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Developing Preservice Science Teachers' Beliefs about New Approaches to Science Education[i]

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ABSTRACT

Science education has to take responsibility, and also the challenge, to include comprehensive perspectives that address a number of aspects of very different nature. In this sense, teachers' beliefs take an important role, given the influence of their actions in the classroom. In this paper, we have researched about the beliefs of a group of pre-service science teachers about new approaches to science education and how such beliefs influenced the reflective process that took place in the activities performed to change those beliefs. The study was carried out in the University of Malaga (Spain), in the fields of "Biology and Geology" and "Physics and Chemistry". The results and conclusions, which have been obtained by applying a qualitative data analysis methodology, contribute to understand that there are beliefs, with common characteristics, that present a great resistance to change and how certain methodological processes, based on reflection and confrontation of ideas, help to bring certain beliefs near to more innovative approaches.

Keywords: Beliefs; Pre-service Science Teachers; Science Education; Reflection.

INTRODUCTION

Nowadays, science and technology education to the citizens of the 21st Century poses great challenges to science and technology teachers, who have to worry not only about what to teach, but how to do it in a more relevant way so that students learn significantly and develop the skills, attitudes and values needed in the world they are going to find.

What teachers believe and think greatly influence the way they conduct their teaching. Lopez & Hinojosa (2012), Mellado (1998), Porlán & Martin del Pozo (2004 & 2006) and Solbes, Vilches & Gil (2001), among others, argue that a major overhaul of science education is necessary, and also those teachers' conceptions about their teaching must be questioned.

Porlán et al. (2010) emphasize the need to influence teachers' beliefs, if we want to change the dominant model of science education. They believe that in doing so, a greater proportion of students will consider scientific disciplines interesting enough to choose them (McMinn, Kadbey & Dickson, 2015).

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Therefore, in pre-service science teacher training, the promotion and the development of new teaching skills are necessary, as curriculum changes are demanding (Tribó, 2008). We have to produce innovations grounded in rigorous research of science education (Gil, Furio & Gavidia, 1998; Martín, Prieto & Jiménez, 2015).

According to the above considerations, teachers' beliefs should be challenged in the initial teacher training programmes, so that those beliefs may evolve in the proper direction that allows the consideration of new approaches in science education. That means pre-service science teachers should gain awareness about the importance of developing students conceptual understanding and attitudes, critical thinking and problem solving skills. These objectives, which include social and conceptual considerations, are pursued bystudying cases involving scientific, technological and moral issues (Çinar, Pirasa, Uzun & Erenler, 2016; Tal, Dori, Keiny & Zoller, 2001).

The research presented here starts from our awareness, as science teachers' trainers , of the nature of this problem, which has led to ask ourselves questions such as: how science teachers's beliefs about today's science education can be challenged in their initial training in order to encourage their development and meet our objectives?

When accessing their educational programmes, teachers in training have a repertoire of beliefs about many aspects of science education, which must be taken into account when planning training activities (Mellado, 1998; Porlán & Martin del Pozo, 2004 & 2006). In doing so, we will help them to overcome obstacles posed by those beliefs that affect their progression.

Hewson et al. (1999) emphasize that constructivist proposals to foster conceptual change in science students are valid when applied to science teachers in training. The interest in the application of these proposals in teacher's education has grown in recent years, both in scientific concepts and in more general aspects, such as those related to teaching and learning (Kyle, Abell, & Shymansky, 1989; Porlán & Martín del Pozo, 2004; Stofflett, 1994; Watts & Jofili, 1998).

According to constructivism, the process of making sense of new experiences is fedby individual reflection and awareness, social interaction and consensus (Medwell & Wray, 2014; Perrenoud, 2004). According to Van Driel & Beijaard (2001), when we reflect on the professional knowledge of teachers and their willingness to implement the innovative ideas that the curriculum proposes, we realize the processes by which teachers build them and become aware of the relevance of applying the model of conceptual change to teacher's education.

Reflection and Metacognition in Changing Beliefs

Promoting the processes of change in pre-service science teachers' beliefs should involve interactions between old and new conceptions. The result will depend, among other things, on the nature of such interactions.

According to Loughran, Mulhall, & Berry (2008), these interactions are encouraged when they are given the opportunity to argue, discuss and reflect in those contexts where they can increase their awareness about not just their beliefs, but, more important, the ways they are learning and how the progression in their beliefs, models and conceptions about teaching and learning science is happening.

Those processes and situations entail reflection on their own knowledge and beliefs, as well as the way these are being challenged. They are metacognition processes. In this kind of contexts, our pre-service science teachers find themselves in a position in which they become aware of their own beliefs and think, contrast, argue and write about their different views. Therefore, special relevance must be given to the reflections, both individual and collective, the contrast of opinions and the debate as part of the decision-making process.

These initial explicit beliefs have been considered as key mobilizing concepts and, from this point of view, have a great deal of potential to promote progression (Porlán et al., 2010; Solis & Porlán, 2003). Reflection requires teachers to analyse the thinking and assumptions on which their teaching is based (Abd-El-Khalick & Akerson, 2004).

Reflection, as a methodological tool, is valuable and classic (Kagan, 1992; Mellado, 1998; Schön, 1991). Hewson et al. (1999) recognize the critical role it plays in education and the role it can play in research on science teacher education, by the research through action (Schön, 1991; Sweeney, Bula & Cornett, 2001). A proper way of promoting the above is through social interaction, negotiation, construction of meaning, practice and reflection (Cabero & Guerra, 2011; Carvalho et al., 2015; Öztürk-Akar, 2016; Schön, 1991; Tribó, 2008).

By integrating these processes into teacher training, we connect with a vision of learning as a generative process, where the construction of meanings and the peer's interaction are very important, as they offer opportunities to express different views and negotiate their knowledge in a democratic and critical way.

Therefore, we should encourage activities in which reflection and debate emerge. Those activities may be performed in the context of real educational problems (Burton, 2007), or in the management of certain types of problems, for example, those known as "socio-scientific problems" (Edwards et al., 2004; Pedretti et al., 2008). They are complex and there are deeply interconnected global challenges that require action mechanisms, which are also carried out, both at global and individual scale (DeBoer, 2011; Fensham, 2011; Zeidler, Sadler, Simmons & Howes, 2005). In other words, they are social problems in which science and technology are involved and have much controversy (España & Prieto, 2010). By working with them, pre-service science teachers may appreciate the opportunities that they have to develop students' skills and, therefore to promote citizens' literacy in science and technology (Sadler & Zeidler, 2009).

METHODOLOGY

a) Research questions

In this paper we aim to get insights of how certain beliefs on science education, which have been previously identified (Martín, Prieto & Jiménez, 2013 & 2015) in a group of pre-service science teachers, are used in a reflective process that has been carried out in the course of activities designed with the purpose of changing those beliefs towards the new approaches in science education (the management of social problems; the promotion of values and attitudes; the treatment of interdisciplinary contents; the approach of science education to everyday life).

We started from the premise that when our teachers in initial training come into their training programme, they bring ideas with them and beliefs about what teaching and learning science is, as a result of their own experience, mainly in school under the benchmark of their own teachers (Hewson & Hewson, 1987; Mellado, 1998).

Specifically, we aimed to answer the following research questions:

- Did the development of activities based on the reflection and the exchange of ideas have any impact on the evolution of pre-service teachers' beliefs in the direction towards new approaches in science education?
- Did the activities based on reflection help them to overcome their beliefs about science teaching?

b) Sample

The context of this study has been the training programme of the University Master for Teachers of Secondary Education. There has been a total of 29 participants, among which 12 were training in the specialization of "Physics and Chemistry" and 17 in "Biology and Geology". The group consisted of 17 women and 12 men.

The intention was to bring our teachers in training faced to new approaches in science education, and make them compare their ideas with those that we were offering them, in order to encourage their reflection and critical thinking about an innovative way of teaching science.

As we have already published, many pre-service science teachers (Martin, Prieto & Jimenez, 2013; Martin, Prieto & Lupión, 2014), tend to consider that the analysis of socio-scientific issues, the promotion of values and attitudes, or the treatment of interdisciplinary aspects, cannot be addressed if the basic scientific concepts of the topic treated have not been previously mastered. We are also aware of the fact that those teachers undervalued other approaches based in fostering students' skills such as reflection, critical thinking and decision making as ways of conceptual learning.

c) Design of the activities

Our purpose has been to develop an approach based on socio-scientific issues, which serves as a springboard for learning, both scientific concepts and other more social aspects, as an innovative way to teach science and as a context well suited to promote attitudes and values in students.

We assume that reflection on the own conceptions is an efficient methodological strategy for conceptual change.

Porlán & Martin del Pozo (2006) suggest that, in pre-service science training strategies, activities such as the work with socially relevant issues, the awareness of the own conceptions and patterns of action and the analysis of innovative teaching experiences, among others, should be fostered, in order to make the evolution of beliefs easier in a social and responsible context, and also to leave the door open to the exchange of ideas between the members of working groups.

Taking into account the above considerations, we designed two activities to be developed in the training course: one individual and the other to be performed in small groups. Both activities began with a reflective reading of a text extracted from the article "Research for the future of science education: new ways of learning, new ways of living" of Lemke (2006).

This text invited participants to reflect on the "education through science", taking into account several non-scientific considerations, without which it is not possible to understand some of the great problems that humanity faces nowadays. Their proposals included some aspects of the new approaches to science teaching, such as the promotion of values and attitudes by using science as an instrument, as well as the direction necessary for science education to provide for the treatment of social problems, with the consequent requirement for interdisciplinarity and applicability in everyday life that this can entail.

Their reflections were used as a tool to promote awareness of both their initial beliefs and the evolution of them through negotiation and discussion, as they performed the activity in a small group on innovative proposals in the document.

In the case of the individual activity, participants had 20 minutes to read the text. Much emphasis was put on the fact that they should take notes and ask questions concerning the understanding of the text, and about what activity was demanded from them. After reflecting on the reading, they were requested to select 5 ideas from the text and express their agreement

or disagreement with them in a reasoned way. They spent about 45 minutes to complete this activity.

Just when the individual activity had finished, the small group activity was conducted. For its development, participants were divided into 9 groups (of 3 or 4 members each), in which one participant assumed the role of spokesperson and another one acted as secretary who took record of the agreements and consensus reached. Further to their discussions, they were requested to reach a consensus about: a) three ideas from the text on which there was more agreement and b) three ideas on which there was more disagreement). It took them about 45 minutes to carry out this activity.

The small group activity required participants to select some ideas at the expense of not considering others. The aim was to determine: a) the assumptions rejected when consensus was reached, b) the mainstream, and c) the main considerations raised.

This consensus gave us important information about the fate of the different proposals in the context of the small group. In addition, it put participants in the specific situation to defend their proposals that were to be included in the consensus.

By searching for these evidences, we wanted to approach the number and nature of the considerations, in every group, in connection with the importance of teaching science through the development of values and attitudes, and guiding science education for the purpose of solving social problems. Both aspects must consider the application of scientific knowledge to everyday life and interdisciplinarity in order to promote the integration of theoretical and experimental approaches.

d) Data Analysis

Data collection was carried out as follows:

a) Participants' report from individual activity.
b) Groups' reports from the small group activity.
c) Participant teacher’s observation.
d) Teacher’s diary.
e) Interviews.

Apart from the participants’ reports, information on the development of the activities and the subsequent reflections were registered in the teacher's diary, in order to cover the broad range of opinions expressed during the process, and the most significant ideas that were proposed.

All groups were asked by the teacher-researcher during the progress of the work.

Two groups were selected to be interviewed by the teacher, according to the following criteria: a) one from each speciality, and b) variety of initial starting points.

We used a qualitative approach in the analysis, which was applied to the contents of the activities, the classroom observations, the teacher’s diary and the answers from interviews (Stake, 1999). The contents of the activities and the answers from interviews were independently organised and developed in categories by the three authors. We agreed with 90% of the categories that were relevant responses and reached a consensus for the remaining responses after further discussion.

The ideas that had been initially put into play were gradually highlighted throughout this process, as well as the way some participants were gaining strength in their arguments while others were losing it.

Fragments in quotation marks, selected from different documents, allow us to illustrate concepts of participants linked to their previous ideas about learning and teaching science and their changes.

FINDINGS

Individual activity

The whole range of considerations and concerns from all participants were organized into the following categories:

a) Science education as an instrument to improve society.

All pre-service science teachers (pst.) mentioned this idea and strongly agreed with it. Their reasoning emphasized the importance of education in the promotion of improvements in people's lives, giving them opportunities to access social standing, progress and welfare. The arguments brought forward by them are expressed in a general way, although, more specific arguments were included in the text.

Example:

"One of the fundamental educational purposes is the training of students, so they can improve their lives and influence the appropriate development of society." (pst.12)

b) The importance of learning beyond the classroom.

Most of them (18) agreed with this idea, defending the usefulness and desirability of integrating learning from their real lives into the classroom in order to use it in the teaching processes. However, many considerations were exposed in a sceptical way.

Example:

"Our life is an ongoing learning process. However, a different issue is whether these lessons are useful and suitable for the education of citizens living in society. Obviously not all of them are appropriate." (pst.7)

c) Approaching science education to students' everyday life

For 18 participants, science education is isolated from the real world and the students' everyday world and, therefore, it is necessary to break away from this isolation.

Example:

"Linking science to daily living situations enables a better understanding and assimilation of concepts." (pst.12)

However, this principle does not arise as a determinant factor when choosing the contents to work in the classroom. Their responses indicate, by contrast, that the contents to teach are there and we have to work with them. Later in their lives, students will find relationships between those contents and real life.

d) Science education oriented towards social problems.

This idea was suggested by 12 participants. Most of them noted the convenience of working with concepts first and then with their application to problems. They did not consider the possibility of starting with a problem and, through its analysis, making progress in learning the concepts involved in the same.

When they talked about encouraging attitudes and values, they treated them as objectives to be achieved by using specific methodologies, which are accepted only on the basis of motivation in students. They insisted on the importance of learning with the only purpose of gaining knowledge.

Example:

"I agree with the position of science guided to social problems, in order to contribute to its attractiveness to students. However, I consider we should not forget that concepts we call "abstract" are needed as a learning platform [...]." (pst.7)

e) Division of curricular disciplines and interdisciplinary approach

For some pre-service science teachers (10), the lack of interdisciplinary approaches in science classes is closely related to the division into disciplines of knowledge caused by the curriculum. In this respect, the idea that this is something which is in other people's hands, but not in ours, predominates. They consider that teachers are not responsible for this situation.

Example:

"I do not share the idea of separating science learning from other disciplines, as they must be linked and interact with each other. Certainly there are cases where some specialization is required, but isolation of concepts should be avoided." (pst.28)

f) Students exhibit a negative attitude towards science.

Six participants manifest this idea.

Example:

"Some students show a negative attitude towards science, although I have met students who loved science [...]." (pst.26)

Finally, most participants appreciated science teaching as a way of providing prosperity to people and accessing to certain professions that may provide them a certain social status. The contribution to achieve that social status explained their tendency towards teaching and learning scientific concepts and their emphasis on knowledge, without paying attention to the need to find interconnections with the reality in which students live.

Additionally, participants showed some difficulties to expand their views to the inclusion of interdisciplinary issues in science subjects, which would help students to understand the problems we are facing. They believe that this multidisciplinary approach is not possible because they have to play with a closed curriculum.

Small group activity

The summary of ideas resulting from the consensus of the nine groups is shown in Table 1 below. Generally, groups paid more attention to the aspects under agreement than to those in which no consensus was reached. These agreements were very helpful to find meaning in the various aspects raised and set up the discourse of consensus. Regarding the disagreements, these tended to occur in those areas where conflicts between certain beliefs were noted.

An example of this was given when two groups expressed their disagreement with the following statement: *"Science teaching should not be so focused on teaching conceptual knowledge"*. They justified their position arguing that it is first necessary to introduce students to the basic concepts that will be necessary to explain everyday problems.

The contribution of group E illustrates this matter and, at the same time, demonstrates the usefulness of debates and how, sometimes, certain elements enrich the discussion:

"It was more difficult to reach common positions in relation to those issues on which there had been an initial disagreement. In the end, the group activity brought us to agree with the following ideas:

It is important to explain conceptual contents in science lessons, but always connecting them to everyday life.

Students' negative attitude does not only relate to science matters, but to everything in general." (group E)

Table 1. *Proposals generating agreement or disagreement during the activity in small groups*

Ideas/proposals generating agreement among groups	Groups								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Interdisciplinary approaches in teaching science should be promoted	x	x			x				x
Science education should contribute to improve social life	x		x		x	x	x	x	
Applicability of science concepts to real life should be encouraged		x	x	x		x	x		x
Convenience of focusing on the context of individual and social problems		x		x		x			x
Convenience of bringing science closer to everyday life			x				x	x	
Convenience of teaching and learning science in a variety of contexts			x		x			x	
Life-long learning						x			
Ideas/proposals generating disagreement among groups	**Groups**								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Scientific concepts can be taught without links to everyday life	x								
In the science classroom, modern science has to be differentiated from ancient science		x				x			
In science teaching, learning scientific concepts should not be so predominant			x		x				
The criteria for selecting science concepts to be taught in school does not have to be globalised				x				x	
When finishing primary school, students are unmotivated towards science							x		
What students do not learn in school can be learned from their parents									x

Interviews

a) Biology-Geology

A high degree of agreement had been reached when the interview took place in this group. Therefore, they had arrived to consensus in an easy way. They had selected three major ideas: interdisciplinary approach, applicability in everyday life and science teaching focused on social problems.

"Science should be integrated with other disciplines to find common goals and foster literacy and responsibility in citizenship." (pst. 5, 15 & 19)

"Classroom learning should be extended to students' social reality and applied to their lives" (pst. 5, 15 &19).

"Science teaching should be focused on social issues, rather than on abstract and theoretical concepts."(pst. 5, 15 & 19)

The three members of the group concluded that science education must consider the practical applicability of what has been learned, and contribute to achieve a meaningful learning.

"We believe that, nowadays, one of the major problems of science teaching is its lack of meaning in students' everyday lives. They are not aware of the importance of scientific advances in social welfare, probably due to the lack of applicability." (pst. 5, 15 & 19)

On the idea of interdisciplinary approaches as key elements to science teaching, two members of the group expressed their agreement, explaining their positions to the third member as follows:

"If we get this connection (science with economy, politics, history, etc.) and introduce science as something that may affect other areas, we will be promoting the development of students' awareness of how scientific advances may affect society and how political decisions about science can influence it [...], the way in which R & D of a country affects its economy, employment, etc." (pst.5)

"Education should be addressed as a multidisciplinary process where every topic or discipline can contribute to train future citizens." (pst.15)

Facing these statements, pst. 19 confirmed his agreement, as long as "abstract knowledge" was not relegated. This argument re-appears when the group draws attention to the idea of scientific education oriented to socially relevant problems. Participants pst. 5 and pst.15 supported this approach and explained it to participant pst.19 in the following way:

"Our aim is not to train students to become scientists in secondary schools, but to promote their science learning so that they become responsible citizens who are able to understand events and situations in their daily lives." (pst. 5)

"Throughout the educational period we train citizens, so it is important to provide them with critical thinking and skills that will help them face the future. Making them understand the scientific knowledge that may be useful at some stage of their lives is more important than scientific theories or more abstract scientific concepts." (pst. 15)

The pst.19 was only partly convinced, and made the following comment:

"Science education should not abandon the paradigm of abstract concepts completely, in favour of a connection with the real world. Those concepts, as well as abstraction and imagination, are part of knowledge and human development." (pst.19)

This idea would be later defended by the pre-service science teacher in order to face his/her colleagues' informal questions, after agreeing with the proposal of the group in opposition to his/her own arguments. It becomes clear how deeply rooted these traditional ideas are, as this is the case of this person, who accepted the agreement of the group, changing his/her mind as soon as the context changed (teacher`s diary).

b) Physics-Chemistry

In this group some individual participants have a more innovative profile although, in the interest of consensus, they accept traditional ideas expressed by other participants. In the end, after having reflected and discussed, they only agreed on the idea of providing an interdisciplinary nature to science subjects.

"Interdisciplinarity: When we acquire the knowledge that science is directly connected to other disciplines, then the learning process is reinforced and concepts are better understood." (pst. 7, 18 y 28)

All members of the group supported this idea, which was the only one they shared from the beginning. They expressed it as follows:

"Human knowledge is not divided into strict compartments, without mutual communication. All disciplines are related in one way or another, and when considered in this way, we encourage the role of scientific knowledge within the context of our society"(pst.7).

"When teaching science under an interdisciplinarity approach we are promoting more solid ideas that connect it with other disciplines." (pst. 18)

"I disagree with the idea that science is separated from other subjects, as they must be closely linked and related to each other [...]." (pst. 28)

Two members of the group agreed on the importance of giving a prominent role to students' everyday life when teaching science. They explained the following points of view:

"We need to approach science teaching in a way that is relevant for students' lives, generating a critical thinking in them about current debates in society. [...]." (pst.28)

"I totally agree with this idea, we should broaden our methods in order to make connections with the practical and useful knowledge that is of interest to students' everyday lives [...].It is absolutely true that science education has been isolated from students' everyday life, which is a serious mistake. There is a clear need to establish connections between science and other disciplines" (pst.28)

This idea generated disagreement, when the third member of the group claimed that the curricular approaches already consider such kind of relationships. In this way, he convinced the rest of the group by defending that this should not be a matter of concern for teachers.

With respect to a teaching approach oriented towards social problems, only one participant in the group claimed his/her agreement, and explained to his/her colleagues that:

"Science teaching should not be limited uniquely to laws and abstract concepts, but should be focused on current issues in society, so that students can see their applications and, this way, we would encourage them to understand science." (pst. 28)

The other members of the group accepted this idea, but manifested some exceptions:

"I agree with the approach of science education through social problems, in order to make this teaching more appealing to students. However, we should always keep in mind that those concepts that we consider "abstract" are also necessary [...]." (pst. 7).

The group disagreed with the above reasoning and dismissed the idea raised by pst. 28.

DISCUSSION AND CONCLUSION

We have conducted an educational innovation with pre-service science teachers whose development has been investigated. These results can help to design interventions in their trainings as teachers, in which the aims could be the encouragement and the assumption of new approaches to science education.

Results show that for many participants, science subjects remain isolated from social issues, favouring the idea of disconnection between science and society. However, it can also be seen in them a willingness to consider attitudes and values as fundamental mainstays in students' scientific and technological literacy.

These considerations are shown in a lesser extent when they are asked to give specific reasons justifying such an approach. Instead, they put emphasis on the obstacles and impossibilities to undertake innovations. Such is the case, for example, of interdisciplinarity, in respect of which curricular impediments and difficulties of coordination between the different subjects are alleged.

Participants, most of whom initially tended to conceive a teacher-centred education, make some progress along interventions in respect of certain actions that students should perform throughout their learning process, in which the teacher's role remains in the background. They also make progress when considering a wider range of strategies and more innovative connotations that allow, not only the assimilation and learning of concepts, but also other learning processes which are equally important. .

Furthermore, results show a high degree of coincidence among the ideas proposed by participants in the individual activity, as well as the areas where the debate took place in the groups' activity. They also show the progress that has occurred as a result of the debate in the group, and the considerations and arguments taken into account in this process.

Debates in the group activity evidence the way some colleagues have discussed and convinced others to accept certain ideas to which they were more reluctant. This is evidenced, for example, by the fact that some ideas are more accepted in individual activities, as in the case of "the advantages associated with interdisciplinary approaches," because some participants have changed their opinion.

Nevertheless, we noted how participants used certain external obstacles to justify the potential failure to apply these teaching approaches. This kind of facts has been reported by researchers as Watts & Jofili (1998), Pedretti et al. (2008) and McMinn, Kadbey, Dickson (2015). We also noted that beliefs associated with external obstacles posed less resistance to change. Evidence of the above is the consideration of the everyday and interdisciplinary knowledge and how it interacts with science subjects as an obstacle, the origin of which is in the division of the curriculum into separate disciplines, which might cause confusion both in students and their teachers.

On the other hand, in the context of the group, innovative ideas were better accepted and regarded as less revolutionary when they are supported by their colleagues. In this way, some innovative ideas made their way and gained more adepts. We observed a significant number of participants, from the beginning to the end of the process, looking for indicators in their progression of their ideas about teaching and learning science.

The above enables us to be aware that, by the debate among colleagues, there is a way to foster the overcoming of certain beliefs, which have been considered as barriers to progress, given that sometimes reluctance have not been absent from the process. This, for instance, is evidenced by our participants' concern about the lack of conceptual learning caused by certain teaching approaches. We can observe their hesitation and resistance to change. In these cases, the role played by pair work helps reduce the reluctance, allowing the adherence to new approaches.

The small group has been sometimes very favourable to the genesis of new ideas in an emerging context. In these cases, the group's work is very positive, given that new ideas, which otherwise would not have come to light, can be generated and assessed. In this regard, a very favourable progress appeared when the proposed deal was accompanied by specific action plans, in which participants could appreciate how to implement such ideas in the classroom.

We agree with authors as Carvalho et al. (2015) when they point out that reflection in a group is a good action to develop new conceptions and beliefs regarding science teaching, as it promotes situations in which pre-service science teachers acquire skills related to critical thinking and effective feedback. The results of this study are just an example.

In light with the above, Porlán et al. (2010) argued that, we, as trainers of science teachers, should contribute, in some way, to the encouragement of new knowledge in order to get over some stereotypes that are linked to the school culture.

We are also in line with Hewson & Hewson (1987) when they refer to making an extension in science teacher training approaches, which includes emotional and social risk associated with the design and development of new classroom' behaviours. In this sense, innovative teachers are usually seen as transgressors of what is considered normal and acceptable.

Our results are also in agreement with those obtained by Benarroch & Martin (2011), who assert that there are opportunities to improve the conceptions and beliefs about teaching and learning science in the pre-service science teachers, although we are still far from creating a common framework to influence and change their future practical action. In conclusion, it would be necessary to research how pre-service science teachers bring these approaches and objectives to the second part of the initial training programme in those centers where they carried out teaching practices. This will be our issue for further research.

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