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Project-Based Learning as a Teaching and Learning Strategy in University Mathematics: A Mapping Review

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ADMINISTRATIVE INFORMATION

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 09 July 2024 and was last updated on 09 July 2024.

INTRODUCTION

Review question / Objective From a theoretical perspective, which specific strategies within Project-Based Learning are most effective in fostering critical thinking in university mathematics courses?
Visualizing specific strategies within Project-Based Learning are more effective in fostering critical thinking in university mathematics courses.

Background The challenge of seeking increasingly efficient and meaningful teaching and learning strategies for various educational and formative actors seems to be a recurring aspect throughout the history of educational innovation proposals. These searches are dynamic processes originated as a social, cultural, and even political construction. The particular case of the strategy or methodology known as Project-Based Learning, specifically in higher education, offers an example of this.

In this sense, this mapping review aims not only to present a global overview of the historical evolution of Project-Based Learning in higher education but also to address two aspects that must be considered both for understanding the strategy and for potential future proposals in this field; namely, the fundamental principles of Project-Based Learning and the advantages it offers in developing competencies and skills for both teachers and the training of future professionals around critical thinking.

In general, educational systems, and particularly subjects associated with mathematics and its applications, have shown not only resistance from students but also significant challenges for Higher Education Institutions, including high levels of repetition, dropout rates, and growing disinterest in learning. It is in this type of context that the need for innovations in mathematics teaching processes constantly emerges among educators, mathematicians, and academic administrators, aiming to create more successful learning

experiences and support the development of professional competencies required by both individuals and society in an increasingly changing world.

Additionally, the current landscape involves new challenges and opportunities regarding virtual learning, the emergence of artificial intelligence, augmented reality, curricular changes focusing on promoting mathematical competence and its use in modeling and problem-solving, the promotion of collaborative learning, and the concern for authentic assessment that is closer to what students will experience in their professional reality. This reality will require continuous self-learning, adaptation, and collaborative work, among other responses to the needs of a changing world with increasingly demanding requirements.

Although contributions have been made for almost three decades to modify conventional practices of traditional education, it remains present in classrooms despite showing that its results no longer meet the mentioned challenges and evidence significant limitations that need to be addressed with innovative strategies such as those intended to be visualized in this review.

Rationale Mathematics courses in the foundational cycles for engineering or economic-administrative sciences degrees aim to lay the groundwork for specific cycle subjects, contribute to systematizing the critical thinking that permeates all dimensions of a well-rounded professional and a citizen who contributes to the society in which they develop their abilities. Consequently, the activities and academic strategies of university mathematics courses should strive to achieve their educational and informational objectives, as well as the learning outcomes through methodologies that promote argumentation, problem-solving, analysis, and evaluation. Therefore, Project-Based Learning is presented as a methodology that can foster the critical thinking of professionals in training. This justifies a visualization of strategies already implemented in similar contexts around critical thinking to achieve a description and categorization of the available evidence through clusters and gaps.

METHODS

Strategy of data synthesis The data extraction table according to Aromataris E, Lockwood C, Porritt K, Pilla B, Jordan Z, editors. JBI Manual for Evidence Synthesis. JBI; 2024. Available from: https://synthesismanual.jbi.global. https://doi.org/10.46658/JBIMES-24-01
Summaries of processes - Summaries of the main findings that answer the mapping question. Visualizations, tables, and charts.

Eligibility criteria For the mapping review, peer-reviewed documents focusing on Project-Based Learning strategies to enhance critical thinking in university mathematics students will be included. The selected documents must be articles in academic journals; conference proceedings, book chapters, theses, or any other dissemination media other than academic journals will be excluded. Grey literature and non-peer-reviewed material such as blog entries or non-academic websites will not be considered. Only documents written in English or Spanish will be included.

Source of evidence screening and selection ERIC, as a specialized database in education, and SCOPUS, as an interdisciplinary database, will be consulted. The search will be conducted using both Boolean operators and truncated symbols to ensure the widest coverage of retrieved documents.
The terms to be included are related to:
Project-Based Learning: "project-based learning", "PBL", "problem-based learning"; Critical Thinking: "critical thinking", "critical analysis", "analytical thinking"; University Mathematics Courses: "university mathematics courses", "college mathematics courses", "higher education mathematics"; Specific Strategies: ("specific strategies" OR "effective methods" OR "teaching strategies")
Population: Students enrolled in mathematics courses at universities. Professors or instructors who implement Project-Based Learning in university-level mathematics courses.
Intervention: Application of specific strategies within Project-Based Learning aimed at fostering critical thinking in the context of university mathematics courses.
Comparator: Studies that compare the use of Project-Based Learning with other teaching methods. Research that analyzes different strategies within Project-Based Learning and their effectiveness in promoting critical thinking.
Design of studies to be included: Only final-state articles that have been published in academic journals after a peer-review process will be included.
Information sources: The sources of information will be exclusively those mentioned to ensure the quality of the publications.

Data management Given the commitment of mapping reviews to the search and evaluation of evidence, and optionally to critical appraisal, the reviewers will jointly create and modify a spreadsheet to determine which variables should be extracted from the retrieved documents. This spreadsheet will serve as a standardized abstraction tool.The data extraction table according to Aromataris E, Lockwood C, Porritt K, Pilla B, Jordan Z, editors. JBI Manual for Evidence Synthesis. JBI; 2024. Available from: https://synthesismanual.jbi.global. https://doi.org/10.46658/JBIMES-24-01
Summaries of processes - Summaries of the main findings that answer the mapping question.
Visualizations, tables, and charts.

Language restriction English and spanish.

Country(ies) involved Colombia.

Keywords Critical thinking; Learning methods; Mapping review; Higher education; Lecturers; Students; Activity learning; Mathematics education; Educational courses (UNESCO Thesaurus); Project-Based Learning.

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