ENHANCING PRE-SERVICE TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE FOR EVOLUTIONARY LITERACY IN ONLINE LEARNING ENVIRONMENTS

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Abstract

Online teacher education programs are rapidly expanding worldwide, raising new challenges for fostering meaningful learning and engagement in virtual environments while ensuring the development of strong pedagogical content knowledge (PCK). In science teacher education, these challenges become particularly relevant when addressing complex and conceptually demanding topics such as biological evolution. Evolution is widely recognized as one of the most difficult topics in science education, as persistent misconceptions and conceptual difficulties are found among students, teachers, and the public.

This study explores a project-based learning experience within an online Secondary Teacher Training Master's Degree aimed at enhancing both engagement and PCK related to evolutionary literacy. A qualitative methodology was employed: students' narratives, reflective reports, and instructional designs were systematically analyzed and contrasted with a theoretical framework of evolution education. Prior to designing their projects, students' preconceptions were assessed and they received targeted instruction on evolutionary concepts and their didactics. Subsequently, pre-service teachers developed learning situations integrating evolutionary thinking across biological and socio-scientific contexts and conducted small-scale educational research projects, whose outcomes were presented as scientific posters in a virtual conference.

The qualitative analysis reveals that students were able to contextualize evolutionary ideas in areas such as health, biodiversity, fossils, environmental change, and antibiotic resistance. Their designs often included inquiry-based activities, scientific evidence analysis, and communication of results, demonstrating progress in pedagogical competencies and in linking evolutionary explanations to real-world contexts. However, recurring patterns indicate that while transversal integration of evolution was achieved, explicit articulation of evolutionary mechanisms was sometimes limited, with adaptation emphasized over population-level processes such as variation and natural selection.

Analysis of the research posters shows generally moderate acceptance of evolutionary theory in the studied populations (using the MATE-E instrument), though lower acceptance was observed for human evolution and Earth's age, with persistence of alternative conceptions in certain groups sampled. Engaging pre-service teachers in the design and implementation of small-scale research projects also appeared to foster reflection on students' ideas and learning difficulties, contributing to the development of their PCK regarding evolution.

Overall, this study highlights the potential of combining project-based learning and educational research in online teacher education to promote engagement, research competencies, and evolutionary literacy. It also underscores the importance of reinforcing conceptual understanding of evolutionary mechanisms during initial teacher training.

Keywords: Discipline-based education research, evolution education, project-based learning, science teacher education, virtual learning environments.

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