Journal of Education Action Research
Volume 8, Number 1, Tahun Terbit 2024, pp. 143-151
P-ISSN: 2580-4790 E-ISSN: 2549-3272
Open Access: https://doi.org/10.23887/jear.v8i1.75354

Discovery Learning Reinforced with 3D Visual Aids: An Action to Foster Learning Engagement

Hasmirah[1], Wawan Krismanto[2*], Rasmi Djabba[3]

[1,2,3] Jurusan Pendidikan Guru Sekolah Dasar , Universitas Negeri Makassar , Sulawesi Selatan , Indonesia

ARTICLE INFO

Article history:
Received October 07, 2023
Accepted February 7, 2024
Available online February 25, 2024

Kata Kunci:
Alat Peraga 3D, Discovery Learning, *Keterlibatan Belajar, Pembelajaran IPA*

Keywords:
3D Teaching Aids, Discovery Learning, Learning Engagement, Science Learning

ABSTRAK

Pembelajaran IPA hendaknya mendorong siswa untuk terlibat dalam membangun makna melalui eksplorasi atau investigasi fenomena alam. Memahami fenomena alam melalui pembelajaran IPA akan menjadi tantangan bagi siswa. Penelitian ini bertujuan untuk mengkaji penerapan pembelajaran penemuan yang diperkuat dengan alat peraga 3D untuk meningkatkan keterlibatan siswa dalam pembelajaran IPA di kelas V SD. Pendekatan yang digunakan adalah kualitatif dengan jenis penelitian tindakan kelas (PTK). Subjek penelitian berjumlah 20 siswa dan 1 orang guru. Penelitian ini dilaksanakan dalam 2 siklus yang masing-masing siklusnya 2 kali pertemuan pembelajaran. Data diperoleh dengan teknik observasi dan dokumentasi. Teknik analisis data yang digunakan adalah kondensasi, penyajian, dan kesimpulan. Penelitian fokus pada proses pembelajaran dan keterlibatan belajar siswa. Hasil penelitian menunjukkan bahwa proses d Discovery l Earning *berbantuan alat peraga 3D mampu meningkatkan aktivitas belajar, semangat belajar siswa, dan proses mengajar guru dalam pembelajaran IPA. Perubahan dan perbaikan dalam proses pembelajaran yang terjadi mendorong peningkatan keterlibatan belajar siswa. Pada siklus I, 75% siswa masih berada pada kategori rendah dan sedang dalam learning engagement ; pada siklus II tidak ada siswa yang berada pada kategori tersebut. Disimpulkan penerapan pembelajaran penemuan yang diperkuat dengan alat peraga 3D dapat meningkatkan pembelajaran dan menumbuhkan keterlibatan siswa dalam pembelajaran IPA. Implikasi penelitian ini adalah memfasilitasi pemahaman konsep yang lebih baik, mendorong kolaborasi dan diskusi dan meningkatkan keterlibatan pembelajaran.*

ABSTRACT

Pembelajaran IPA hendaknya mendorong siswa untuk terlibat dalam membangun makna melalui eksplorasi atau investigasi fenomena alam. Memahami fenomena alam melalui pembelajaran IPA akan menjadi tantangan bagi siswa. Penelitian ini bertujuan untuk mengkaji penerapan pembelajaran penemuan yang diperkuat dengan alat peraga 3D untuk meningkatkan keterlibatan siswa dalam pembelajaran IPA di kelas V SD. Pendekatan yang digunakan adalah kualitatif dengan jenis penelitian tindakan kelas (PTK). Subjek penelitian berjumlah 20 siswa dan 1 orang guru. Penelitian ini dilaksanakan dalam 2 siklus yang masing-masing siklusnya 2 kali pertemuan pembelajaran. Data diperoleh dengan teknik observasi dan dokumentasi. Teknik analisis data yang digunakan adalah kondensasi, penyajian, dan kesimpulan. Penelitian fokus pada proses pembelajaran dan keterlibatan belajar siswa. Hasil penelitian menunjukkan bahwa proses d Discovery l Earning berbantuan alat peraga 3D mampu meningkatkan aktivitas belajar, semangat belajar siswa, dan proses mengajar guru dalam pembelajaran IPA. Perubahan dan perbaikan dalam proses pembelajaran yang terjadi mendorong peningkatan keterlibatan belajar siswa. Pada siklus I, 75% siswa masih berada pada kategori rendah dan sedang dalam learning engagement ; pada siklus II tidak ada siswa yang berada pada kategori tersebut. Disimpulkan penerapan penemuan pembelajaran yang diperkuat dengan alat peraga 3D dapat meningkatkan pembelajaran dan menumbuhkan keterlibatan siswa dalam pembelajaran IPA. Implikasi penelitian ini adalah memfasilitasi pemahaman konsep yang lebih baik, mendorong kolaborasi dan diskusi dan meningkatkan keterlibatan pembelajaran.

Corresponding author.
*E-mail address: wawan.krismanto@unm.ac.id (Wawan Krismanto)

1. INTRODUCTION

Facilitating student engagement in the learning process is an important element, including science learning. Student learning involvement can be seen from 3 dimensions, namely affective-emotional involvement, which includes attitude, interest, sense of belonging, and identification; cognitive involvement, which is seen from perseverance, willingness, motivation, and psychological conditions for learning; behavioral involvement, such as participation in activities (Bowden et al., 2017, 2021; Godec et al., 2018; Pietarinen et al., 2014.) The evaluation of the learning program recommends that science learning should encourage students to engage in constructing meaning through exploration or investigation of the natural phenomena studied by involving student discussion, data collection, analysis, and initial explanation, followed by reading relevant literature to activate them to broaden their understanding (Ann Haefner & Zembal-Saul, 2004; Lombardi et al., 2021; Tyler et al., 2018). Understanding natural phenomena in science learning (content, inquiry, and process skills) is challenging for students because it involves complex construction processes and requires time and effort while learning (Hadzigeorgiou & Schulz, 2019; Rumjaun & Narod, 2020). They further assert that building student engagement in science learning is an important teacher task as it is clear that understanding can occur with a certain level of engagement. In addition to helping students build scientific understanding, every science teacher should engage and motivate students with science, its content, and techniques (concepts, equations, laws, and laboratory skills) (Calder et al., 2020; Friedrichsen et al., 2021; Hadzigeorgiou & Schulz, 2019).

However, in reality, there is still learning in elementary schools that need to facilitate maximum student involvement. Science learning is still oriented towards transferring knowledge from teachers to students. It prioritizes content mastery, so learning seems monotonous and prioritizes students' memorization of science material content. Learning also runs monotonously in explaining the material by the teacher, then reading textbooks and answering exercise questions in textbooks or student worksheets. The activities of observing, investigating, collecting data, analyzing, and concluding data have not been the teacher's choice. It aligns with observations at SDN 95 Pinrang in early January 2023, which showed that students still seemed passive in learning and needed to be facilitated to engage in various meaningful science learning experiences. It occurs due to several factors, such as using less relevant learning models to engage students, not maximizing the use of media or visual aids that facilitate student involvement, and not facilitating various learning activities/experiences. The problem of low learning engagement of fifth-grade students of SDN 95 Pinrang needs to be addressed immediately to improve the process and results of students' science learning.

Based on the literature study, one of the alternatives that teachers can apply to overcome low student involvement in learning is through the application of discovery learning because the discovery learning model is a learning model that facilitates and requires students to be involved and play an active role in following a series of learning process activities (Darling-Hammond et al., 2013; Honomichl & Chen, 2012; Memarovic et al., 2012) The discovery learning model is also a learning strategy for understanding concepts, meanings, and relationships through intuitive processes and inquiry to conclude (Clements & Joswick, 2018; Marisya, 2020; Ozdem-Yilmaz & Bilican, 2020). The discovery learning model consists of 6 steps: first, stimulation, and stimulation to students. The second problem statement is the stage of identifying problems relevant to the subject matter. Third is data collection, the stage of collecting students' data. Fourth, data processing is the stage of processing the data that has been collected; fifth, verification; and sixth, generalization, namely the process of concluding the findings. The previous research concluded that the discovery learning model could increase students' learning activities and engagement; in this case, the teacher facilitates students' learning activities and engagement through a series of stages in discovery learning (Ozdem-Yilmaz & Bilican, 2020; Rachmawati & Koeswanti, 2021). The activeness and involvement of student learning in question are activities that require students to participate directly during the learning process so that students gain new experiences or knowledge. The Discovery Learning model is suitable to be applied because, in the learning process, it can change teaching and learning activities from teacher-oriented to student-oriented.

In addition to the application of learning models, one alternative to support student learning involvement in the learning process is the presence of learning aids or teaching aids to solidify mastery of concepts in science subjects. These aids can be teaching aids that help demonstrate a concept, law, or procedure or show certain phenomena in science learning materials. Teaching aids are tools or materials used in learning to assist students in improving their skills and knowledge, illustrate and solidify information messages, and relieve tension and student learning obstacles (Suprayanti et al., 2017). In other words, teaching aids are tools, methods, and techniques teachers use to facilitate communication and interaction between teachers and students in the school's education and learning process.

Based on the description above, the researcher argues that conducting classroom action research is important and necessary to improve student engagement in science learning at SDN 95 Pinrang, South

Sulawesi. This study aims to answer two research questions regarding the implementation of discovery learning reinforced with 3D teaching aids to improve the learning process and the implementation of discovery learning reinforced with 3D teaching aids to increase student learning engagement. Research combining the Discovery Learning approach with 3D teaching aids has several significant advantages in fostering learning engagement. 3D teaching aids provide a more real and in-depth visual representation of the studied concepts. It can trigger greater fascination in students, increasing their engagement in the learning process. 3D teaching aids allow students to interact directly with the subject matter, such as manipulating objects or exploring virtual spaces. It creates a more interactive and dynamic learning experience, which can increase student engagement.

2. METHODS

This research was conducted in the fifth grade of SDN 95 Pinrang, South Sulawesi, Indonesia. The research subjects totaled 20 students. This research was conducted in May 2023. The research design used in this study was Elliot's Classroom Action Research model (Elliott, 2001). Learning improvement is designed through several stages: planning, implementation, action observation, and reflection. Implementation of the action refers to the Discovery Learning model procedure, which consists of 6 steps, namely stimulation, providing stimulation to students, problem statement, the stage of identifying problems relevant to the subject matter, data collection, the stage where students collect the necessary data, data processing, stage of processing the data that has been collected, verification, the stage where students and teachers carry out checks related to the data obtained and generalization, the stage of the concluding process (Kemendikbud, 2013; Memarovic et al., 2012). The categorization of students' critical thinking abilities is presented in Table 1. Observation indicators of student engagement in learning are presented in Table 2.

Table 1. Categorization of Students' Critical Thinking Abilities

Score	Categorization
90-100	Very high
80-89	High
70-79	Medium
<70	Low

(Sihpiwelas et al., 2014)

Table 2. Observation Indicators of Student Learning Engagement

Aspect	Indicator
Physical Engagement	1. 1. Students observe the teacher's explanation during learning. 2. 2. Students write/take notes in the learning process. 3. 3. Students focus on working on student worksheets according to the teacher's directions 4. 4. Students actively participate in step-by-step activities during learning
Mental Engagement	1. 1. Students take the initiative to express their opinions/feelings regarding the learning process that day 2. 2. Students actively discuss during group work 3. 3. Students take the initiative to ask questions both when discussing with the teacher and fellow students 4. 4. Students take the initiative to answer questions both when discussing with the teacher and fellow students
Emotional Engagement	1. 1. Students show enjoyment in participating in the learning process. 2. 2. Students interact intensely with fellow students and various teaching aids and learning media resources. 3. 3. Students are enthusiastic and enthusiastic about participating in learning from start to finish. 4. 4. Students look serious about doing every task during learning.

(Sihpiwelas et al., 2014)

The research data collected was student and teacher activity data, taken using observation sheets to determine the learning process and implementation of Discovery Learning with the help of teaching aids;

data on the level of student learning engagement was taken using observation instruments. During learning, observers make observations based on learning engagement instruments on each student. The student engagement learning instrument was developed based on student engagement indicators, as shown in Table 1. The results of each student's observations are then given a score to categorize the level of student learning engagement based on the table of indicators for observing student engagement, as shown in Table 2. The standard for success in the actions in this research is when, at the end of the lesson, > 75% of students are in the learning category. High and Very High engagement.

3. RESULT AND DISCUSSION

Result

Implementation of learning as a form of implementing the action plan in this research is carried out through the opening stages of learning, core learning, and closing of learning. At the core of learning, the actions in this research are implemented in the form of implementing all stages (syntax) of discovery learning, and each stage is supported by the use of teaching aids, namely 3D teaching aids about the Water Cycle. The learning stages can be described as follows. The first is the stimulus stage, which provides stimulation (stimulus) to students. The teacher allows students to read material about the Water Cycle in the textbook. The teacher provides 3D teaching aids about the Water Cycle presented in Figure 1, and then students pay attention, study, and deepen the knowledge contained in the 3D teaching aids. In the process, the teacher asks students several questions, such as why water on Earth never runs out and what the benefits of water are for living creatures.

Figure 1. 3D Teaching Aids used when Carrying Out Actions

Second, the problem identification stage facilitates students in identifying problems that arise in everyday life in the water cycle and the consequences they cause. The teacher gives a worksheet to each group to guide and summarize the results. At this stage, the teaching aids help explain and demonstrate the phenomena and problems that occur when one component of the Water Cycle is disrupted. Each group is free to identify problems so that there is a diversity of problems identified by students. For example, what will happen to the Water Cycle when gardens, rice fields, forests, and empty land on the Earth's surface are replaced by houses, buildings, and roads? Why do rivers dry up, what happens if the rivers on Earth dry up, and what are the impacts On the Water Cycle?.

The third is the data collection stage, which facilitates students in searching for and finding answers to questions identified in the previous learning stage. Students are facilitated through various data sources such as textbooks, additional teaching materials prepared by teachers, and information contained in teaching aids, including teacher explanations and demonstrations through teaching aids. Fourth, the data processing stage facilitates students in inventorying data and information, connecting and assembling them into temporary answers to the problems they solve. Through the available worksheets, they write down the results of data processing. Fifth, the proof stage, in the form of facilitating students to prove their tentative answers. Visual aids help with this, and with the data and information they obtain from various sources, they demonstrate and explain proven answers to the problems they solve. The proof process is carried out using a presentation strategy. Students explain data processing results while demonstrating using 3D Water Cycle teaching aids. Each group must present at this stage, and other groups can ask questions and respond to other groups' presentations.

The sixth is the concluding stage, in the form of conclusions on the answers to the problems solved by each group. At this stage, the teacher and all students contribute to each other by concluding the problems solved by each group. Thus, even though the problems solved by each group are different, all students understand the problems, solutions, and temporary answers and conclusions. Weaknesses that are still visible in the implementation of the first cycle of action are that students still seem confused about continuing to the next learning stage, teaching aids are still not utilized optimally during data collection and presentation at the proof stage, and there are still too few material references so that students are still not optimal in data collection stage. For this reason, improvements need to be made to the second cycle. The teacher must intensively explain the learning procedures at the beginning of the core learning activities. The teacher must direct students at each learning step to take advantage of the teaching tools, and teachers must add learning reference sources to obtain data and information from a more diverse range of learning sources.

Results of Implementation of First Cycle Actions. Changes were seen in student learning activities after carrying out the actions in the first cycle. Student learning activities, which were previously passive, just listening to the teacher's explanation of the material, have changed to student activity-based learning. Students are facilitated to actively learn starting from the stage of providing stimulation by reading textbooks and exploring teaching aids, actively discussing in their groups when starting to identify problems, collecting and processing data, and proving answers to concluding answers to the problems found. This change in activity also encourages changes in students' learning focus from the beginning of learning to the end. Changes can also be seen in student learning interactions between students during group discussions, between groups at the presentation stage, and students with various learning resources when reading textbooks, teaching materials, and exploring 3D teaching aids. Observations made by observers during the implementation of the first cycle of actions in teacher teaching activities showed that 83% of learning indicators had been implemented well; in other words, it can be categorized as good. Student learning activities show that 73% of learning indicators have been followed by students or are categorized as good.

The changes in the learning process that were explained in the previous paragraph then have an impact on increasing student learning engagement. This increase can be seen in the results of student involvement observations. Before teachers implemented discovery learning assisted by teaching aids, most students had low learning engagement. It is based on initial observations and the results of interviews with teachers/homeroom teachers. After implementing Discovery Learning, reinforced with 3D teaching aids, the level of student involvement in the first cycle was only 35% of students in the Low category and 40% in the Medium category. Although only 15% is in the High category, and 10% is in the Very High category. Based on observations of the learning process, the results of observations of learning activities, and the level of student learning engagement in the first cycle of actions, it can be concluded that actions need to follow the indicators of success of the actions. Thus, the actions in this research need to be continued into the second cycle.

Implementation of second cycle actions. The steps for implementing the second cycle of action are still the same as the first cycle, namely, implementing discovery learning procedures or syntax. What is different is the topic of material studied, the teaching aids given to students, and various efforts to improve the learning process as a follow-up to the results of reflection in the first cycle. After implementing the actions in the second cycle, various changes or improvements were seen in the learning process. First, learning activities became more diverse and relied on student learning activities. Second, learning has facilitated student learning engagement, especially for uninvolved students. Third, learning resources are increasingly diverse because apart from textbooks, the learning process is also facilitated by additional teaching materials. Fourth, the 3D teaching aids used during learning complement learning resources and can make it easier for students to explore them independently for their learning process. Fifth, during learning, students are facilitated to identify problems and solve or find answers independently. Sixth, students are facilitated to take responsibility for finding solutions and answers by communicating and presenting them using the available teaching aids.

Based on the results of observations of the learning process from the teacher and student aspects carried out by observers in the second cycle, it can be stated that the learning process in terms of the implementation of learning by teachers has reached the good category with a percentage of 96% of the learning indicators that have been implemented. The results of observations of the learning process from the student side reached the Good category with a percentage of 92% of the learning indicators that had been implemented. The changes and improvements to the learning process described in the previous paragraph have led to student learning engagement. In the first cycle, 75% of students were still in the low category and learning engagement, while in the second cycle, there were no longer any students in that category. A recapitulation of first and second-cycle student learning engagement is presented in Table 3.

Table 3. Recapitulation of Student Learning Engagement Levels

	Low		Medium		High		Very high	
Action	F	%	F	%	F	%	F	%
First cycle	7	35	8	4	3	15	2	10
Second cycle	0	0	0	0	1	5	19	95

Discussion

After carrying out actions in the first and second cycles, there were various changes or improvements in the learning process in class 5 of SDN 95 Pinrang, especially in the learning material about the Water Cycle. Below, we discuss various changes in the learning process using various literature. First, learning activities that seemed passive and teacher-centered learning in class 5 at SDN 95 Pinrang changed to activities that were more diverse and truly based on student-centered learning after the implementation of Discovery Learning, which was reinforced using 3D teaching aids during learning. It follows the confirmation from various literature that discovery learning is a model that facilitates student-centered learning (Coklat, 2021; Lavine, 2012; Pusat, 2010). The use of 3D teaching aids when implementing learning steps is very relevant because they support the learning process so that students are encouraged to get involved. It is in line with the concept that science learning should encourage students to be involved in building meaning through exploration or investigation of the natural phenomena studied by involving student discussion, data collection, and analysis, as well as initial explanations, followed by reading relevant literature to activate the learning process them to expand their understanding (Ann Haefner & Zembal-Saul, 2004; Lombardi et al., 2021; Tyler et al., 2018).

Second, as long as the action takes place, learning facilitates student learning engagement, especially for those who are not involved. By the nature of the Discovery learning model, students are facilitated and required to play an active role in a series of learning process activities. In carrying out the actions in this research, Discovery learning directs students to actively participate in the learning stages, from providing stimulation to the final stage, which is the conclusion of the new information and knowledge they have learned. This discovery learning model is also a learning strategy for understanding concepts, meanings, and relationships through intuitive processes and investigations to conclude (Marisya, 2020; Ozdem-Yilmaz & Bilican, 2020).

Third, learning resources become more diverse when the action occurs because, apart from textbooks, the learning process is facilitated with additional teaching materials. In addition, the 3D teaching aids used during learning complement learning resources and can make it easier for students to explore independently. Teachers must provide teaching aids to help students improve their skills and knowledge, illustrate and strengthen information messages, and eliminate tension and obstacles experienced by students (Kija & Msangya, 2017; Suprayanti et al., 2017).

Fourth, during learning, students are facilitated to identify problems and solve or find answers independently. In addition, students are facilitated to take responsibility for finding solutions and answers by communicating and presenting them using the available teaching aids. It is by the statement that through discovery learning, students are facilitated to understand or solve problems based on the discovery of facts, relationships, and solutions independently by the students themselves, especially when they explore, manipulate objects, discuss or carry out experiments, utilize their own experience and existing knowledge (Lavine, 2012; Ozdem-Yilmaz & Bilican, 2020). Next Djamarah (Berlinda et al., 2020), who explains that discovery learning is learning to discover and discover oneself. In this teaching and learning system, the teacher presents learning material that is still being determined. However, students can find it themselves by using problem-solving techniques.

The changes in the learning process above encourage increased student learning engagement, which can be seen in students' physical, mental, and emotional involvement. It relates to student engagement indicators (Sihpiwelas et al., 2014). Indicators of physical involvement include observing the teacher's explanation during learning, students writing/taking notes in the learning process, students focusing on student worksheets according to the teacher's direction, and students actively participating step by step. Mental involvement includes students taking the initiative to express opinions/feelings related to the learning process that day, actively discussing during group work, taking the initiative in asking questions when talking about with the teacher and fellow students, and taking the initiative in answering—questions both when discussing with the teacher and fellow students. Emotional involvement arises when students show joy in participating in the learning process. Students interact intensely with fellow students and various learning resources; students enthusiastically participate in learning from beginning to end. Students appear serious when carrying out each task during learning. Observations using observation sheets showed that 75% of students were in the low and medium categories of learning engagement in the first cycle. On the other hand, in the second cycle, no students fell into that category.

Based on the description in the previous paragraph, it can be concluded that the application of discovery learning reinforced with 3D teaching aids can improve the learning process and student learning engagement in learning the Water Cycle material in class 5 at SDN 95 Pinrang. It follows the conclusion of one previous study that the Discovery learning model can increase student learning activity and involvement; in this case, the teacher facilitates student learning activities and involvement through a series of stages in discovery learning (Ismanto et al., 2012; Martin & Evans, 2019; Rachmawati & Koeswanti, 2021). The activeness and involvement of student learning in question are activities that require students to participate directly during the learning process so that students gain new experience or knowledge. In addition, using teaching aids can reduce difficulties in learning science because teaching aids can make it easier for students to understand the subject matter and can be applied in real terms based on clear facts by students (Ding & Zhang, 2023; Wijaya et al., 2021). The implication of this research is to facilitate better conceptual understanding. With 3D teaching aids, students can explore abstract concepts more concretely. It can help them understand the material better because they can see, feel, and manipulate objects in three-dimensional space, encouraging collaboration and discussion. In other words, the use of 3D teaching aids in learning contexts. Discovery Learning can encourage student collaboration and facilitate greater in-depth discussion about learning material. Then, students can interact with the teaching aids, share ideas, complement each other's understanding, and increase learning engagement, whereas 3D visual aids can help attract students' interest and attention in learning. By utilizing engaging technology, such as 3D models that can be rotated and interacted with, students tend to be more engaged in their learning process.

Although the use of 3D teaching aids in the learning context of Discovery Learning has many benefits, several limitations need to be considered. The following are some limitations that may arise and recommendations for overcoming them: Limited technological accessibility, the use of 3D teaching aids may require sophisticated technology such as 3D printers or special software, which may not be widely available in all educational institutions. Recommendations for these limitations include paying attention to simpler alternatives or developing more affordable solutions, such as using 3D models that are already available online or utilizing technology that already exists in the learning environment, then the limitations of infrastructure and resources, which schools or educational institutions may do not have adequate infrastructure to support the use of 3D teaching aids, such as sufficient space or sufficient budget to purchase teaching aids. Based on these limitations, the recommendation is to utilize existing resources more efficiently, such as sharing teaching aids between classes or developing collaborations with other institutions with better resources. This research aims to facilitate a better understanding of concepts, encourage collaboration and discussion, and increase learning engagement.

4. CONCLUSION

The application of discovery learning reinforced with 3D teaching aids can improve the learning process and foster student involvement in science learning in grade 5 at SDN 95 Pinrang, South Sulawesi, Indonesia. Research combining the Discovery Learning approach with 3D visual aids has several significant advantages in fostering learning engagement, namely that 3D visual aids provide a more real and in-depth visual representation of the studied concepts. It can trigger greater interest in students, increasing their involvement in the learning process, and 3D learning tools allow students to interact directly with the lesson material, such as manipulating objects or exploring virtual spaces.

5. REFERENCES

Ann Haefner, L., & Zembal-Saul, C. (2004). Belajar dengan melakukan? Calon guru sekolah dasar mengembangkan pemahaman tentang penyelidikan ilmiah dan pengajaran serta pembelajaran sains. *Jurnal Internasional Pendidikan Sains*, *26*(13), 1653–1674. https://doi.org/10.1080/0950069042000230709.

Berlinda, K., Maizora, S., & Hanifah. (2020). Penerapan Model Pembelajaran Discovery Learning Berbantuan Alat Peraga Untuk Meningkatkan Hasil Belajar Matematika Siswa di SMP Negeri 11 Kota Bengkulu. *Jurnal Penelitian Pembelajaran Matematika Sekolah*, *4*(2), 185–193. https://doi.org/10.33369/jp2ms.4.2.185-193.

Bowden, J. L.-H., Tickle, L., & Naumann, K. (n.d.). Empat pilar keterlibatan dan kesuksesan mahasiswa: Pendekatan pengukuran holistik. *Studi Di Pendidikan Tinggi*, *46*(6), 1207–1224. https://doi.org/10.1080/03075079.2019.1672647.

Calder, N., Murphy, C., Mansour, N., & Abu-Tineh, A. (2020). Transformasi Pedagogi dalam Matematika dan Sains di Qatar: Studi tentang Perspektif Guru dan Siswa. In D. A. MacDonald, L. Danaia, & S. Murphy (Eds.), *Pendidikan STEM di Seluruh Kontinum Pembelajaran* (pp. 269–292).

https://doi.org/10.1007/978-981-15-2821-7_15.
Clements, D. H., & Joswick, C. (2018). Memperluas cakrawala penelitian pembelajaran berbasis penemuan. *Ilmu Instruksional*, *46*(1), 155–167. https://doi.org/10.1007/s11251-018-9449-1.
Coklat, K. (2021). Menemukan Pembelajaran Penemuan. *Batu Penjuru*. https://www.gcsu.edu/sites/files/page-assets/node-808/attachments.
Darling-Hammond, L., Newton, S. P., & Wei, R. C. (2013). Developing and assessing beginning teacher effectiveness: The potential of performance assessments. In *Educational Assessment, Evaluation and Accountability* (Vol. 25, Issue 3). https://doi.org/10.1007/s11092-013-9163-0.
Ding, J., & Zhang, Y. (2023). Survei dan Analisis Statistik Situasi Saat Ini dalam Pengajaran Ilustrasi Sains di Sekolah Menengah Pertama. In D. G. V. Bhau, Y. Shvets, & H. Mallick (Eds.), *Prosiding Konferensi Internasional Statistik Matematika dan Analisis Ekonomi 2022*. https://doi.org/10.2991/978-94-6463-042-8_171.
Elliott, J. (2001). *Penelitian Tindakan untuk Perubahan Pendidikan*. Pers Universitas Terbuka. https://www.researchgate.net/publication/372555372_Metodologi_Penelitian_Pendidikan.
Friedrichsen, P. J., Ke, L., Sadler, T. D., & Zangori, L. (2021). Menetapkan Unit Kurikulum Berbasis Isu Sosio-Ilmiah yang Dirancang Bersama: Kasus Pembelajaran Guru Sains Sekunder. *Jurnal Pendidikan Guru IPA*, *32*(1), 85–106. https://doi.org/10.1080/1046560X.2020.1795576.
Godec, S., King, H., Archer, L., Dawson, E., & Seakins, A. (2018). Examining Student Engagement with Science Through a Bourdieusian Notion of Field. *Science and Education*, *27*(5–6), 501–521. https://doi.org/10.1007/s11191-018-9988-5.
Hadzigeorgiou, Y., & Schulz, R. M. (2019). Melibatkan Siswa dalam Sains: Peran Potensial dari "Pemikiran Naratif" dan "Pemahaman Romantis. *Perbatasan Dalam Pendidikan*, *4*, 38. https://doi.org/10.3389/feduc.2019.00038.
Honomichl, R. D., & Chen, Z. (2012). Peran bimbingan dalam pembelajaran penemuan anak. *Ilmu Kognitif WIREs*, *3*(6), 615–622. https://doi.org/10.1002/wcs.1199.
Ismanto, B. D., Pramesti, G., Suwarsi, T. U., & Chrisnawati, H. E. (2012). *Peningkatan pemahaman konsep dan aktivitas siswa menggunakan pembelajaran penemuan dengan resitasi*. https://doi.org/10.1063/1.5139775.
Kemendikbud. (2013). *Model Pembelajaran Penemuan (Discovery Learning*. https://gurudikdas.kemdikbud.go.id/news/Mengenal-Model-Pembelajaran-Discovery-Learning.
Kija, B., & Msangya, D. B. W. (2017). *Peran Alat Bantu Belajar Mengajar dalam Pembelajaran Mata Pelajaran IPA: Studi Kasus di Kotamadya Morogoro* (Vol. 6, Issue 1, pp. 65–69). https://doi.org/10.35446/diklatreview.v3i1.349.
Lavine, R. A. (2012). Pembelajaran Penemuan Terbimbing. In D. N. M. Seel (Ed.), *Ensiklopedia Ilmu Pembelajaran*. https://doi.org/10.1007/978-1-4419-1428-6_526.
Lombardi, L., Mednick, F. J., Backer, F., & Lombaerts, K. (2021). Menumbuhkan Pemikiran Kritis di Seluruh Kurikulum Sekolah Dasar dalam Sistem Sekolah Eropa. *Ilmu Pendidikan*, *11*(9), 505. https://doi.org/10.3390/educsci11090505.
Marisya, A. (2020). *Konsep Model Discovery Learning Pada Pembelajaran Tematik Terpadu di Sekolah Dasar Menurut Pandangan Para Ahli [Skripsi*. Universitas Negeri Padang. http://repository.unp.ac.id/29220/1/A_06_AULIA_MARISYA_16129295_4074_2020.pdf.
Martin, A. J., & Evans, P. (2019). Instruksi pengurangan beban (LRI): 14Mengurutkan instruksi eksplisit dan penemuan terbimbing untuk meningkatkan motivasi, keterlibatan, pembelajaran, dan prestasi siswa. In D. S. Tindall-Ford, S. Agostinho, & J. Sweller (Eds.), *Kemajuan dalam Teori Beban Kognitif*. https://doi.org/10.4324/9780429283895.
Memarovic, N., Langheinrich, M., Alt, F., Elhart, I., Hosio, S., & Rubegni, E. (2012). Menggunakan tampilan publik untuk merangsang keterlibatan pasif, keterlibatan aktif, dan penemuan di ruang publik. In *Prosiding Konferensi Biennale Arsitektur Media ke-4 tentang Partisipasi - MAB* (Vol. 12, pp. 55–64). https://doi.org/10.1145/2421076.2421086.
Ozdem-Yilmaz, Y., & Bilican, K. (2020). Pembelajaran Penemuan—Jerome Bruner. In D. B. Akpan & T. J. Kennedy (Eds.), *Pendidikan Sains dalam Teori dan Praktek* (pp. 177–190). Penerbitan Internasional Springer. https://doi.org/10.1007/978-3-030-43620-9_13.
Pietarinen, J., Soini, T., & Pyhältö, K. (n.d.). Keterlibatan emosional dan kognitif siswa sebagai penentu kesejahteraan dan prestasi di sekolah. *Jurnal Internasional Penelitian Pendidikan*, *67*, 40–51. https://doi.org/10.1016/j.ijer.2014.05.001.
Pusat, T. E. A. L. (2010). Pembelajaran yang Berpusat pada Siswa. *Keunggulan Pengajaran Dalam Literasi Orang Dewasa*. https://lincs.ed.gov/sites/default/files/6 _TEAL_Student-Centered.pdf.
Rachmawati, L. A., & Koeswanti, H. D. (2021). Model Discovery Learning Berbantuan Media Audio Visual Untuk Meningkatkan Keaktifan Dan Hasil Belajar IPA Siswa Sekolah Dasar. *Edukatif: Jurnal Ilmu*,

3(3), 770–777. https://doi.org/10.31004/edukatif.v3i3.394.

Rumjaun, A., & Narod, F. (2020). Teori Pembelajaran Sosial—Albert Bandura. In D. B. Akpan & T. J. Kennedy (Eds.), *Pendidikan Sains dalam Teori dan Praktek* (pp. 85–99). Penerbitan Internasional Springer. https://doi.org/10.1007/978-3-030-43620-9_7.

Sihpiwelas, H., Sugiyono, & Kartono. (2014). Peningkatan Keterlibatan Siswa Secara Aktif Dalam Pembelajaran IPA Menggunakan Pendekatan Kontekstual Pada Siswa Kelas IV. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa*, *3*(3), 1–10. https://doi.org/10.26418/jppk.v3i3.4829.

Suprayanti, I., Ayub, S., & Rahayu, S. (2017). Penerapan Model Discovery Learning Berbantuan Alat Peraga Sederhana untuk Meningkatkan Aktivitas dan Hasil Belajar Siswa Kelas VII SMPN 5 Jonggat Tahun Pelajaran 2015/2016. *Jurnal Pendidikan Fisika Dan Teknologi*, *2*(1), 30–35. https://doi.org/10.29303/jpft.v2i1.285.

Tyler, B., Britton, T., Iveland, A., Nguyen, K., & Hipps, J. (2018). Terlibat dan mempelajari sains: Bagaimana siswa memperoleh manfaat dari pengajaran Standar Sains Generasi Berikutnya. *BaratEd*. https://files.eric.ed.gov/fulltext/ED596827.pdf.

Wijaya, S., Nursehah, U., & Dewi, F. S. (2021). Penggunaan Alat Peraga Peredaran Darah Manusia Untuk Meningkatkan Hasil Capaian Belajar IPA Di Sekolah Dasar. *Ibtida'i: Jurnal Kependidika Dasar*, *8*(1), 1–10. https://doi.org/10.32678/ibtidai.v8i1.4261.