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Evolution of Knowledge of Future Primary Teachers: an Education Proposal using Inquiry-Based Science

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Abstract

The research presented is part of an R&D+i project entitled "The progression of prospective primary teachers' didactic knowledge in a research-based course and in interaction with innovative science teaching"* carried out in three Spanish universities. For this course, a set of educational resources was elaborated and presented as a workbook which outlines the different elements that must be taken into account to create a proposal for classroom teaching – what to teach, the pupils' ideas, how to teach, and what, how, and when to evaluate. This workbook is supplemented with various materials, including as a new resource the viewing and analysis of videos on innovative educational practices in primary education. To study the evolution of the prospective teachers' views regarding science teaching and learning, their production during the course will be analysed, and a Likert-scale questionnaire will be applied before and after the course.

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*Keywords:*Teacher training, teachers' conceptions, inquiry-based science education, video;

1. Introduction

There is a broad consensus among researchers on the need to design, implement, and evaluate training strategies in which prospective teachers learn to question their approaches towards fundamental curriculum issues (what to teach and why, what to do with the ideas that pupils have, which tasks to start on in the classroom, how to track the evolution of pupils' learning, etc.). These actions should initiate solidly founded changes in our students' vision of science education, leading to a didactic knowledge base that is coherent with school inquiry-based approaches (Abell, 2007).

In this regard, we have for some time been working in our initial training classrooms with resources that have this orientation (Azcárate, 2000; Martín del Pozo, 2000; Rivero, 2000). They have allowed us to detect a certain progression in the approaches of our prospective teachers – from teaching that is teacher-centred to one that is more pupil-centred, but not really reaching one that is based on school research. The specific results we have obtained

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indicate that, while some obstacles have been overcome, there remain others (Porlán et al., 2010, 2011; Martín del Pozo, Porlán & Rivero, 2011; Rivero et al., 2011). One cannot forget that the only direct practical referents our student teachers have come from the experiences they themselves have lived as pupils. Even unwittingly, they design and develop their teaching proposals on these personal experiences. We believe, therefore, it to be imperative that prospective teachers should be able to analyse innovative teaching practices, and thereby contrast their own vision with others about which generally they only receive theoretical information. This approach, based on experience and its reflexive analysis, seems a very promising form of fostering authentic professional development.

Given this context, we have designed a teacher education resource that promotes educational processes which are consistent with constructivist teacher training models based on professional research into relevant curricular issues, and on the interaction with innovative teaching practices.

2. Method

The objective is to analyse the change in the didactic knowledge of prospective teachers about school-research-based science education. To this end, we split the study into two parts – one quantitative and the other qualitative. In the quantitative study, we designed and validated by expert judgement a 6-value Likert-type questionnaire to be completed by the students both before starting the course and once they had completed it (Rivero et al., 2012). In the qualitative study, the main instruments we shall use are the documents that the prospective teachers must elaborate during the course. We shall also use interviews with which we intend to complement and better understand the progression of the prospective teachers' knowledge and their assessment of the activities they have carried out. Furthermore, each of the instructors will maintain a diary with the information relevant to the course.

The sample of this research consists of prospective primary teachers of classes developed over the course of one semester. Specifically, the course is taught in two classrooms at the University of Seville and two at the Complutense University of Madrid, all in the 2nd year of the degree course, and before carrying out teaching practices in primary schools. For the qualitative study, the source of information is constituted by the materials generated by the student-organized research teams. Table 1 presents the phases of the research.

Table 1. Phases of the research

	First semester	Second semester
2011-2012	Phase I: Course design and other instruments	Phase II: Implementation and data collection
2012-2013	Phase II: Implementation of the rest of the course and data collection	Phase III: Data analysis and results
2013-2014	Phase III: Data analysis and results	Phase IV: Re-elaboration of the course and final report

2.1. A teacher education resource for learning to teach science: Workbook

The teacher-training resource that structures the course is a workbook which we have entitled "Learning to teach science through school research" (Martin del Pozo et al., 2012; Rivero et al., 2012). The research team designed this workbook based on the results of previous educational research projects on professional knowledge and initial primary teacher training in the area of Experimental Sciences.[†]

It has been validated by six experts in the field by means of a discussion session in which they were asked to value both the formative aspects (how coherent the workbook was with the principles of research on practical

[†] "*Diseño y producción de recursos formativos a partir de prácticas profesionales innovadoras*" (Universidad Complutense de Madrid, PIMCD 2006/2008-445).
"*Producción de recursos audiovisuales para la formación inicial de maestros sobre la enseñanza por Proyectos en la Educación Primaria"* (Universidad Complutense de Madrid, PIMCD 2009/2010-81).
"*Elaboración de recursos audiovisuales para la formación del profesorado*" (Universidad de Sevilla, PIMD 2010/11-136).

professional problems, on socio-constructivism, and on interaction with innovative experiences) and its capacity as a research tool (the extent to which research can be conducted on the basis of the students' productions using the workbook – in particular, considering the progression of the students' didactic knowledge and the definition of their Itineraries of Progression, together with the ideas that either hinder or facilitate that progression).

The workbook proposes the investigation of four professional issues related to the school curriculum:

1. School content (selection criteria, types of content, organization, and presentation to pupils).
2. Ideas of the pupils (nature of their ideas, change, and educational use).
3. Teaching methodology (types, concept and sense of the activities, and sequencing criteria).
4. Evaluation (sense, criteria, and instruments).

The working summary, complemented with the use of different types of documents (legislation, textbooks, the students' own documents, etc.), is as follows:

Table 2: Working proposal

Initial activity. Presentation of the work proposal and choice of content of the area of environmental knowledge.
Activity 1. Elaboration of the first version of the proposal to teach some given content ofthe area of environmental knowledge.
Activity 2. Analysis by teams of the first version of the proposal.
Activity 3. What to teach?
Activity 4. How to teach?
Activity 5. Do you have to take the pupils' ideas into account in order to teach? How to do so?
Activity 6. Evaluating the pupils – why, what, and how?
Activity 7. Second version of the teaching proposal.
Activity 8. The practice of school research.
Activity 9. Third version of the teaching proposal.
Final activity. Comparison of the first version with the third.

2.2 Contrast with innovative teaching practices, and using educational videos

After the initial work of reflection and analysis, there will be the task of contrasting this with the overall reality of the classroom. To this end, a set of videos will be shown (Ezquerra et al., 2010a, 2010b; Ezquerra et al., 2012) which illustrate the reality of school inquiry-based science teaching. These documents will be discussed, and a final version of the teaching proposal will be elaborated (Activity 9). We presume that this will promote the progression of the prospective teachers' didactic knowledge (Rodríguez et al., 2012).

However, the creation of audiovisual materials in teacher education is not a widespread practice (Pro & Ezquerra, 2008), and indeed very few have been prepared with a specific educational purpose. The process of creation and design of educational videos is quite complex as it depends simultaneously on creative and technical aspects (Ezquerra & Polo, 2011). First, schools must be selected that have innovative teaching projects and school inquiry-based science education. And second, the recording process has to be planned, involving the combination of the classes with the requirements of recording (position of cameras, cables, power supplies, lighting, etc.). These factors may distort the natural development of the class.

The next step is to create an audiovisual script. For this purpose, it is convenient to bear in mind that an audiovisual document is not a register of reality. In it, one decides what to show and how. In writing the script we make an audiovisual transposition of educational content (Ezquerra, 2010) into the language of film of what we see in a class. Finally, one does the montage sequences of the videos. This involves knowing how to use a video editor, having a sufficiently powerful computer, etc.

3. Analysis

In the quantitative study, the information obtained will be checked, coded, digitized, and analysed using the SPSS statistics program package. In the qualitative study, the data will be processed according to the techniques of content analysis (Bardin, 1986). This requires the identification of relevant information units in each source of information

and their subsequent classification, whenever possible, into either pre-determined categories, or into newly created categories or subcategories. Both the categorization of the information units and the elaboration of the proposals of synthesis will be validated by means of triangulation processes. The initial category system (which may be reformulated during the development of the work) is as follows:

Table 3. Category system.

1. School content	1.1. Design/presentation of the content 1.2. Content selection 1.3. Content types
2. Pupils' ideas	2.1. Nature of pupils' ideas 2.2. Changing pupils' ideas 2.3. Using pupils' ideas
3. Teaching methodology	3.1. The sense of activities 3.2. Types of activities 3.3. Methodological sequence
4. Evaluation	4.1 The sense of evaluation 4.2. Evaluation criteria 4.3. Evaluation instruments

4. Conclusion

With this research we hope to provide evidence on how to produce significant progress in prospective primary teachers' didactic knowledge when one works using resources based on inquiry into relevant professional problems and on interaction with innovative teaching practice. Furthermore, we aim to contribute to the development of resources and techniques for teacher education research, especially regarding the analysis of prospective teachers' production and the determination of the Itineraries of Progression that can act as hypotheses for future studies.

The work done so far has shown the richness in the opportunities offered by the creation of classroom videos. The details that need to be considered in their creation include the aspects that should be selected from the classroom activities, and the relative weights to give to the pupils' verbal and non-verbal communication, in particular, their gestures, silences, and facial expressions in the different classroom situations.

The present research is targeted at benefiting the training of primary teachers and, above all, at the relationship with primary schools. One expected benefit is the creation of new training resources (the prospective teacher's workbook and the classroom videos) which, in this case, are focused on school-research-based science teaching.

The work done so far has shown us the potential of the teacher training opportunities offered by the elaboration of classroom videos. We believe that the use of these videos will enrich the prospective teachers' teaching proposals. It will allow them to compare their ideas with real practice, and then to reflect on and analyse that comparison. Moreover, exercises with images captured from the videos will encourage their participation free from the corseting of academic discourse (Ezquerra, 2004, 2008). However, one will have to bear in mind that even a single image, and more so a sequence of images, shows so much information that it can distract or hinder the assimilation of the information that is really relevant. What the individual usually does is select only what is important to them (Soler, 2002). In other words: "In the perception we see a confirmation of reality, and at the same time of ourselves" (Doelker, 1982). Therefore, trying to determine which aspects are most attractive to our students might be an interesting starting point from which to attempt to discover what they see and what goes unnoticed, what is important to them and what is ignored, on what to insist, and how to provide them with tools with which to analyse the reality of the classroom.

We also intend to try to improve the quality of our own actions as teacher trainers using these resources, the aim being to foster the development of our prospective teachers' knowledge about teaching. Furthermore, the fact of having worked together with the primary schools is a reflection of the growing interest in collaboration between

different fields and institutions in education (academic and vocational) to improve science education for primary pupils, an approach endorsed by the European Higher Education Area.

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