Ariza, M. R.; Quesada, A.; Abril, A. M.; García, F.J.

Science teacher training through an IBL experience

inhaltlich überarbeitete Version der Originalveröffentlichung in:
content revised edition of the original source in:
Bruguière, C. [Hrsg.]; Tiberghien, A. [Hrsg.]; Clément, P. [Hrsg.]: E-Book Proceedings of the ESERA 2011 Conference: Science learning and Citizenship. Lyon, France : European Science Education Research Association 2012, S. 1-6

urn:nbn:de:0111-opus-72159

SCIENCE TEACHER TRAINING THROUGH AN IBL EXPERIENCE

Ariza, M.R., Quesada, A., Abril, A.M., García, F.J.
Department of Didactic of Sciences. University of Jaén

Abstract: Educational research has revealed that inquiry-based learning (IBL) methodologies facilitate science understanding and the development of scientific competences, offering strategies to overcome academic failure and to ensure students' scientific literacy. A review of the Spanish projects with a focus on science education carried out in the last twenty years, shows very few initiatives explicitly based on the application of IBL approaches, pointing out a potential way to improve science learning. In the present paper, we describe a work aimed at promoting IBL methodologies among teachers. The main purpose is to make prospective teachers aware of the benefits associated with this kind of pedagogies, through offering them the opportunity to live an IBL experience and to reflect on practice.

Keywords: Science education, science learning, scientific process skills, IBL, teacher training.

INTRODUCTION: BACKGROUND AND RATIONALE

The implementation of the "Lisbon Strategy" and the subsequent "Education and Training 2010 work program" are causing many changes in most of the European educational systems. The report "Educational system and human capital" published by the Spanish Economic and Social Council1 in 2009, claims that "the high percentage of students' failure is connected with internal factors like the use of teaching methodologies with few practical applications of knowledge and the limited pedagogical training of teachers...". As a consequence experts have suggested that a reflection about current pedagogical models, which are mainly based on lecturing and involve very little knowledge transfer, should be made, prompting the evolution towards new teaching methods.

IBL in Science Education

The current educational research along with the publication of several national reports, reveal the necessity to look for new approaches to science and mathematical education. There is a great deal of evidence showing not only a lack of students' motivation towards science and mathematics (Rocard, 2007), but also that science learning often becomes a "transitory experience with little application to future thought and action" in students' lives (National Research Council, 2000: 121).

With respect to the learning of mathematical and scientific knowledge, it is usually obstructed by inadequate students' preconceptions about natural phenomena, by the

[1] The Spanish Economic and Social Council, made up of employees' organizations, trade unions and other representatives of public interests, is a government advisory body, which means that its voice is heard in decision-making affecting the various sectors of Spanish society. The Spanish ESC studies and analyzes issues of concern to our society on its own initiative. Its annual memorandum has become an essential point of reference for understanding Spain's development and socioeconomic situation.

lack of significant instructional contexts to promote situated and transferable learning and by the abstract nature of many scientific theories and models (Ariza and Quesada, 2010). As a consequence of this lack of coherence between students' prior ideas and theories, research has repeatedly shown that students learn normative knowledge in a superficial way, just to face or deal with school activities and exams. However, they are unable to apply scientific theories to explain real world phenomena, and their preconceptions persist after years of instruction (Franco and Taber, 2008; Taber, 2002).

Meaningful acquisition of scientific theories is promoted through active, collaborative, and inquiry-based learning (IBL), in authentic contexts. According to the National Research Council (2000), inquiry-based teaching may be understood as the experiences that help students acquire concepts of science, skills and abilities of scientific inquiry, and understanding about scientific inquiry. The American National Science Education Standards describe inquiry in education as "a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in the light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations and predictions; and communicating results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations". (p. 23)

IBL in the Spanish context

In Spain there is a high amount of didactic projects to improve mathematics and science learning. An analysis of the theoretical backgrounds underlying these projects shows a predominance of constructivist claims. Nevertheless, though not explicitly embraced, the IBL paradigm is somehow present in some of the pedagogical features guiding these approaches. One of the very few initiatives explicitly mentioning the use of Problem Based Learning (PBL) and IBL, is that carried out by Bárcena and Ibáñez[2] (1991-2001) or by Sierra[3] (2004). However, it must be said that although these projects led to interesting learning experiences or resulted in valuable pedagogical materials, they might be considered as isolated initiatives carried out in a limited time spam, with no continuity, or with none or very little impact on the national context.

IBL for teacher education

Research on effective learning and learning environments has proved that IBL methodological approaches foster inquiring minds and scientific attitudes in students. However, although inquiry promotes deeper science and mathematics understanding teachers may find obstacles planning and applying this methodology successfully (Olson and Loucks-Horsley, 2000). Furthermore, in Spain, there is a lack of explicit training on IBL methodologies in teacher initial education, both for primary and secondary schools. Thus, for in service teachers the implementation of inquiry learning in classrooms entails a number of significant challenges. Teacher education institutions are expected to provide opportunities for teachers to develop not only knowledge and skills as future educators, but also a good and a deep understanding of learning processes and approaches to create better learning environments for their students.

---

[2] Bárcena, A.I., Ibánez, M.T. (2001). Estudio de la influencia en el aprendizaje de los alumnos de educación secundaria de una metodología de investigación para la resolución de problemas: aplicación para la enseñanza de la química y la biología. Available from: Redined Database.

[3] Sierra, J.L. (2004). Integración de las tecnologías electrónicas de la información en la enseñanza de las ciencias mediante estrategias de investigación. Available from: Redined Database.

In this paper, we describe a work on science teacher training carried out using an IBL experience, designed and developed under the PRIMAS[4] framework.

Purpose

Taking into consideration the aforementioned, the objectives underlying the approach being described are:

- Helping students (prospective science teachers) to make sense of scientific ideas and mathematical tools and recognize their value to understand and explain the world.
- Motivating students towards science and mathematical learning.
- Developing inquiry skills and becoming lifelong learners and inquirers.
- Increasing students' engagement in their own learning processes and giving them opportunities to become active and more autonomous learners.
- Helping prospective teachers to recognize the pedagogical value of IBL approaches, experiencing them as students and reflecting on the practice.

METHODS

Our IBL proposal starts by introducing a problematic situation which prospective teachers have to face and solve using an inquiry approach. The associated materials[5] have been developed on repeated cycles of design, implementation and improvement, involving research on mathematics and science education.
The activity has been designed and refined to be carried out in three sessions (2 hours each):

- **Session 1**: Introduce the activity, check group planning and revise the experimental design made by students.
- **Session 2**: Students perform their experiments, gather and represent data and analyze results
- **Session 3**: Presentation and discussion of the scientific report made by each group.

RESULTS

The implementation of the IBL activity has offer students the opportunity to develop inquiry skills related to:
simplify and structure complex problems
formulation of hypothesis
design of experiments
control of variables
experimenting and using lab tools and equipment,
observing systematically
measuring and quantifying
representing experimental data

[4] In Europe there are some international initiatives that are focused on changes of teaching sciences. An international team of expertises has established a multinational research network to work and offer a more widespread uptake of IBL. The PRIMAS project (*Promoting Inquiry in Mathematics and Science Education across Europe*) perseveres on a change in teaching and learning of mathematics and science at different educational levels across Europe, providing the necessary to support teachers in their professional development and supporting actions to develop, disseminate and implement the IBL.

[5] The full activity can be downloaded form: http://www.primas-project.eu/artikel/en/1140/Hydratation+of+legumes/view.do

establishing relationships and connections among variables and phenomena on the basis of the available evidence
visualizing
inferring
making a scientific report
Discussing and communicating results.
Furthermore, different topics from science and mathematics have been addressed: hydration, osmosis, health, differentiation and identification of variables, continuous magnitudes (mass, volume, capacity), measurement of continuous magnitude (estimation and comparison of measures), equivalent magnitudes, units and values (additive and subtractive comparisons), data handling and representation and modeling of dynamic systems.

CONCLUSIONS AND IMPLICATIONS

On one side national reports on academic achievement suggest the necessity to promote the use of new pedagogies to improve science and mathematic learning. In this sense, teachers are widely considered as the key players of any educational reform; thus teacher initial training is one of prior goals to aim when considering the improvement of education. On the other side, research on effective learning and learning environments has interesting parallels to the process of scientific inquiry itself. Therefore, a classroom in which students use scientific inquiry to learn is one that resembles those that research has found the most effective for learning for understanding (National Research Council, 2000). However an analysis of the Spanish context shows that IBL methodologies are not broadly spread in our country.
Taking into account the two sides just outlined, we have designed, implemented and refined an IBL activity for teacher initial training, as a way to promote the use of IBL methodologies in future teachers. The opportunity to experience an IBL activity as students and to reflect on that as prospective educators could be a valuable tool, not only to improve their own science understanding and scientific process skills, but also, to develop interesting teaching competences for the application of IBL methodologies. The role of teachers in the implementation of IBL methodologies is a crucial factor affecting their success. Throughout the whole process teachers should try to encourage reasoning rather the answer getting, build own students' previous knowledge and conceptions, and celebrate mistakes as opportunities for learning and improving, subtly showing students how they can work in profitable ways. It is also important to efficiently orientate group discussions, help students to make connection between ideas and draw out the important ideas. A balance should be worked on to find the optimal degree of guidance.

REFERENCES

Ariza, M.R., Quesada, A. (2010). Interoperability: Standards for Learning Objects in Science Education. In F. Lazarinis, S. Green and E. Pearson Handbook of Research on E-Learning Standards and Interoperability: Frameworks and Issues. Information Science Publishing.

Franco, A.G., Taber, K. (2008). Secondary students' thinking about familiar phenomena: Learners' explanations from a curriculum context where 'particles' is a key idea for organizing teaching and learning. International Journal of Science Education, 31(14), 1917-1952.

National Research Council. (2000). Inquiry and the National Science Education Standards. A Guide for Teaching and Learning. Washington, D.C.: National Academy Press.

Olson, S.; Loucks-Horsley, S. (2000). Inquiry and the National Science Education Standards: a guide for teaching and learning. Washinton DC: National Academy Press.

Rocard, M. (2007). Science Education Now: A renewed pedagogy for the future of Europe. Retrieved from: http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf.

Taber, K.S. (2002). Chemical misconceptions prevention, diagnosis and cure. London: Royal Society of Chemistry.