learning (specific and content syllabus).
C3	**Teaching actions**	Reports involving classroom experiences.
C6	**Experience exchange**	Reports involving syllabus contents and practical activities.
C9	**Shared goals**	Reports involving the search process to achieve joint goals.
C10	**Commitment to the group**	Reports stating commitment to one another.
C11	**Trust**	Reports indicating a feeling of belonging and comfort.
C13	**Dialog/Interaction**	Reports showing recognition of group dialogs' worth.
C14	**Autonomy development**	Reports indicating more confidence in decision-making.
C15	**Reflection on action**	Reports showing the reconstitution of pedagogical practices applied.

Hence, out of the fifteen categories listed by Lobo da Costa (2004), ten were found in this study. As shown by the excerpts of the participants' reflexive log entries, they exemplify the different categories of collaborative work as described below:

C1 – Shared reflection C2 – Learning C13 – Dialog/interaction C11 – Trust	*Sharing with this group was a great help, because many of my doubts were clarified and the themes discussed here were of great importance. For instance, studying Parsysz's levels was very interesting, because we thought a little more about how children's minds work. The interaction was intense in this study group.* (Teacher_A's log)

C1 – Shared reflection C2 – Learning C6 – Experience exchange C13 – Dialog/interaction	*The meetings in which we did practical exercises were more profitable, we managed to exchange experiences and learned how to solve the exercises in various ways, because different ways to solve them came up.* (Teacher_B's log)

In these two logs we notice that mastering the mathematical content is essential and is the first step to lead the teacher to rethink his pedagogical practice, although we know that having the mathematical knowledge does not ensure reflection upon action or changes in the classroom.

C1 – Shared reflection C2 – Learning C15 – Reflection on action	*I could notice that talking about geometry to my students is not that complex, it's possible and real, the geometry presented in the modules is a beautiful geometry, easy to be developed, and worked as an incentive to be applied in the classroom. For instance, about the Pythagorean theorem, when we made the drawing on the poster paper and explored various issues (as one leads to another), building the tangram, using it as a puzzle, gee, that was awesome! Soon after that we tackled another topic about the trapeze area (...) and went deeper into the Pythagorean theorem.* (Teacher_C's log)

In the above entry, it is clear that when the teacher realizes there are new possibilities to approach mathematics which he finds meaningful, he becomes elated and concludes that it can be adapted to his students; from then on, a motion is set and it can have an impact in the classroom.

C1 – Shared reflection C2 – Learning C11 – Trust	*I learned a lot, it's hard to tell what was more meaningful, because everything and every subject were meaningful. I learned about the different types of trends in mathematical teaching and fitted in some of them, I learned how we can use geometry in the classroom by just using concrete materials in a simple, constructive way, I learned a lot about the Pythagorean theorem and its contextualization. The most meaningful content was the development of geometry exercises, the part about triangles similarity, in which I had the opportunity to clear doubts and learn…* (Teacher_D's log)

The word that appears most frequently in the entry above is "learned". We found that for this to happen it is essential the group of teachers feel at ease and confident to take an open attitude as a "learner", which allows him to establish relations between what is being discussed and studied in the group and his daily actions in the classroom. It can be noticed in this entry that the learning of mathematical contents did not happen as an isolated event, but rather related to the context and in a reflexive way.

C1 – Shared reflection C2 – Learning C3 – Teaching actions C6 – Experience exchange C11 – Trust C15 – Reflection on action	*The demonstrations for the Pythagoras theorem and others performed in the triangles were presented exactly when I was teaching similarity to my 9th grade students. I had to make a few changes, doing practical applications instead of using technical terms. I made good use of some of my colleagues' ideas that were used in the demonstrations and they worked very well.* (Teacher_E's log)

What can be noticed in this entry is the openness to *learn with each other* and that the learning in the group has catalyzed changes in classroom practice. We noticed that, as there was a coincidence between what was being discussed in the meetings and the class syllabus, it was possible to develop teaching actions using materials and methodologies previously discussed and analyzed in the group's work.

C1 – Shared reflection C9 – Shared goals C10 – Commitment to the group	*What attracts me most in this and other courses is to set up groups who have the same focus of interest: improving the ways to approach contents in the classroom. And, for that, I realized that undergraduate education for teachers has shortcomings, because many colleagues show, and admit having, a lot of difficulty in understanding many of the contents, which worries me, because I don't know how to go round this situation.* (Teacher_F's log)

The teacher recognizes having the same focus of interest as one of the most important characteristics of collaborative work in a group. His view of his peers, identifying their conceptual shortcomings deriving from deficiencies in their undergraduate education, gives us the feeling that in many cases the teacher is the casualty of an educational system which will continue to lead to a vicious circle that hinders improvements in education, unless changes are made to it.

C1 – Shared reflection C2 – Learning C9 – Shared goals C10 – Commitment to the group C15 – Reflection on action	*In the second module, which was a positive continuity of the first, we had more approaches to geometry, Broadening our understanding. There was one extremely interesting lecture conducted by teacher Serrazina that made me think and startle when she said, 'If I teach and my students don't learn, it's because I'm not teaching'.* (Teacher_G's log)

The effect produced by the phrase “if I teach and my students don’t learn, it’s because I'm not teaching” shows the teacher’s moment of awareness to recognize that, although teaching and learning are two distinct processes, they are interrelated in educational actions. Teacher and student constitute one system and while interacting, one teaches and learns how to teach while the other learns and teaches how he learns, being both accountable for each other’s development.

C1 – Shared reflection mudar C2 – Learning C11 – Trust	*...I refreshed my knowledge, I learned certain subjects that I had not studied before, either in high school or at college. Certainly, what I learned has helped me a lot, both to my personal and professional growth. (...) I'm thankful for the opportunity to be part of this group, with wonderful teachers and colleagues. I learned a lot with all of you*. (Teacher_H’s log)

The feeling of accomplishment expressed by the teacher as soon as he recognizes his learning potential, shows that the educator, regardless of his specialty, must feel prepared in terms of syllabus contents to perform his trade autonomously. Hence, a deep revision of role of the educational institution is required.

C1 – Shared reflection C2 – Learning C3 – Teaching actions C14 – Autonomy development C15 – Reflection on action	*Geometry undoubtedly contributed a lot for classroom teaching. (...) It was easy to clarify students’ doubts, because we had discussed exactly the same content with the group. I worked on problems using everyday situations, like the ladder and the kite we had used in our meetings. I found the group assignments interesting. Usually, while in the classroom, I apply exercises to be solved individually, but from then on I started to use group work study and the students like it very much.* (Teacher_I’s log)

This entry confirms what we have previously discussed and brings some complementary information related to group work practices; he underscores that what has been experienced in the project - such as situations where they can learn with each other by interacting, clarifying ideas and debating viewpoints -, have enriched his learning.

C1 – Shared reflection mudar C2 – Learning C11 – Trust	*Ways to solve exercises. I wish we had moreIn Module 2: I was dazzled by the many diverse meetings with geometry, because I still have many doubts, I have a lot to learn. As Einstein said, 'I know that I know nothing'*. (Teacher_J's log)

The desire and openness, that is, the internal motivation to learn presented by the teacher shows that it was possible to create a relationship of trust among group members, allowing for each of them to genuinely recognize themselves in terms of what they know and what they need to know.

C1 – Shared reflection mudar C2 – Learning C3 – Teaching actions C6 – Experience exchange C13 – Dialog/Interaction C15 – Reflection on action	*At first I thought it would be yet another course which, at our level of learning, would be useless, but I noticed in the subsequent meetings that it wasn't just a course, but a lot more: it was about exchanging ideas and experiences lived by other teachers in their daily teaching practices in the classroom. (...) I learned that calculating a simple area in a figure like a square, is something that we can teach at least in three different ways, thus creating a more interactive environment between the content and the students.* (Teacher_K's log)

The entry hints that throughout time, a more flexible relationship was established, with a less hierarchy than the one established in continued education courses. In other words, more than college professors going

to conduct a course for mathematics public school teachers, we became a group of mathematics educators, discussing and exchanging experiences about learning and teaching mathematics.

C1 – Shared reflection C2 – Learning C11 – Trust	*The group helped me solve difficulties in. At first, when requested that we geometry developed activities about certain subjects, I felt a little insecure sometimes; but as the course developed, I noticed that my difficulties were the same as some of my colleagues'. I also noticed that the way we had our group meetings helped us solve doubts that everyone had.* (Teacher_L's log)

C1 – Shared reflection C2 – Learning C11 – Trust C6 – Experience exchange	*I learned a little with each one of the participants and with the professors' interventions bringing in viewpoints I had not yet conceived, (...), it's an area which I found difficult to work with: the theoretical field of demonstrations and proofs of some axioms. I profited a lot from all the explanations given by the colleagues (...). It was enough for me to generalize this knowledge. (...) with the group's help, I improved. (Teacher_M's log)*

C1 – Shared reflection mudar C2 – Learning	*I could tell I'm different from when I started, I have a 'little' more knowledge, but I believe it serves to improve my teaching practice.* (Teacher_N's log)

C1 – Shared reflection mudar C2 – Learning C15 – Reflection on action C13 – Dialog/Interaction	*I learned to reflect more about questions to be worked on with the students, thus developing a better perception in the thinking, emphasizing the researches and commentaries in group. Valuing everyone's opinion for a better understanding of mathematical applications*. (Teacher_O's log)

C1 – Shared reflection C15 – Reflection on action C11 – Trust C6 – Experience exchange C3 – Teacher actions	*What is interesting is that we can bring situations* ***that*** *happen in the classroom to be discussed by the group, the way the students behave, how they learn and their behavior in relation to the various subjects of the content applied.* (Teacher_P's log)

These last entries show that teachers recognize the existence of a new way to learn based on the exchange of experiences in a development context that provides collaborative work, thus establishing and strengthening an atmosphere of trust to teach and learn with each other.

A wider lookout allows us to notice the constant presence of the characteristic Shared reflection (C1) in the entries. This is due to the fact that all participants had access to the logs, which were available in the virtual environment at any time. This opportunity for the participating teacher to write and re-write their logs, as well as to read and re-read his and his fellow teachers' logs as many times as he wished and make comments, is what encourages the sharing of ideas, reflections, experiences and queries among group members.

The second characteristic that was most frequent in the logs was Learning (C2), showing that openness to learn in collaborative work is imperative. Some of the entries clearly show that the teacher

recognizes the importance of the fellow teacher's role in his own learning process.

The characteristic Trust (C11) is related with learning, as teachers experiencing a collaborative task must feel confident to expose their shortcomings to peers without being afraid of judgments but rather with the courage and expectations of his personal and professional development.

Besides the above interpretative analysis of the logs, we also treated the resulting categories using CHIC, which allowed us to carry out a relational analysis among them. The next figure shows the similarity tree produced:

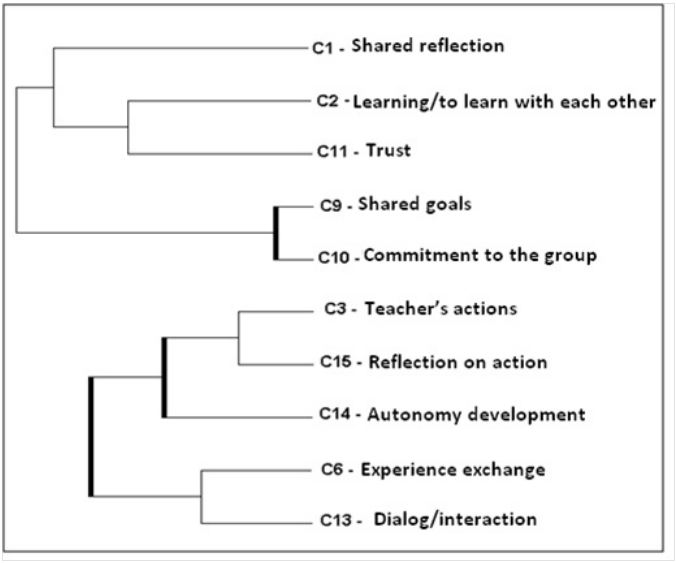

Figure 1. **Category Similarity Tree**

In figure 1, the similarity tree, two classes are found: Class-1, formed by categories (C1) Shared reflection, (C2) Learning/learning with each other, (C11) Trust, (C9) Shared goals and (C10) Commitment to the group, and Class-2, composed by categories (C3) Teaching actions, (C15) Reflection on practice, (C14) Autonomy development, (C6) Experience exchange and (C13) Dialog/interaction.

Class-1 was named **Interaction** and contains a sub-class, constituted by categories (C1, (C2, C11) and by a cluster formed by categories (C9, C10), as shown in the figure below:

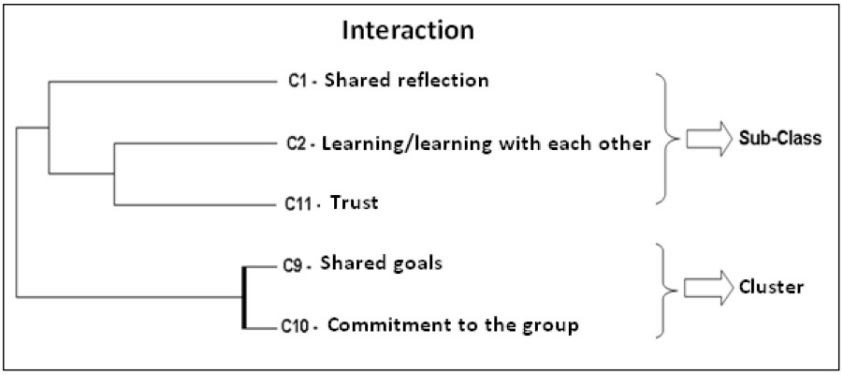

Figure 2. **Class 1 - Interaction**

It can be observed that the *cluster* (C9, C10) shows a significant level of similarity indicating a high probability that some interaction occurred among the teachers in the group in terms of sharing goals and creating attitudes of commitment. This possibility of interaction among peers is paramount and should be one of the goals for developers, since this experience can contribute for the establishment of commitment with one another in the learning context provided by the Education Observatory Program.

The sub-class formed by the set of categories (C1 (C2, C11), shows a discreet level of similarity, but still hints that the teachers recognize the fact that an atmosphere of trust must be created to enable learning with each other so that they can expose their conceptual frailties. Such trust allows the teacher to feel accepted by the group, and he can change his behavior towards learning with his colleagues' experiences and sharing his reflections about practical and theoretical questions studied in group, supported by the developers' pedagogical mediation.

Class-2 was named **Teacher's work** and is composed by the chaining of categories {((C3, C15), C14), (C6, C13)}, as shown in the figure below:

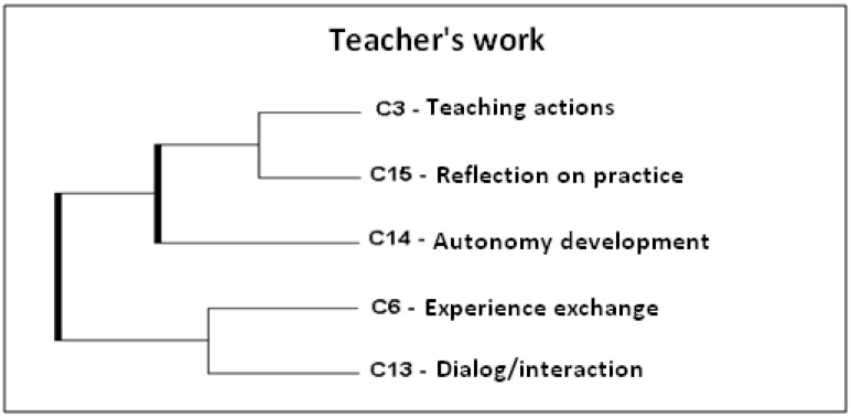

Figure 3. **Class 2 - Teaching Activity**

This chain of categories clearly demonstrates the existence of a higher degree of similarity between the categories (C3, C15), showing that the experiences lived by the teachers participating in the Education Observatory Project, allowed for the teacher's classroom practice to be reported, reflected upon and understood. Thus the importance for development courses to incorporate the teacher's actions, those experienced in his school context. However, such actions should be reflected upon and understood.

This probably happened through experience exchanging between the teacher and his peers and through the dialogs established among group members, as well as between the teachers and the studied theoreticians, the ones who clarify their understanding, providing better conditions for the development of intellectual autonomy.

Such autonomy can propel the mathematics teacher of elementary schools to pursue professional self-development, taking into account that this learning process should be continuous and dynamic for him to interact with the students, the future professionals in a new society.

We can notice that these characteristics are interrelated: the teacher's professional development is linked to reflecting on his practice to reconstruct it, and it is within this process that exchanging experiences becomes encouraging, because it shows new possibilities which allow them to dare to change their teaching actions concerning learning

strategies. Hence, the acknowledgement of the role played by dialog and interactions established in collaborative work on continued development for teachers. The characteristics which appeared more discreetly in these logs were “Shared goals” and “commitment to each other”, which indicate that such characteristics develop as group members feel they have more autonomy to share their goals in search of knowledge, as well as to develop commitment to their peers' learning.

We insist that, for the developers, understanding this process is essential to design development strategies that incorporate dynamic actions, so as to establish a movement between analysis and deepening of mathematical contents, and almost simultaneously, incorporate various aspects from the teacher’s pedagogical practice. It is in this movement between action and reflection, between mathematical contents and their re-contextualization in the school practice, that the knowledge of the teacher’s praxis will be developed towards a learning spiral.

Conclusion

This study showed the connection between collaborative network as a collective learning space in the context of continued education and the potential it has to propel the teacher’s professional development. The network is created through a process in which the development actions are designed based on experiences that reinforce characteristics that are typical of collaborative work.

The indication is that this network includes the use of the contributions provided by virtual environments, as the latter allow for breaking barriers of space and time among group members and also enable dialogs/interactions which are established by means of writing using various communication resources in the virtual environment. This type of interaction, involving the sharing of experiences, knowledge, reflections and queries, helps build a collaborative learning-reflection space among the teachers. This form of learning, in turn, makes every participant able to experience simultaneously being a learner and a teacher to the others, and to move towards the sustainability of learning throughout life.

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Notes

[1] According to the reference document available at: portal.mec.gov.br/arquivos/pdf/conae/documento_referencia.pdf

[2] SIPEM: International Research Seminar in Mathematical Education, Águas de Lindóia, São Paulo, Brazil, 2006.GT7: Research Group about Teacher Development.

[3] GT7 report, available at: http://www.sbem.com.br/files/RelatorioGT7.pdf

[4] In English, "Continued Education for Mathematics Teachers of Elementary and High Schools: Establishing a Study and Research Group about Development Processes".

[5] For more details about CHIC, see Gras (2000) and Almouloud (1992).

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