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Y DESPUÉS DE PISA, ¿QUÉ? PROPUESTAS PARA DESARROLLAR LA COMPETENCIA CIENTÍFICA EN EL AULA DE CIENCIAS DE PROFESORES EN EJERCICIO Y FUTUROS PROFESORES DE CIENCIAS

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Resumen

PISA has evidenced that, despite pupils' scientific competence is the main goal of Science Education, this goal is not met. Previous research suggest that one of the reasons is in-service teachers' conceptual difficulties regarding the competency framework. This is particularly the case for the sub-competence "Using Scientific Evidence". In this research, we address this problem for both in and pre-service teachers by proposing a new mentor-mentee model that focus on the use of this competence in the Science classroom. First results indicate that, despite shortcomings of the initial tasks, understandings of the competency framework have improved. The analysis also offers an instrument for the analysis of the quality (regarding argumentation, data, contextualisation and view of NOS) of teaching tasks to develop the competence.

Theoretical framework

Scientific competence has different definitions, all of them involving Scientific Knowledge but making clear the need to move beyond *having* towards *being able to use* knowledge. A well-known framework for the definition of scientific competence is the one used by the PISA study for assessing scientific literacy (Fensham 2007). In this model, scientific literacy is characterised as consisting of four interrelated aspects: Context, Knowledge (*of* and *about* Science), Attitudes and Competencies. Within the PISA 2006 framework, scientific competence implies to be able to: Identify scientific issues; Explain phenomena scientifically; and

Use scientific evidence.

In Spain, as in many other countries, students' results to PISA have not been satisfactory. One of the reasons that has been argued are the challenging distance between the described "scientific competencies" that PISA assessment tasks demand from students and the sort of competences the students are demanded, and thus able to develop, in the average Science classroom. This has lead to recent changes in the national curriculum (2007), which has become standard-based and focused in the idea of teaching and learning for the achievement of basic competences, including scientific competence. For its definition, the curriculum document is inspired in PISA 2003 definition. Despite the difficulties foreseen for such a curriculum change, in-service teachers who are now implementing this new "competence-based" curriculum have not received any special support.

In our context, the lack of teachers' professional development on this "competency framework" has shown particularly problematic regarding one of the aforementioned sub-competencies: "Using scientific evidence". A research study of one of the authors (Pintó & El-Boudamoussi, *in press)* showed that most Spanish in-service and long experienced teachers do not recognise when this competence is being assessed in PISA tasks, neither do they understand what knowledge *about* Science would students' need to solve them. According to teachers, students' solving a PISA task that assess an aspect of the competence "Using scientific evidence" (such as assessing the interpretation of scientific evidence to make conclusions; identifying assumptions, evidence and reasoning behind given conclusions; or reflecting on the social implications of science and technological developments) within a particular Science context (for instance, the case of a bacteria), need mainly factual and conceptual knowledge about biology (about bacteria) instead of knowledge *about* science (how to make conclusions, evaluate evidence, identify reasoning, etc). In this sense, we focus on the competence "Using scientific evidence" for our work with teachers and student teachers.

In this sense, we have involved a group of in-service teachers of Physics and Chemistry in an international project (GIMMS) that uses a mentoring model of *critical co-enquiry* among mentors (Wang and Odell 2007) supported by Science Education researchers, and also notions of co-learning between mentors and mentees. The idea is to address the recognised difficulty of the use of the "competency framework" in the Science classroom teaching student' teachers this framework in their university training; discussing and inquiring this framework with mentor teachers, and supporting the work between mentors and mentees about this framework in the *practicum* setting, so that they can learn from each other within this challenging scenario.

Methods

Student teachers (n=50) have been introduced to the framework of teaching for the achievement of scientific competence and have worked around the competence "Using scientific evidence" in their theoretical course with university researchers (the authors), developing teaching tasks for students to achieve the competence of "using scientific data". Teacher mentors (n=34) have participated in a series of seminars and collaborative discussions for the introduction of the same competence, also elaborating examples of teaching tasks. Finally, both mentor teachers and mentees were asked to develop together, as part of the *practicum* training, a teaching unit including an activity focused on the development of the mentioned competence. The analysis of data includes analysis of the different teaching tasks developed in the process and also the analysis of students and teachers' semi-open questionnaires.

Analysis of teaching tasks. The aforementioned teaching tasks are analysed regarding the level of depth at which the competence "Using scientific evidence" is taught/dealt with in the classroom. This analysis is done regarding different dimensions of the analysed competence. The instrument of analysis is based on previous works on argumentation in the classroom (Osborne et al. 04), quality of scientific evidence (Gott et al,) and ideas on the nature of science based on constructivist and cognitive notions, among others.

Design of questionnaires. Mentor teachers fill a questionnaire that asks them aspects of their own understanding of the competence, their use in their classroom (in their normal teaching), and also the use by their student' teachers in their classroom (in the practicum sessions). Student teachers fill a similar questionnaire regarding the same issues. The intention is to evaluate to which extend, by using the new mentoring model, both student teachers and mentors have improved their understanding and use of the competence in their teaching and how, according to them, the different interactions within the *communities* involved (mentors, mentees, researchers) foster and support their learning and development regarding the mastering of the competence in classroom.

Results and Conclusions

Our initial analysis of teachers' and student teachers' initial tasks shows that for both it is demanding to design teaching materials to promote the achievement of the competence "Using scientific evidence" in the classroom. Some of the designed tasks include activities that do not analyse the competence, just demanding factual scientific knowledge. This is the case more for in-service teachers than student teacher: the former seem to perceive the tasks as "incomplete" without a central focus on knowledge of Science. Most of the developed tasks refer to the sub-competence "drawing conclusions from evidence", very few of them addressing issues of experimental design. Regarding knowledge about Science, quality of socio-scientific contexts and quality of data, tasks by student teachers were more contextualised in richer scenarios and reflected a more appropriate view of the nature of Science and more realistic data sources and data than those of their mentors. This could be related with the fact that these pre-service teachers have more recent experiences with scientific inquiry: some students used examples based on their own research projects within the Science faculty. Regarding level of argumentation and quality of evidence in contexts with multiple sources of evidence available, both were quite poor. In general, both teacher and student teachers' tasks lack enough scaffolding for pupils, showing perhaps a problematic influence from PISA tasks which are designed to assess but not to develop scientific competence in the classroom. Despite these results are not satisfactory enough, they show improvements regarding teachers' and students' understanding on the competence when compared with previous results (Pintó et al).

At this moment, teachers and students' final tasks have been used in the classrooms and are being analysed and compared with initial ones. Teachers' and students' answers to questionnaires, which helped us in the interpretation of previous results, are also being analysed. In the conference we will provide final results regarding the type and quality of teachers and student teachers' tasks, and also on the influence of the new mentoring model and the diverse learning interactions proposed. As implications, we will revise our mentor-mentee-researchers model accordingly.

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