ENHANCING GEOGRAPHY EDUCATION THROUGH PROBLEM-BASED LEARNING: A QUASI-EXPERIMENTAL AND BIBLIOMETRIC STUDY OF PEDAGOGICAL EFFECTIVENESS

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ABSTRACT

This study evaluates the pedagogical effectiveness of Problem-Based Learning (PBL) in geography education through a design combining a quasi-experimental school intervention with bibliometric analysis. The empirical study involved 371 students from six general education schools in the Jizzakh, Samarkand, and Tashkent regions of Uzbekistan and was conducted in diagnostic, formative, and summative stages. Students in the experimental group received geography instruction based on problem situations, case studies, project work, practical tasks, and interactive learning, while the control group received traditional instruction. Student outcomes were assessed using surveys, diagnostic tests, and academic assessments. The experimental group showed a clear shift toward higher achievement levels: the proportion of students at the high level increased from 17% to 28%, the medium level from 30% to 42%, and the low level decreased from 53% to 30%. The study reports a 14.7% performance advantage for the experimental group over the control group. A VOSviewer co-occurrence analysis based on Lens.org records was also used to situate the study within international research trends. Overall, the findings support PBL as a promising approach for strengthening geographical knowledge, practical skills, analytical reasoning, and independent learning.

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Keywords: *Problem-Based Learning; geography education; quasi-experimental study; pedagogical effectiveness; independent thinking; bibliometric analysis; VOSviewer; learning outcomes.*

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Introduction

Contemporary education is increasingly expected to develop more than the reproduction of subject knowledge. Students also need opportunities to analyze information, formulate questions, make evidence-based decisions, and apply knowledge to situations that resemble problems outside the classroom. These expectations are particularly relevant in geography, where learners must connect physical, environmental, social, and economic processes across different spatial scales. For this reason, instructional approaches that require active inquiry and problem solving have become important in efforts to improve the quality of geography education. In pedagogical research, the effectiveness of such innovations should be examined through systematic evidence rather than assumed from classroom novelty alone (Rudenko, 2024; Shermukhamedova, 2020).

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Problem-Based Learning (PBL) offers a suitable framework for this purpose because learning begins with a meaningful problem that requires students to identify what they know, determine what additional information is needed, examine possible explanations, and construct a reasoned solution. In geography lessons, this structure can be used for environmental problems, regional development questions, resource use, population processes, or other issues that require students to integrate concepts and evaluate alternatives. Previous work in geography education has emphasized the value of interactive instruction, problem-centered learning, and activities that strengthen modern skills such as critical thinking and independent learning (Dustiyeva et al., 2024; Jurakhujaev, 2023).

The present study combines two complementary forms of evidence. First, a quasi-experimental school study compares learning outcomes under PBL-oriented and traditional instruction. Quasi-experimental designs are useful when educational interventions are implemented in existing schools and classes where full random assignment may not be feasible (Campbell & Stanley, 1963; Maciejewski, 2020). Second, a bibliometric keyword co-occurrence analysis is used to position the local study within broader research trends. Together, these components allow the paper to examine classroom outcomes while also showing how PBL in geography relates to themes visible in the wider scholarly literature.

The practical purpose is not to present PBL as a universal replacement for all forms of instruction, but to evaluate whether a structured PBL approach can strengthen learning in ordinary school settings. The study therefore focuses on changes in achievement levels, the contrast between experimental and control groups, and the pedagogical meaning of those changes. It also identifies reporting limitations that should be addressed in future replications so that the effectiveness of the approach can be estimated more precisely.

LITERATURE REVIEW

PBL is closely associated with learner-centered instruction because it shifts part of the intellectual responsibility for learning from the teacher to the student. Rather than receiving a completed explanation and then practicing it, students encounter a problem, examine evidence, discuss alternatives, and refine their understanding through guided inquiry. In geography education, this process is especially useful because many geographical questions do not have a single isolated answer; they require interpretation of relationships among place, environment, population, economy, and human decision making. Jurakhujaev (2025a) describes a methodological model for improving problem-based teaching in geography and emphasizes competency-based, integrative, reflective, and activity-oriented principles. These principles correspond to the present study's emphasis on analysis, independent inquiry, and practical application.

PBL also works naturally with other active-learning strategies. Interactive methods can increase student participation and create opportunities for discussion, explanation, and collaborative reasoning (Dustiyeva et al., 2024). Case studies place learners in a concrete situation that must be interpreted and resolved, while project work extends inquiry over a sequence of tasks that can culminate in a product, presentation, or proposed solution. The geography-focused case-study and project-method publications used in the present study provide a methodological basis for including these forms of activity in the experimental lessons (Jurakhujaev, 2024, 2025b). Interdisciplinary integration can further strengthen geography learning because geographical problems frequently connect natural science, economics, history, civics, and environmental studies (Khamroeva & Jurakhujaev, 2023).

The literature used in the manuscript also points to the importance of adapting instruction to learners and classroom conditions. Ibragimov (2020) discusses the design of individualized teacher training, while Dustiyeva and Jurakhujaev (2024) examine aspects of the Finnish education system that emphasize learner-centered organization and practical learning. These sources do not by themselves establish the effectiveness of the intervention reported here, but they support the broader pedagogical rationale for combining structured guidance with active student participation.

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Methodologically, educational interventions require careful design, measurement, and analysis. Lodico et al. (2010) emphasize alignment among research questions, design, data collection, and interpretation, while Ott and Longnecker (2010) provide a general foundation for descriptive and inferential analysis. The study also uses bibliometric mapping to visualize conceptual relationships in the literature. VOSviewer is specifically designed to construct and display bibliometric networks, including keyword co-occurrence maps (van Eck & Waltman, 2010). In Figure 1, the visible network places problem-based learning in relation to themes such as geography education, active learning, project-based learning, and learning outcomes. This map provides contextual evidence of thematic connections; it should not be interpreted as causal evidence of instructional effectiveness.

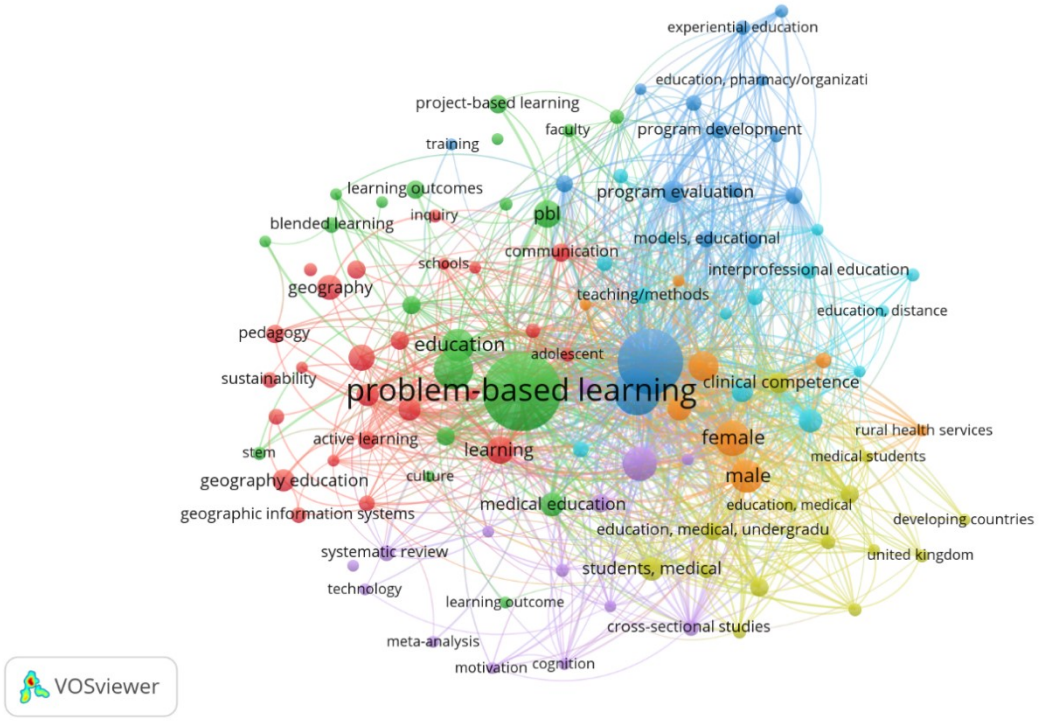


Figure 1. Keyword co-occurrence network related to Problem-Based Learning and geography education (generated with VOSviewer).

RESEARCH METHOD

The empirical component of the study used a quasi-experimental design. A total of 371 students from six general education schools in Uzbekistan participated in the reported experimental work. The schools represented three geographical areas. In Jizzakh Region, the study included General Education School No. 27 in Jizzakh City and General Education School No. 32 in Sharof Rashidov District. In Samarkand Region, General Education School No. 80 in Samarkand City and General Education School No. 7 in Oqdaryo District were included. The Tashkent-area sites were General Education School No. 278 in Olmazor District of Tashkent City and General Education School No. 1 in Chirchik City. Geography teachers at the selected schools were involved in implementation, although the source manuscript does not report a separate teacher sample size.

The experimental work was organized in three stages: diagnostic, formative, and summative. During the diagnostic stage, surveys and baseline assessments were used to examine the existing use of PBL in geography lessons and to identify initial attitudes and achievement levels. This stage also provided information for organizing the subsequent intervention. The use of a staged design is consistent with the general logic of educational experimentation in which baseline information is established before an instructional change is introduced and outcomes are then compared at the end of the intervention (Lodico et al., 2010; Rudenko, 2024).

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During the formative stage, students were organized into experimental and control groups. The experimental group received geography instruction based on PBL, whereas the control group received traditional instruction. PBL lessons included analysis of problem situations, independent inquiry, case-study tasks, project work, practical exercises, interactive activities, and opportunities for students to formulate conclusions from evidence. The intervention also used specially developed problem tasks, interactive lesson plans, multimedia resources, and instructional materials intended to support analytical thinking. The selection of these activities was informed by research on interactive methods, case studies, project work, interdisciplinary integration, and problem-based methodology in geography education (Dustiyeva et al., 2024; Jurakhujaev, 2024, 2025a, 2025b; Khamroeva & Jurakhujaev, 2023).

Student outcomes were assessed through surveys, diagnostic tests, and academic assessments. The final stage compared achievement distributions in the experimental and control groups using predefined high, medium, and low performance levels. The source manuscript also reports an inferential comparison summarized as a 14.7% performance advantage for the experimental group. General statistical references used in the study support the need to distinguish descriptive change from inferential evidence and to report statistical procedures clearly (Ott & Longnecker, 2010; Rudenko, 2024). However, the available manuscript does not specify the exact group sizes, duration of the intervention, scoring scale, test statistic, degrees of freedom, p value, or effect-size calculation. Consequently, the present paper reports the available numerical outcomes but does not reconstruct statistics that are not documented in the source material.

The second component was a bibliometric keyword co-occurrence analysis. Records were retrieved from Lens.org and visualized with VOSviewer. Co-occurrence mapping is appropriate for identifying how frequently keywords appear together and for showing clusters of related research concepts (van Eck & Waltman, 2010). The source manuscript provides the resulting network visualization but does not document the exact search string, search date, number of records, threshold settings, or counting method. The bibliometric component is therefore used as a contextual mapping exercise rather than as a systematic review or meta-analysis.

RESULTS

The achievement distributions shown in Figure 2 indicate a substantial shift in the experimental group between the beginning and end of the intervention. At baseline, 17% of students in the experimental group were classified at the high level, 30% at the medium level, and 53% at the low level. At the end of the experiment, the corresponding proportions were 28%, 42%, and 30%. Thus, the combined proportion of students at the high and medium levels increased from 47% to 70%, a gain of 23 percentage points, while the proportion at the low level decreased by the same amount.

The control group changed more modestly. At the beginning of the experiment, 18% of students were at the high level, 30% at the medium level, and 52% at the low level. By the end, these values were 19%, 33%, and 48%, respectively. The combined high-and-medium proportion therefore increased from 48% to 52%, while the low level decreased by 4 percentage points. Descriptively, the improvement in the experimental group was considerably larger than the change observed in the control group.

The study additionally reports that the experimental group's performance was 14.7% higher than that of the control group according to the authors' statistical comparison. Because the underlying inferential statistics are not included in the source manuscript, the 14.7% value is treated here as a reported study result rather than as an independently reproducible effect estimate.

The bibliometric map in Figure 1 complements these classroom findings by showing that PBL is connected in the research literature with active learning, project-based learning, learning outcomes, and related educational concepts. The dense network around the central PBL term indicates that the approach is discussed alongside multiple dimensions of teaching and learning rather than as an isolated technique. This pattern supports the decision to examine PBL in geography as part of a broader movement toward

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active and inquiry-oriented instruction, while the school experiment remains the primary source of evidence about local pedagogical effectiveness.

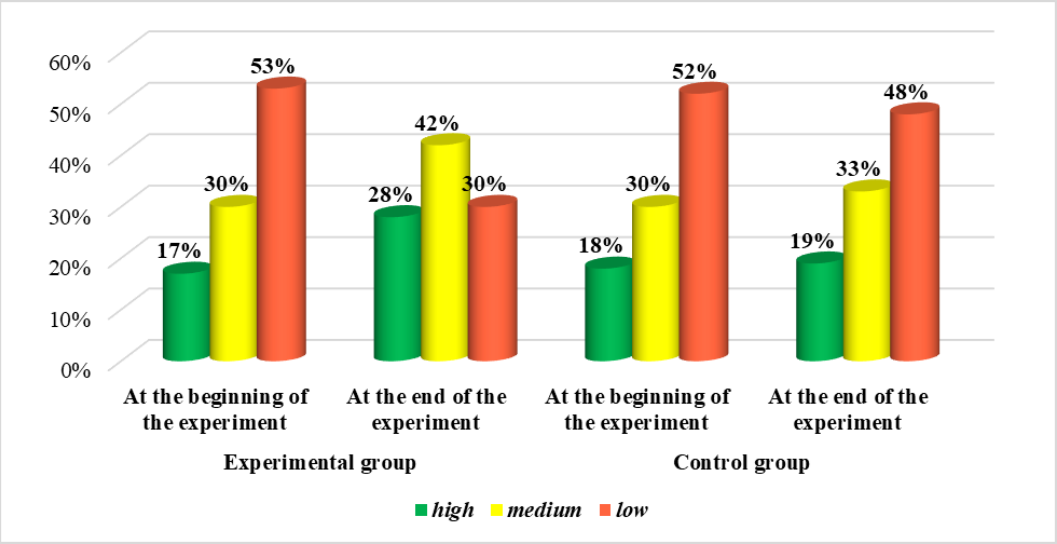


Figure 2. Comparison of achievement levels in the experimental and control groups.

DISCUSSION

The results are consistent with the pedagogical logic of PBL. Students in the experimental group were repeatedly asked to engage with problems, examine information, discuss possible solutions, and produce conclusions rather than relying only on the reception and reproduction of prepared content. Such activities can create more opportunities for higher-order thinking and for the practical application of geographical knowledge. The stronger shift from low achievement toward medium and high achievement in the experimental group therefore provides descriptive evidence that the PBL-oriented lessons were associated with improved learning outcomes under the conditions of this study.

Several elements of the intervention may have contributed to this pattern. Interactive methods can increase participation and make students' reasoning visible during instruction (Dustiyeva et al., 2024). Case-study tasks can connect concepts to realistic situations, and project activities can require learners to organize information across a longer sequence of inquiry (Jurakhujaev, 2024, 2025b). Interdisciplinary activities are also relevant because geographical problems often require the integration of environmental, social, and economic knowledge (Khamroeva & Jurakhujaev, 2023). In addition, problem-based methodology is intended to strengthen students' ability to identify a problem, search for relevant resources, evaluate evidence, and reach a reasoned conclusion (Jurakhujaev, 2023, 2025a). These mechanisms help explain why PBL may be particularly suitable for geography.

The findings also have practical implications for teachers. PBL should not be understood as simply giving students difficult questions and leaving them to work without support. Effective implementation requires purposeful problem selection, clear learning goals, appropriate resources, opportunities for collaboration, and assessment aligned with the intended skills. Individualized support may also be necessary because students differ in prior knowledge and readiness for independent learning (Ibragimov, 2020). The discussion of international educational practices by Dustiyeva and Jurakhujaev (2024) similarly suggests that learner-centered methods are most useful when they are adapted to the local curriculum and classroom context rather than copied mechanically.

At the same time, the study has limitations that should moderate interpretation. A quasi-experimental design can provide useful evidence in real educational settings, but causal conclusions are stronger when group formation, baseline equivalence, intervention fidelity, and potential confounding variables are reported in detail (Campbell & Stanley, 1963; Maciejewski, 2020). The available manuscript does not provide the experimental and control group sizes, the duration of instruction, reliability

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information for the assessment instruments, or the full inferential output. Future reporting should include these details together with the exact statistical test, test statistic, degrees of freedom, p value, confidence interval where appropriate, and an effect-size measure. The bibliometric analysis also requires fuller documentation of the Lens.org search strategy and VOSviewer settings for reproducibility. These limitations do not negate the observed descriptive differences, but they define the level of confidence with which the magnitude of the effect can be generalized.

CONCLUSION

This study provides evidence that Problem-Based Learning can be a productive approach to geography instruction when it is organized through structured problem situations, case studies, projects, practical tasks, and interactive learning. Across 371 participants in six schools, the experimental group showed a markedly larger movement from low achievement toward medium and high achievement than the control group. The authors also report a 14.7% performance advantage for the experimental group, although fuller statistical reporting is required to evaluate that estimate independently.

The study's bibliometric component places the intervention within a broader research landscape in which PBL is connected with active learning, project-based learning, and learning outcomes. Taken together, the classroom and bibliometric evidence support continued development of PBL in geography education. Future research should report group characteristics, intervention duration, instrument reliability, complete inferential statistics, and reproducible bibliometric search procedures. With these improvements, subsequent studies will be better positioned to estimate effect magnitude, compare implementation across regions, and identify which PBL components contribute most strongly to students' geographical understanding, analytical reasoning, practical competence, and independent learning.

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