

PRACTICAL WORK AND THE IMPROVEMENT OF SCIENTIFIC KNOWLEDGE IN INITIAL SECONDARY TEACHER TRAINING THROUGH CURRICULUM DESIGN

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Abstract

Practical assignments are a common element in training for teaching experimental sciences. However, in recent years, limited scientific training has been observed among Spanish students in teacher's training at master level programs, which negatively impacts the application of this type of activity. This study aims to analyse how integrating simple home experiments into teaching and learning processes, can contribute to improving scientific training of future teachers, as well as the quality of their approach to design the curriculum to be taught. For this, a sample of 201 teachers in training ($N = 201$) were given a questionnaire on specific science content taught in mandatory high school education. Subsequently, in a second phase, a training proposal was developed with a sample of 20 teachers in training ($N = 20$), based on the integration of simple home experiments into different teaching strategies, such as the creation of scientific posters or the Predict, Observe, Explain (POE) strategy. The results of the first phase show data similar to those obtained by other authors, suggesting a low level of scientific content knowledge, as well as the presence of numerous conceptual errors. Regarding the second phase, it was observed that the curriculum designs developed by the participants were influenced by deficiencies in content knowledge and the presence of alternative ideas. However, these designs showed significant improvement after the implementation of the training proposal.

Keywords: *Practical assignments, conceptual errors, pre-service teacher training.*

1. Introduction

Spain has a summative model for secondary school teacher training. This means that students first complete a degree in one of the various fields of knowledge (240 ECTS credits) and then a master's degree in pedagogical training (60 ECTS credits). At first glance, it might seem that future teachers have sufficient and adequate foundational training; however, several studies in the field of experimental sciences have detected limited scientific training among them (Pro et al., 2022). Furthermore, there is a growing concern about why they systematically exhibit conceptual errors (Mazzitelli et al., 2022), raising questions about whether they truly possess content knowledge.

Initial teacher training should aim to help future teachers develop a lasting professional identity that they can apply to their future practice (Vilches & Gil, 2010). In this context, the use of teaching strategies in a safe environment is especially important (Fernández & Marrero, 2013), not only for improving future teachers' scientific knowledge but also in providing them with guidelines for their future classes through didactic transposition. This fosters the evolution of prospect teachers' traditional approaches toward those committed to provide meaningful learning for their students.

2. Objectives

To analyse how the integration of practical experiences into teaching and learning processes contributes to strengthening the scientific training of future teachers and helps improving the quality of their curriculum design.

3. Context

This work was developed within the Master's Program in Secondary Education Teacher Training, offered at the University of La Laguna (Tenerife, Spain), specifically in the subject of Learning and Teaching Physics and Chemistry during the 2025-2026 academic year.

4. Methods

This research has been carried out in two distinct phases. In the first phase, which is part of a larger study, a survey was performed by giving out a questionnaire on scientific content knowledge to classes from 2014-15 to 2024-25. The questionnaire proposed by Carrascosa et al. (2014), consisted of 18 questions on content specific to the Compulsory Secondary Education stage, and it resulted in a final sample of 201 trainee teachers ($N = 201$). The analysis and results of these questionnaires justified the training proposal for the second phase, which was carried out during the 2025-2026 academic year with a sample of 20 pre-service teachers ($N = 20$). The proposal is described below.

4.1. Didactic proposal design

The proposal is organized into four stages.

In the first stage, the didactic proposal, "the development of a learning situation that addresses specific scientific content through simple home experiments and its presentation in a poster format," is explained to the class. Instructions regarding format, content, and resources are provided, along with some suggestions on methodology.

In the second stage, the class is divided into small groups of three or four students. Each subgroup must reflect and propose a learning situation that will develop various basic knowledge areas from the curriculum of the Secondary Education stage in the Canary Islands. Next, the poster is created using various digital tools.

Finally, in the last stage, the posters are presented to the class and evaluated using two rubrics designed for this purpose. In addition, the students will self-evaluate and assess the work presented by their classmates, as well as the educational proposal implemented.

5. Results and discussion

In regards to the first phase, it is important to consider that it is part of a larger study. Therefore, this paper only presents the overall results obtained that justify the importance of implementing educational proposals such as the one presented in the second phase. In this case, the 201 questionnaires ($N=201$) yielded an average score of 10.53 out of 18 points, representing 58.5% correct answers and 41.5% errors. These results are similar to those obtained by other authors, suggesting a low-level scientific knowledge, as well as the presence of numerous conceptual errors. From this perspective, the conceptual deficiencies identified appear to be consistent with a low level of content knowledge, potentially leading future teachers to transmit incorrect information to their students and reinforcing misconceptions in the classroom (Kartal & Dilek, 2021).

Regarding the second phase, it was observed that five out of seven of the initial curriculum designs developed by the participants were hampered by deficiencies in content knowledge and the presence of erroneous alternative ideas. Therefore, specific work was required with these students to improve the development of their proposals. Likewise, incorporating simple home experiments allowed for a proper understanding of the content and a revision of the initial designs, resulting in a significant improvement after the implementation of the training program.

6. Conclusions

In conclusion, there is a lack of a solid foundation in disciplinary knowledge among the student teachers, which is reflected both in the questionnaire used for analysis and in the curriculum designs initially developed by the participants. Following the training program, an improvement in this knowledge and in the final designs presented was observed.

It is also important to highlight that the methodological approach proved to be interesting and educational for the students, and the program as a whole was positively evaluated.

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References

- Carrascosa, J. (2005). The problem of alternative conceptions today (Part I). Analysis of the causes that originate and/or maintain them. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, 2(2), 183-208. <https://revistas.uca.es/index.php/eureka/article/view/3918>
- Fernández, J., & Marrero, J. J. (2013). The strategy of the theoretical analysis of the practice of secondary teachers in training: critical incidents. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, 10 (Nº Extra), 694-708. <https://revistas.uca.es/index.php/eureka/article/view/2817>
- Kartal, T., & Dilek, İ. (2021). Preservice science teachers' TPACK development in a technology enhanced science teaching method course. *Journal of Education in Science, Environment and Health (JESEH)*, 7(4), 339–353. <https://doi.org/10.21891/jeseh.994458>
- Mazzitelli, C. A., Guirado, A. M., & Laudadio, J. (2023). Model for reflective practice in Natural Scienceteacher training. *Didáctica de las ciencias experimentales y sociales*, 44, 161-178. <https://doi.org/10.7203/dces.44.25405>
- Pro Bueno, A., de Pro Chereguini, C., & Cantó Doménech, J. (2022). Five problems in training teachers to teach science in Primary Education. *Revista Interuniversitaria De Formación Del Profesorado. Continuación De La Antigua Revista De Escuelas Normales*, 97(36.1). <https://doi.org/10.47553/rifop.v97i36.1.92510>
- Vilches, A. & Gil, D. (2010). Master's degree in initial teacher training for secondary education. Some analyses and proposals. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, 7(3), 661-666. <https://revistas.uca.es/index.php/eureka/article/view/2680>