MODELS AND MODELLING AS A TRAINING CONTEXT: WHAT ARE PRE-SERVICE TEACHERS’ PERCEPTIONS?

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In this research, we aim to know pre-service teachers’ perceptions about a training program on models and modelling in which they participated. Using a semi-open questionnaire, we analyzed the opinion of 70 PTs about the course and about their future teaching of science. Results show that PTs highly value modelling activities as useful to learn science but suggest other tasks are also necessary to construct their scientific knowledge, which makes us rethink our instructional modelling cycle. PTs are aware of the methodological approach used in the training context and most of them state they would teach this way in the future. Nevertheless, they also mention the big challenges of this methodology and suggest to combine modelling with other approaches to teaching and learning, such as context-based or inquiry-based.

Keywords: modelling, pre-service teachers, perceptions

INTRODUCTION

Viewing science learning as participation in the practice of science is a framework gaining momentum in both the science education research literature and recent policy documents (NRC 2007). Scientific practices can be considered discursive, cognitive and social activities to be carried out in the science classroom (Osborne 2014). The introduction of scientific practices in the science classroom can be justified in terms of both learning potential (Lave & Wenger, 1991) and epistemic adequacy (Osborne, 2014) but unfortunately, these school scientific practices are not taking place in schools, where it prevails a focus on the products rather than the processes of science (Duschl and Grandy 2008). For teachers to be able to involve their pupils in scientific practices, they should first be able to engage themselves in such practices actively and adequately (Davis 2003). However, this new framework poses great challenges to PTs and it demands well-designed teacher education courses (Reiser 2013). This research aims to contribute in this sense, by designing an initial training course for primary school teachers and investigating its results.

The focus of the course is on the scientific practice of modelling because we aim to put pre-service teachers in the situation of building themselves ‘adequate enough’ explanations of how the world works, in other words, to construct School-based Scientific Models (SSM). By these SSM we understand a small number of big or core ideas (Harlen, 2010; NRC, 2012) that have the potential to explain a lot of different phenomena (Izquierdo-Aymerich & Adúriz-Bravo, 2003), such as the particle model of matter.

The teaching scenarios that provide opportunities for PTs to engage fruitfully in modelling practices to learn the aforementioned SSM are those that promote interaction within a classroom culture that motivates them to ‘figure things out’ (Reiser 2013). A plausible context is that of small-group laboratory-based discussions where the need for an explanation arises from work on phenomena that can be interpreted with key scientific models. To organize the teaching, we defined and used an instructional modelling cycle (Garrido Espeja, 2016) based on previous literature on model-based instruction and consisting of 6 phases: M1-Recognising the need of a model, M2-Expressing initial model, M3-Evaluating the model, M4-Revising the model, M5-Expressing a consensus model, M6-Applying the model.

The course is called Didactics of Science and is done in the third year of the primary school teacher education degree in Catalonia, Spain. It is compulsory and divided into 12 lecture and seminar sessions during one trimester. In a previous research (Garrido Espeja, 2016) we identified that, by participating in the course, PTs were able to engage in sophisticated modelling patterns (continuously evaluating and revising their models) and also to improve their versions of the models (achieving adequate versions of the SSM by the end of the course). In this paper we now analyze PTs’ opinions about this training context, aiming to know: 1) Do PTs value modelling as useful for learning science? 2) Do they recognize the methodological approach used in the training course? and 3) Would they use the same approach in their future teaching?
METHODOLOGY

To identify PTs’ perceptions about the course, we designed and piloted a semi-open questionnaire. The final version of the questionnaire was given to all PTs in the last session of the course of 2015-16 school year. The data collected and analyzed corresponds to the responses given by 70 PTs. Each PT was given a unique code for the analysis, according to its group in the course (i.e. A21, A22, A23...). The questionnaire had 3 main questions and some information that, due to the limited space of the proposal we synthesize in Table 1.

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<tr>
<th>Questions included in the questionnaire</th>
<th>Information given in the questionnaire</th>
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<tr>
<td>1. Which tasks in the course have helped you learn science the most?</td>
<td>None (Open question).</td>
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<td>2. From the list of 12 tasks, choose those 5 tasks that have helped you the most learning science. Explain why.</td>
<td>A list of 12 type of tasks already done in the training course: - 6 tasks regarding the 6 phases of the modelling cycle (i.e. Review and change my explanation after having discussed it with my peers) - 6 other type of tasks, not necessarily characteristic of modelling (i.e. Doing experiments in the lab in an autonomous way)</td>
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<td>3. Read the 3 teaching proposals and: a. Say which one is more similar to what we have done in the course and explain this way of teaching science, b. Say which one you would do as a future teacher and explain why.</td>
<td>Three hypothetical teaching proposals for primary-school: - Proposal 1: Hands-on inquiry proposal - Proposal 2: Modelling-based proposal - Proposal 3: Context and community-based proposal</td>
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The PTs’ answers were analyzed bottom-up, creating and iteratively modifying the categories based on the analyzed data and on the modelling theoretical framework already mentioned.

RESULTS

In their open answers, PTs mention basically two types of tasks to be useful for learning science: practical experiments, to see phenomena first hand (i.e. “I could see it with my own eyes” A55), and modelling activities, to build knowledge (i.e. “To imagine how phenomena works, do the experiment and find an explanation; then share with peers and rethink my ideas. This way we build our knowledge all together” A14). Our results also show that most modelling activities were highly valued by PTs (by more than half of the group), yet not all of them equally (Figure 1). Other type of tasks were also important to most PTs, such as “do experiments in the lab” (86%) or “have the key ideas written” (60%).

Figure 1. Tasks that have been chosen by PTs as useful to learn science (In green: modelling activities. In blue: other tasks).

When analyzing PTs’ reasons for choosing modelling activities from the list, many of them recognize the minds-on nature of these tasks, while others highlight the importance of these tasks for being aware of their learning, that is, for meta-modelling (“I realized whether I didn’t understand the ideas or I was on the right path” C41). On the other hand, the reasons PTs give for valuing the task of “experimenting in the lab”
reflect the current debate on inquiry in the science education community: the value of direct observation and the opportunity for theory construction. Regarding the reasons for choosing the task “having the key ideas written in the end”, PTs express how crucial this is to organize their learning and know which are the most important ideas to be learnt (“It helps me clarify the fundamental ideas of the lesson” A52).

When asking PTs which proposal is similar to the approach used in the training course, 100% identify the correct one (prop. 2). What’s more, most of them describe the methodological approach in agreement with the modelling cycle actually used (“We start drawing our first ideas and making predictions. Then we experiment, explain the process, and finally we build a conclusion with the group.” B11). From all PTs, more than 80% would use this approach in their future classes, whether alone (53%) or combined with other ones (30%), because they see it useful for constructing scientific models and motivating students. However, some of them expressed this is a big challenge (“Right now I don’t feel capable enough to teach this way; I wouldn’t know how to solve doubts or guide my students to work on their own” A16). When choosing other proposals, PTs give importance to active participation of students when experimenting (prop. 1) and to real contextualization and community implication (prop. 3), crucial elements that shouldn’t be forgotten.

CONCLUSIONS

To sum up, PTs do appreciate modelling activities as useful for learning science, although they also place important value to other tasks that are not necessarily about modelling. These results suggest that we can revisit our modelling cycle and introduce some improvements. Perhaps the initial phases of the cycle can be more packed, whereas the evaluation of the model should be given a stronger empirical emphasis and in the end, PTs need to be sure of what they have learnt. If we want to promote a discursive modelling approach, in which the construction of key scientific models is crucial, it is important that, in the end, we share in expert words what “science” says about the phenomena students have been modelling with.

Finally, the approach used in the training, based on modelling and models, was easily identified by PTs, even though no explicit reflection was done during the course. This shows how important it is to experience firsthand the methodologies that PTs are expected to later apply in their future teaching practice. However, we still need to know if they would be able to include modelling practices in their actual teaching. Although most of them declare they will teach this way, they also confess how challenging this methodology is for them, which should make us think of new ways to help them overcome these challenges.

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