Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram
https://e-journal.undikma.ac.id/index.php/prismasains/index
e-mail: prismasains.pkpsm@gmail.com

April 2025. Vol. 13, No. 2
p-ISSN: 2338-4530
e-ISSN: 2540-7899
pp. 204-220

The Use of Padlet Application as a Reflection Tool for Science Teachers' Teaching Practice: A Mixed Methods Study

***Sri Wahyuni, Wirawan Fadly**
Tadris IPA Department, Faculty of Education and Teacher Training, IAIN Ponorogo, Ponorogo, Indonesia

*Corresponding Author e-mail: wahyuniis2021@gmail.com

Received: February 2025; Revised: March 2025; Published: April 2025

Abstract

Many science teachers have not yet used reflection as a means of learning evaluation, making it difficult for them to identify problems and find solutions. They also face challenges in determining the right medium for reflection. This study aims to explore the use of Padlet as a reflection tool for science teachers. A mixed-method approach was employed, involving three science teachers as qualitative data sources and 52 students as quantitative research subjects, divided into two classes. Data analysis was conducted using N-Vivo for qualitative data and SPSS for quantitative data, with t-tests and N-Gain tests applied to test the hypotheses. The results indicate that all three teachers agreed that using Padlet significantly improves learning quality. Quantitative data confirms the effectiveness of Padlet in enhancing reflective skills, with a t-test result of 0.000 and an N-Gain score of 75%. These figures indicate that learning with Padlet, integrated with the Group Investigation model in the experimental class, is categorized as effective. This study serves as a reference for science teachers to innovate in using technology for learning reflection, as Padlet has been proven to facilitate reflection for both teachers and students in science education.

Keywords: Instructional Media, Reflection, Group Investigation Learning Model, Padlet Application, Science Teachers

How to Cite: Wahyuni, S., & Fadly, W. (2025). The Use of Padlet Application as a Reflection Tool for Science Teachers' Teaching Practice: A Mixed Methods Study. *Prisma Sains : Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram, 13*(2), 204-220. doi:https://doi.org/10.33394/j-ps.v13i2.14942

https://doi.org/10.33394/j-ps.v13i2.14942

INTRODUCTION

The Industrial Revolution 4.0 era has brought significant changes in various aspects of life, including education (Halimurosid, 2022; M. U. Lubis et al., 2023). The rapid development of information technology requires students to possess skills beyond mere academic knowledge (Dewi, 2019; Kim et al., 2025; Карінцева et al., 2020). In this era, students need to be equipped with 21st-century skills, such as effective communication, teamwork, critical thinking in problem-solving, and creativity in facing challenges. Schools play a crucial role in preparing students to navigate an increasingly digital and competitive world Learning should not only focus on theory but also integrate technology and innovative teaching methods to enhance students' practical skills. Additionally, teachers should encourage students to actively participate in discussions, collaborate in groups, and explore new ideas that can improve their competitiveness (Ansya, 2023; Istiqomah et al., 2023). With this approach, students are expected to adapt to the changing times, become more independent and innovative individuals, and be well-prepared to face future challenges.

The learning of Natural Sciences requires both students and teachers to possess abilities that can support all the needs of the education world (Ramadhan et al., 2024). Most Natural Sciences teachers experience difficulties in carrying out teaching practices, particularly in

focusing on teaching and managing students in the classroom (Stenberg & Maaranen, 2022). Teachers are also required to understand effective teaching methods so that students can receive and comprehend the material well (Killen & O'Toole, 2023). The Natural Sciences subject has several important characteristics, including logical, critical, creative, and innovative thinking abilities. Natural Sciences teaching also emphasizes appreciation for diversity, discipline, independence, and responsibility. Students are encouraged to be environmentally conscious and to love science (Amarullah, 2024). Therefore, reflection skills are emphasized as a guide for both teachers and students in achieving better learning objectives (Slade et al., 2019; Veine et al., 2020). Through reflection, teachers can evaluate the effectiveness of the teaching methods they use, while students can review their understanding of the material and their attitudes during the learning process (Oo et al., 2021).

Reflection is defined as an activity aimed at reviewing the entire problem-solving process that students have undertaken comprehensively (Costello, 2020; Sümen, 2023). Through reflection, students are encouraged to motivate themselves and find learning methods that best suit their needs (Silver et al., 2023). In this process, students are invited to identify mistakes, successes, and the steps taken in solving a problem, allowing them to refine or enhance their critical thinking skills (Muthmainnah et al., 2022). The reflection process not only helps students understand the learning process they have experienced but also strengthens their ability to self-evaluate, increases intrinsic motivation, and ultimately guides them towards better achievements in solving the problems they encounter (Baresh, 2022).

Reflection in Natural Sciences learning is a systematic process carried out by both teachers and students to analyze, evaluate, and improve the effectiveness of the learning process based on past experiences (Lynch et al., 2021). Reflection aims to reassess the methods, strategies, and approaches used in learning so that improvements can be made to achieve optimal learning outcomes (Nabi & Somerville, 2024). Reflection-oriented Natural Sciences learning aims to develop individuals who not only have deep scientific understanding but also strong character and the ability to face various challenges positively and productively (Indriyani et al., 2023). Reflection in Natural Sciences learning is not limited to pedagogical aspects but also includes students' conceptual understanding of scientific phenomena and how they apply scientific methods to solve problems (Ali, Kaigere, et al., 2024). Reflection is carried out by considering various indicators such as conceptual understanding, active participation in experiments, critical thinking skills, and students' ability to connect theory with real-world phenomena (Pratiwi et al., 2019).

Science learning based on reflection requires students to be actively involved in understanding scientific concepts, evaluating their thinking processes, and developing independent problem-solving skills (Aprina et al., 2024; Darwati & Purana, 2021). To support this process, learning media are needed as tools to facilitate reflection more systematically and effectively. Media play a crucial role in bridging abstract concepts with real phenomena (Dwipayana et al., 2020; Ningrum & Dahlan, 2023). The use of learning media such as interactive simulations, experimental videos, and digital-based applications can help students explore scientific concepts more deeply. Additionally, media provide teachers with the opportunity to record, analyze, and evaluate students' responses and understanding, making reflection more objective and data-driven (M. Lubis, 2023).

One digital medium that can be used in reflective learning is the Padlet application. With Padlet, teachers can create digital spaces where students can upload discussion results, compile reflection notes, and share their thoughts on the concepts they have learned (Deni & Zainal, 2018; Purwanto et al., 2024). The real-time collaboration feature allows students to discuss, exchange ideas, and provide feedback on their peers' thoughts, making reflection not only an individual activity but also a social process that enriches collective understanding (Ali, Apriyanto, et al., 2024). Additionally, Padlet's documentation feature enables teachers to conduct in-depth analyses of students' understanding patterns, the challenges they face, and

the effectiveness of the teaching methods applied (Deni & Zainal, 2018). Teachers can review students' notes, track their understanding over time, and design more appropriate teaching strategies based on the collected reflective data. By integrating various media formats such as text, images, videos, and audio, Padlet also provides a richer and deeper reflective experience, allowing students to express their understanding in various ways that match their learning styles (Gill-Simmen, 2021).

By delving deeper into the theory of the Padlet application as a reflection medium in the teaching practices of Natural Sciences teachers, this study utilizes several previous studies. Research conducted by Suryana et al (2024) confirms that Padlet helps improve students' extensive reading skills by providing space to share ideas, discuss, and reflect on their understanding. However, this study focuses more on student learning without considering how Padlet can be used as a reflection tool for teachers to enhance their teaching strategies. Furthermore, Phenwan (2023) in his research shows that Padlet can enhance nursing students' reflection, helping them evaluate their learning experiences more structurally. Additionally, Fadlan (2022) in his research also revealed that Padlet serves as a tool for educators to deliver interactive information, making it a solution to various problems in the education sector. This research proves that Padlet and Educaplay can increase students' motivation and learning outcomes in Geography through a more interactive and technology-based approach. Similarly, Adyani (2023) also expressed the same findings, stating that the use of the Padlet application in learning can increase student participation in Natural Sciences lessons by providing a more interactive and collaborative learning environment. As a digital platform, Padlet Digital Library enables students to access learning materials, share ideas, and discuss more flexibly, both inside and outside the classroom.

From these studies, several key points become the main focus of this research. Most studies have only focused on Padlet's role in improving students' skills, such as writing, reading, learning motivation, and classroom participation. However, few studies have specifically examined how Padlet can be used as a reflection tool for Natural Sciences teachers to improve their teaching effectiveness. Previous studies have only explained how Padlet is used without comparing it with other reflection methods, such as reflective journals, group discussions, or peer mentoring. No studies have compared the effectiveness of Padlet with conventional reflection methods, so it remains unknown whether digital-based reflection is truly superior to traditional reflection in supporting teachers' professional development.

This research focuses on exploring Padlet as a reflection tool for Natural Sciences teachers, not just as a learning medium for students as in previous studies. Additionally, this study uses a mixed-methods approach that combines quantitative and qualitative analysis, enabling a deeper understanding of how teachers use Padlet to evaluate and improve their teaching practices. Unlike previous studies that only describe the use of Padlet, this study also compares the effectiveness of Padlet-based reflection with conventional reflection methods, such as written journals and peer discussions, to identify the advantages and limitations of each method. This research not only provides new insights into the use of technology in teacher reflection but also contributes to the development of a digital reflection model that can be widely applied in science education to enhance professional reflection-based teaching quality.

Preliminary study results at the research site indicate that the average student reflection score is moderate. Students are fairly capable of evaluating their learning progress well and recognizing their strengths and weaknesses in the learning process. However, the teaching methods used by teachers are still dominated by traditional lectures, which do not fully support the optimal development of students' reflection skills. The role of teachers in facilitating reflection, both for students and themselves, needs further exploration. Therefore, further research is needed to examine how more interactive teaching strategies can enhance students' reflection skills and how teachers can optimize their roles in creating a more reflective and dynamic learning environment.

METHODS

This research employs a qualitative and quantitative method using the Exploratory Sequential Design. According to Creswell J.W. & Creswell J.D. in Vebrianto et al., (2020) the Exploratory Sequential Design is defined as research that prioritizes qualitative research first, followed by quantitative research afterward, or vice versa. Each type of research approach used in this design is conducted separately (not simultaneously) (Vebrianto et al., 2020). This research design was chosen because (relate it to the research objectives).

The qualitative data instrument used is an interview focusing on discussions about "Learning Media, Reflection, Group Investigation Learning Model, Padlet Application, and Science Teachers" with three research subjects, namely three junior high school Science teachers. These three Science teachers serve as respondents selected through purposive sampling. According to Hennink, purposive sampling is a sampling technique based on specific considerations, such as selecting samples with more knowledge about the topic discussed or those directly involved in the research (Hennink et al., 2010). The sample was selected based on their direct involvement in the research. Furthermore, the three samples are Science teachers who meet the criteria as individuals with greater knowledge about the topic discussed in the study.

For quantitative data collection, this research uses pretest and posttest questions consisting of 20 questions, including 8 multiple-choice questions, 4 essay questions, and 8 socio-emotional questions. Each type of question is adjusted according to the indicators of reflection ability. The subjects in the quantitative research are seventh-grade students from SMPN "X" in Ponorogo, who serve as participants in the Science teachers' teaching practice using the GI learning model with the Padlet application as a reference for quantitative data. Additionally, three Science teachers are also respondents for qualitative data collection. A total of 52 students participated as research subjects. The sample was selected using purposive sampling, as these two classes were considered to have specific characteristics, such as students' backgrounds, level of engagement in technology-based learning, and experience with group learning, which align with the research objectives.

The teaching practice analysis of Science teachers using the GI learning model with Padlet as a qualitative data reference is conducted using N-Vivo. Meanwhile, quantitative data analysis is performed using a two-tailed t-test to examine the effect of the experiment conducted. The Shapiro-Wilk test is used for decision-making, as the number of respondents in each class does not exceed 50 students a (Hardani, 2020). In formulating the research hypothesis, the researcher aligns it with the research objectives. Thus, the null hypothesis (H0) in this research states: H0: The integration of the Padlet application with the Group Investigation learning model is not effective in improving reflection ability. Once the experiment's influence is identified, the N-Gain test is conducted to determine the extent of the experiment's effectiveness. The N-Gain parameter, as proposed by Hake (2002), Hake, (2002), is detailed in Table 1.

Table 1. N-Gain Measurement Scale

N-Gain Value	Category
< 40	Not effective
40 – 55	Less effective
56 - 75	Quite effective
> 76	Effective

RESULTS AND DISCUSSION

Teachers' Perspectives on Reflection in Learning

In the explanation of the perspectives of Science Teacher 1, Science Teacher 2, and Science Teacher 3, the analysis is based on the theory of Aaron et al. (2021) and Yildiz Durak

(2020) which categorize the discussion into four aspects: Science Teacher, Pedagogy, Evaluation, and Self-Assessment. This categorization facilitates the researcher in analyzing the interview results by focusing on each aspect individually. Each aspect is visualized using a mind map created through NVivo, making it easier for both the researcher and the readers to comprehend. This approach aligns with the study conducted by Mufidah et al (2024) which used a case study method to examine a phenomenon by focusing on specific indicators. Science Teacher 1, Science Teacher 2, and Science Teacher 3 were asked similar questions during the interviews, which were conducted using a semi-structured technique. This technique allows the researcher to explore both the knowledge and experiences of the teachers more comprehensively in relation to the discussed topic (Naila et al., 2023; Wakhudin et al., 2024; Yanti et al., 2024).

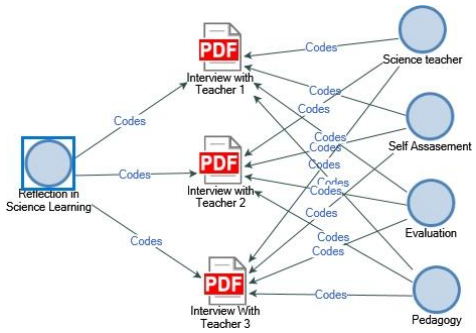

Figure 1. Reflection in Science Learning Based on Interview Coding Results with Science Teacher 1, Science Teacher 2, and Science Teacher 3

The first keyword in the focus of discussion on reflection in science learning can be seen in Figure 2. Science Teachers 1, 2, and 3 each have different perspectives in positioning themselves as teachers in reflection-based science learning. Science Teacher 1 focuses on how they act as the primary guide for their students in each learning process. According to Pramesti et al (2023) teachers play a role in directing students on how they should process their learning experiences. Science Teacher 1 places greater emphasis on the process of delivering lesson material and how students comprehend the taught concepts. This means that learning is directed toward how students and teachers achieve results through collaborative reflection. The outcome is determined by how the learning process unfolds and how the reflection approach applied by Science Teacher 1 is oriented toward direct interaction between teachers and students. In this process, reflection serves as a tool to assess the effectiveness of material delivery and student engagement in understanding the taught concepts. From Figure 1, it is evident that Science Teacher 1 positions themselves as the primary facilitator, guiding learning by providing support to students at every stage of reflection. This aligns with the research by Seco & Cendana (2022) who state that in carrying out the role of a facilitator, the results depend on how the teacher organizes all learning activities to be interactive and meaningful for students. As a facilitator, a teacher is not only responsible for delivering material but also for managing classroom dynamics, ensuring student engagement, and creating a learning environment that encourages active reflection.

Science Teacher 2 interprets reflection-based science learning as requiring greater innovation in determining teaching methods. In their role as a science teacher, they also emphasize the necessity of finding solutions to every problem encountered in the learning process. Science Teacher 2 realizes that reflection in science learning is not just about evaluating previously used methods but also serves as a tool for continuously developing innovations in teaching strategies. Through reflection, they can identify challenges that arise in the classroom, such as lack of student engagement, difficulties in understanding certain concepts, or limitations in the use of learning media. As a science teacher, they feel responsible for finding appropriate solutions to overcome issues encountered during learning. This means

that teachers should not rely solely on previously used methods but must also be open to new approaches that better suit students' needs. This aligns with the research Yildiz Durak (2020) which explains that science teachers must always be prepared for any problems that arise. Science teachers must quickly find solutions to occurring issues, such as selecting more varied and effective teaching methods.

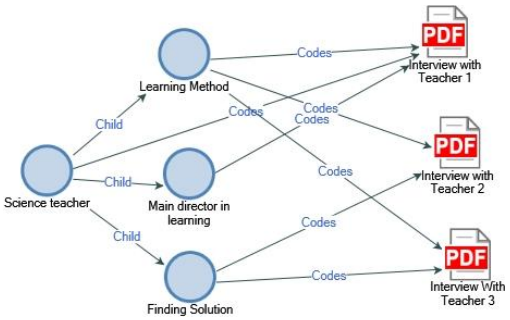

Figure 2. Keywords of Science Teacher in the Coding Review of Interview Transcripts with Science Teachers 1, 2, and 3

Science Teacher 3 expresses a view similar to Science Teacher 2, in which they see a science teacher as someone who must be skilled in finding solutions to each problem through reflection. In their perspective, reflection is not merely an evaluation tool but also a process of finding solutions to challenges in learning. They use reflection to identify obstacles in material delivery, understand students' difficulties, and adjust teaching strategies to be more effective. When encountering problems, they differentiate between major and minor issues, then formulate key questions to find more precise solutions. For example, when they realize that their explanation pace is too fast for students to understand, they seek alternatives such as slowing down the delivery or adding visual aids to clarify concepts. This aligns with the research conducted by Lalu Muhammad Fauzi (2018) which explains that through reflection, a teacher can identify problems in various ways. In prioritizing the effectiveness of problem-solving methods, an initial breakdown of the problem is conducted to determine the main focus of the discussion.

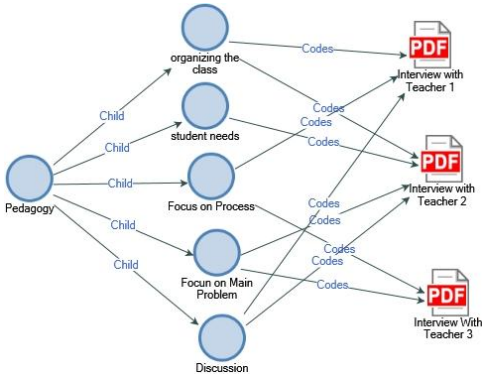

Figure 3. Pedagogical Keywords in the Review of Coding Transcripts of Interviews with Science Teachers 1, 2, and 3

The second keyword, namely Pedagogical Ability, in the discussion focus on reflection in science learning can be seen in Figure 3. Science Teacher 1 focuses more on the learning process itself, reflecting on how reflection is used to evaluate and adjust teaching methods to be more effective. For them, reflection is not just about managing the classroom but more about how students experience and understand the learning process deeply. In their reflection, Science Teacher 1 strives to assess to what extent the strategies applied help students understand scientific concepts, whether through experimental methods, discussions, or project-based learning. Additionally, they see reflection as a means to find new ways to present

material that is more engaging and relevant to students. Science Teacher 1 realizes that science learning based on reflection requires them to be more innovative in determining teaching methods and finding solutions to various challenges that arise during the learning process. Therefore, the reflection they conduct emphasizes improving the quality of students' learning experiences through continuous evaluation. This aligns with the research findings of Prieto et al (2020) which explain that reflection makes individuals more aware of occurring problems, thereby making them more prepared to find brilliant ideas and implement them in their teaching.

Science Teacher 2 emphasizes class organization and meeting students' needs in reflection-based learning. This indicates that for Science Teacher 2, reflection serves as the primary tool to enhance classroom management, whether in terms of teaching strategy arrangements, student interactions, or managing classroom dynamics. Through reflection, they can evaluate the effectiveness of the methods used to deliver material and ensure that every student has an optimal learning opportunity. Moreover, reflection helps them understand how well students have grasped the material being taught and how they interact throughout the learning process. Science Teacher 2 sees reflection not only as a means to identify weaknesses in teaching but also as a tool to improve the quality of learning, making it more structured and goal-oriented. This aligns with the research conducted by Colomer et al (2020) which explains that organizing learning after reflection leads to more effective learning implementation. A well-organized classroom fosters a collaborative and effective learning environment, producing high-quality learning outcomes.

Science Teacher 3 adopts a more analytical and problem-solving approach in utilizing reflection in learning. They highlight a focus on the main issues emerging in learning and the importance of discussion as a key strategy for finding solutions. Science Teacher 3 believes that in the learning process, there are always challenges or obstacles to be addressed, whether from the students' side or from the teaching strategies used. Therefore, for them, reflection becomes a tool to identify problems occurring in the classroom, then categorize them into minor and major issues to be resolved systematically. This way, they can prioritize handling emerging challenges, ensuring that the solutions implemented genuinely positively impact student learning. Furthermore, they use reflection to evaluate the effectiveness of applied teaching methods, then discuss the results with fellow teachers or even students to gain a broader perspective in efforts to improve the quality of science learning. This aligns with the study by Ayu Kartika Dewi & Erman (2021) which compares models of reflective thinking practice, where it is found that reflective thinking involves retrospection, self-evaluation, and reorientation, all of which are crucial in problem-solving.

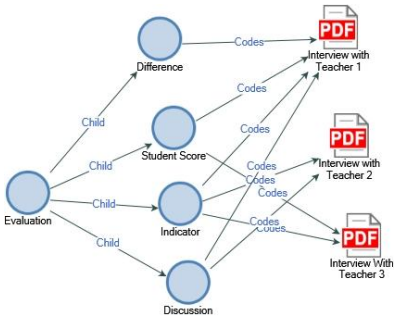

Figure 4. The Keyword *Evaluation* in the Coding Review of the Interview Transcripts of Science Teacher 1, 2, and 3

The third keyword, *evaluation skills*, in the discussion focus on reflection in science learning can be seen in Figure 4. Each teacher has their own way of evaluating their teaching. The figure shows that Science Teacher 1 uses evaluation as a means to assess the differences in students' understanding before and after learning. This indicates that reflection in evaluation plays an important role in measuring the effectiveness of the applied teaching methods and the

extent to which learning impacts students' development. He also utilizes students' scores in each lesson and compares them against the pre-designed indicators. Through discussions and presentations, Science Teacher 1 uses these as an illustration of how much understanding students have gained. According to Handiyati et al (2023) reflection serves as a medium for teachers to evaluate the entire process and assessments conducted.

Science Teacher 2 focuses evaluation on students' responses obtained from discussions. He explains that in his teaching, he always conducts discussions as an evaluation of each lesson. He always sets the words "How" and "What" as indicators in understanding the evaluation results in his learning with students. This aligns with research by Howe et al (2019) which explains that direct dialogue between teachers and students as an evaluation platform in learning provides a different impression for them. Students will have more freedom to express any shortcomings they find in their learning process.

Meanwhile, Science Teacher 3 uses students' test or exam scores based on indicators. This is a very common method used by most teachers in Indonesia, where they focus on score acquisition and compare it with indicators to determine whether student learning is effective or not (Indahri, 2021). This method is considered effective in assessing the effectiveness of learning as a final evaluation in each lesson. However, teachers may face difficulties when encountering a problem where they cannot deeply identify the root cause of the issue (Amany, 2020).

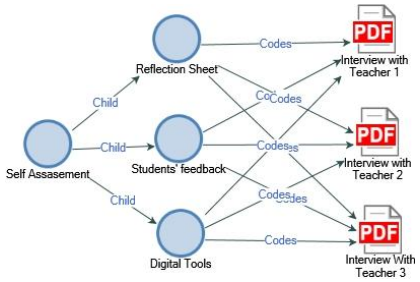

Figure 5. *Self-Assessment* Keyword in the Coding Review of Science Teachers 1, 2, and 3 Interview Transcripts

The fourth keyword, Self-Assessment, in the discussion focus on reflection in science learning can be seen in Figure 5. The figure shows that all three teachers use the same method for self-assessment as a form of reflection on their teaching practices. Science Teachers 1, 2, and 3 utilize reflection sheets to evaluate themselves by asking each student or their guardians to fill out a form provided by the teacher. This allows students to assess teaching practices, understand the effectiveness of the methods used, and identify areas for improvement. Teachers do not only evaluate learning outcomes from the students' perspective but also assess their role in supporting students' understanding (Diasti & Kuswandono, 2020; Graf & Harris, 2016). Science Teachers 1, 2, and 3 also use student feedback as a reference to gauge their teaching effectiveness. This feedback can include students' responses, motivation, and engagement in the learning process, helping teachers determine whether they have successfully facilitated the expected level of understanding. This aligns with the study by Sulistiani & Nugraheni (2023), which suggests that in self-assessment, teachers can observe the classroom atmosphere and student engagement throughout the lesson. From this, teachers can evaluate whether students actively provide feedback, contribute, and participate in discussions during the learning process.

Science Teacher Teaching Practice with Padlet Integration and Group Investigation Learning Model

In introducing the Padlet application as a reflection tool, the researcher invited the three science teachers who were the subjects of the study for an open discussion. This discussion reflected on the teaching process conducted by Science Teacher 1, utilizing Padlet as a medium

for reflection in learning. The reflection was carried out by showing a video of Science Teacher 1's seventh-grade class lesson on each teacher's mobile phone. Then, through the Padlet application, each teacher provided comments and discussion topics on the teaching video. Each teacher shared their comments. The discussion resulted in an output that was visualized as follows.

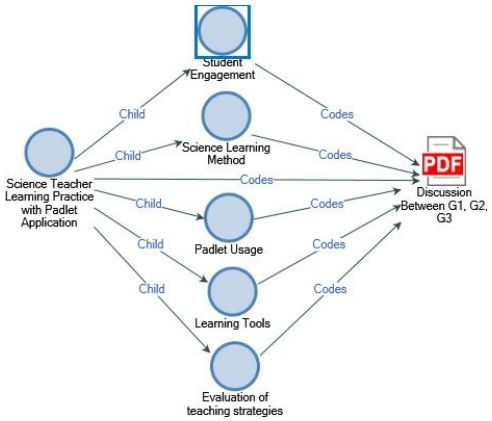

Figure 6. Discussion on the Use of the Padlet Application in Science Learning Based on the Coding Results of the Discussion Between Science Teacher 1, Science Teacher 2, and Science Teacher 3

The discussion between Science Teacher 1, Science Teacher 2, and Science Teacher 3 revealed various important aspects in applying Padlet as a reflection media in science learning. This discussion is divided into several main points that reflect the teachers' experiences and views. First, in the aspect of Student Engagement, the teachers discussed how Padlet can increase students' involvement in learning, especially in providing feedback and more open reflection. Second, in Science Learning Method, they explored how science learning methods can be enriched through Padlet integration, especially in facilitating interactive discussions and exploration of scientific concepts. Furthermore, in Padlet Usage, they reviewed the advantages and challenges in using this application, including the ease of documentation of reflections as well as the technical obstacles faced. The discussion also covered the aspect of Learning Tools, where teachers compared Padlet with other learning tools and the potential integration of various technologies in science teaching. Finally, under Evaluation of Teaching Strategies, teachers highlighted how Padlet-based reflection helped them to evaluate the effectiveness of their teaching strategies and design learning improvements more systematically. By coding these discussions, the research was able to identify important patterns that support the effectiveness of Padlet as a reflection tool for science teachers in improving the quality of their teaching.

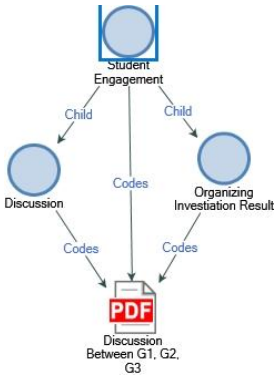

Figure 7. Focus on Student Engagement in Science Learning Using Padlet Media Based on the Coding of the Discussion Transcript of Science Teacher 1, 2, and 3

Learning with the Padlet application in Science subjects highlights how student engagement plays a role in the learning process. From the discussion results, it was explained that throughout the lesson, students actively participated in discussions and organized their findings. The use of Padlet has encouraged students to be more engaged in discussions and express their opinions. This platform provides a reflection space that was previously only conducted verbally, which was not well-documented. Science Teacher 1 explained that students utilized various features available in Padlet, such as *Wall* for openly sharing ideas, *Timeline* for arranging experimental steps sequentially, and *Shelf* for organizing their responses based on specific categories. Additionally, the *Comments* feature allows them to respond to their peers' reflections, fostering more interactive engagement. By using Padlet, students can systematically organize their investigative findings, ultimately deepening their understanding of scientific concepts. This aligns with the research by Subramaniam & Fadzil (2021) which states that the Padlet application offers engaging and highly useful features for learning. These features provide space for students to express ideas, experiment, and explore various aspects that support their learning in Science.

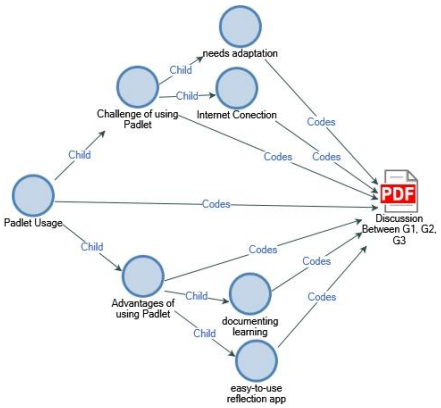

Figure 8. Focus on Padlet Usage in Science Learning with Padlet Media Based on the Coding of the Discussion Transcript of Science Teacher 1, 2, and 3

In a discussion among the three Science teachers regarding the use of the Padlet application as a reflection tool in Science learning integrated with the Group Investigation (GI) model, Science Teacher 1 requested feedback from Science Teacher 2 and Science Teacher 3 on the effectiveness of this strategy. During the first session, Science Teacher 2 and Science Teacher 3 observed that some students were still unfocused and inactive in discussions. Science Teacher 1 explained that this was due to the lack of initial reflection, as the first meeting primarily aimed to assess classroom conditions and students' prior knowledge. Science Teacher 1 stated:

> *"I did not do an in-depth reflection in the first meeting, because I wanted to see how the class dynamics went naturally first."*

However, after the integration of Padlet in the second and third meetings, there was a significant change in student participation. The Science 2 teacher revealed that students seemed more confident in expressing their opinions:

> *"From the second meeting, I see students are more courageous in discussing and conveying their thoughts. It seems to be because they have time to organize their ideas in Padlet before speaking."*

The same thing was also observed by Science Teacher 3, who stated that students became more orderly and structured in delivering their reflections:

"I see that students are starting to be more focused, no more busy themselves or not paying attention. Maybe because they know that the results of their reflections are well documented in Padlet."

In addition to the perceived benefits, teachers discussed the challenges in implementing Padlet. Science teacher 2 mentioned that there were technical obstacles that arose:

"The biggest challenge for me is the internet connection. Sometimes students have problems accessing Padlet, so there needs to be a solution to keep the learning going."

Nevertheless, the integration of Padlet with Group Investigation is still considered effective. Science 3 teacher highlighted Padlet's advantage in documenting learning outcomes:

"With Padlet, students' reflections are more documented. It helps me see the development of their understanding over time."

Science Teacher 2 and Science Teacher 3 agree that this integration enhances learning effectiveness. Science Teacher 2 emphasized:

"I think the combination of Group Investigation and Padlet is very interesting. Not only does it improve students' reflection, but it also makes them more independent in learning."

Based on the discussion results, it was found that both Teacher 2 and Teacher 3 provided similar responses, stating that the integration of the Padlet application as a learning medium with the Group Investigation learning model produced effective and engaging learning outcomes. This approach is seen as one of the ways teachers can enhance the quality of their teaching. According to Boateng & Nyamekye, Padlet is an application that is easy to use and provides benefits in science learning. One of the main features that teachers focus on in Padlet is *documenting*, which functions as a repository for all learning-related aspects such as learning reflections, feedback and suggestions, assignments, and more (Boateng & Nyamekye, 2022). A similar statement was made by Etfita et al. (2022) who stated that Padlet provides a space for teachers and students to support more interactive and flexible learning (Etfita et al., 2022).

To support the interview results regarding the effectiveness of using the Padlet application integrated with the Group Investigation learning model in enhancing reflective abilities, the findings can be further supported quantitatively. According to Creswell (2014), qualitative data is often subjective and difficult to generalize, so quantitative data plays a role in providing more objective and representative numbers or statistics.

Table 2. Normality Test Results

N	Max	Min	Mean	STD DEV
26	60	35	45.96	6.33
26	65	40	53.85	7.52
26	60	35	49.04	7.21
26	100	75	87.50	7.65

Table 3. Normality Test Results

Tests of Normality			
Class	**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**
Pretest Control	0.935	26	0.104
Posttest Control	0.930	26	0.079
Pretest Exsperiment	0.934	26	0.096
Posttest Exsperiment	0.928	26	0.068

Table 4. Two Tailed t test results in Control and Experimental Classes

Class	Instrument Type	Sig	Cronbach Alpha	Description
Exsperiment and Control	Pretest	0.60	0.05	H_0 Accepted

Table 5. Two Tailed t test results in Control and Experimental Classes

Class	Instrument Type	Sig	Cronbach Alpha	Description
Exsperiment and Control	posttest	0.000	0.05	H_0 Rejected

Table 6. N-Gain Test Results in Control and Experimental Classes

Class	N-Gain Value	Description
Experiment	0.750	Effective
Control	0.157	Not effective

The results of the two-tailed t-test show that the improvement in reflective ability in the experimental class is more effective compared to the control class. In Table 5, the post-test significance value of 0.000 (<0.05) indicates a significant difference, while Table 4 shows a pre-test value of 0.60, which is not significant. Thus, hypothesis H1, stating that the integration of Padlet with the Group Investigation model is effective in improving reflective skills, is accepted. These findings support the study conducted by Phenwan (2023) which states that the use of the Padlet application is effective in enhancing students' reflective abilities. According to Phenwan, Padlet provides ease of use, allowing users to operate it effortlessly for specific purposes, Farshad & Fortin (2024) explain that digital collaboration tools can enhance the quality of reflection and metacognition, as they enable users to structure their thoughts more systematically and receive immediate feedback.

These results are further supported by the N-Gain test (Table 6), where the experimental class achieved 0.750 (categorized as effective according to Hake, 2002), whereas the control class only achieved 0.157 (categorized as ineffective). This confirms that using Padlet in learning is more effective in improving students' reflective skills. These findings also align with the study by Reka (2024) which emphasizes that using Padlet for reflection can enhance critical thinking skills, as students can revisit their reflection notes in a more systematically visualized format.

This study provides significant contributions to the field of education, particularly in developing a more systematic technology-based reflection method. Through Padlet, teachers can document their teaching experiences, evaluate the effectiveness of the teaching methods used, and identify various challenges that arise during the learning process. This approach makes reflection a more objective process that can be analyzed in depth through feedback from colleagues and students. Additionally, the application of technology in teaching reflection plays a role in enhancing teacher professionalism by providing a platform that supports data-driven decision-making. Well-documented reflections enable teachers to design more innovative learning strategies tailored to students' needs. Furthermore, the integration of Padlet with the Group Investigation learning model provides evidence that an interactive learning model integrated with engaging educational media can improve students' reflective abilities. The experimental results offer teachers insights into selecting appropriate learning models and teaching media to enhance students' reflection skills.

CONCLUSION

This study highlights how science teachers at SMP "X" in Ponorogo perceive Padlet as a reflection tool. In their interviews, they expressed different ways of reflecting on their teaching. However, after using Padlet, all three teachers shared the same perception that Padlet supports a more systematic and structured learning reflection, leading to increased teaching effectiveness in the classroom. They agreed that this application allows teachers to evaluate

lessons more easily, identify weaknesses in the teaching process, and design more targeted improvements. Quantitative data obtained from the experiment showed a significant difference between the control class and the experimental class. This indicates that the use of Padlet, integrated with the Group Investigation learning model, is effective in improving students' reflective skills. The integration of Padlet with the Group Investigation (GI) model also proved to enhance student engagement in the learning process compared to conventional lecture methods. This study contributes significantly to the field of education, particularly in developing a more systematic technology-based reflection method. Through this research, science teachers can see the application of Padlet as a tool that supports them in reflecting on their teaching practices. Additionally, the application of technology in teaching reflection plays a role in enhancing teacher professionalism by providing a platform that supports data-driven decision-making. Well-documented reflections enable teachers to develop more innovative learning strategies tailored to students' needs. This study also serves as a reference for science teachers to use Padlet as a reflection-based learning tool.

RECOMMENDATION

Building on the qualitative insights and the statistically significant gains in students' reflective skills (t-test $p < 0.001$; N-Gain 0.750) achieved when Padlet was integrated with the Group Investigation model, we recommend that (1) science teachers adopt Padlet—or comparable cloud-based collaborative boards—as a routine medium for structured reflection, pairing it with inquiry-oriented strategies so that students can externalize, revisit, and refine their thinking; (2) school leaders provide sustained professional development that couples digital-tool training with reflective-pedagogy workshops, while simultaneously guaranteeing robust classroom internet access and device availability to minimize the technical barriers noted by teachers; (3) departments institutionalize a cycle of peer discussion and evidence-based lesson study, using Padlet archives and simple pre-/post-tests to triangulate student artefacts, dialogue, and learning data, thereby turning reflection into an ongoing, data-driven improvement loop; (4) teachers augment reflection sheets with student-generated feedback on Padlet to capture both cognitive and affective indicators of learning, enriching evaluation beyond traditional test scores; and (5) researchers and policymakers extend this work by conducting longitudinal, multi-school trials across varied subjects and grade levels, refining guidelines that formally embed digital reflection tools within curriculum standards and teacher-appraisal systems. Collectively, these steps will transform episodic self-evaluation into a continuous, technology-supported practice that advances teacher professionalism and deepens students' metacognitive engagement in science learning.

REFERENCES

Aaron, L., Hicks, J., McKnight, A., & Andary, J. (2021). Reflection as a Tool for Personal and Professional Development. *Radiologic Technology*, *93*(2).

Adnyani, N. M. (2023). Pemanfatan Padlet Digital Library Dalam Meningkatkan Partisipasi Belajar Peserta Didik Kelas XI IPA 3 SMA NEGERI 1 BONTANG. *Sang Acharya: Jurnal Profesi Guru*, *4*(1), 26–36.

Ali, A., Apriyanto, A., Haryanti, T., & Hidayah, H. (2024). *Metode Pembelajaran Inovatif: Mengembangkan Teknik Mengajar Di Abad 21*. PT. Sonpedia Publishing Indonesia.

Ali, A., Kaigere, D., Apriyanto, A., Haryanti, T., & Rusli, T. S. (2024). *Eksplorasi Sains Melalui Inquiry: Pendekatan Inovatif dalam Pembelajaran IPA*. PT. Sonpedia Publishing Indonesia.

Amany, A. (2020). Quizizz sebagai media evaluasi pembelajaran daring pelajaran matematika. *Buletin Pengembangan Perangkat Pembelajaran*, *2*(2), 1–11.

Amarullah, K. (2024). Learning Citizenship Education in Implementing Character Education at Mis Nurus Salam Primary School. *Proceeding of International Seminar On Student Research In Education, Science, and Technology*, *1*, 182–189.

Ansya, Y. A. (2023). Upaya Meningkatkan Minat dan Prestasi Belajar Siswa Kelas IV Sekolah Dasar pada Pembelajaran IPA Menggunakan Strategi PjBL (Project-Based Learning). *Jurnal Ilmu Manajemen Dan Pendidikan*, *3*(1), 43–52.

Aprina, E. A., Fatmawati, E., & Suhardi, A. (2024). Penerapan model problem based learning untuk mengembangkan keterampilan berpikir kritis pada muatan IPA sekolah dasar. *Didaktika: Jurnal Kependidikan*, *13*(1), 981–990.

Ayu Kartika Dewi, V., & Erman. (2021). Pensa E-Jurnal : Pendidikan Sains Model-Model Praktik Berpikir Reflektif Dalam Pembelajaran Ipa: Sebuah Studi Perbandingan. *Pensa E-Jurnal : Pendidikan Sains*, *9*(1), 119–126.

Baresh, E. F. (2022). Developing Libyan Undergraduates'Writing Skills Through Reflective Journaling: A Critical Literature Review. *Journal of English Language Teaching and Learning*, *3*(1), 27–35.

Boateng, S., & Nyamekye, M. (2022). Learning sciences with technology: the use of padlet pedagogical tool to improve high school learners' attainment in integrated sciences. *International Journal of Learning, Teaching and Educational Research*, *21*(5), 239–262.

Colomer, J., Serra, T., Cañabate, D., & Bubnys, R. (2020). Reflective learning in higher education: Active methodologies for transformative practices. In *Sustainability* (Vol. 12, Issue 9, p. 3827). MDPI.

Costello, G. J. (2020). *The Principle of Reflection BT - The Teaching of Design and Innovation: Principles and Practices* (G. J. Costello (ed.); pp. 71–87). Springer International Publishing.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th ed.)*. SAGE Publications.

Darwati, I. M., & Purana, I. M. (2021). Problem Based Learning (PBL): Suatu model pembelajaran untuk mengembangkan cara berpikir kritis peserta didik. *Widya Accarya*, *12*(1), 61–69.

Deni, A. R. M., & Zainal, Z. I. (2018). Padlet as an educational tool: Pedagogical considerations and lessons learnt. *Proceedings of the 10th International Conference on Education Technology and Computers*, 156–162.

Dewi, D. R. (2019). Pengembangan kurikulum di Indonesia dalam menghadapi tuntutan abad ke-21. *As-Salam: Jurnal Studi Hukum Islam & Pendidikan*, *8*(1), 1–22.

Diasti, K. S., & Kuswandono, P. (2020). ' Thriving through Reflecting': Current Perspective on Teacher Professional Development Research in Asia Context. *Journal of English Teaching*, *6*(3), 220–231.

Dwipayana, P. A. P., Redhana, I. W., & Juniartina, P. P. (2020). Analisis kebutuhan pengembangan multimedia interaktif berbasis konteks budaya lokal untuk pembelajaran IPA SMP. *Jurnal Pendidikan Dan Pembelajaran Sains Indonesia (JPPSI)*, *3*(1), 49–60.

Etfita, F., Wahyuni, S., Satriani, E., Alber, A., & Asnawi, A. (2022). Exploring the Use of Padlet in Synchronous Learning: Students' Perceptions of its Advantages and Disadvantages. *JELTL (Journal of English Language Teaching and Linguistics)*, *7*(2), 271–282.

Fadlan, M. S. (2022). *Penerapan Media Padlet dan Educaplay Sebagai Media Assessment Diagnostik dan Kognitif Untuk Meningkatkan Motivasi Belajar dan Hasil Belajar Geografi Siswa Kelas X SMA Islam Nusantara (Studi: Implementasi Kurikulum Merdeka)*. UNISMA.

Farshad, S., & Fortin, C. (2024). *Improving Collaborative Engineering Design and Learning through Feedback Systems in the Age of Digitalization and AI*.

Gill-Simmen, L. (2021). Using Padlet in instructional design to promote cognitive engagement: a case study of undergraduate marketing students. *Journal of Learning Development in Higher Education*, *20*.

Graf, A. J., & Harris, B. R. (2016). Reflective assessment: opportunities and challenges.

Reference Services Review, *44*(1), 38–47.

Hake, R. R. (2002). Relationship of Individual Student Normalized Learning Gains in Mechanics with Gender, High-School Physics, and Pretest Scores on Mathematics and Spatial Visualization. *Physics Education Research Conference*, *8*, 1–14.

Halimurosid, A. (2022). Strategi Pembelajaran Pendidikan Agama Islam dalam Menghadapi Era Revolusi Industri 4.0. *Jurnal Pendidikan Dan Konseling (JPDK)*, *4*(4), 3642–3650.

Handiyati, T., Qomariyah, S., & Kurniawan, J. (2023). Peran Pembelajaran Berbasis Lingkungan Dalam Meningkatkan Pemahaman Peserta Didik Di MI Cimahi Peuntas Kabupaten Sukabumi. *Pendekar: Jurnal Pendidikan Berkarakter*, *1*(4), 86–105.

Hardani. (2020). *Metode Penelitian Kualitatif & Kuantitatif*. CV Pustaka Ilmu.

Hennink, M., Hutter, I., & Bailey, A. (2010). *Qualitative Research Methods*. SAGE Publications.

Howe, C., Hennessy, S., Mercer, N., Vrikki, M., & Wheatley, L. (2019). Teacher–student dialogue during classroom teaching: Does it really impact on student outcomes? *Journal of the Learning Sciences*, *28*(4–5), 462–512.

Indahri, Y. (2021). Asesmen nasional sebagai pilihan evaluasi sistem pendidikan nasional. *Jurnal Masalah-Masalah Sosial*, *12*(2), 195–215.

Indriyani, N., Hanifah, R., & Fitria, Y. (2023). Penilaian Autentik Pada Kurikulum Merdeka Belajar Dalam Pembelajaran Ilmu Pengetahuan Alam (IPA) di Sekolah Dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *8*(1), 28–48.

Istiqomah, N., Lisdawati, L., & Adiyono, A. (2023). Reinterpretasi Metode Pembelajaran Sejarah Kebudayaan Islam: Optimalisasi Implementasi dalam Kurikulum 2013 di Madrasah Aliyah. *IQRO: Journal of Islamic Education*, *6*(1), 85–106.

Karintseva, O. I., Yevdokymov, A. V., Yevdokymova, A. V., Kharchenko, M. O., & Dron, V. V. (2020). Designing the Information Educational Environment of the Studying Course for the Educational Process Management Using Cloud Services. *Mechanism of an Economic Regulation*, *3 (89)*, 87–97

Killen, R., & O'Toole, M. (2023). *Effective teaching strategies 8e*. Cengage AU.

Kim, J., Yu, S., Detrick, R., & Li, N. (2025). Exploring students' perspectives on generative AI-assisted academic writing. *Education and Information Technologies*, *30*(1), 1265–1300.

Lalu Muhammad Fauzi, F. (2018). Identifikasi kesulitan dalam memecahkan masalah matematika. *Jurnal Ilmiah Pendidikan Matematika*, *3*(1), 21–28.

Lubis, M. (2023). Digital learning media in elementary science: stimulating or demotivating? *Assyfa Journal of Multidisciplinary Education*, *1*(1), 18–26.

Lubis, M. U., Siagian, F. A., Zega, Z., Nuhdin, N., & Nasution, A. F. (2023). Pengembangan kurikulum merdeka sebagai upaya peningkatan keterampilan abad 21 dalam pendidikan. *ANTHOR: Education and Learning Journal*, *2*(5), 691–695.

Lynch, M., Kamovich, U., Longva, K. K., & Steinert, M. (2021). Combining technology and entrepreneurial education through design thinking: Students' reflections on the learning process. *Technological Forecasting and Social Change*, *164*, 119689.

Mufidah, A., Fadly, W., & Zayas, J. D. M. (2024). Case Study of Interactive Teaching of Science" Food and Digestive System": Developing Communication Skills Towards Science Literacy of Grade VIII Junior High School Students. *Journal of Science Learning*, *7*(1), 33–46.

Muthmainnah, Ibna Seraj, P. M., & Oteir, I. (2022). Playing with AI to Investigate Human-Computer Interaction Technology and Improving Critical Thinking Skills to Pursue 21st Century Age. *Education Research International*, *2022*(1), 6468995.

Nabi, S. W., & Somerville, D. (2024). The Role of Reflection in Effective Work-Based Learning and Assessment. In *Approaches to Work-Based Learning in Higher Education* (pp. 179–196). Routledge.

Naila, I., Atmoko, A., Dewi, R. S., & Kusumajanti, W. (2023). Pengaruh artificial intelligence tools terhadap motivasi belajar siswa ditinjau dari teori Rogers. *At-Thullab: Jurnal Pendidikan Guru Madrasah Ibtidaiyah*.

Ningrum, P. P., & Dahlan, Z. (2023). Pengembangan Medıa Swıvel Wheel Untuk Menıngkatkan Hasıl Belajar Sıswa Pada Mata Pelajaran IPS Dı Kelas VI Sekolah Dasar. *Jurnal Elementaria Edukasia*, *6*(2), 250–262.

Oo, T. Z., Magyar, A., & Habók, A. (2021). Effectiveness of the reflection-based reciprocal teaching approach for reading comprehension achievement in upper secondary school in Myanmar. *Asia Pacific Education Review*, *22*(4), 675–698.

Phenwan, T. (2023a). Enhancing nursing students' reflection through Padlet: an action research. *MedEdPublish*, *13*.

Phenwan, T. (2023b). *Enhancing nursing students' reflection through Padlet: an action research [version 2; peer review: 1 approved*, *2*.

Pramesti, A. A., Ilmiah, F., & Ramadhani, T. R. (2023). Peran Guru dalam Menumbuhkan Motivasi Belajar Siswa. *PROCEEDING UMSURABAYA*.

Pratiwi, N. P. W., Dewi, N. S., & Paramartha, A. A. G. Y. (2019). The reflection of HOTS in EFL teachers' summative assessment. *Journal of Education Research and Evaluation*, *3*(3), 127–133.

Prieto, L. P., Magnuson, P., Dillenbourg, P., & Saar, M. (2020). Reflection for action: Designing tools to support teacher reflection on everyday evidence. *Technology, Pedagogy and Education*, *29*(3), 279–295.

Purwanto, J., Muliyati, R., stywan Soesanto, D. A., & Wiyananda, A. S. R. (2024). Penerapan Aplikasi Padlet dan Google Meet Dalam Upaya Meningkatkan Hasil Belajar dan Motivasi Belajar Siswa Pada Siswa Kelas XI IPA 2 SMAN 1 Sumberrejo Bojonegoro Menggunakan Model Pembelajaran Discovery Learning. *Journal Educatione*, *1*(2).

Ramadhan, S., Kusumawati, Y., & Aulia, R. (2024). *Pendidikan dan Pembelajaran Dalam Kurikulum Merdeka di Sekolah Dasar*. Penerbit K-Media.

Reka, A. (2024). Pembelajaran Kolaboratif Menulis Teks Rekon Berbantuan Media Padlet Sebagai Sarana Latihan Siswa Kelas IX SMPM 1 Surabaya. *J-SES: Journal of Science, Education and Studies*, *3*(3).

Seco, V. Y. R., & Cendana, W. (2022). Penerapan refleksi pribadi untuk membantu guru menjalankan peran sebagai fasilitator pada pembelajaran daring. *Padma Sari: Jurnal Ilmu Pendidikan*, *1*(02), 103–116.

Silver, N., Kaplan, M., LaVaque-Manty, D., & Meizlish, D. (2023). *Using reflection and metacognition to improve student learning: Across the disciplines, across the academy*. Taylor & Francis.

Slade, M. L., Burnham, T. J., Catalana, S. M., & Waters, T. (2019). The Impact of Reflective Practice on Teacher Candidates' Learning. *International Journal for the Scholarship of Teaching and Learning*, *13*(2), 15.

Stenberg, K., & Maaranen, K. (2022). Promoting practical wisdom in teacher education: a qualitative descriptive study. *European Journal of Teacher Education*, *45*(5), 617–633.

Subramaniam, G., & Fadzil, H. M. (2021). Using Padlet to Enhance Year 11 Students Engagement in Learning Genetic. *Jurnal Pendidikan Sains Dan Matematik Malaysia*, *11*(2), 39–50.

Sulistiani, I., & Nugraheni, N. (2023). Makna guru sebagai peranan penting dalam dunia pendidikan. *Jurnal Citra Pendidikan*, *3*(4), 1261–1268.

Sümen, Ö. Ö. (2023). Reflective Thinking in The Problem-Solving Process: A Model Proposal. *Sakarya University Journal of Education*, *13*(1), 6–23.

Suryana, A. R., Puspitasari, W. T., & Rizqiya, Z. S. (2024). Effectiveness of Using the Padlet Application in Extensive Reading Courses for English Language Education Study Program Students at Wiralodra University. *Manajia: Journal of Education and*

Management, *2*(2), 41–48.

Vebrianto, R., Thahir, M., Putriani, Z., Mahartika, I., Ilhami, A., & Diniya. (2020). Mixed Methods Research: Trends and Issues in Research Methodology. *Bedelau: Journal of Education and Learning*, *1*(2), 63–73.

Veine, S., Anderson, M. K., Andersen, N. H., Espenes, T. C., Søyland, T. B., Wallin, P., & Reams, J. (2020). Reflection as a core student learning activity in higher education-Insights from nearly two decades of academic development. *International Journal for Academic Development*, *25*(2), 147–161.

Wakhudin, W., Barir, B., Rukhmana, T., Ikhlas, A., Sartika, D., & Muarif, S. (2024). Model Pembelajaran Investigasion Based Scientific Collaborative (IBSC) untuk Melatih Ketrampilan Komunikasi dan Kolaborasi Siswa. *Indonesian Research Journal on Education*, *4*(3), 496–503.

Yanti, B. A. S., Adnyana, P. B., Wesnawa, I. G. A., & Ariawan, I. P. W. (2024). Analisis Hasil Belajar Kognitif Siswa Pada Pembelajaran IPA Fisika Kelas X Sekolah Menengah Atas Dengan Pendekatan Konstruktivisme. *Kappa Journal*, *8*(3), 379–387.

Yildiz Durak, H. (2020). The effects of using different tools in programming teaching of secondary school students on engagement, computational thinking and reflective thinking skills for problem solving. *Technology, Knowledge and Learning*, *25*(1), 179–195.