

CHARACTERIZATION OF THE DEVELOPMENT OF A COMMUNITY OF PRACTICE TO SUPPORT PRE-SERVICE CHEMISTRY TEACHERS

Valéria C. Santos, Agnaldo Arroio

University of São Paulo, São Paulo, Brazil

E-mail: valcampos07@hotmail.com, agnaldoarroio@yahoo.com

Abstract

The concept of communities of practice can be used in different contexts, included the educational context. The development of communities of practice where pre-service teachers work together, refine their practices and learn is a good training for these future teachers. Since communities of practice help teachers learn about teaching and improve their practices, this study aim to characterize the project PIBID of chemistry carried out at the University of São Paulo as a community of practice. On the first half of 2013 the PIBID project included 12 pre-service teachers who attended weekly meetings. These meetings consisted of theoretical training about the use of visual tools in teaching and other concepts about education and meetings to plan activities and classes about topics of chemistry to be applied in a public school at the city of São Paulo, Brazil. During these meetings was possible to notice that the pre-service teachers were engaged in a community of practice, demonstrating the three characteristics emphasized by Wenger (2008): mutual engagement, joint enterprise, and a shared repertoire. Thus the project PIBID of chemistry could be characterized as a community of practice. Furthermore, it was noticed that the community helps in the training of pre-service teachers, since it is providing support to them learn about teaching in practice and implement their knowledge.

Key words: chemistry teaching, community of practice, pre-service teacher training.

Introduction

One of the most significant discussions in Science Education is about the teacher education programs and how it prepares pre-service teachers for a good performance in Science classrooms. In recent years, there has been an increasing interest of researchers in studying teacher education programs and shows its importance on training well prepared teachers, enough skilled to be able to create and plan teaching activities that conduct students to apprenticeship.

Since teaching practice is an important part of teachers training, the introduction of pre-service teachers at the practical context and the reflection about their practices are emphasized by some authors (Dewey, 1974; Zeichner, 1993; Schön, 1998). Zeichner (1993) points out teachers who act as reflective practitioners play important role in the knowledge production about teaching. According to Dewey (1974), the practical work can be conducted with the objective to give teachers the knowledge about the essential tools for their profession and proficiency in teaching. The author also emphasizes that the practical work can be an instrument used to make real the theoretical knowledge acquired during teacher's training. Schön (1998) emphasizes that when someone is involved in practical work, is initiated in traditions of a community of professionals and learn about their conventions, limits, languages and other principles that are just known acting in practical contexts. Thus, learning in practice should be a process of reflection about the knowledge and the action, which lead to the ability to deal with conflicting situations.

Concerned to providing to pre-service teacher students ability to integrate theory and practice experiencing the teacher's work, the Brazilian Government created in 2007 the program PIBID (Programa Institucional de Bolsas de Iniciação à Docência – Institutional Program to Teaching Introduction). In this program, Universities create projects in several areas of teaching to be developed by pre-service teacher's students at some public schools. Thus, these students have the opportunity to experience the teaching practice even in the first years at the University and learn how to lead with school problems, putting into practice the theories they have learned at school.

In general, the program aims to contribute to: appreciation of the teaching career by pre-service teachers; enhance the quality of teachers courses; insert these students in public schools providing the opportunity to experience the teaching practice; encourage University students to pursue the teaching career and contribute to the link of theory and practice, improving the quality of pre-service teachers education (Brazil, 2013). In the specific case of the chemistry subjects in Brazil, where there is a lack of chemistry teachers for basic education and a high level of abandonment of courses for pre-service chemistry teachers, the PIBID try to reduce these cases of abandonment and increase the demand for teachers training courses. Some results are already emerging in many Universities, with the training of teachers better prepared to teach and a greater appreciation of the teaching profession.

The PIBID project about chemistry carried out at University of São Paulo support chemistry education based on theories about visualization and the use of visual resources to help students understand chemistry for complete. Thus, the project promotes training activities and supports in the preparation, implementation and evaluation of teaching sequences using visualization on the teaching of chemistry. Currently, there are several visual tools such as diagrams, images, simulators, movies, animation, models, experiments and many other tools that started to get an important space on the construction of knowledge. According to Barnea and Dori (2000), the use of visual tools is important because chemistry studies are invisible, these tools can facilitate understanding chemical interactions at macroscopic, microscopic and symbolic level allowing students to move between these levels facilitating the learning of chemical concepts.

In a previous work was stated that the project PIBID of chemistry carried out at University of São Paulo enables the training of undergraduate students to be more conscious about their practice as future teachers. They learn about the limits and possibilities of these practices, the necessity to be more reflective about their practice and link the theoretical knowledge with the practical knowledge. Therefore, this project has proved to be an important complement for pre-service teachers' education, since it enables them to learn being involved in teaching practice (Santos, Gouvêa and Arroio, 2013).

Projects like PIBID show the importance of teachers' education and allow learning in a different way than they have in University classes. In these projects pre-service teachers have the opportunity to learn in practice, being part of a group. Therefore, the PIBID can be characterized as a community where people learn together and have the opportunity to practice the knowledge acquired in the community. Akerson et al. (2012) emphasize that developing communities of practice where teachers work together to refine their teaching with the support of others, helps to improve learning.

Wenger (2008) defines the communities of practice through his social theory of learning, in which he characterizes social participation as a process of learning. According to the author, for the involvement in a community of practice it is necessary to integrate some components that characterize this participation: meaning, practice, community and identity. In this context, the components community and practices are the key by which the other components are defined. Thus, the participation in community is a process by which people can experience the world and give meaning to their actions.

Wenger (2008) also suggests that there are three key components that characterize an effective community of practice: 'mutual engagement, joint enterprise, and a shared repertoire'

(p. 73). Applying these components in the context of pre-service teacher's education, Akerson et al. (2012) define that mutual engagement includes having learners share training experiences or commit to a professional development program to engage in the learning and practice activities. By committing to professional development, the learners embark on a joint enterprise toward a shared goal. Finally, there is a need for a shared repertoire which can be achieved by sharing knowledge and learning experiences as well as resources and activities that have been modeled for professional development participants. According to Wenger (2008), the formation of an identity is also related to mutual engagement, the responsibility with the joint enterprise and the shared repertoire.

This study aims to evaluate the characteristic of a pre-service teachers' group participant of the project PIBID of chemistry at University of São Paulo that describe it as a community of practice according to the three components emphasized by Wenger (2008): mutual engagement, the responsibility with the joint enterprise and the shared repertoire. Likewise, this study also aims to identify the contributions of this community of practice to the training of these pre-service teachers.

Methodology of Research

The PIBID Project Characteristics

The PIBID subproject of chemistry started its activities at University of São Paulo on the second semester of 2012. The project is being developed through a partnership between the University of São Paulo and a public school in the city of São Paulo, Brazil. The activities developed to provide training for pre-service and in-service teachers with emergent themes of the researches on science education.

As stated, the PIBID subproject of chemistry aims to promote chemistry education based on theories about visualization and the use of visual resources to help students understand chemistry for complete. Throughout the project the pre-service chemistry teacher students have had a theoretical training on theories related to visualization, representational levels, modeling, multimodality, etc. (Barak, Ashkar & Dori, 2011; Hofstein & Lunetta, 2004; Jewitt *et al.*, 2001; Johnstone, 1993, 2000; Justi, 2006). In these weekly trainings the students were involved in group discussions that was helpful for both, the reflection about their future practice as a teacher and the practice of preparing the teaching activities to be developed in a public school.

Coupled with the theoretical training, the pre-service teachers produced in groups teaching learning sequences supported by visual tools and applied these sequences to high school students. The pre-service students was divided into two large groups, one that applied their teaching learning sequences for chemistry high school classes and others that applied their teaching learning sequences in extra-classes for science students aged 13 to 14. These large groups are divided into 6 small groups of 2 people, named as work groups, at these groups pre-service teachers plan classes and activities and apply them at school. All the groups are supervised by a chemistry and a science teacher. The themes of the didactic sequences, the visual tools used and the profile of students that have these classes are specified in Table 1.

In the first year, the project included 12 pre-service chemistry teachers of the University of São Paulo who received a scholarship to participate in the project activities. The participation of these pre-service teachers consisted of: meetings with the work groups to plan the teaching and learning sequences; meetings with the large group to present and discuss the activities planned; and monitoring of the classes at school to identify the methodologies of the teachers and know the students. The pre-service teachers were from different years in the chemistry undergraduate course at University of São Paulo and have different experiences about teaching, whereas, the most part had no experience with education before join the project.

Table 1. Description of the teaching and learning sequences (TLS) and implemented by each group

Groups	Designed and Implemented TLS	Visual resources utilized	Audience
1	Change of physical state of matter	Experiments	Science students aged 13-14
	The influence of loads on the behavior of Chemical substances and their miscibility	Experiments	
	Pure substances and mixtures	Modeling	
2	Physical state of the water	Modeling	Science students aged 13-14
	Density and its properties	Experiments Video	
	Pure substances and mixtures	Experiments	
3	The chemistry of the microscopic world (atoms and molecules)	Modeling	Science students aged 13-14
	Density: alternative concepts at the microscopic level	Experiments and modeling	
4	Conservation of mass	Experiments	Chemistry students of the first year of high school
5	Conservation of mass	Experiments	Chemistry students of the first year of high school
6	Miscibility and polarity	Experiments and modeling	Chemistry students of the third year of high school

Stages of the Research

This study presents results collected at the first semester of 2013. During this semester the researchers conducted the weekly meetings with the large groups aiming to observe the group characteristics. Seeking to investigate the development of a community of practice, the pre-service teachers were monitored during the process of discussion, preparation and application of the activities at school. At each meeting, notes were taken and conversations were audio recorded. At school, the pre-service teachers were observed teaching chemistry and notes were taken. Besides the researchers the other work groups also observed the performance of the groups and helped them when necessary. Thus, in the meetings, after each activity, the observations were discussed and the groups had the opportunity to share their concerns and their experiences of teaching.

The researchers also had access to the groups' teaching and learning sequences (TLS) and, at the end of the semester, the pre-service teachers presented to the whole group the activities they have conducted at school, the results they have reached and their impression about the project. This moment was important for the pre-service teachers share their experiences, know about the different methodologies used in class and share their difficulties and strategies used to overcome these problems. The groups also handed a report about these activities and its results. The teaching and learning sequences and reports were shared with the whole group.

Data Analysis

The data analysis entailed transcription and coding of the audio recordings and analysis of the groups' reports. The results were analysed following the steps proposed by Miles and Huberman (1984), consisting of selection and simplification of the original data; organization of data for the researcher make decisions and draw conclusions; identification of patterns, possible explanations and conclusions. The data analysis aimed to identify three main patterns that characterize a community of practice: mutual engagement, joint enterprise, and a shared repertoire (Wenger, 2008). The transcriptions and reports were analysed carefully, seeking to identify speeches or discussions showing the presence of these three patterns.

Thus, this paper seeks to analyse the moments, acts, discourses, characteristics of the pre-service teachers' group that characterizes the project PIBID of chemistry of the University of São Paulo as a community of practice. The research was done under permission of the pre-service teachers. The names used in this work were changed to preserve the identity of the participants of this research.

Results of Research

The results presented below show the development of a community of practice, the characteristics of the pre-service teachers that are part of this community and the community contributions for these pre-service chemistry teachers learning about teaching. This study describes the development of a community of practice according to the three key components that Wenger (2008) uses to characterize an effective community of practice: mutual engagement, joint enterprise, and a shared repertoire. For this, will be shared insights of some meetings to illustrate this development.

The previous semester for this research the pre-service teachers had just theoretical trainings and applied one activity at school, as a prior experience. The semester when the research was carried out, they had to plan and apply at least two classes, even if it is on the same subject. In the meetings, addition to theoretical training, the focus was on discussing the production, application and results of the teaching and learning sequences. At the beginning, the pre-service teachers had many doubts about the development of concepts with the students. Thus, they have focused on sharing strategies for teaching chemistry using visual tools, raising requests for feedback from the collaborators (university professor, teachers and doctoral student) and from the other pre-service students, which could share their experiences and help with their doubts. This focus on sharing strategies and experiences is evidence of building a shared repertoire.

To characterize the presence of a shared repertoire in the group meetings, some moments will be analysed. For example, at one meeting, one pre-service teacher shared how was his experience to attend a conference for chemistry students and researchers (the annual meeting of the Brazilian Chemistry Society). He has described the works he had seen about other PIBID's projects around the country and which contributions these works can bring to their work:

"Last week I was at the meeting and had a lot of work about PIBID there. One work used visualization, they had created a computer program (...) they have constructed a city and the program shows the chemical components of the things in the city and how it is produced (...). Another work was about the PIBID difficulties, they have talked about the school infrastructure and the lack of encouragement from school where the PIBID acts. I found this interesting because it was exactly the problems we had at the other school."

This experience had motivated the other pre-service teachers. They also had problems to apply their teaching sequence in another school where the project was developed, because of the lack of support from the school administration. For these pre-service teachers, it was important to know more about other PIBID projects, they have seen that the same problems

they have at other school groups also have had and this shared experience could help others to solve their problems.

After each activity that the pre-service teachers applied at school, the work group was called to discuss their observations, difficulties and the students' outcomes. At these moments it could be seen that, beyond a shared repertoire, the group presented a mutual engagement in a joint enterprise. In these moments of sharing experiences was possible to notice that the group was so involved in it that they have listened advices from others and have learned a lot of things based on the others' experiences. The pre-service teachers also created a space on Facebook to share activity results and news that they judge be useful for the group. Two of them were more engaged with this task, and have shared much important news about education and the use of visual tools in teaching. The news was seen by the most part of the group and at some meetings the group has pointed out this news. This experience can also be characterized as a moment of sharing repertoire. About this opportunity to share and see other groups' results, one pre-service teacher has stated that:

"We try to apply the things we learn at theoretical discussions, but the class largely depends on the students' behavior. The rhythm and the class development depend on the answers the students give. So, sometimes we have the methodology 'Y' and the other group has the methodology 'X' and their methodology is working better than ours. From this conversation we can adapt or complement our methodology. I think they are productive (the discussions to share experiences)".

The mutual engagement can be exemplified by some episodes of the meetings. The pre-service teachers were clearly involved with the project's general purpose and were willing to help other groups to produce their class plans. In several meetings was possible to notice that when one group was concerned about produce some activities for their class, other groups were engaged to help them to improve their planning, questioning and founding possible faults. At the end of the semester, one pre-service teacher remembered these moments and related how important the assistance of the groups was:

"I found very interesting the opportunity to arrive at the meetings and present our planning and someone of another group help us. There have been situations that Sophie and other PIBID members that were not directly involved in our planning have given ideas. I think it was very helpful because if we were working with a more complex idea, one opinion from other group could make the idea simpler.

In one moment of the semester, two of the groups proposed a mutual help, the idea was the two groups work with the same theme (conservation of mass) in two different classes of the first year of high school, so they would share ideas to construct the class plan. This experience was a good demonstration of mutual engagement, because the two groups were engaged in produce the class plan, one helping the other and with the help from other groups. Each group has given two classes about the theme. For each class the groups that were not teaching has accompanied and assisted the group performing the class. About this experience one pre-service teacher has stated: *"One thing that has helped me was seeing their planning and watch their class, it helped me to plan and improve my class"*. About this, another pre-service teacher has also stated: *"And not just see the class plan or watch the class, when they suggested ideas was very enriching, one group was supporting the other."* Groups 1 and 2 also have this experience, they shared a class about substances and mixtures, but the two groups have applied together the class because the two groups were planning to teach this content and the mutual help could improve the class.

Mutual engagement was noticed when other groups watched the class of one group and helped them both, at the class activities and after, when they discussed the activities and gave suggestions to improve the teaching. Watch other group classes were helpful to improve the

performance of the pre-service teachers, because this change of experience made them learn more about teaching. However it was possible to notice that to have a mutual engagement, the subjects of the community have to be all engaged in a joint enterprise. If one subject has an individual characteristic and doesn't share knowledge, experiences and projects with others the group couldn't develop a mutual engagement. About this, one group has related in their final report:

“The fact that our classes take place every three weeks, intercalated with other groups, enabled us to create a critical thinking about the classes of our peers and about our classes, since in a group we always helped each other. Watch the class of our colleagues was good for us to make self-criticism about our classes, because we were not just as spectators of other groups' classes, but we were analysing the dynamic of our colleagues, what helped us to reflect about our activities”.

Many of these experiences of mutual engagement and shared repertoire shows that pre-service teachers were engaged in a joint enterprise. The idea of attending the class of other groups came from the pre-service teachers themselves and they have shown be committed with this enterprise. In a meeting a pre-service teacher has told that she has seen the other group activities about density and she think her group could help to complement these activities in another class using modeling activities. This attitude indicates that these pre-service teachers were concerned about the main objective of the project, that is teaching chemistry using visual tools to support the learning, and have joined their enterprises towards this goal. As an example a group have related at the final report that: *“All the classes had a common objective, which is the same of the other groups, that consists of using visual tools to assist in the students learning”.*

The engagement in a community of practice has assisted the pre-service teachers in identify themselves as teachers and to improve their practice, as stated by one pre-service teacher: *“The PIBID give us the status of teacher, what is an experience very significant to the upgrading of our careers”.* The pre-service teachers also reported that the practice at the project have contributed for their learning about education. In the final report one group has stated:

“This form of organization the project have adopted is interesting because the pre-service teachers have more involvement with the pedagogical practice (...) Is remarkable the progress of the pre-service teachers, either in the class or in the knowledge of the theories about education, thus we can say that, in fact, the project has reached its objectives of form good teachers and contribute to the education of our country”.

Discussion

The project PIBID of chemistry developed at the University of São Paulo presented some characteristics of a community of practice emphasized by Wenger (2008). The mutual engagement between the pre-service teachers could be noticed since the first meetings when all of them were engaged in the perspective of produce a teaching through the use of visual tools. At each meeting the pre-service teachers were open to share experiences and concerns related to teaching and these shares helped them on their work in group, because they were engaged in a joint enterprise.

Through the activities was possible to notice that the pre-service teachers have also developed a shared repertoire of teaching strategies, by means of sharing of ideas, strategies and resources. In this context, the pre-service teachers that had some experience on teaching used to tell about their experience in class or offer some help with the class plan.

Wenger (2008) emphasizes that mutual engagement in a community of practice involves not only our competence, but the competence of others. Thus the community depends of a shared practice to connect participants to each other. During the semester was possible to see

that the practice in the PIBID community allowed the development of a shared practice by means of shared repertoire and the involvement with the project. However, this shared practice would not be possible if the pre-service teachers did not develop mutual engagement in the activities proposed by the project.

The author also emphasizes that the practice in community provides opportunities to negotiation of meaning, which leads to learning. In the context of developing mutual engagement, shared repertoire and joint enterprise in a community of practice, learning is an ongoing practice. Learning is not static, but an ongoing process to be engaged in some enterprise. A significant learning affects and is affected by these three dimensions of practice. It is what changes the ability to engage in practice and the understanding of why engage in it. Thus, learning has to do with the development of practices, leading to the formation of an identity (Wenger, 2008).

Therefore, engagement in a community results in the creation of an identity. At this PIBID project is noticed that, over time, the pre-service teachers started to create an identity as a community, they recognize themselves as a specific group at the University that work towards the objective of teaching chemistry and learn with this experience. Furthermore, the pre-service teachers have developed an individual identity as teachers that even in pre-service training are already acting in a classroom and have the responsibility to produce meaningful learning. This process was only possible by the practice in a group. According to Wenger (2008), the relationship in communities helps to form the identity of individuals, through the participative experience that occurs by the meaning negotiation.

Thus, the development of a community of practice acts in an improvement on learning and the formation of an identity in the group. Other researches have related how the community of practice helps pre-service teachers to improve their practice. Akerson et al. (2012) studied the teacher training in a community of practice. These teachers were involved in internships and developed instructions based on concepts of nature of science. The authors have concluded that the community of practice was instrumental in providing some of the support the pre-service teacher need to implement their instruction. Similarly, is possible to determine that the community of practice designed from the project PIBID of chemistry developed at the University of São Paulo is providing support to pre-service teachers learn about teaching at practice and implement their knowledge.

However it is emphasized that this research was done into just one of the PIBIDs projects existing in Brazil, so the conclusions are limited by this group. Is required and recommended a broader research to characterize the general project as an opportunity to pre-service teachers to be involved in communities of practice.

Conclusions

Wenger (2008) and other authors indicate the importance of communities of practice. For teachers, communities of practice help to improve the practice and learning about the teaching. This work showed how the PIBID of chemistry carried out at the University of São Paulo could be characterized as a community of practice. During the semester could be noticed that the pre-service teachers have engaged in experiences that characterized processes of mutual engagement, joint enterprises and shared repertoire. It was also noticed that the pre-service teachers have created an identity in the group, as individuals who belong to a community and work for a shared goal. They also have stated that the community of practice has helped them to learn more about education. Thus the project PIBID studied in this work presents a positive impact on the pre-service teacher education.

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Advised by Vincentas Lamanauskas, University of Siauliai, Lithuania

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Valéria Campos dos Santos	PhD. Student in Science Education, Faculty of Education, University of São Paulo, São Paulo, Brazil. E-mail: valcampos07@hotmail.com
Agnaldo Arroio	PhD., Associate Professor, Faculty of Education, University of São Paulo, São Paulo, Brazil. E-mail: agnaldoarroio@yahoo.com Website: http://usp-br.academia.edu/AgnaldoArroio