IMPLEMENTATION OF VYGOTSKY'S CONSTRUCTIVISM LEARNING THEORY THROUGH PROJECT BASED LEARNING (PJBL) IN ELEMENTARY SCIENCE EDUCATION

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Abstract

The study aims to describe the implementation of planning, implementation and evaluation of learning of Vygotsky constructivism through project-based learning on IPA exploration. This research uses a qualitative approach to the type of case study research. A case study is an enquiry to investigate phenomena occurring on the ground. This research was conducted at SDN Mojolangu 3 Kota Malang and the research subjects were 3 class teachers, students of 4.5 and 6. Data was collected through interview techniques, observations, and documentation. Data analysis is carried out in three stages: data reduction, data presentation, and conclusion delivery. The initial phase analysis is done by designing learning to determine the theme of the project, determine the implementation, and carry out evaluations to find out the project's success. Research results show that the application of Vygotsky learning through project-based learning to IPa learning can create new experiences for students and attract attention. Vygotsky's approach to constructivism emphasises student-centred learning in the acquisition of knowledge and the process of interaction with the social environment. Active participation of students in learning as the application of constructivist theory can be implemented in project-based learning, where learning project-based learning is one of the learning models that uses projects in problem-solving and student involvement independently through peer mediation in completing a project that has been designed by the teacher.
Keywords: Vygotsky theory constructivism, project-based learning, science learning, elementary school.

Abstrak

Penelitian bertujuan untuk mendeskripsikan pelaksanaan perencanaan, pelaksanaan dan evaluasi pembelajaran konstruktivisme Vygotsky melalui pembelajaran berbasis proyek pada eksplorasi IPA. Penelitian ini menggunakan pendekatan kualitatif dengan jenis penelitian studi kasus. Studi kasus adalah penyelidikan untuk menyelidiki fenomena yang terjadi di lapangan. Penelitian ini dilakukan di SDN Mojolangu 3 Kota Malang dan subjek penelitiannya adalah guru kelas 3, siswa kelas 4,5 dan 6. Data dikumpulkan melalui teknik wawancara, observasi, dan dokumentasi. Analisis data dilakukan melalui tiga

tahap yaitu reduksi data, penyajian data, dan penyampaian kesimpulan. Analisis tahap awal dilakukan dengan merancang pembelajaran untuk menentukan tema proyek, menentukan pelaksanaan, dan melakukan evaluasi untuk mengetahui keberhasilan proyek. Hasil penelitian menunjukkan bahwa penerapan pembelajaran Vygotsky melalui pembelajaran berbasis proyek pada pembelajaran IPA dapat menciptakan pengalaman baru bagi siswa dan menarik perhatian. Pendekatan Vygotsky terhadap konstruktivisme menekankan pembelajaran yang berpusat pada siswa dalam perolehan pengetahuan dan proses interaksi dengan lingkungan sosial. Partisipasi aktif siswa dalam pembelajaran sebagai penerapan teori konstruktivis dapat diimplementasikan dalam pembelajaran berbasis proyek, dimana pembelajaran berbasis proyek merupakan salah satu model pembelajaran yang menggunakan proyek dalam pemecahan masalah dan keterlibatan siswa secara mandiri melalui mediasi teman sejawat dalam menyelesaikan suatu proyek. yang telah dirancang oleh guru.
Kata Kunci: Konstruktivisme teori Vygotsky, pembelajaran berbasis proyek, pembelajaran IPA, sekolah dasar.

INTRODUCTION

Education is a crucial aspect of human life, enabling individuals to develop their inherent potential. Humans are considered social beings due to their ability to interact with both the physical and social environments.[1] Therefore, appropriate methods are needed that not only make the teaching and learning process engaging but also provide students with opportunities to express their creativity and actively participate in learning activities.[2] Education can be systematically and plannedly implemented to achieve its goals through effective and efficient learning activities.[3]

In the learning process, teachers are required to adapt to the development of their students. A teacher cannot transfer knowledge directly to students, but they can guide students to build their own knowledge.[4] Moreover, teachers must understand how students think and learn. This means that teachers no longer view students as objects of instruction but as subjects of teaching. Learning is defined as an activity organized by teachers so that students can achieve competence and values in a structured process through the stages of planning, implementation, and evaluation of teaching

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[1] Pinton Setya Mustafa and Roesdiyanto Roesdiyanto, "Penerapan Teori Belajar Konstruktivisme Melalui Model PAKEM Dalam Permainan Bolavoli Pada Sekolah Menengah Pertama," *Jendela Olahraga* 6, no. 1 (2021): 50–56, https://doi.org/10.26877/jo.v6i1.6255.

[2] Dewi Rokhmah, "Ilmu Dalam Tinjauan Filsafat: Ontologi, Epistemologi, Dan Aksiologi," *CENDEKIA: Jurnal Studi Keislaman* 7, no. 2 SE- (2021): 172–86.

[3] Lizzie Abderrahim and Mar Gutiérrez-Colón Plana, "A Theoretical Journey from Social Constructivism to Digital Storytelling," *The EuroCALL Review* 29, no. 1 (2021): 38, https://doi.org/10.4995/eurocall.2021.12853.

[4] Vishal Dagar and Aarti Yadav, "Constructivism: A Paradigm for Teaching And Learning," *Arts and Social Sciences Journal* 7, no. 4 (2016): 1–4.

and learning activities (KMB), considering the internal aspects of talent, interest, development, and psychology of students.[5]

In reality, many teachers still employ lecture methods, expecting students to sit quietly, listen, take notes, and memorize. In this regard, students may not receive optimal attention from the learning message aspect because students have different choices in receiving or responding to the taught lessons. The teacher's role in teaching and learning activities is to motivate, guide, and provide learning opportunities for students to achieve the expected learning goals. Thus, in implementing learning, teachers must apply integrated learning with a learning theory that aligns with students' characteristics. One of the learning theories that give meaning to the concept of learning is the constructivism learning theory.

Constructivism emphasizes that the study of learning is about how we understand the world.[6] Constructivism is a learning approach based on the premise that cognition (learning) is the result of "mental construction".[7] In other words, students learn by integrating new information with what they already know. Constructivism believes that learning is influenced by the context in which ideas are taught, as well as students' beliefs and attitudes.[8] Constructivism is a learning theory found in psychology that explains how humans can acquire knowledge and learn. The constructivist learning theory helps students build new knowledge, where students already have previous knowledge.[9]

Vygotsky's constructivism assumes that knowledge is collaboratively constructed by individuals in varying circumstances.[10] The method of understanding is aimed at intellectual development in a sociocultural context. Vygotsky's theory emphasizes the interaction of interpersonal (social), socio-cultural, and individual factors as key to human development. The principles of Vygotsky's constructivism theory state that humans have the ability to use mental functions to enhance learning, memory, and logical thinking. According to Vygotsky, the biological

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[5] Sri Irawati, "Penerapan Model Problem Based Learning Untuk Meningkatkan Motivasi Dan Prestasi Belajar Sosiologi," *Cakrawala Pedagogik* 4, no. 1 (2020): 35–43, https://doi.org/10.51499/cp.v4i1.131.

[6] Sydney Enock Msonde, "Revisiting the Idea of Learner-Centered Pedagogy: The Theoretical Perspective," *Journal of Education* 203, no. 2 (2023): 468–78.

[7] Laura Plummer et al., "Teaching Psychomotor Skills in a Virtual Environment: An Educational Case Study," *Education Sciences* 11, no. 9 (2021), https://doi.org/10.3390/educsci11090537.

[8] João Mattar, "Constructivism and Connectivism in Education Technology: Active, Situated, Authentic, Experiential, and Anchored Learning," *RIED. Revista Iberoamericana de Educación a Distancia* 21, no. 2 (2018): 201, https://doi.org/10.5944/ried.21.2.20055.

[9] Aravind B R and Bhuvaneswari G, "Utilizing Blogs on ESL Learners' Vocabulary Learning through Social Constructivist Theory: A Descriptive Study," *MethodsX* 10, no. December 2022 (2023): 101970, https://doi.org/10.1016/j.mex.2022.101970.

[10] Setyo Adi Nugroho, "Indonesian Journal of Curriculum and Educational Technology Studies Peningkatan Keaktifan Dan Hasil Belajar Siswa Melalui Penerapan Teori Konstruktivisme Berbasis Media Wondershare Quizcreator Article History," *Ijcets* 4, no. 2 (2016): 73–78.

basis of human mental functions functions to develop these mental functions, with humans playing a role as society and culture.[11]

Vygotsky's constructivist learning theory emphasizes the importance of social interaction and guidance in learning.[12] According to Vygotsky, learning occurs when an individual is in the zone of proximal development (ZPD), a level achieved when engaging in social behavior.[13] This theory underscores the importance of a learning environment that supports diverse perspectives and experiences of reality, knowledge construction, and other activities based on experience.[14] In its implementation, Vygotsky's constructivism emphasizes the importance of social interaction, guidance, and support in helping students achieve their cognitive potential.[15]

One of the subjects taught in elementary school is natural sciences (IPA). IPA plays a crucial role in improving students' abilities as it relates to daily life based on the scientific process.[16] IPA learning aims to instill and develop scientific knowledge, skills, attitudes, and values in students. It involves problem-solving processes, the application of scientific methods, and the development of curiosity about objects, natural phenomena, and living things.[17] In IPA learning, which is closely related to problem-solving processes and the formation of scientific attitudes, the teacher should choose and use a learning model that suits the concept of IPA learning and the characteristics of the students' backgrounds.[18]

One learning model that provides students with the opportunity to experience discovering a concept and emphasizes the environment as a source of learning is the project-based learning

[11] Ahmet Gurses, Cetin Dogar, and Kubra Gunes, "A New Approach for Learning: Interactive Direct Teaching Based Constructivist Learning (IDTBCL)," *Procedia - Social and Behavioral Sciences* 197, no. February (2015): 2384–89, https://doi.org/10.1016/j.sbspro.2015.07.296.

[12] Nirmal Raj Mishra, "Constructivist Approach to Learning: An Analysis of Pedagogical Models of Social Constructivist Learning Theory," *Journal of Research and Development* 6, no. 01 (2023): 22–29, https://doi.org/10.3126/jrdn.v6i01.55227.

[13] Hawwin Muzakki, "Teori Belajar Konstruktivisme Ki Hajar Dewantara Serta Relevansinya Dalam Kurikulum 2013," *Southeast Asian Journal of Islamic Education Management* 2, no. 2 (2021): 261–82, https://doi.org/10.21154/sajiem.v2i2.64.

[14] Like Suoth, Elsye Jesti Mutji, and Robinsor Balamu, "Penerapan Pendekatan Konstruktivisme Vygotsky Terhadap Pembelajaran Bahasa Indonesia," *Journal for Lesson and Learning Studies* 5, no. 1 (2022): 48–53, https://doi.org/10.23887/jlls.v5i1.40510.

[15] Mulyadi Mulyadi, "Teori Belajar Konstruktivisme Dengan Model Pembelajaran (Inquiry)," *Al Yasini : Jurnal Keislaman, Sosial, Hukum Dan Pendidikan* 7, no. 2 (2022): 174, https://doi.org/10.55102/alyasini.v7i2.4482.

[16] Yuliana Wahyu, Ambros Leonangung Edu, and Mikael Nardi, "Problematika Pemanfaatan Media Pembelajaran IPA Di Sekolah Dasar," *Jurnal Penelitian Pendidikan IPA* 6, no. 1 (2020): 107, https://doi.org/10.29303/jppipa.v6i1.344.

[17] Nurhayati, Asep Sukenda Egok, and Aswarliansyah, "Penerapan Model Pembelajaran Kooperatif Tipe TGT Pada Pembelajaran IPA Sekolah Dasar," *Jurnal Basicedu* 6, no. 5 (2022): 3.

[18] Ari Nurwidiyanti and Prima Mutia Sari, "Pengembangan Media Pembelajaran Flipbook Berbasis Literasi Sains Pada Pembelajaran IPA Sekolah Dasar," *Jurnal Basicedu* 6, no. 4 (2022): 6949–59, https://doi.org/10.31004/basicedu.v6i4.3421.

constructivism model.[19] Project-Based Learning or PjBL is a learning method where teachers have the opportunity to manage the learning system by producing a product in the classroom learning process.[20] Through this project task, teachers formulate fundamental questions or problems as instructions for the product to be created. The project-based learning model is an innovative learning model that involves students independently through peer mediation in groups to complete a project designed by the teacher.[21]

Previous research results Ulfadhilah explain that learning creates meaning and student engagement in learning is not just about memorization but the process of constructing knowledge through experience.[22] Another study states that integrative thematic learning is in line with Vygotsky's constructivism theory, providing students with the opportunity to build knowledge and acquire their own knowledge.[23] Naufal's further research shows that the constructivist approach can improve student activity and learning outcomes.[24] This is in line with the conclusion Sawyer in his study titled "Creative Pedagogy and Practice in the Engineering Classroom," stating that problem-based learning is a pedagogical approach focused on helping students develop self-directed learning skills.[25]

Therefore, this study aims to identify gaps that have not been explored much by previous researchers, as outlined above. The focus of this research is the application of Vygotsky's constructivist learning through project-based learning in elementary school IPA learning. The results of this study describe the extent to which the process of Vygotsky's constructivist learning through project-based learning is planned, implemented, and evaluated at SDN Mojolangu 3. Additionally, the researcher also describes the implications of Vygotsky's constructivism theory through project-based learning in education.

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[19] Safaruddin Safaruddin et al., "The Effect of Project-Based Learning Assisted by Electronic Media on Learning Motivation and Science Process Skills," *Journal of Innovation in Educational and Cultural Research* 1, no. 1 (2020): 22–29, https://doi.org/10.46843/jiecr.v1i1.5.

[20] Lilik Handayani, "Peningkatan Motivasi Belajar IPA Melalui Model Pembelajaran Project Based Learning Pada Masa Pandemi Covid-19 Bagi Siswa SMP Negeri 4 Gunungsari," *Jurnal Paedagogy* 7, no. 3 (2020): 168, https://doi.org/10.33394/jp.v7i3.2726.

[21] Carl Marnewick, "Student Experiences of Project-Based Learning in Agile Project Management Education," *Project Leadership and Society* 4, no. August (2023): 100096, https://doi.org/10.1016/j.plas.2023.100096.

[22] Khairunnisa Ulfadhilah, "Konstruktivisme dan Implementasinya dalam Pembelajaran Anak Usia Dini," *... EduKids: Jurnal Pendidikan Anak Usia Dini* 3, no. 1 (2021): 1–13.

[23] As Janah Verrawati, "Implikasi Teori Konstruktivisme Vygotsky dalam Pelaksanaan Model Pembelajaran Tematik Integratif di SD," no. 17712251063 (n.d.): 1–15.

[24] Hanif Naufal, "Model Pembelajaran Konstruktivisme Pada Matematika Untuk Meningkatkan Kemampuan Kognitif Siswa Di Era Merdeka Belajar," *Seminar Nasional Pendidikan Matematika* 2, no. 1 (2021): 143–52.

[25] R Keith Sawyer, "Teaching Creativity in Art and Design Studio Classes: A Systematic Literature Review," *Educational Research Review* 22 (2017): 99–113.

RESEARCH METHODS

This research employs a descriptive qualitative research method using a case study research technique.[26] A case study is an empirical inquiry that investigates phenomena within the context of real-life situations where the boundaries of phenomena and contexts are not clearly evident.[27] The choice of using a case study is because the phenomenon under investigation requires an in-depth descriptive examination. The objectives of this research are (1) to describe the process of Vygotsky's constructivist learning through project-based learning in terms of planning, implementation, and evaluation, and (2) to describe the implications of Vygotsky's constructivism theory through project-based learning in education.

This study is conducted at one level of elementary school, namely SDN Mojolangu 3 in Malang City. The research subjects include teachers of grades 4-6 and all students in grades 4-6. Data collection is carried out through in-depth interviews, non-participant observations, and documentation. Data analysis is conducted through three stages: data reduction, data presentation, and drawing conclusions. Data reduction is performed to find similar or relevant data as a reference for the researcher, while data presentation is obtained in the form of brief paragraphs presented in a narrative format (text). Drawing conclusions involve providing explanations and drawing conclusions from the research based on interview results, observations, and supported by documents. The validity of the data is tested using source triangulation and technique triangulation.

RESULTS AND DISCUSSION

Based on interviews, observations, and documentation, it was found that the project-based learning process using Vygotsky's constructivism theory in science learning is implemented through three steps: planning, implementation, and evaluation. In this context, the application of project-based learning in line with the Vygotskian constructivist paradigm can help teachers actualize pedagogical and professional competencies. Pedagogical competence involves skills related to the interaction between teachers and students in the classroom. Pedagogical competence includes the teacher's ability to explain materials, implement teaching methods, lead the class, and conduct assessments. Professional competence is a skill aimed at mastering the subject matter comprehensively, thoroughly, and comprehensively.

1. Initial planning aims to ensure that the project aligns with the desired learning objectives and provides experiences for students. The learning provided by teachers to students allows the use of

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[26] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, Dan R&D* (Bandung: Alfabeta, 2015).
[27] Muh Fitrah and others, *Metodologi Penelitian: Penelitian Kualitatif, Tindakan Kelas \& Studi Kasus* (CV Jejak (Jejak Publisher), 2018).

media or tools that can support project-based learning in line with the Vygotskian constructivist paradigm to help students develop their social characters. The planning of project-based learning is carried out with the following steps or syntax:

Table 1. Steps in Planning Project-Based Learning (PjBL)

Steps	Explanation
Start with the essential question	a. Conducting quizzes or initial trigger questions to assess students' abilities and stimulate their engagement in the instruction for a particular activity. b. Identifying learning objectives that encompass cognitive, affective, and psychomotor aspects. c. Determining a topic of discussion that aligns with the real-world context and is relevant to students, starting with an investigation in an assignment. d. Team formation involves group work and assigning clear roles to each team member.
Design a plan for the project	a. Collaboratively planning project activities between teachers and students. b. Determining the selection of activities that support answering essential questions. c. Integrating various subjects in the surrounding environment to find tools, materials, and reference books that can be used in completing the project.
Create a schedule	a. Creating a timeline for project completion. b. Guiding students in creating the project according to the schedule. c. Directing students to effectively plan the project creation. d. Setting a deadline or final completion date for the project.
Monitor the students and the progress of the project	a. Monitoring student activities during project completion. b. Monitoring is conducted by facilitating students at every stage. In this, the teacher plays the role of a mentor for student activities.
Assess the outcome	a. Evaluating the progress of each student.

	b. Providing feedback on the level of understanding achieved by students.
	c. Developing strategies for the next learning phase.
Evaluate the experience	a. Reflecting on the activities and the project's outcomes.
	b. Measuring students' responses to the implementation of Project-Based Learning.
	c. Developing outcomes to address issues.

The lesson plan created by the teacher is crucial for assessing the achievement of the chosen instructional model. Its purpose is to serve as a strong foundation for developing classroom learning. A teacher must think and work diligently to prepare various alternatives to address potential issues and challenges that may hinder project-based learning activities. Project-based learning emphasizes student-centered learning in the in-depth exploration of a particular topic.[28] Students actively explore and deepen their knowledge through a research-based approach to real-world issues and relevant questions. The project-based learning plan for each class is detailed as follows:

Table 2 Project-Based Learning Plan for Science Education

Class	Teaching Level	Main Subject	Learning Objectives	Project
4	Plant Reproduction	Parts of a flower and their functions in pollination and seed dispersal	Students can create a plant life cycle diagram based on observations and practical activities	1. Students plant seeds and observe the entire process from germination to growth. 2. Students cultivate vegetables such as pak choi, chili, tomatoes, and water spinach. 3. Students observe the weekly progress by examining the increase in the number of leaves

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[28] Nur Azizah, Siska Desy Fatmaryanti, and Nur Ngazizah, "Penerapan Model Pembelajaran Konstruktivisme Berbasis Problem Based Learning (PBL) Untuk Meningkatkan Kemampuan Berfikir Kritis Pada Siswa SMA Negeri 1 Kutowinangun Kelas X Tahun Pelajaran 2013 / 2014," *Radiasi* 5, no. 2 (2014): 24–28.

				and the height of the plants. 4. Students are given a 30-day timeframe for the project
5	A harmonious ecosystem	Causes and impacts of ecosystem imbalance	Students can understand the role of humans in maintaining ecosystem balance	1. Students can utilize the role of decomposers in food webs to break down leftover food remains, preventing them from becoming wasted energy. 2. Students create a simple decomposer and stove starter from organic waste or dry leaves. 3. The experiment is conducted at school under the guidance of the teacher. 4. Students are given a working period of 14 days until it transforms into compost.
6	My Plant Companion	Reproduction in Plants	Students can understand the reproduction of plants through generative and vegetative methods	1. Students are asked to observe plants in the school environment to differentiate between generative and vegetative characteristics. 2. Students are tasked with identifying as

				many generative and vegetative plant types around their homes as possible.
				3. Students explain the process of plant reproduction.
				4. Students are given a working period of 10 days.

Project-Based Learning within the constructivist framework of Vygotsky's theory serves as a worthy reference for implementation in the learning process, capable of realizing optimal learning experiences. Learning within the constructivist theory emphasizes experimental learning, involving human adaptation based on concrete experiences, such as discussions with classmates, which are then formulated into ideas and the development of new concepts. The main priorities in constructivist learning include: (a) specific learning within relevant contexts, (b) emphasis on the learning process itself, (c) learning in a social environment through shared experiences, and (d) learning aimed at building experiences.[29]

2. Implementation of Project-Based Learning within the Constructivist Framework of Vygotsky's Theory in Science Education

Creating a learning environment that allows students to engage in the construction of their own knowledge, the implementation at SDN Mojolangu 3 identifies learning objectives that align with the content and characteristics of the students. The implementation has progressed well, encompassing the integration of knowledge presented in the learning process, skills needed to complete the project, and self-research skills. Before starting the project, the teacher provides stimuli and guidance to students, giving an overview of the steps they need to take. Project-Based Learning illustrates to students that knowledge is not solely acquired from teachers but is a process of self-directed learning. Student collaboration within group settings forms social interactions and decision-making skills in problem-solving.

In the learning activities, the materials, knowledge, and concepts that students need to understand are integrated into the project's activities and experiences. Skills acquired during project

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[29] Mattar, "Constructivism and Connectivism in Education Technology: Active, Situated, Authentic, Experiential, and Anchored Learning."

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implementation include (a) the ability to identify, organize, plan, and allocate information from available sources, (b) adaptability and the ability to adjust while working in groups, (c) discovering and managing available information, (d) understanding reciprocal relationships, and (e) using existing technology to work on and complete projects.[30] The implemented project is detailed as follows:

Table 3 Implementation of Project-Based Learning in Science Education

Class	Project Achievement
4	• At the beginning, students prepare the tools and materials to be used in planting the plants. • Students engage in planting and caring for the plants by watering and fertilizing. They will monitor the plant's development three times a day. • Next, students observe the growth of the plants, including the emergence of leaves, the overall health or wilting of the plants, and their height. • Every three days, students monitor the plant's progress for one month to understand the development of their plants. • Presenting the group's findings.
5	• Students prepare tools and materials such as clay pots/covered containers, a small shovel, dried leaves, morning dew, rice washing water, and organic compost. • Students conduct an experiment by setting up a container for composting, and then they stack the materials in one container. • Students observe the composting process and monitor it every three days until it successfully turns into fertilizer. • Students identify the success of the compost for 14 days to assess its effectiveness.
6	• In the initial stage, students differentiate between generative and vegetative types of plants to facilitate grouping. • Students observe plants every two days to identify the types of plants around them and understand the methods of plant reproduction. • Students identify as many plants as possible to comprehend the plant reproduction process over a period of 10 days. • Presenting the group's findings.

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[30] Adi Nugroho, "Indonesian Journal of Curriculum and Educational Technology Studies Peningkatan Keaktifan Dan Hasil Belajar Siswa Melalui Penerapan Teori Konstruktivisme Berbasis Media Wondershare Quizcreator Article History."

Furthermore, the implementation of this project can cultivate students' independence and responsibility towards assigned tasks. Initially reserved students begin to interact with groupmates, exchanging ideas. Students' knowledge is shaped in determining the success of the project, wherein they develop critical thinking skills and solve encountered problems. This is also related to self-skills or intrapersonal skills, which are crucial for students to socialize and collaborate with others, especially their groupmates, in completing project tasks. By combining a constructivist approach with Vygotsky's theory, the learning experience can build knowledge, skills, and a strong conceptual understanding for students to construct their experiences.

3. Evaluation of project-based learning using constructivism and Vygotsky's theory in science education

Conducted by teachers through weekly monitoring to assess the progress of the project. In this regard, teachers provide assessments as self-reflection by monitoring the following processes: (a) students' understanding of scientific concepts achieved through the project and its relevance to real-world situations, (b) active engagement, meaning the evaluation of the extent to which students actively participate in learning, (c) critical thinking skills, meaning the assessment of students' abilities in analysis, synthesis, and evaluation within the project, (d) collaboration and social interaction, meaning students' skills in generating ideas, solving problems collectively, and supporting each other, (e) the role of the teacher as a guide, meaning the teacher's ability to support students' development according to Vygotsky's concept of the zone of proximal development, (f) project outcomes, meaning the review of the final product or solution produced by students, and (g) reflection, meaning students' evaluative reflection on the learning process related to challenges, successes, and acquired learning.[31] The evaluation of project-based learning is detailed as follows:

Table 4 Public Presentation Rubric

Class	Assessment Criteria	Very Good	Good	Sound	Fail
4	Understanding of concepts during the project presentation on planting plants	When explaining, I do not look at the	Occasionally looking at the media, and the	Often looking at the content of the presentation	Reading the presentation media during the

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[31] B. I. Fuada, Sarwi, and S . Linuwih, "Penerapan Model Pembelajaran Problem Based Learning Berbasis Konstruktivisme Untuk Meningkatkan Pemahaman Konsep Siswa Kelas VII," *Unnes Physics Education Journal* 3, no. 1 (2014): 11–15.

		PowerPoint slides, and the explanation can be understood	explanation can be understood	media, but the explanation is not easily understood	explanation does not lead to understanding
5	The product and its functions are evaluated based on simplicity and practicality, ease of use in the school environment, availability of tools and materials, sufficient capacity for holding organic waste from school/home, and absence of odor	Fulfilling all expected criteria	Fulfilling 4-5 expected criteria	Fulfilling 2-3 expected criteria	Fulfilling 1 expected criterion
6	The understanding of concepts during the presentation of findings on plant reproduction	Explaining without frequently referring to PowerPoint slides, and the explanation is understandable	Occasionally looking at the media, and the explanation can be understood	Frequently looking at the content of the presentation media, but the explanation is not easily understood	Reading the media during the presentation, and the explanation cannot be understood

The evaluation is conducted by the teacher as a reflective tool for project activities to assess students' success during presentations and the overall success of the project. This evaluation provides the teacher with insights into designing learning experiences using models and media that are relevant to students, aiming to foster independence in learning. In the learning process, the

teacher provides feedback after the completion of the project. Additionally, the teacher offers formative assessments throughout the learning process to guide students in improving and enhancing their performance. Evaluation in project-based learning with a constructivist approach, guided by Vygotsky's theory, requires a deep understanding of social interaction, cognitive development, and the construction of students' knowledge. The evaluation encompasses cognitive, affective, and social aspects in a balanced manner.

4. Advantages of Project-Based Learning and Vygotsky's Constructivist Theory in Science Education

Implementing project-based learning offers advantages in education for both teachers and students: (a) Building Fundamental Skills:Fosters the development of essential skills such as critical thinking, decision-making, creativity, and self-management, (b) Increasing Motivation:Enhances motivation in learning science as students actively participate in the learning process and receive recognition for their achievements, (c) Encouraging Collaboration:Promotes group collaboration to tackle problems and complete projects, aiding students in developing collaborative skills, (d) improving Improving Conceptual Understanding: Enhances students' comprehension of science concepts as they gain insights through experiences and the construction of knowledge, (e) curiculum Integration: Integrates seamlessly into the science curriculum, requiring no additional implementation efforts and (f) Applicability Across Various Classes: Demonstrates effectiveness in enhancing understanding and skills across diverse classes.[32]

Vygotsky's constructivism emphasizes that knowledge is formed through students' experiences. This method enhances cognitive abilities, collaboration skills, and student engagement in science education. The application of project-based learning based on Vygotsky's constructivist theory has proven effective in improving students' understanding, problem-solving abilities, fostering creativity, independence, responsibility, and critical thinking.[33] According to the constructivist paradigm, Vygotsky underscores collaborative learning, reducing disparities among students, and focusing on the process of problem-solving, reflecting a skill-focused learning approach rather than solely emphasizing the end results.[34]

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[32] Abdurrahmansyah, "Kontribusi Pendekatan Pembelajaran Konstruktivisme Dalam Meningkatkan Kualitas Pembelajaran Pai Di Sekolah" XIX, no. 01 (2014): 111–22.

[33] Darna and Isthifa Kemal, "Penerapan Pendekatan Konstruktivisme Dalam Meningkatkan Keterampilan Menulis Surat Pribadi Pada Siswa Kelas Iv Sd Negeri 11 Tanah Jambo Aye Kabupaten Aceh Utara," *Jurnal Tunas Bangsa* 2, no. 2 (2015): 41–66.

[34] Mardiana Mardiana, "Penerapan Pembelajaran Ipa Berbasis Konstruktivisme Dalam Meningkatkan Sikap Ilmiah Pada Siswa Madrasah Ibtidayah," *Al-Madrasah: Jurnal Pendidikan Madrasah Ibtidaiyah* 3, no. 1 (2018): 61–80, https://doi.org/10.35931/am.v0i0.69.

5. Implications of Vygotsky's Constructivist Theory through Project-Based Learning

Vygotsky's constructivist theory emphasizes that knowledge is not external to the mind, is not absolute, and is not discovered but rather constructed through experiences. This aligns with the evolution of education, emphasizing student-centered learning to explore knowledge and cultivate student autonomy. Teachers serve as facilitators, guiding students to discover knowledge, fostering a sense of responsibility within students. The fundamental assumptions and principles of Vygotsky's constructivist view of learning include: (a) learning is an active process, (b) learning is an adaptive activity, (c) learning is situated in the context in which it occurs, and (d) all knowledge is personal and varies among individuals.[35]

In constructivism, learning is represented as a constructive process where students build internal illustrations of knowledge, interpreting personal experiences. Learning is an active process where experiences play a crucial role in understanding concepts thoroughly.[36] Experiences also help students develop fundamental skills such as thinking, decision-making, and assist in overcoming cognitive gaps through social interaction. This perspective on knowledge does not outright reject the existence of the real world but agrees that reality imposes limitations on existing concepts, arguing that everyone's knowledge about the world is an interpretation of their experiences.[37] Furthermore, conceptual growth results from various perspectives and simultaneous changes in individuals' internal representations in response to these perspectives and through their experiences.

The application of Vygotsky's constructivist theory involves peer collaboration as experts in knowledge formation through interactive processes, aligning with the peer tutoring learning strategy.[38] Peer tutoring is a form of applying social constructivism that emphasizes the concept of a student becoming a teacher for another student. Peer tutoring involves student interaction to facilitate exchanging ideas, practicing communication, and enhancing students' critical thinking skills.[39] This minimizes the shortcomings of students who may feel hesitant to ask questions to the teacher and facilitates quicker information absorption. In cross-age peer tutoring, an older student teaches, while in same-age peer tutoring, a student teaches a peer in the same class.

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[35] Iszur Fahrezi et al., "Meta-Analisis Pengaruh Model Pembelajaran Project Based Learning Terhadap Hasil Belajar Siswa Pada Mata Pelajaran IPA Sekolah Dasar," *Jurnal Ilmiah Pendidikan Profesi Guru* 3, no. 3 (2020): 408, https://doi.org/10.23887/jippg.v3i3.28081.

[36] Lathifah Abdiyah and Subiyantoro Subiyantoro, "Penerapan Teori Konstruktivistik Dalam Pembelajaran Tematik Di Sekolah Dasar," *ELSE (Elementary School Education Journal) : Jurnal Pendidikan Dan Pembelajaran Sekolah Dasar* 5, no. 2 (2021): 127, https://doi.org/10.30651/else.v5i2.6951.

[37] Hawwin Muzakki, "Teori Belajar Konstruktivisme Ki Hajar Dewantara Serta Relevansinya Dalam Kurikulum 2013."

[38] Istiqomah As Sayfullooh et al., "Relevansi Teori Konstruktivistik Vygotsky Dengan Kurikulum Merdeka : Studi Kepustakaan," *Jurnal Tinta* 5, no. 2 (2023): 73–82.

[39] Khadidja Kouicem, "Psychological & Educational Studies Constructivist Theories of Piaget and Vygotsky: Implications for Pedagogical Practices," *Psychological & Educational Studies* 13, no. 3 (2020): 359–72.

The peer tutoring strategy can be implemented in learning by considering the students' surrounding environment as follows: (a) cross-age tutoring or mentoring by older students if possible, (b) providing space and opportunities for students to participate both as teachers and learners. In this way, students feel assisted and helpful, (c) monitoring tutors to collaborate in solving test problems, (d) teachers accompanying tutors by providing knowledge and guidance as additional preparation for students and encouraging students to ask questions to deepen their knowledge.[40] Vygotsky's constructivism states that knowledge within oneself is formed through a process of social interaction between two or more individuals. Thus, peer tutoring activities involving two students interacting and learning within a group help students construct their knowledge.[41]

In the application of project-based learning, teachers play the role of facilitators, aiding students in a smooth learning process. Teachers provide learning experiences that enable students to design, process, and research. Moreover, teachers can stimulate students' curiosity, assist in expressing ideas, and communicate their scientific ideas.[42] In learning, the availability of facilities that support stimulating students to think productively and provide opportunities for active student engagement in the learning process is essential.[43] This helps students understand concepts thoroughly because they acquire knowledge through experiences and the construction of knowledge. Thus, integrating Vygotsky's constructivist theory into learning allows students to actively engage through collaborative experiences and problem-solving processes.

DISCUSSION

Implementing constructivist learning through project-based learning in science education involves 4th to 6th-grade teachers to enhance their teaching skills. The execution must align with the pre-planned strategies. Constructivist application emphasizes learning derived from students' interaction with the environment. Knowledge is a result of cognitive construction through activities.[44] The constructivist learning theory envisions future individuals as sensitive,

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[40] Marheny Lukitasari et al., "Developing Student's Metacognitive Ability in Science through Project-Based Learning with e-Portfolio," *International Journal of Evaluation and Research in Education* 10, no. 3 (2021): 948–55, https://doi.org/10.11591/IJERE.V10I3.21370.

[41] Abdiyah and Subiyantoro, "Penerapan Teori Konstruktivistik Dalam Pembelajaran Tematik Di Sekolah Dasar."

[42] N Balemen and M Özer Keskin, "The Effectiveness of Project-Based Learning on Science Education: A Meta-Analysis Search," *International Online Journal of Education and Teaching (IOJET)* 5, no. 4 (2018): 849–65.

[43] N. Remziye Ergül and Elif Keskin Kargın, "The Effect of Project Based Learning on Students' Science Success," *Procedia - Social and Behavioral Sciences* 136 (2014): 537–41, https://doi.org/10.1016/j.sbspro.2014.05.371.

[44] Rudiana Agustini, "Journal of Technology and Science Education STUDENTS THROUGH SELF-PROJECT BASED LEARNING (SjBL) IN" 11, no. January 2020 (2021): 371–87.

independent, responsible decision-makers, capable problem solvers, and continuous learners -a process known as "to learn to be".[45]

Conceptually, learning is not about acquiring information from outside but constructing meaning through events and experiences.[46] Learning is viewed as the process of acquiring knowledge from facts. Individuals ascribe meaning to objects and experiences through social interactions within the unique group culture in and outside the classroom.[47] From a constructivist perspective, learning is a knowledge creation process carried out by individuals actively thinking, conceptualizing, and understanding what they learn.[48]. While teachers play a vital role in disseminating knowledge and developing student character, students' learning intention ultimately determines the realization of their learning interest, and control lies entirely with the students [49].

In constructivist learning, teachers facilitate students' knowledge construction and assist them in forming their own knowledge. Teachers must gain a deeper understanding of students' cognitive processes and learning perspectives [50]. Following constructivist principles, a teacher acts as a facilitator ensuring smooth student learning, including (a) providing learning experiences that make students feel ownership of their knowledge, (b) offering activities that cultivate students' curiosity and help them express their scientific thoughts and ideas. Teacher-student engagement fosters independence and responsibility in the teaching and learning process [51].

Constructivist approaches emphasize independent learning. Vygotsky's constructivist approach underscores learning closely related to the social environment [52]. Students are required to actively communicate and build relationships with both teachers and peers during the learning process. By employing constructivist learning methodology, students are guided to acquire knowledge and explore religious interactions among individuals [53]. This allows students to develop

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[45] I Cahyani, "Peningkatan Keterampilan Menulis Dengan Model PAKEM Melalui Teknik Menjadi Wartawan Junior Di Sekolah Dasar," *Sosiohumanika* 8, no. 1 (2015): 39–54.

[46] Mulyadi, "Teori Belajar Konstruktivisme Dengan Model Pembelajaran (Inquiry)."

[47] Nurhayati, Egok, and Aswarliansyah, "Penerapan Model Pembelajaran Kooperatif Tipe TGT Pada Pembelajaran IPA Sekolah Dasar."

[48] Amna Saleem, Huma Kausar, and Farah Deeba, "Social Constructivism: A New Paradigm in Teaching and Learning Environment," *Perennial Journal of History* 2, no. 2 (2021): 403–21, https://doi.org/10.52700/pjh.v2i2.86.

[49] Alfredo Ardila, "L.S. Vygotsky in the 21st Century," *Psychology in Russia: State of the Art* 9, no. 4 (2016): 4–15, https://doi.org/10.11621/pir.2016.0401.

[50] Poonam Gupta, "Constructivism: A New Paradigm in Teaching and Learning," *International Journal of Academic Research and Development* 2, no. 4 (2017): 183–96.

[51] Kate O'Connor, "Constructivism, Curriculum and the Knowledge Question: Tensions and Challenges for Higher Education," *Studies in Higher Education* 47, no. 2 (2022): 412–22.

[52] Hemant Sharma and Poonam Gupta, "Constructivist Approach for Teaching English: Making Sense of Paradigm Shift from the Traditional Approach," *International Journal of Science and Research (IJSR)* 5, no. 10 (2016): 778–92.

[53] Gede Artawan, "Pengaruh Pendekatan Konstruktivisme Terhadap Aktivitas Dan Hasil Belajar Siswa Dalam Pembelajaran Teks Biografi," *Journal of Education Research and Evaluation* 1, no. 4 (2017): 217, https://doi.org/10.23887/jere.v1i4.12151.

a deeper understanding and appreciation of religiosity, fostering open-mindedness, care, and responsibility, thus enhancing students' learning interest.

In science education, crucial skills include critical thinking, problem-solving, experimentation, and data analysis [54]. Therefore, in the learning process, students discover knowledge themselves by interacting with teachers, peers, and their social environment using their skills. Creating engaging learning that piques student interest requires a creative and relative approach using the project-based learning mode [55]l. Applied project-based learning can enhance students' knowledge and experience in exploring their knowledge. Project-based learning is an active, student-centered teaching approach that involves students working on real-life problems, collecting and analyzing data, and producing solutions [56].

The implementation of project-based learning at SDN Mojolangu 3 involves students applying their knowledge, and their skills become evident during project planning and completion. The progress of project-based learning is monitored weekly by teachers, who inquire about students' difficulties, provide feedback for project improvement, and evaluate cognitive concepts as well as self-assessment in affective and psychomotor aspects.

Schools need to analyze the factors contributing to the success of project-based learning. The school head fully supports and supports teachers who apply collaborative learning using various models and learning media to improve educational quality. Moreover, there is a need for facilities that support easy student access to learning. In constructivist application, utilizing the environment as a learning source is crucial in the student learning process [57]. The environment serves as learning materials and activities, encompassing both social and physical environments.

Implementing constructivist project-based learning offers advantages, such as (a) providing students the opportunity for independent thinking in decision-making, (b) enhancing students' understanding of the material or knowledge they acquire, (c) facilitating students in comprehending lesson materials as they are directly involved and active, (d) improving social communication through interactions with teachers and peers, and (e) making learning interesting and enjoyable as students seek and obtain new knowledge [58].

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[54] Rona Taula Sari, Siska Angreni, and Retno Aulia Fortuna, "Pengembangan Modul Pembelajaran Ipa Berbasis Pendekatan Konstruktivisme Untuk Kelas V Sd," *Bio-Pedagogi* 8, no. 2 (2019): 89, https://doi.org/10.20961/bio-pedagogi.v8i2.34725.

[55] Desti Vitriani et al., "Implementasi Pendekatan Konstruktivisme Pada Pembelajaran IPA Untuk Meningkatkan Hasil Belajar IPA Siswa Kelas V SD," in *Prosiding Seminar Nasional Pendidikan Dasar*, vol. 1, 2023, 88–101.

[56] Agus Hariyadi Suprianto, "Konstruktivisme Dan Pembelajaran IPA," *Jurnal Pendidikan Modern* 4, no. 2 (2019): 46–52, https://doi.org/10.37471/jpm.v4i2.20.

[57] Sri Murni Soenarno and Astari Miranti, "Conservation Education for Elementary School Students," *Edukasi* 15, no. 1 (2021): 74–82, https://doi.org/10.15294/edukasi.v15i1.30196.

[58] M Ilham and L Arba'iyah, "Implementasi Teori Belajar Perspektif Psikologi Konstruktivisme Dalam Pendidikan Anak Sekolah Dasar," *Jurnal Multilingual* 3, no. 3 (2023): 1412–4823.

CONCLUSION

The application of constructivism involves the active participation of students in the learning process to construct their existing knowledge. This aligns with the project-based learning model, where students understand concepts well through experiences and the construction of knowledge. Project-based learning encourages collaboration among students to solve problems and enhances students' critical thinking skills. The utilization of the environment as a learning resource has a positive impact and can improve teachers' abilities to manage learning effectively. Consequently, teachers and students can create a more efficient and engaging learning environment, helping students develop critical, creative, and productive thinking skills.

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