Role-playing for learning to explain scientific concepts in teacher education

Juego de roles para aprender a explicar conceptos científicos en formación de profesores

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Abstract

This study explores role-playing as a method for learning to teach scientific concepts through explanation during teacher education. The participants were 38 biology and primary school science student teachers from three Chilean universities. They were involved in the simulation of teaching, playing the roles of teachers, pupils and assessors in small groups; they mutually assessed each other and implemented their explanations. Fourteen role-playing sessions were analyzed including three focus groups at the end of the experience. The explanations were analyzed in their structural and representational elements, which could involve aspects of nature and or history of science. Qualitative analysis was conducted following the processes of Grounded Theory. Results showed post explanation to be more structured and richer in resources. The participants recognized and identified their explanations as models that might change. However, they did not incorporate elements related to history or nature of science. This study concluded that although role-playing of teaching and peer assessment are useful social activities for promoting rehearsal of teaching practice - and improving some aspects of explanations - a different strategy is needed for incorporating all the elements. The implications for initial teacher education and science teaching research are discussed.

Keywords: *role-playing, explanations, student teachers*

Resumen

Este estudio exploró la metodología de juego de roles en formación inicial de profesores para aprender a explicar conceptos científicos. Participaron 38 estudiantes de pedagogía en biología y ciencias para primaria, provenientes de tres universidades chilenas. Ellos desarrollaron simulaciones de enseñanza, jugando roles de profesores, alumnos y evaluadores en pequeños grupos, se evaluaron formativamente entre pares e implementaron nuevamente sus explicaciones. Catorce sesiones de juego de roles y tres grupos focales fueron analizados. Las explicaciones fueron codificadas en sus elementos estructurales y representacionales que podían incluir aspectos relacionados con la naturaleza y/o historia de las ciencias. Se condujo un análisis cualitativo basado en la Teoría Fundada. Los resultados mostraron que las explicaciones luego del juego de roles fueron más estructuradas, ricas en recursos, y los participantes las visualizaron como modelos sujetos a cambios. Sin embargo, no incorporaron elementos relacionados con la naturaleza o historia de la ciencia. Se concluye que aunque el juego de roles en la formación de profesores es una metodología formativa útil para aprender a explicar conceptos, que apoya el ensayo y práctica de enseñanza, una estrategia diferente se requiere para incorporar dichos elementos. Implicancias para la formación docente y la enseñanza de las ciencias son discutidas.

Palabras clave*: juego de roles, explicaciones, estudiantes de pedagogía*

INTRODUCTION

There is much public discussion concerning the need to develop the quality of teacher education and knowledge based on changing their conceptions (Kember & Kwan, 2000). In this field, it has been suggested that different types of assessment should be implemented to encourage teachers to self-reflect on their teaching and adjust their practice (Borman, Mueninghoff, Cotner, & Frederick, 2009). The difficulties in the shift from the student role to the teacher role are well known (Fernandez, 2010, Jian, Odel, & Schwille, 2008), as the fact that early microteaching experiences can help student teachers to develop individually teaching competences (l'Anson, Rodrigues, & Wilson), for instance, rehearsing to teach through simulated contexts (Inoue, 2009; Lu, 2010; Ostrosky, Mouzorou, Danner, & Zaghlawan, 2013). However, identifying the reasons for their efficacy remains under-researched. In science education only a few studies have reported the development of teaching practices during teacher education based on peer assessment or feedback.

Peer collaboration has been explored as a method of developing practical skills during initial teacher education, as part of peer learning (Cabello & Topping, 2014; Lu, 2010). Peer assessment is a procedure by which students evaluate the level, value and quality of the work/performance of other students of equal status, usually incorporating feedback (Topping, 2010). Moreover, it has been noted that peer assessment encourages more participatory culture (Kollar & Fisher, 2010) whilst serving to analyze and identify good practices in teacher education (Sonmez & Can, 2010), and helping teachers with the problem of giving individual attention to members of large groups (Orlik, 2010). For some authors, peer assessment is a social process that works mainly because of the feedback received. From their viewpoint, feedback is the component that contributes most to the learning experience[1]. Nonetheless, the few studies conducted in teacher education do not offer robust evidence for this assertion, which implies the need for a profound investigation into how teaching skills are acquired during this preparation and peer learning (Koziol, Minnick and Sherman, 1996).

Otherwise, constructing concepts through explanations and models is one of the teaching practices that, when performed competently, will likely improve students learning; thus it is a central skill to develop during initial teacher education (Ball, Sleep, Boerst, & Bass, 2009). In fact, among Chilean science in-service teachers, explanations are the most commonly used strategies to illustrate concepts (Preiss, Alegría, Espinoza, Núñez, & Ponce, 2012), but with one of the lowest performance indicators in the national evaluation for in-service teachers (Gobierno de Chile, 2013).

In this study, teacher explanations are understood as a coherent unit by which the teacher connects representational devices to guide student comprehension (Geelan, 2003), including not just verbal aspects, but also non-verbal, representational and experimental elements - and the connections between the students' and the teacher's ideas (Cabello & Topping, 2014, p. 87). Teacher explanations do not necessarily contradict the inquiry views of teaching or constructivist learning theories (Geelan, 2012). In fact, Orlik (2010) asserted that one of the most important purposes of explanations is they serve teachers for choosing and representing the subject matter. Devices such as metaphors, analogies and models could stimulate new inferences and insights, and advance the conceptual understanding of phenomena (Glynn, Taasoobshirazi, & Fowler, 2007). Through examples, images or graphs students can create mental images (Ogborn, Kress, Martins, & MGillicuddy, 1996), which, as well as schemas, are useful supportive signals for their learning. Likewise, demonstrative experiments are powerful tools for learning when they are connected with students' daily life or experience (Orlik, 2010). It is also worthy explaining by addressing the common misconceptions in order to avoid these later on (Thompson & Logue, 2006). Moreover, teacher explanations express implicit messages on the nature of science (Edgington, 1997) and, explicitly, about history of science for contextualizing the ideas (Abd-El-Khalick & Lederman, 2000).

Regarding those elements, research has been centered on the explanations that students construct to demonstrate their knowledge (i.e. Camacho, 2012; Ruiz-Primo et al., 2010; Sandoval & Reiser, 2004), and not on teacher explanations. A meta-analysis by Geelan (2012) searched for the terms: science, teach and explain on the ERIC database. It resulted in 1,362 hits; but fewer than 35 of these articles were about aspects of teacher explanations, mainly analogies. Thus, the research potential in this area is clear and overlooked (Charalambous, Hill, & Ball, 2011; Geelan, 2012).

This study explored role-playing in learning to explain scientific concepts in student teachers, based on the idea that formative peer assessment might enrich their explanation elements.

1 See for example Gielen & De Wever (2012), Liu & Carless (2006), Thurlings, Vermeulen, Bastiaens, & Stijnen (2013), Van der Pol, Van den Berg, Admiraal, and Simons (2008).

METHODS

The participants were 38 student teachers from three Chilean universities during their final year of undergraduate education in the field of Biology and primary school science. They participated in fourteen sessions of simulated microteaching of scientific concepts as an intervention in which they were volunteers, playing the following roles: teacher, pupils and assessors. The sessions were recorded and transcribed verbatim.

The intervention(s) had the following format: two sessions introduced the requirements for participating in the study, so that the formative peer assessments would be carried out properly (respect, constructive criticism, etc.). The participants signed an informed consent. Furthermore, a session was dedicated to analyzing a class video to rehearse peer assessment and the feedback that a young teacher would likely receive. Subsequently, the initial role-playing and peer assessment was conducted in two sessions, where the student teachers developed microteaching episodes of scientific concepts of their choice and provided feedback to one and another. Some of the concepts chosen were; the structure of the Earth, evolution, electric charge, and the transformation of matter.

After the first round of role-playing, two sessions were held in which the participants discussed their practice models and which ones could be improved. This discussion covered some guidelines from the cognitive model for science teaching (Jorba & Sanmartí, 1996), such as the incorporation of students' misconceptions when introducing new perspectives, contextualizing the explanation, inquiry and application/transference of the concept to other fields. The participants discussed these ideas and agreed on some common points/criteria in which their explanations could improve. Following this, two sessions were dedicated to the second round of role-playing and peer assessment. During these assessments, the concepts that the participants chose for their explanations included: the Earth's movements, hormonal cycles, electrical current flow in a circuit, and atomic structure, among others. It should be noted that the participants did not have access to the rubric used by the researchers to analyze their explanations, in order to avoid a possible improvement guided only by the need to fulfill the criteria of the test, and give them the opportunity to perform based on self evaluation and the effects of peer assessment on their practice. The explanations were analyzed in three main areas; structural elements – including clarity; coherence and consistency; organization; conceptual precision; completeness; connection with students prior ideas-, elements of the nature of science - observed through the use of analogies, metaphors, simulations, experiments or models; use of examples, images or graphs mentioned as representations; use of representational gestures; treatment of students misconceptions as learning opportunities - and elements of history of science. Table 1 describes, in general terms, each criteria.

Table 1. Components examined in student teachers explanations of scientific concepts

Component	Description
Clarity	Proper use of explanatory language
Coherence and consistency	Connection between different parts that configures the explanation as a coherent unit
Organization	Structural progression of explanation
Conceptual precision	Adherence to actual scientific models and theories
Completeness	Explanation's sufficiency in terms of teaching objectives
Connection with students' ideas	Link between explanation and students' prior ideas or experiences
Use of analogies, metaphors, simulations, experiments or models	Proper application of tools to help students deconstruct the concept
Use of examples, images or graphics	Proper application of tools to help students interpret the concept
Use of representational gestures	Gestures to represent concept, intonation or inflections in voice
Treatment of students misconceptions as learning opportunities	Usage of errors in understanding of concept as source of inquiry, opportunity for learning and/or evaluation
Incorporation of history of science perspective	Usage of elements related with history of science

At the end of the experience, three focus groups were conducted to gather student teachers perceptions about the methodology. A qualitative approach was used for data analysis, following two of the coding types by the Grounded Theory: open and axial (Glaser, 2004) aided by NVivo software for ordering data (QSR, 2011). Researcher triangulation was accomplished to work towards reliability (Patton, 2001).

RESULTS AND DISCUSSION

From the participants perspective, role-playing allowed the change in their conceptions about science teaching through explanations as a consequence of reflecting on their practice; confronting the familiar theories about teaching with practice within microteaching - identifying their strengths and weaknesses. Discussing about good explanation was important for them, as mentioned in the following extract. However, a more powerful effect is envisioned if they would have known the analytical framework of the explanations, but this was avoided for the study design characteristics.

"I think the creation of criteria was fundamental. Because now I check it in my mind, and I am going to the criterion I've formulated. Because the things we learned at university, after… we do not remember it, but when you create a criteria, it is different, because you think "let's see how I taught the lesson"". (Interview 1:11)

They mentioned that playing the role of teacher and receiving feedback from peers was a key factor for changing their focus of analysis towards their practice, and, consequently, self-regulating it. This change was projected in their future real teaching and some of the participants proposed sharing the experience with student teachers in earlier years as a potential transference of learning. Other participants suggested running role-playing within their future schools, arguing that they had learned from one another in this activity and it can be also useful between colleagues.

Our analysis led to the following interpretation, feedback was not the only element encouraging changes in the participants' practice of explaining, but two psychosocial processes enhanced the changes: projection and reflection. When the participants took the role of assessors they projected their own decision-making on the peer performance and the participant performing the role of teacher reflected what the assessors would do in a similar teaching situation. Figure 1 shows an interpretative model. Each line represents an element of the model for this role-playing using assessment and feedback, organized from (a) to (h).

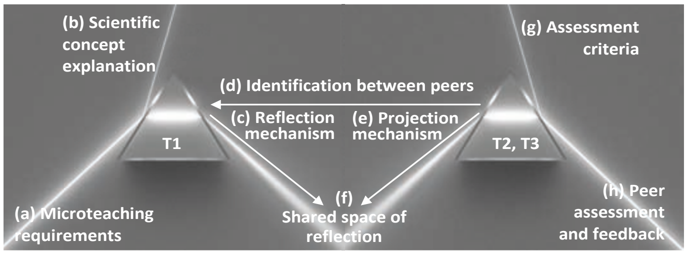

Figure 1. Model of projection and reflection mechanisms in Peer Assessment

(a) Student teacher 1 (T1) is required to simulate a microteaching episode and (b) creates an explanation of a scientific concept. The T1 prism represents T1's performance. (c) As in a mirror, reflection process operates: T1's practice, decisions and mistakes reflect what other teachers (T2, T3) would do. (d) Teachers in the assessor role (T2, T3) are identified with T1's practice because it is performed by a peer and (e) projection mechanism runs: assessors mentally project their own possible decisions and practice on the participant in the role of teacher performance. Thus, both refractions join in the middle in a shared space of reflection (f) on teaching experiences – and hence perceived possibilities and general understanding are increased. Lastly, T2 and T3 use assessment criteria (g) to base their comments on and generate peer feedback (h) about T1's performance. However, this feedback speaks not only about T1's performance, but also about T2 and T3's projection onto it and their teaching experience and expectations about what real teaching will be in the future, including the representations of the challenges that pupils will bring into the classroom.

Regarding student teacher explanations, results showed that after peer assessment, on the one hand, their explanations were more structured and contained more resources, whilst more explicitly mentioning elements related to the nature of science. This meant effectively that their explanations were clearer in terms of language and also more accurate in terms of scientific terminology. Moreover, the participants pointed out their explanations as models that might change. The explanations were more connected with simulated pupils' ideas and experiences, and contained more analogies, metaphors and demonstrations after role playing and peer assessment, which are powerful representational elements for learning (Ogborn, Kress, Martins, & MGillicuddy, 1996; Glynn, Taasoobshirazi, & Fowler, 2007). No variation was found in the explanations coherence, consistency, organization and completeness because they were already well developed. Otherwise, considering students misconceptions as an opportunity for learning and incorporating elements related to the history of science showed the lowest performance and almost no improvements. These elements were orientations in the science teaching courses, thus, an improvement was expected as in the other ones. The participants mentioned that changes in their initial teacher education curriculum must be made, such as including workshops about history of scientists and their discoveries or simulated lessons with real pupils and their ideas. This fact revealed that although role-playing of teaching could be a useful social activity for promoting rehearsal of the explaining practice, improving explanation resources for connecting the concepts with teaching the history of science as well as using misconceptions for learning need a different strategy. These are relevant for good teaching (Abd-El-Khalick, & Lederman, 2000, Thompson & Logue, 2006), because they illustrate science as a human and dynamic construction, open to reformulations, and increase students' motivation for learning it in spite of possible mistakes. Actually, taking misconceptions as a source of learning might promote students' perseverance, viewing how knowledge is constructed.

Finally, regarding peer feedback and assessment; Van der Pol, Van den Berg, Admiraal, and Simons (2008) and Gielen & De Wever (2012), argued that effective peer feedback depends on the skill of the assessor in giving feedback. The present research supports this. Significant learning would be achieved not only as a consequence of the assessor skills when giving feedback, but also in the internalization and enactment of the assessment criteria. This process is crucial for self-regulated learning and for teaching science in daily life. This means that in effect the design of assessment criteria in teacher education for peer assessment and feedback would contribute to teachers developing an internalized self-assessment tool; through assessing and giving feedback to others they can become their own assessors at the moment of teaching in schools, taking decisions to improve their performance moved by their own self-criticism.

Some authors have stated that peer feedback provides the most important learning component of peer assessment (Liu & Carless, 2006; Thurlings, Vermeulen, Bastiaens, & Stijnen, 2013). However, the present research showed that discussing assessment criteria and its application in providing peer feedback was the crucial element in the contribution to the further internalization of criteria and generalization of behaviors into the teaching context, more so than receiving feedback. In other words, peer feedback might be the engine of student teacher improvements, nonetheless, the internalization of assessment criteria - designed for peer feedback - perhaps is the crucial element for promoting improvement in reciprocal role-playing.

CONCLUSIONS

In the field of changing teacher thoughts and perceptions, one of the missing elements was the potential role of peers. In this argument, although the importance of collaborative learning is clear (Orlik, 2010), the available studies in peer assessment do not offer a conceptualization of the restructuring process itself or what roles the peer assessment elements performed. The present research proposed a model based on reflection and projection mechanisms and several other factors described by the participants. The research reveals the current gap in knowledge about the conditions that make this process effective in teacher education. Nevertheless, as this study did not involve typical experimental control and test groups, it is not possible to establish causality, which might be considered a limitation. Even so, the results added new elements to the comprehension of student teachers thoughts and practice.

This study revealed that role-playing and peer assessment of teaching are useful for promoting not only rehearsal of teaching practice, but also eliciting student teachers expectations of the challenges they will face as teachers. This rehearsing to teach might help student teachers becoming reflective practitioners through discussing, projecting and reflecting their performance with peers. In this study, discussions resulted in productive inputs, which might have led to an individual revising their particular form of practice by recognizing and pointing out their explanations as models, which enriches the ideas of l'Anson, Rodrigues, & Wilson (2003) on this.

Otherwise, role-playing as a social process facilitated the negotiation of meaning (Clarke, 2002) and internalization of assessment criteria, which is crucial when promoting understanding and enactment of high quality performance in the transition into real teaching (Stiggings, 1991). In this study, role-playing promoted regulation of learning between student teachers and changes in student teacher conceptions about teaching. This is relevant because changes in the quality of teaching are unlikely to happen without changes to teacher conceptions (Kember & Kwan, 2000).

The broad scope of this research has implications for practice beyond the context of the Chilean teacher education. This study outlines methodologies that consider the educational power of peers, which distributes responsibility of teaching-learning among the learners themselves. This can help not only student teachers, but also in-service teachers to assume a more professional role in their teaching and a sense of ownership of their learning, through constructing criteria to peer and self-assess their work. Likewise, the explanation elements that are easier and more difficult to change are a point of consideration for stakeholders in teacher education for directing resources and time, offering curriculum emphasis such as in history of science.

In terms of immediate further research, this study suggests investigating different effects of peer feedback combined with other techniques derived from the critical analysis of teacher practice in weak areas, like incorporating an historical perspective in science teaching. For instance, comparing groups that receive peer feedback with others that have peer *and* tutor feedback would be relevant to understand development of teachers' conceptions and practice. This possibility is an open gate for new researchers.

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Factors influencing the adoption of ICT by universities from the technological infrastructure dimension

Factores que influyen en la adopción de las TIC por parte de las universidades desde la dimensión tecnológica

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Abstract

Given the need for the Higher Education Institutions (HEI) to adopt, adapt and appropriate the Information and Communication Technology (ICT) to transform their process of teaching – learning, this study was conducted to identify the factors that influence this process, from the technological dimension. For the study it was necessary to perform a conceptual theoretical review of the past 10 years based on various literature sources. The results show a better theoretical understanding of the elements from this dimension that must be taken into account when incorporating ICT by the HEI. The factors found are related to: Personnel, Infrastructure and Strategic Management. These, in turn, are divided into sub-factors. The first group consists of: ICT management (technical support) and users support and competency (teacher training). The second group consists of: hardware, software and networks. Finally, the third and final factor is composed of: technological prevention and technological improvement.

***Key words** - factors, ICT appropriation, university, education, technological infrastructure.*

Resumen

Dada la necesidad que tienen las Instituciones de Educación Superior (IES) de adoptar, adaptar y apropiarse de las Tecnologías de Información y Comunicación (TIC) para transformar sus procesos de enseñanza – aprendizaje, se realizó este estudio a fin de identificar los factores que influyen en este proceso, desde la dimensión tecnológica. Para el estudio fue necesario realizar una revisión teórica conceptual de los últimos 10 años, basándose en diversas fuentes bibliográficas. Los resultados encontrados evidencian una mejor comprensión teórica de los elementos que, desde esta dimensión, deben tenerse en cuenta al momento de incorporar las TIC por parte de las IES. Los factores encontrados se refieren a: Personal, Infraestructura y Gestión Estratégica. Estos a su vez se dividen en sub-factores: el primer grupo se compone de Gestión de TIC (soporte técnico), usuarios y alfabetización (formación docente). El segundo grupo se compone de: hardware, software y redes. Finalmente el tercer y último factor se compone de prevención tecnológica y mejoramiento tecnológico.

***Palabras clave:** factores, apropiación TIC, universidad, educación, infraestructura tecnológica.*

INTRODUCTION

The exponential growth of ICT has created new and unimaginable opportunities and educational alternatives that provide ubiquitous features and continuous accessibility and flexibility of interactivity to the learning, allowing in turn improving the teaching - learning process. These potentials and qualities are recognized by the international community (Sandia Saldivia, 2015). However, the responsiveness of Higher Education Institutions (HEIs) and flexibility against the momentous changes is a complex problem, because the challenge goes far beyond the simple addition of technologies. This represents a redefinition,