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Expanding Student Teachers' Implicit Theories about Explanations for the Science Classrooms

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Abstract. This study explored student teachers' implicit theories about explaining for the science classroom in three courses at diverse universities. Based on microteaching situations, the participants simulated explanations and discussed the elements they considered relevant for giving peer feedback. This led to the design of rubrics for peer assessment, which expressed their implicit theories about what a good explanation for the science classroom would look like. The three rubrics are presented and discussed in the light of the connections between teachers' thinking and practice. Shulman's ideas about professional teaching knowledge development, as well as negotiation of meaning, provide theoretical under-pinning for understanding and expanding student teachers' thinking about explanations for the science classrooms.

Keywords: Explanations · Implicit theories · Science education · Peer feedback

1 Introduction

1.1 Implicit theories in teachers

Implicit theories are a system of thoughts with a certain degree of articulation, not totally codified by their owners -because of their implicit character- but typically inferred and reconstructed by researchers [1, 2]. These theories also could be idiosyncratic to a group or community. They have an important function in intergroup relations, mediating the construction of social meaning - and they have a regulatory effect on action [1, 3]. The origin of the examination of implicit theories was in cognitive psychology, as the product of implicit or informal learning and the construction of regularities in the world, in order to make it more predictable and controllable [4]. Moreover, they are representations that make connections between information units, which adds complexity [4]. Although implicit theories could be considered as a type of belief [1], in fact they{ ADDIN EN.CITE <EndNote><Cite AuthorYear="1"><Author>Pozo</Author><Year>1998</Year><RecNum>396</RecNum><DisplayText>Pozo and Gómez (1998)</DisplayText><record><rec-number>396</rec-number><foreign-keys><key app="EN" db-id="0vr0srz2m0dsr7ezd2mvtat0z2v099dzaffx">396</key></foreign-keys><ref-type name="Book">6</ref-type><contributors><authors><author>Pozo, Juan</author><author>Gómez, Miguel</author></authors></contributors><titles><title>Aprender a enseñar ciencias: Del conocimiento cotidiano al conocimiento científico</title></titles><dates><year>1998</year></dates><pub-location>Madrid</pub-location><publisher>Ediciones Morata</publisher><urls></urls></record></Cite></EndNote>} are deeper, more stable and more difficult to change [3]. This might be because implicit theories tend to be eclectic aggregations of propositions from many sources, rules of thumb, and generalizations drawn from personal experience, values, biases and prejudices [2]. In the theory of Nonaka and Takeuchi [5], this would constitute tacit knowledge, which is conceived as the fruit of a multiplicity of non-verbalized internal sources (personal beliefs, perspectives and values). Explicit knowledge, on the contrary, is easily-accessible, expressed and shared formally. For instance, in this research we worked with explanations of scientific concepts as a form of explicit knowledge. We conceptualized explanations and explanatory frameworks as the way in which teachers use analogy, metaphor, examples, axioms and concepts, linking them together into a coherent whole for the classroom { ADDIN EN.CITE <EndNote><Cite><Author>Geelan</Author><Year>2003</Year><RecNum>343</RecNum><DisplayText>(Geelan, 2003)</DisplayText><record><rec-number>343</rec-number><foreign-keys><key app="EN" db-id="0vr0srz2m0dsr7ezd2mvtat0z2v099dzaffx">343</key></foreign-keys><ref-type name="Journal Article">17</ref-type><contributors><authors><author>Geelan, David</author></authors></contributors><titles><title>Teacher expertise and explanatory frameworks in a successful physics classroom</title><secondary-title>Australian Science Teachers Journal</secondary-title></titles><pages>22-32</pages><volume>49(3)</volume><number>3</number><dates><year>2003</year><pub-dates><date>14 March 2012</date></pub-dates></dates><isbn>0045-0855</isbn><urls><related-urls><url>http://search.informit.com.au.ezproxy.library.uq.edu.au/fullText;dn=131832;res=AEIPT</url></related-urls></urls></record></Cite></EndNote>}

Teachers are not used to articulating their knowledge of practice, and as a consequence, they usually know more than they can say about what they do. This tacit knowledge includes reasons for approaching teaching practices in particular ways, knowledge of teaching procedures and their impact on students' learning [7]. We will focus specifically on the organization and modification of implicit theories.

1.2 Modification of implicit theories

To understand how teacher theories can change, it is necessary to understand how they are organized. As is shown by Pozo, Gomez and Sanz [8], at the surface level of representational analysis there are the beliefs, conceptions, predictions, judgements and interpretations that people enact to face situations or tasks. This level is more accessible and explicit for the person because it is in a more conscious level of representation. Changing theories requires a deep restructuring of implicit suppositions, conducting a conceptual change to overcome the restrictions imposed by the person's cognitive system. This change should operate on the deepest conceptual structures to construct new knowledge [4]. According to Karmiloff-Smith [9], a specific level of representation should be re-described in new and more complex categories in a sequence of progressive complexity, in order to integrate or re-interpret previous ideas into others that are more structured.

As implicit theories are a cost-effective way of reasoning, to be restructured they need to be confronted with practice [4], to make them explicit and re-integrated [8]. This means making theories progressively fit into a position where they can be affected [10]. Concept maps, metaphors and flow charts are techniques to aid teachers in the elucidation of thoughts and theories. Moreover, using the same information input twice offers the possibility to look for transformation [11]. As a goal of teacher education is to help student teachers to challenge and refine their ideas about teaching, cognitively supportive environments are needed [12]. Effective teacher education programmes recognise the development of teachers' knowledge about teaching practices for specific objectives [13]. In the current research, implicit theories held by student teachers about explaining for the classroom were investigated, through the optic of constructing criteria for peer assessment and feedback as a mechanism of elicitation. Indeed, we consider that both constructing criteria for peer assessment and performing microteaching could be powerful supports to challenge participants' implicit theories in a protected environment. These are the focus of the next section.

1.3 Microteaching

Microteaching is a short duration teaching episode, often around 5-15 minutes [14, 15]. It is a common practice used for teacher education [16]. In theoretical terms, microteaching has been presented as an efficient and effective technique in teacher training programs, because the simulated practice context gives a teaching experience to be aware of the skills of which teaching is composed. Student teachers can focus their attention on defined aspects of teaching, removing the problem of control or discipline that would be distracting with real students. Indeed, video recording the microteaching episode, peer and tutor feedback to stimulate self-analysis is recommended { ADDIN EN.CITE <End-
Note><Cite><Author>Mohan</Author><Year>2007</Year><RecNum>605</RecNu
m><DisplayText>(Mohan, 2007)</DisplayText><record><rec-number>605</rec-
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id="0vr0srz2m0dsr7ezd2mvtat0z2v099dzaffx">605</key></foreign-keys><ref-type
name="Book">6</ref-type><contributors><authors><author>Mohan, Ra-
dha</author></authors></contributors><titles><title>Innovative science teaching for
physical science teachers</title></titles><edition><style face="normal"
font="default" size="100%">3</style><style face="superscript" font="default"
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location>India</pub-location><publisher>Prentice Hall</publisher><urls><related-

urls><url>http://books.google.co.uk/books?id=xCfeUdolvM4C&pg=PA127&lpg=PA127&dq=teacher+microteaching+science&source=bl&ots=gr8sJdS6oC&sig=vDge4Tha-M0wDPiQsK-h9QHia7o&hl=es-419&sa=X&ei=KNqqUMb9OoTQ0QXNpYCoBQ&redir_esc=y#v=onepage&q=teacher%20microteaching%20science&f=false</url></related-urls></urls></record></Cite></EndNote>} Similarly, observing, analyzing and discussing classroom performance could help student teachers to see themselves from a different perspective [16]. In general, microteaching provides a simulated situation to develop confidence and skills in managing a lesson, critiqued mainly by other student teachers or colleagues { ADDIN EN.CITE <EndNote><Cite><Author>Mohan</Author><Year>2007</Year><RecNum>605</RecNum><DisplayText>(Mohan, 2007)</DisplayText><record><rec-number>605</rec-number><foreign-keys><key app="EN" db-id="0vr0srz2m0dsr7ezd2mvtat0z2v099dzaffx">605</key></foreign-keys><ref-type name="Book">6</ref-type><contributors><authors><author>Mohan, Radha</author></authors></contributors><titles><title>Innovative science teaching for physical science teachers</title></titles><edition><style face="normal" font="default" size="100%">3</style><style face="superscript" font="default" size="100%">rd</style></edition><dates><year>2007</year></dates><pub-location>India</pub-location><publisher>Prentice Hall</publisher><urls><related-urls><url>http://books.google.co.uk/books?id=xCfeUdolvM4C&pg=PA127&lpg=PA127&dq=teacher+microteaching+science&source=bl&ots=gr8sJdS6oC&sig=vDge4Tha-M0wDPiQsK-h9QHia7o&hl=es-419&sa=X&ei=KNqqUMb9OoTQ0QXNpYCoBQ&redir_esc=y#v=onepage&q=teacher%20microteaching%20science&f=false</url></related-urls></urls></record></Cite></EndNote>}

Microteaching in pre-service science teaching was part of a study on the teachers' perceptions of microteaching performances in connection with their beliefs about teaching science. Results showed that teachers' beliefs, rather than instructor or peer-based assessments, served as the primary determinant by which they perceived personal success in microteaching { ADDIN EN.CITE <EndNote><Cite><Author>Mohan</Author><Year>2007</Year><RecNum>605</RecNum><DisplayText>(Mohan, 2007)</DisplayText><record><rec-number>605</rec-number><foreign-keys><key app="EN" db-id="0vr0srz2m0dsr7ezd2mvtat0z2v099dzaffx">605</key></foreign-keys><ref-type name="Book">6</ref-type><contributors><authors><author>Mohan, Radha</author></authors></contributors><titles><title>Innovative science teaching for physical science teachers</title></titles><edition><style face="normal" font="default" size="100%">3</style><style face="superscript" font="default" size="100%">rd</style></edition><dates><year>2007</year></dates><pub-location>India</pub-location><publisher>Prentice Hall</publisher><urls><related-urls><url>http://books.google.co.uk/books?id=xCfeUdolvM4C&pg=PA127&lpg=PA127&dq=teacher+microteaching+science&source=bl&ots=gr8sJdS6oC&sig=vDge4Tha-M0wDPiQsK-h9QHia7o&hl=es-419&sa=X&ei=KNqqUMb9OoTQ0QXNpYCoBQ&redir_esc=y#v=onepage&q=teacher%20microteaching%20science&f=false</url></related-urls></urls></record></Cite></EndNote>}Similarly, using video in teacher education can increase student teachers' ability to apply the knowledge gained during training [19]. Recently, great interest has been shown in the processes of reflection in the sharing of video in the teaching community [20]. Personal relevance in a video is perceived to play an important role in the process of in-depth analysis and can increase awareness in the reflection [21,22]. However, video is not effective in itself [23]. To be useful, it must be embedded in appropriate instructional contexts and have adequate scaffolding for critical thinking about the practice [20]. Although{ ADDIN EN.CITE <EndNote><Cite AuthorYear="1"><Author>Pauline</Author><Year>1993</Year><RecNum>606</RecNum><DisplayText>Pauline (1993)</DisplayText><record><rec-number>606</rec-number><foreign-keys><key app="EN" db-id="0vr0srz2m0dsr7ezd2mvtat0z2v099dzaffx">606</key></foreign-keys><ref-type name="Journal Article">17</ref-type><contributors><authors><author>Pauline, Ronald F.</author></authors></contributors><titles><title>Microteaching: An integral part of a science methods class</title><secondary-title>Journal of Science Teacher Education</secondary-title><alt-title>J Sci Teacher Educ</alt-title></titles><periodical><full-title>Journal of Science Teacher Education</full-title></periodical><pages>9-17</pages><volume>4</volume><number>1</number><dates><year>1993</year><pub-dates><date>1993/12/01</date></pub-dates></dates><publisher>Kluwer Academic Publishers</publisher><isbn>1046-560X</isbn><urls><related-urls><url>http://dx.doi.org/10.1007/BF02628852</url></related-urls></urls><language>English</language></record></Cite></EndNote>} the main critique of the microteaching setting is its artificialness -it would not be sufficiently comparable to the classroom for transfer of skills- [25], all previous work recommended it as a valuable technique to prepare teaching skills, sometimes even the most effective [14]. Future studies should specifically focus on student teachers' predetermined criteria or conceptions for assessing microteaching in order to increase understanding on it y[17].

1.4 Constructing criteria for peer assessment processes

Communicating information about performance criteria provides a basis for the improvement of that performance [24]. Each student should also be able to take the responsibility to make critical judgements about the performances of a peer applying the appropriate criteria [26]. However, conducting peer assessment and giving feedback is a complex skill that needs to be developed.

Peer feedback has been used extensively in many different fields and is considered a reliable and valid approach to assessment and teaching [27]. Peer feedback can be more timely and individualized than instructor feedback, encourage students to take increased responsibility for their progress, broadening and deepening reflection [28]. In the current research, peer assessment and feedback were applied through microteaching episodes in a peer assessment and feedback course.

2 Methods

2.1 Aims of the study and participants

The research aim was to explore implicit theories about explanations for the science classrooms in three groups of student teachers and to describe possible differences related to participants' science knowledge, measured by the number of science courses taken. The design was exploratory and descriptive. Qualitative techniques were used to gather and interpret the implicit theories. A social constructivist paradigm was adopted to understand how knowledge was created and transformed by groups [29].

The participants were 20 student teachers, 25 years old on average (min.23, max.28). They represented low and lower-medium socioeconomic status, had had similar practical teaching experiences before (from zero up to a few weeks) and came from an urban zone of Santiago, the capital of Chile. Purposive sampling was carried out to select participants from universities that offer diverse numbers of science courses as part of their compulsory teacher education program, as shown in Table 1.

Table { SEQ Table \n }. Groups' characteristics.

Characteristic	University 1 (U1)	University 2 (U2)	University 3 (U3)
Science courses	14	9	4
Group size	6	8	6

2.2 Design of the training

The participants joined voluntarily in a ten-session course as Figure 1 summarizes. The first part included assessment of videos. Later on, the participants simulated and peer-assessed their microteaching episodes, taking the role of pupils and teachers. They constructed instruments for peer feedback in the second round of microteaching.

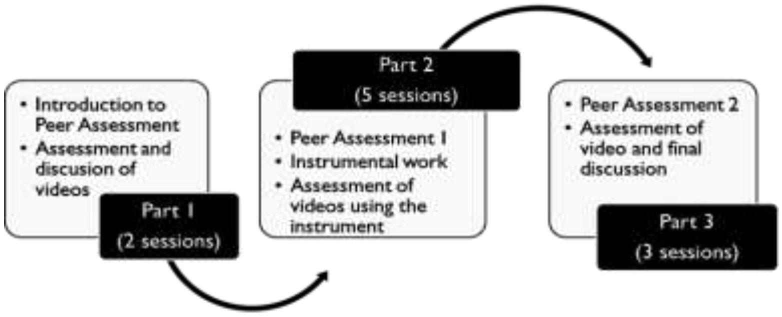

Fig. { SEQ Fig. \n }. Schema of 10-session peer assessment and feedback microteaching course.

2.3 Data analysis

Implicit theories about explaining for science classrooms were elicited through the construction of assessment criteria, giving and receiving feedback. Thematic and content analysis were used to analyze the sessions transcribed. The steps used were: familiarizing with the data, generating initial codes, searching for themes, defining, reviewing and naming themes. This process involved a constant moving back and forward within the entire data set, as well as generating priorities. The results are presented and organized for each of the three groups (U1; U2 and U3) in the next section.

3 Results

In the U1 group, the implicit theories that embodied the peer assessment and feedback instrument construction (Table 2) were associated with constructivist theory applied to teaching science. The participants valued the explicit inclusion of diversity approaches in addressing the topic being explained, for instance from gender, cultural, ethnic, inter- or intra-individual differences. Likewise, reaching consensus on the scientific terms used in the explanations between the teacher and the students was relevant. The contextualization of the content appeared relevant for students' conceptual understanding, which meant putting the content in more concrete, simpler or wider elements connected with the concept. This allowed linking the explanation with what the students already knew. The correct connections between the concepts in the explanations were also mentioned as useful to support conceptual understanding, as well as links, similarities and differences between the explanation and students' everyday life. The good explanations, in their view, used students' prior knowledge and answers, which implied explanation as a transforming vehicle of students' ideas. Examples are good for explaining when they illustrate the content, are pertinent and familiar to the students and their experiences. Finally, the emphasis on the students' notes during the explanation was seen as a way of formalising the knowledge learned.

The teachers from U2 created a rubric (Table 3) based on the idea that every explanation constructed for science teaching could work as a model of the scientific concept or phenomenon being explained, and this character should be communicated to the students. The implicit theory here was that there are many ways of representing knowledge and explanation is just one of them. The first three criteria identified the moment of the lesson when the explanation appeared, as well as its function (such as motivational, demonstrative, explanatory or evaluative), and the percentage of the lesson time used to explain. Within the quality criteria they mentioned -as the U1 group- the links with students' prior knowledge had priority. The implicit theory was connecting students' ideas with the proposed model of the concept, but this was positive only when the teacher explicitly used the prior knowledge in the explanation. The participation of the students in the explanation was another important criterion. It elicited student teachers' views about the constructive process of explanations in science, which was flexible to enable integration of students' questions, ideas, etc. The accuracy of the explanation also appeared. This group thought that a teacher who explains correctly and answers all the students' questions is better than the one who is explaining correctly but leaving questions unanswered. Besides, this group of participants highlighted the importance of the clarity of the explanation, which was connected for them with the conceptual clarity the teacher had about the scientific concept. Their idea was that, if the teacher has clarity about the content knowledge (no mistakes when explaining), the explanatory model will be enriched. Otherwise, unclear content knowledge is unlikely to produce a good explanation through the model.

In the U3 group, the analysis of the construction of their instrument (Table 4) indicated it could be assumed they had a simpler view about explanations in science. A few elements were similar to the other two groups of teachers, but teachers from U3 presented less sophisticated ideas, which were more difficult to transform into criteria.

For these teachers, the use of examples in the explanation was the most important element in defining its quality. After questioning about the characteristics and applying the criteria, it was observed that good examples for them were: familiar or close to the students' experience, as concrete as possible and related to the scientific concept being explained. The connection with students' prior knowledge also emerged largely in this group's discourse, as in the other two groups. Here, the clue was gathering what students already knew through questions, and linking this knowledge with the concept being explained. For this group, good questions are posed to the entire class without giving priority to one student or a group of them for particular reasons.

A different aspect of explanations that appeared in this group and not in the others was the sequence and conciseness of the explanation. They mentioned the explanation should have neither unnecessary nor missed elements, but it must have a connective thread. The implicit theory appeared to be making the connection between both aspects; if there are missed elements the thread would be broken, and only if each part of the explanation connects to another would a good sequence be established. Isolated elements not connected with others would be unnecessary parts for the explanation.

In terms of the accuracy of the explanation, the U3 teachers asserted that the teacher must handle content knowledge. The way in which they referred to this was is in the precision of the explanation or when the teacher was not repetitive, because redundancy meant for them the teacher was staying only in his or her 'safe place'. Another related element was what the teacher did with students' answers. The participants mentioned clearing the conceptual mistakes and integrating them in the explanation as relevant pedagogical actions. Nevertheless, in their discourse, the teacher needed to have good content knowledge to be able to correct student misconceptions. Thus, both criteria were clearly connected.

Finally, this group mentioned collaborative work as an important criterion in the quality of conceptual explanations. By collaborative they meant constructing the explanation between the teacher and the students and also between the students. This could be achieved through activities that allowed collaboration which reflected a more flexible view about the nature of the science knowledge and its construction.

Through this process of product analysis, it was possible to observe the group of student teachers' theories varied according to the university they belonged to, then, perhaps by the program views. There were not observable differences in the participants' implicit theories which might be due to the amount of science courses they have had. This is assumed because the three groups referred to elements related to scientific knowledge in an equally relevant manner. Although all the groups adhere to constructivist theories of teaching science, at the moment of deciding why a peer simulated explanation was better, the groups U1 and U2 presented more elements than U3. In this last group, the participants' implicit theories included broader elements, not only useful to analyze and assess explanations for the science classroom, but for the whole lesson and subjects, such as collaborative work, teachers' feedback, etc.

Table { SEQ Table \n }. Student teachers' rubric for peers' explanations assessment U1

Criterion	Not achieved	Half achieved	Achieved
1. Diversity approach: how the teacher explicitly teaches topics from a diversity approach.	The teacher does not include address any from the diversity approach.	The teacher includes in the explanation a topic from the diversity approach.	The teacher approaches a topic from the diversity approach giving examples that globalize it or refer to how the diversity enriches the concept understanding
2. Terms usage: How the teacher gives meaning to the concepts.	Most of the terms the teacher uses in the explanation do not have meaning got by consensus.	The teacher gives a definition of the terms without exploring the students' prior knowledge.	The teacher explores in students' prior knowledge about the terms being used, making them participate, correcting the mistakes and enhancing the successes.
3. Contextualization: How the teacher presents a general context to introduce the explanation.	The teacher does not contextualize the explanation.	The teacher asks to the students to contextualize the explanation but does not declare the context.	The teacher contextualizes the explanation in a simple way, interacting with the students and presenting them a concrete context.
4. Link with other concepts: How the teacher links the concept with other scientific concepts.	The teacher does not link the concepts, or the link is conceptually incorrect.	The teacher links some concepts, but the link does not support the concept understanding or it is a not clear link.	The teacher establishes a clear and conceptually correct link between two or more concepts, and it supports the concept understanding.
5. Link with everyday life: How the teacher links the concept with elements from the students' everyday life.	The teacher mentions a link with the students' everyday life, but does not explain the link.	The teacher mentions a link between the concept and the students' everyday life but only for a memory function.	The teacher mentions a link between the concept and the students' everyday life mentioning similarities and differences between both without losing the focus.
6. Prior knowledge: How the teacher links the concept with students' knowledge.	The teacher does not gather students' prior knowledge.	The teacher gathers students' prior knowledge but does not use explicitly to explain.	The teacher gathers students' prior knowledge and uses it explicitly to explain, linking it with the concept explained.
7. Questions: How the teacher uses different type of questions and poses them to the class.	The teacher does not ask questions during the explanation or they are always closed.	The teacher asks open and closed questions but poses only to a student or group, or does not wait for the answers.	The teacher asks specific open and closed questions and poses them widely to the class.
8. Answers: How the teacher manages the students' answers.	The teacher does not do anything with the answers or always says "good".	The teacher gathers answers but integrates only the related answers to the question.	The teacher integrates the answers, corrects the errors or allow students realising and self-regulate.
9. Examples: how the examples with the explanation are.	The explanation present examples non-pertinent to the concept or no examples.	Examples are ambiguous, not close to the students or do not illustrate the concept.	The teacher uses examples pertinent to the content, familiar to the students, accurate and illustrative.
10. Taking notes: Whether or not the teacher encourages it.	The teacher doesn't encourage students to take notes during the explanation.	The teacher encourages students' notes but does not verify if they do it.	The teacher encourages students to take notes and verifies if they do it during the explanation.

Table { SEQ Table \n }. Student teachers' rubric for peers' explanations assessment U2

Criterion	Indicators		
1. Moment	Beginning of the lesson	Middle of the lesson	End of the lesson
2. Observable function	Motivational: The teacher promotes the students' motivation.	Demonstrative: The teacher explains nature elements through examples.	Explanatory: The teacher explains phenomena or processes that occur in nature.
	Evaluative: The teacher evaluates students' knowledge to challenge their prior theoretical knowledge.	Other	Other
3. % of time used for expl.	0-33% of the lesson	34-66% of the lesson	67-100% of the lesson
Criterion	**Not achieved**	**Half achieved**	**Achieved**
4. Integrating students' prior knowledge	The teacher neither gathers nor identifies the students' prior knowledge about the content or the model presented.	The teacher gathers and or identifies the students' prior knowledge about the content or the model presented, without linking them with the model.	The teacher gathers and or identifies the students' prior knowledge about the content and links explicitly the prior ideas with the explanation or model.
5. Reference to explanation as a model or representation	The teacher does not refer implicitly or explicitly the model used to explain is a representation of the reality and, but assumes the model is the reality.	The teacher refers implicitly or explicitly the model used to explain is a representation, without mentioning implicitly or explicitly the existence of other models to explain, or that it is a provisional model.	The teacher refers implicitly or explicitly the model used to explain is a representation of reality and there are other models to represent the content.
6. Students' interaction with the explanation	The teacher does not make students interact with the explanation.	The teacher achieves partial interaction between the students and the model, because there are doubts about the explanation and its uses.	The teacher achieves student interaction with the model through the students' participation in the explanation of the model or questions.
7. Scientific accuracy	The teacher does not explain correctly, causing conceptual mistakes in the students.	The teacher explains correctly, but making mistakes when answering students' questions, or the teacher does not answer all the question	The teacher explains correctly and answers all the questions raised from the students.
8. Conceptual clarity	The teacher does not have a conceptual clarity, which causes making mistakes when using the model.	The teacher has a medium clarity about the concept being explained at the moment of using the model.	The teacher has plenty clarity about the content being taught, which enhances the usage of the model.

Table { SEQ Table \n }. Student teachers' rubric for peers' explanations assessment U3

Criterion	Not achieved	Half achieved	Achieved
1. Examples usage: Quality of the examples the teacher gives when explaining.	The teacher does not use examples when explain or the examples used are not related with the concept being explained	The teacher uses concrete examples that are related with the concept, but they are not close to student's experience or knowledge.	The teacher uses concrete examples, related with the concept and close to students' experience
2. Prior knowledge: How the teacher relates the concept being explained with the students' prior knowledge.	The teacher does not gather students' prior knowledge or ideas.	The teacher gathers students' prior knowledge or ideas but does not use them explicitly to explain.	The teacher gathers students' prior knowledge or ideas and uses it explicitly to explain, linking them with the concept.
3. Questions: How the teacher different type of questions and poses them to the class.	The teacher does not ask any question during the explanation.	The teacher opens a moment to ask questions (open and closed), but they are directed only to a student or a group.	The teacher opens a moment to ask questions, directing them widely to the students.
4. Sequence and succinctness.	There is not a conductive tie in the explanation, or it is interrupted because more than one part of the explanation is missed or unnecessary.	Each part of the explanation conducts to the next one (conductive tie), but there is one part of the explanation missed or unnecessary.	Each part of the explanation conducts to the next one (conductive tie), and there is any part of the explanation missed or unnecessary.
5. Accuracy/ Conceptual knowledge	The teacher does not handle the concepts being explained, there is redundancy, mistakes or he induces conceptual mistakes in the students.	The teacher handles the basic concepts, but when explaining is not accurate (there are inaccuracies).	The teacher demonstrates handling the concepts because the explanation is accurate and there are not mistakes.
6. Answers management: What the teachers does with the students' answers.	The teacher does not do anything with students' answers or says "good" independently of the quality of the answer.	The teacher integrates only the answers that seem correct for him, or does not correct the inaccuracies in the student's answers (they keep the mistake).	The teacher integrates the answers related with the explanation and corrects the errors, clearing the conceptual mistakes.
7. Collective work with concepts.	The teacher does not do any type of collective work with the concepts.	The teacher works collectively a concept.	The teacher works a concept, collectively giving it a shared meaning.

4 Discussion

The instruments generated by the participants were considered as the participants' products of their implicit theories. Working on a concrete artefact for each group helped the participants to reorganize their knowledge from the implicit to the explicit, so that it could be observed and influenced [1, 19]. As the participants engaged in both roles –teacher and simulated student, giving and receiving feedback- empathetic feelings necessary for creating a challenging but protected learning environment were developed [12]. We think it is in this type of environment where new meanings can be explored and negotiated through reflective thinking.

It was possible to observe that the three groups of student teachers' implicit theories were different, perhaps because of the teacher education programs in which they were enrolled. Nonetheless, there were no differences in the mentioned elements related to science knowledge in the arguments which might be have been due to the differences in the amount of science courses the participants had had. This is remarkable because explanations for the classroom are highly dependent on the content, processes or concepts being taught [6]. The groups from U1 and U2 presented more relevant elements than U3, and in this last university group the implicit theories about the explanations for the science classroom were less sophisticated, simpler and less articulated than in the others. However, there were two common points between the three groups of student teachers: the use of examples and the interaction between the teacher and the students during the explanation. Elements such as analogies, metaphors or simulations, or using mistakes as a learning opportunity appeared indistinctly, which were relevant for teaching science constructively.

The process of making explicit the implicit theories of student teachers through simulated teaching practices in microteaching can be seen through the lens of developing pedagogical content knowledge (PCK). This is an amalgam of content knowledge transformed by the teacher into a form that makes it understandable, including analogies, illustrations, examples, explanations and demonstrations to reformulate the subject knowledge and make it understandable to the students [30]. The problem is how to enhance its development when no teaching experience in real classrooms is available? In the present research, simulating teaching and observing peers' teaching in several microteaching episodes for giving and receiving feedback, gave an opportunity to develop the roots of PCK because explanations are a form of transformation of the science concepts for teaching purposes. We believe that PCK is embedded in details of classroom experiences, especially in those that present difficulties, in which personal theories are put into action. Thus, peer assessment and feedback of microteaching might be useful for exploring and sharing in early teacher education.

This study involved the construction of assessment criteria as a way of negotiating and constructing collective meaning about practices for the classroom. From this perspective, the discussion allowed negotiation of meaning, and the rubric constructed per each group allowed internalization of assessment criteria as a personal parameter for reflective learning about their own practice, and perhaps, a source of internalised self-critique for future practice.

5 Conclusion

We analyzed implicit theories about explanations for the science classroom held by student teachers and described their differences. Although we are aware of the difficulties in generalizing the results, given the qualitative nature of the study, we strongly believe this is a methodological advance in terms of the use of microteaching, not only for putting theories into practice but for eliciting and challenging student teachers' deeply rooted ideas on teaching for the science classroom. The results confirm the centrality of reflection, useful for enhancing skills and teachers' thinking. Moreover, peer assessment and feedback, aided by the construction of an assessment tool such as a rubric, was shown to be useful for constructing and negotiating meaning. Reflection through peer assessment was central and the video evidence supports this, in the light of the creation of assessment criteria to assess not only their peers' but also their own strengths and weaknesses in a self-critique opportunity. This is one of the projections of the analyses conducted here. We argue that being aware of this might develop the roots of PCK during early teacher education programs, even with no real teaching experience undertaken by the student teachers.

The present research expanded the role of simulated teaching practice during teacher education, as well as enhancing the negotiation of meaning for making explicit student teachers implicit theories. The internalization of the jointly constructed achievement criteria might also enhance improvement in teaching performance, based on a reflective rather than imposed process. Future research should extend and broaden these findings.

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