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Social Constructivism Based Project Based Learning in Senior High School Mathematics Education a Systematic Review

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ABSTRACT

This study aims to systematically review the implementation of social constructivism-based Project-Based Learning (PjBL) in mathematics education at the senior high school level over the past five years. The review focuses on the forms of PjBL implementation, types of projects, characteristics of student products, project authenticity, meaningfulness, relevance to classroom time constraints, and proposed solutions. A Systematic Literature Review (SLR) method was employed by analyzing twenty-two articles retrieved from Google Scholar, DOAJ, ERIC, and SINTA databases. The article selection process followed the PRISMA framework, including identification, screening, eligibility, and inclusion stages, and the data were analyzed using a thematic approach. The findings indicate that PjBL generally aligns with social constructivist principles through collaborative activities and social interaction. However, most projects remain dominated by academic and symbolic products, such as reports and presentations, with authenticity levels categorized as low to moderate. Furthermore, limited instructional time and teachers' readiness emerge as major challenges. This review highlights a significant research gap in developing authentic and meaningful mathematics projects that support deep learning and the achievement of advanced-level competencies, providing a novel epistemological perspective on how social constructivism is practically translated into project designs.

Informasi Artikel

Kata Kunci:

pembelajaran berbasis proyek; konstruktivisme sosial; pendidikan matematika; keautentikan proyek; tinjauan literatur sistematis

ABSTRAK

Penelitian ini bertujuan untuk mengkaji secara sistematis implementasi Project-Based Learning (PjBL) berbasis konstruktivisme sosial dalam pembelajaran matematika di tingkat sekolah menengah atas selama lima tahun terakhir. Tinjauan ini berfokus pada bentuk implementasi PjBL, jenis proyek, karakteristik produk siswa, keautentikan proyek, kebermaknaan, relevansi terhadap keterbatasan waktu kelas, dan solusi yang diusulkan. Metode Systematic Literature Review (SLR) digunakan dengan menganalisis dua puluh dua artikel yang diperoleh dari basis data Google Scholar, DOAJ, ERIC, dan SINTA. Proses seleksi artikel secara ketat mengikuti kerangka kerja PRISMA, meliputi tahapan identifikasi, penapisan, kelayakan, dan inklusi, di mana data kemudian dianalisis menggunakan pendekatan tematik. Temuan menunjukkan bahwa PjBL pada umumnya sejalan dengan prinsip-prinsip konstruktivisme sosial melalui kegiatan kolaboratif dan interaksi sosial. Namun, sebagian besar proyek masih didominasi oleh produk akademik dan simbolik, seperti laporan dan presentasi, dengan tingkat keautentikan yang dikategorikan rendah hingga sedang. Selain itu, terbatasnya waktu pembelajaran dan kesiapan guru muncul sebagai tantangan utama. Tinjauan ini menyoroti adanya kesenjangan penelitian yang signifikan dalam mengembangkan proyek matematika yang autentik dan bermakna untuk mendukung pembelajaran mendalam (deep learning) dan pencapaian kompetensi tingkat lanjut, serta memberikan perspektif epistemologis baru tentang bagaimana konstruktivisme sosial secara praktis diterjemahkan ke dalam desain proyek.

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1. Introduction

Mathematics education at the Senior High School level plays a strategic role in shaping students' thinking skills, not only in procedural and computational aspects but also in developing reasoning, problem-solving, and the ability to connect mathematical concepts with real-life contexts. In the contemporary educational paradigm, mathematics is no longer understood merely as a collection of formulas and calculation techniques, but as an intellectual activity that involves thinking processes, meaning construction, and social interaction. This view positions mathematics learning as a vehicle to build deep and meaningful understanding through the active involvement of students in the learning process [9], [23].

The social constructivism perspective provides a strong philosophical foundation for mathematics learning oriented towards meaning-making and interaction. In this view, knowledge is understood as a social construction built through dialogue, collaboration, and negotiation of meaning among students, with the teacher acting as a facilitator. Ernest [9] asserts that mathematics is a social practice that develops through human activity, so mathematical understanding cannot be separated from the social context in which the knowledge is constructed. To implement these principles, various active learning approaches have been developed, one of which is Project-Based Learning (PjBL) [14]. PjBL positions students as the main subjects of learning who are actively involved in planning, executing, and evaluating learning projects.

Despite the widespread acceptance of PjBL as a relevant and potential learning approach, various challenges arise in its practical implementation. Several studies show that projects developed in mathematics learning still tend to be oriented towards symbolic activities and classroom artifacts, such as written reports, presentations, or making miniatures [11]. These projects may support conceptual understanding but do not fully reflect the principle of authenticity, which is the main characteristic of social constructivism-based PjBL. Authenticity demands a strong connection between learning activities and real-world contexts outside the classroom [15]. Authentic projects ideally encourage students to use mathematical concepts as tools to analyze, model, and provide solutions to contextual problems.

Furthermore, the implementation of PjBL in senior high school mathematics is also confronted with practical constraints, such as limited instructional time, curriculum completion demands, and teacher readiness. This condition often encourages the simplification of project designs so they can be completed within a limited time, focusing projects on easily manageable classroom activities. As a result, PjBL has the potential to be practiced as a pedagogical formality without generating truly deep and meaningful learning experiences for students.

Until now, studies on PjBL in senior high school mathematics have been dominated by empirical research focusing on measuring effectiveness on cognitive outcomes. Meanwhile, studies that specifically map the types of projects developed, analyze product characteristics, and evaluate their connection to social constructivist principles and deep learning are still relatively limited. Therefore, this systematic literature review aims to present a comprehensive overview of the implementation of social constructivism-based PjBL in senior high school mathematics learning over the past five years. This study seeks to identify general patterns, practical limitations, and existing research gaps regarding the authenticity and meaningfulness of mathematics projects.

2. Research Method

This research utilizes a Systematic Literature Review (SLR) approach, a method of literature synthesis conducted systematically, explicitly, and reproducibly to identify, select, and evaluate scientific articles relevant to the research topic. The SLR approach was chosen because this research is conceptual and reflective, aiming to critically map the implementation of social constructivism-based PjBL in senior high school mathematics. The data were obtained from open-access scientific databases, namely Google Scholar, SINTA, DOAJ, and ERIC. The search strategy used combinations of keywords such as “Project Based Learning mathematics senior high school”, “social constructivism”, “authentic project mathematics”, and “deep learning in mathematics education”.

To ensure accurate replicability, the article selection process strictly followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework through four stages. The first stage was identification, gathering initial articles from all databases. The second stage was screening, eliminating duplicates and assessing initial relevance via titles and abstracts. The third stage was eligibility, reading full articles to ensure compliance with inclusion criteria. The inclusion criteria included: (1) articles written in Indonesian or English; (2) published within the last five years (2020–2025); (3) focusing on mathematics learning at the senior high school level; (4) implementing PjBL, social constructivism, or active contextual learning; and (5) available in full text.

The final stage was inclusion, where articles meeting all criteria were selected for in-depth analysis. The data were analyzed using a qualitative thematic approach, grouping articles based on project types, product authenticity levels, the role of mathematics in the project, implementation constraints, and proposed solutions.

3. Result and Discussion

The literature search process initially yielded 73 articles from four databases: Google Scholar (30), DOAJ (15), ERIC (8), and SINTA (20). During the screening stage of titles and abstracts, 30 articles were eliminated for not matching the criteria (e.g., focusing on elementary or junior high levels). Subsequently, 20 articles were read in full during the eligibility assessment. Ultimately, 20 articles met the criteria as core studies, and 2 additional articles were used as supporting studies to strengthen the theoretical framework. The synthesis of the reviewed articles is presented comprehensively. As shown in Table 1, the characteristics of the analyzed articles highlight the forms of PjBL implementation, project types, authenticity levels, and constraints.

Table 1. Summary of Analyzed Articles

Author & Year	PjBL Implementation	Project Type & Product	Project Authenticity	Constraints & Solutions
Andriani et al., 2025	Collaborative activity, teacher as facilitator	Visual media and math concept representations	Low: products unused outside classroom	Time & student readiness; dividing project stages
Nursa'idah et al., 2022	Applied to increase student engagement	Report writing and contextual problem solving	Moderate: daily contexts present, academic products	Time management; structured project planning
Junita & Masrukan, 2025	Technology-assisted PjBL (GeoGebra)	Exploration and visualization of concepts	Moderate: tech supports understanding, not real-world	Project design; strengthening teacher training
Murtiyasa & Budiningsih, 2022	Problem-solving and group work	Trigonometry case-based problems; reports	High cognitive authenticity, lacks real-world utility	Time & complexity; scaffolding by teachers
Saro'i, 2024	Social constructivism via group discussion	Mini investigative projects; concept models	Low to Moderate: academically dominant	Student readiness; habituating collaborative work

Implementation of Social Constructivism-Based PjBL

The synthesis results indicate that PjBL implementation generally adopts the basic principles of social constructivism, primarily through group work with contextual problems as learning triggers. The teacher acts as a facilitator who guides discussions and provides scaffolding. This pattern aligns with Vygotsky's view that learning occurs through social interaction and scaffolding within the zone of proximal development [10]. However, the application remains highly procedural. The social interactions are mostly directed at task division and project completion rather than profound mathematical argumentation [14]. This indicates that PjBL is frequently utilized as an active learning strategy but has not been fully maximized as an epistemological approach to constructing mathematical knowledge reflectively.

Project Types and Authenticity Levels

The characteristics of the products generated show that most projects remain oriented toward classroom learning needs. Projects in senior high school mathematics generally take the form of academic problem-solving, concept visualization, or technology-based media projects [3]. Problem-solving projects usually end with written reports or presentations [1]. Consequently, the level of project authenticity generally falls into the low to moderate categories. The use of real-life contexts often functions merely as an initial learning trigger, without the development of solutions that are actually utilized to solve real problems outside the classroom [21]. Mathematics in these projects is more frequently positioned as a learning object rather than an analytical tool for real-world decision-making. This limits the potential of PjBL to encourage the transfer of learning and high-order thinking, revealing a gap between ideal PjBL concepts and classroom realities.

Constraints and Solutions

The most frequently reported constraint is limited instructional time, making it difficult for teachers to design and implement complex, authentic projects [19]. The burden of the curriculum and demands to complete materials force teachers to simplify project designs [24]. Furthermore, a lack of teacher readiness and experience in designing authentic projects is frequently noted. Existing literature offers solutions such as developing PjBL modules, dividing projects into structured stages, using scaffolding, and providing assessment rubrics [11]. However, these solutions primarily focus on pedagogical feasibility and technical implementation, rather than explicitly directing the development of mathematics projects that yield authentic products and foster deep learning [2].

4. Conclusion

Based on the systematic review of twenty-two selected articles, it can be concluded that social constructivism-based Project-Based Learning (PjBL) has been widely implemented in

senior high school mathematics education over the past five years. The implementation generally emphasizes student activity through group work, discussion, and problem-solving, aligning with the basic principles of social constructivism. However, the projects developed are largely dominated by academic and symbolic activities, such as writing reports, journals, presentations, and creating concept models, which function merely as classroom artifacts. The level of project authenticity generally ranges from low to moderate, meaning mathematics is treated more as a learning object rather than a practical tool for real-world analysis and decision-making. Consequently, the contribution of these projects to fostering deep learning and achieving advanced-level competencies remains sub-optimal. Limited instructional time, curriculum burdens, and teacher readiness are the primary obstacles. While various pedagogical solutions like structured modules and scaffolding have been proposed, there remains a critical research gap concerning the design of mathematics projects that are not only pedagogically active but also genuinely authentic, applicable, and capable of driving deep learning.

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