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Enhancing Students' Cognitive and Conceptual Understanding in Biology through Project-Based Learning: An E-LKPD Approach within the Understanding by Design Framework

Egina Bumiarti[1], Ria Yulia Gloria[2*], Evi Roviati[3]

[1,2,3]Tadris Biologi, Universitas Islam Negeri Siber Syekhnurjati Cirebon, Indonesia

*Corresponding author: ria_yulia_gloria@syekhnurjati.ac.id

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ABSTRACT

Purpose – This study addresses the 21st-century curriculum demands by integrating digital literacy and enhancing students' habits of mind (HOM) through meaningful learning. Based on Wiggins' Understanding by Design (UbD) framework, the study aims to analyze the impact of a Project-Based Learning (PjBL) model, assisted by digital E-LKPD, on students' HOM and conceptual understanding compared to traditional teaching methods.

Methodology – A quasi-experimental pretest-posttest control group design was used. Participants were purposively selected and divided into experimental and control groups. The experimental group received PjBL with digital E-LKPD, while the control group followed conventional PBL with printed LKPD. Data were collected using HOM and Wiggins-based understanding tests, student activity observations, and response questionnaires. The Mann-Whitney U test was applied for data analysis.

Findings – The results showed a significant difference in the improvement of HOM and Wiggins-based understanding in the experimental group compared to the control group. Student learning activities and responses in the experimental group also met the excellent criteria.

Novelty – This research uniquely integrates PjBL with digital E-LKPD to enhance thinking habits and foster deep understanding, a combination that is still rarely implemented in secondary education.

Significance – The study offers valuable insights for teachers, curriculum developers, and policymakers in implementing innovative 21st-century learning strategies that combine digital tools with pedagogical approaches, fostering critical and reflective thinking.

Keywords: Habits of mind; Project-based learning; Understanding wiggins.

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1. Introduction

The 21st-century curriculum demands learning methods that are not only adaptive to technological advancements but also capable of cultivating students' critical thinking and digital literacy. However, in many educational settings, particularly in Indonesia, learning practices remain conventional-dominated by teacher-centered instruction and rote memorization. This situation presents a clear problem: students' thinking habits and conceptual understanding are not developing optimally, especially in science subjects like biology. Despite policy reforms and technological innovations, the lack of integrated learning models that simultaneously foster Habits of Mind (HOM), promote deep understanding, and utilize digital media meaningfully remains a persistent issue (Ubaidillah et al., 2022 ;Gloria et al., 2020; Damayanti, 2023 ;Suaidiah et al., 2024;).

The results of the 2022 PISA survey show that the performance of Indonesian students is still relatively low. Science score 383 (Hariri & Kania, 2025; K. K. Putri & Khadijatuzzahra, 2025; Susanto et al., 2024). While there have been some improvements over the years, this score highlights the persistent challenges in achieving meaningful progress in science education. The underperformance reflects a broader issue in the educational system, where traditional methods may not sufficiently foster critical thinking, problem-solving skills, and a deep understanding of scientific concepts.

Habits of Mind refer to a set of intelligent thinking dispositions that individuals use when confronted with problems that require thoughtful decision-making. (Costa & Kallic, 2009). These include persistence, metacognition, managing impulsivity, and thinking flexibly. Meanwhile, Understanding by Design (UbD), developed by Wiggins & McTighe (2008), is a curriculum design framework that defines understanding as a transferable process with six facets: explanation, interpretation, application, perspective, empathy, and self-knowledge. In the context of biology learning, which demands conceptual clarity, real-world relevance, and problem-solving, both HOM and UbD provide a foundation for designing instruction that fosters higher-order thinking and reflective habits. (Faridayanti et al., 2025; Nopriana et al., 2023; Y. Putri & Nurhuda, 2023).

Several studies have explored these individual components. Gloria (2017) and Isfiani (2016), demonstrated that HOM can be developed through inquiry-based methods. Desi et al., (2023), showed that Project-Based Learning (PjBL) enhances critical thinking. Komalasari et al., (2024) highlighted the potential of E-LKPD to improve engagement, while Trissa et al., (2022) noted that many digital learning tools lack contextual relevance. However, existing literature tends to examine these elements separately, without integrating HOM, UbD, PjBL, and digital learning tools into a cohesive instructional design. This integration gap is crucial, as a unified model can offer a more holistic solution to improving biology learning outcomes in the 21st century.

This study was conducted at the Indonesian School of Kota Kinabalu (SIKK), Sabah, Malaysia, which serves children of Indonesian migrant workers. The school operates under unique circumstances, often facing limited educational resources, outdated teaching models, and sociocultural constraints. Preliminary observations at SIKK revealed that the highest HOM indicator among students was responding with wonderment and awe score of 93, while metacognition was the lowest score, 63. In contrast, at SMAN 1 Sumber, learning was still conventional, leading to passive student engagement and a weak understanding of biology Ayuni, et.al, (2025). These findings justify the need for an innovative learning approach that is both contextually responsive and pedagogically effective (Darji, 2023; Firman & Ida Bagus Putu Arnyana, 2023; Kania et al., 2025; Masyitoh et al., 2023; Nur & Pratiwi, 2024) .

The objective of this study is to investigate the impact of integrating Project-Based Learning (PjBL), supported by digital E-LKPD, on students' development of Habits of Mind (HOM) and their understanding as framed by Wiggins' Understanding by Design (UbD) model in the context of biology education. Additionally, the study aims to explore students' perceptions and responses to this instructional model, providing insights into its effectiveness in fostering deeper cognitive engagement and conceptual understanding. By integrating PjBL, E-LKPD, HOM, and UbD into a single model, this study contributes a novel instructional design that addresses current gaps in theory and practice. It provides insights for educators, curriculum developers, and policymakers on how to implement 21st-century learning that is reflective, technology-integrated, and grounded in transferable understanding, especially within underserved educational contexts.

2. Methods

This study employed a quantitative experimental method with a pretest-posttest control group design. This quasi-experimental design is suitable for examining differences in learning outcomes between two groups in natural classroom conditions, where full randomization is not feasible. The pretest and posttest allow the measurement of changes before and after the intervention.

The research was conducted during the second semester (even) of the 2024/2025 academic year, specifically from January 20 to February 24, 2025, at SMA Negeri 1 Sumber, located on Sunan Malik Ibrahim Street, Sumber District, Cirebon Regency, West Java, Indonesia. The population included all 439 tenth-grade students across 12 classes. The sample was selected using purposive sampling, with inclusion criteria such as active enrollment in biology classes, regular attendance, and access to digital devices (Rustamana et al., 2024). Two classes were chosen: Class X-5 (control group, 37 students) and Class X-7 (experimental group, 35 students), ensuring balanced and manageable group sizes for instructional intervention. Before data collection, ethical approval was obtained from the school administration, and informed consent was received from students and their guardians.

The topic covered in both groups was "Environmental Changes", as per the Indonesian biology curriculum. The intervention spanned 5 weeks, with 2 sessions per week, and each session lasted 90 minutes. Experimental Group Students were taught using the Project-Based

Learning model integrated with digital E-LKPD. The E-LKPD was designed with interactive features, multimedia content, HOM-based questions, and Wiggins' UbD alignment. Control Group Students received instruction using conventional PBL and printed LKPD. The same subject matter and duration applied, but without the integration of digital or HOM/UbD elements. Teachers followed a more traditional lesson structure. In both groups, the teacher acted as the facilitator, while the researchers supervised the implementation and collected relevant data.

Table 1 - Data Collection Techniques

Purpose	Instruments	Describe	Data Collection Procedures	Data analysis
Student activities	Observation sheet	20 items based on 6 indicators of active engagement during the PjBL stage, adapted from (Damayanti, 2023) 4-point rating scale.	Data collection procedure by teachers with observers during the PjBL model intervention in the classroom	Using Microsoft Excel for data tabulation and SPSS 25 for data analysis
Habits of Mind	Questionnaire sheet	32 items consisting of 16 positive and 16 negative items based on 16 HOM indicators adapted from (Costa and Kallic, 2009), 4-point rating scale for positive items and vice versa for negative items	Procedures for data collection by the teacher at the beginning of the lesson and after the lesson in the classroom	Using Microsoft Excel for data tabulation and the Mann-Whitney U test from SPSS 25, Significance level set at α = 0.05.
Understanding Wiggins concepts	Question (Pretest and Posttest)	30 questions based on 4 HOM indicators adapted from (Wiggins & McTighe, 2008), using a maximum score of 100. Before implementation, the questions were analyzed using the Anates application, yielding the following results: 0.8 validity, 0.93 high reliability	Procedures for data collection by the teacher at the beginning of the lesson with pretest questions and after the lesson with posttest questions in the classroom	Using anates for question analysis, Microsoft Excel for data tabulation, and the Mann-Whitney U test from SPSS 25, Significance level set at α = 0.05.
Student Response	Questionnaire Sheet	20 items consisting of PjBL learning responses and the use of E-LKPD with a 4-point scale for positive items and vice versa for negative items (Sugiyono, 2017).	Procedures for data collection by teachers at the end of learning	Using Microsoft Excel for data tabulation and SPSS 25 for data analysis

This study obtained ethical clearance from the Research Ethics Committee of SMA Negeri 1 Sumber.

3. Results and Discussion

3.1. Results

3.1.1 Student Engagement in Biology Learning Using the E-LKPD-Assisted PjBL Model

This figure illustrates the sequential stages of student activities involved in the implementation of the Project-Based Learning (PjBL) model, supported by digital E-LKPD, in biology education. It highlights the key phases in which students engage, from initial problem identification and research to collaborative project development and final presentation. The diagram emphasizes how each stage contributes to the development of students' critical thinking, problem-solving skills, and deep understanding of biological concepts. By detailing these stages, the figure aims to provide a comprehensive overview of the E-LKPD-assisted PjBL learning process.

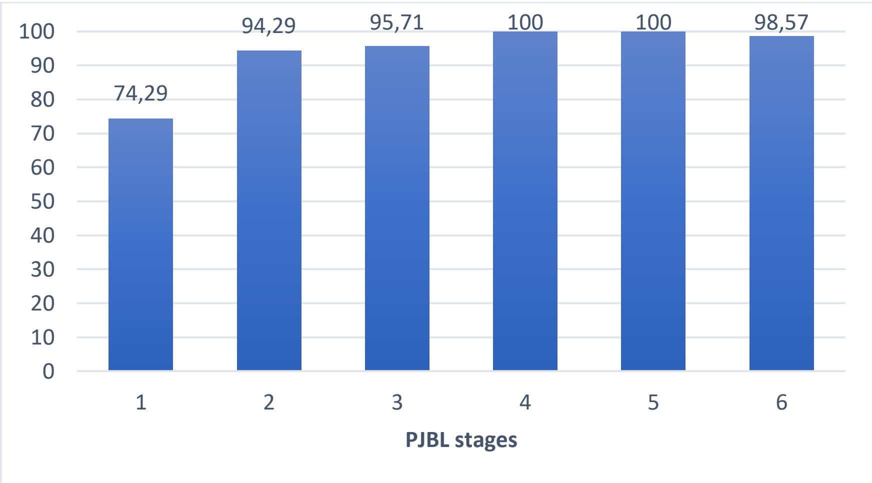

Figure 1. Stages of Student Activities in the Application of the E-LKPD-Assisted PjBL Model

Figure 1 shows that the results of the research on student activities by applying the PjBL learning model assisted by E-LKPD with products from waste materials show that 1 stage of good criteria and 6 stages of very good criteria, which have the same high value, namely stages 4 and 5 of 100%. The product assessment criteria include: 1) The selection of materials used, 2) The usefulness of each material used, 3) Product innovation, and 4) Product appearance. The following presents the value of the results of the experimental class product in Table 2:

Table 2 - Data Collection Techniques

Group	Product Type	Score
1	Soap resulting from the fermentation of fruit peels	81
2	Pencil Box made of plastic bottles and straws	75
3	Coconut shell glass	81
4	Mirror made of a plastic spoon	88
5	Decoration made from shellfish waste	94
6	Plastic pot	88

The data in Table 2 shows that the activity of making crafts from waste management consists of 6 groups out of a total of 35 students. The highest score was obtained by group 5 with a score of 94, including a very good criterion, because the product was made from shell waste used as a decoration. Meanwhile, the lowest value was obtained for type 2 of product with a value of 75, including good criteria, because the product was made with new plastic bottles and straws and did not use waste. So it can be concluded that students make products that vary from group to group and are different. The products produced by the students are the result of applications in environmental pollution materials.

3.1.2 Comparison of HOM Scores between Students Using and Not Using the E-LKPD-Assisted PjBL Model

The highest indicator, with a score of 92 in the experimental class, was in the 3rd indicator, namely empathy, and the 16th indicator, namely continuous learning, while the indicator with the lowest score of 76 was the 10th indicator, namely utilizing the senses in collecting and processing data. This improvement shows that students are able to understand the impact of environmental change emotionally and are encouraged to continue learning and actively engage in environmental issues. On the other hand, the indicator with the lowest score, the 10th indicator (utilising the senses in collecting and processing data), only reached a score of 76, indicating that students' direct observation skills still need to be improved.

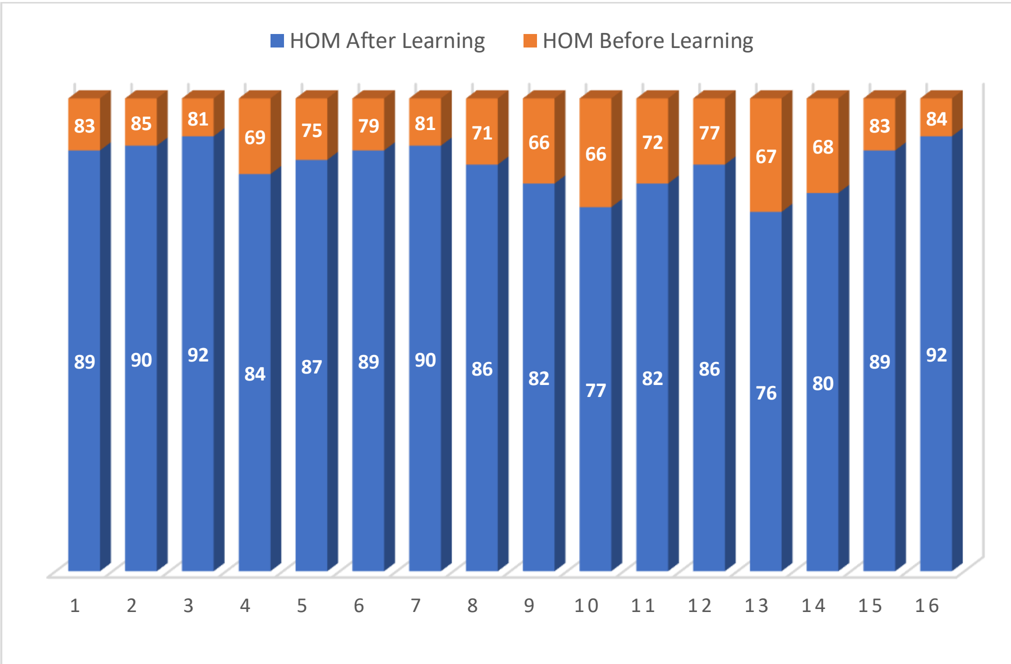

Figure 2. Average HOM Values Per Experimental Class Indicator

Before the treatment, the experimental class displayed a range of performance levels, with 3 indicators (18.75%) categorized as Excellent, 8 indicators (50%) in the Good category, and 5 indicators (31.25%) in the Adequate category. This suggests that while students demonstrated a moderate level of proficiency, there was considerable room for improvement, especially in areas classified as Adequate. However, following the intervention, a significant improvement was observed, with 10 indicators (62.5%) moving to the "Very Good" category, and 6 indicators (37.5%) remaining in the "Good" category. Notably, there were no indicators in the Adequate category after the treatment, indicating that all students progressed to at least a "Good" level of performance or higher.

This shift highlights the positive impact of the treatment, which likely involved targeted instructional strategies aimed at addressing areas where students initially struggled. The increase in the number of "Very Good" indicators demonstrates that the treatment not only improved students' performance but also enabled them to achieve a higher level of mastery. The absence of indicators in the Adequate category post-treatment further underscores the effectiveness of the intervention in bridging learning gaps and boosting students' overall competence. Overall, these findings underscore the success of the treatment in fostering substantial academic progress and improving the consistency and quality of students' learning outcomes.

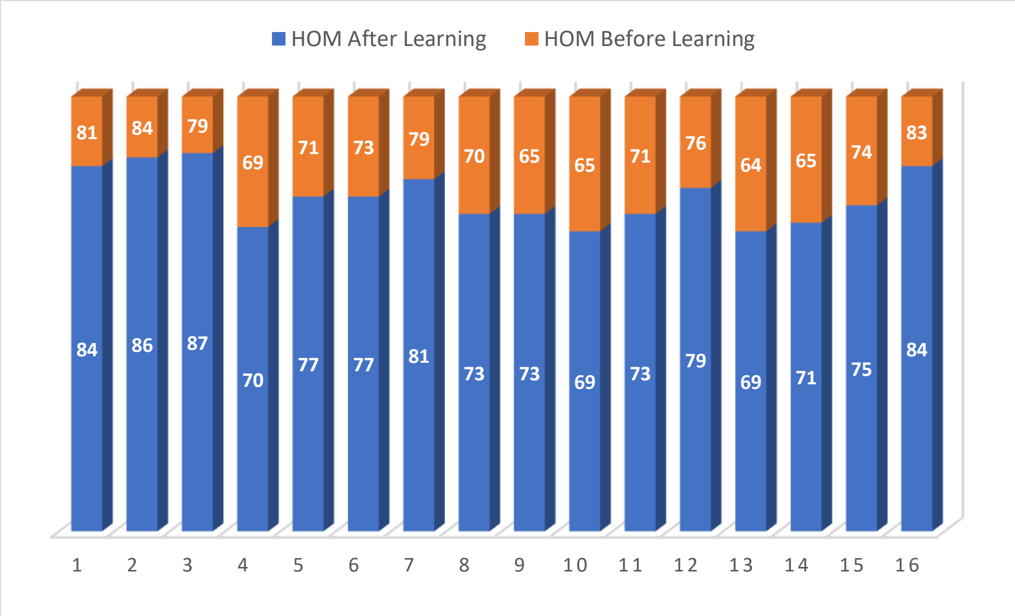

Figure 3. Average HOM Values Per Control Class Indicator

In the control class, the highest score was achieved in the third indicator, empathy, with a score of 87, indicating that students demonstrated concern for environmental issues. However, the lowest scores were observed in the 10th indicator, which measures the use of the senses in collecting and processing data, and the 13th indicator, which assesses the courage to take responsibility and face risks, both of which scored only 69. These low scores suggest that students have limitations in critical thinking skills and a reluctance to take action in the learning context.

Before the intervention, no indicators were categorized as "Very Good." A total of 11 indicators (68.75%) fell into the "Good" category, while 5 indicators (31.25%) were categorized as "Adequate." After the intervention, 2 indicators (12.5%) improved to the "Very Good" category, 11 indicators (68.75%) remained in the "Good" category, and 3 indicators (18.75%) were still categorized as "Fair." This improvement is further supported by the N-Gain test results, which revealed that the average increase in the Habits of Mind (HOM) of students in the experimental class was higher than that of the control class. This indicates that the treatment implemented in the learning process was effective in enhancing students' Habits of Mind.

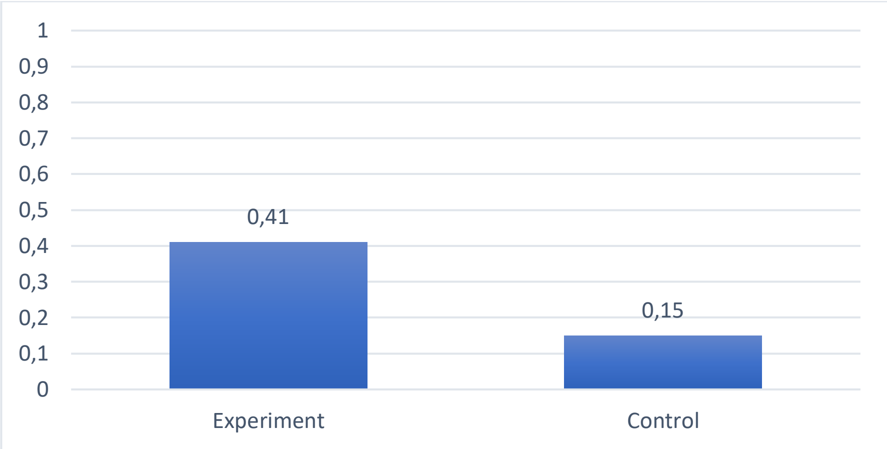

Figure 4. Average Value of N-Gain HOM

The N-Gain value for the experimental class was 0.41, classified as medium, while the N-Gain value for the control class was 0.15, classified as low. Based on the data interpretation presented in Figure 2, it is evident that there is a significant difference in the N-Gain of the Habits of Mind (HOM) between the experimental and control classes, with the experimental class showing a higher value by 0.26%.

3.1.3 Wiggins-Based Understanding Scores: Students Using vs. Not Using the E-LKPD-Assisted PjBL Model

The results of the Wiggins understanding assessment, comparing students in the experimental and control groups, were analysed based on the Wiggins framework, which includes the aspects of explanation, interpretation, application, and perspective. These aspects reflect the students' understanding of biological learning, as demonstrated by their responses and performance in each area.

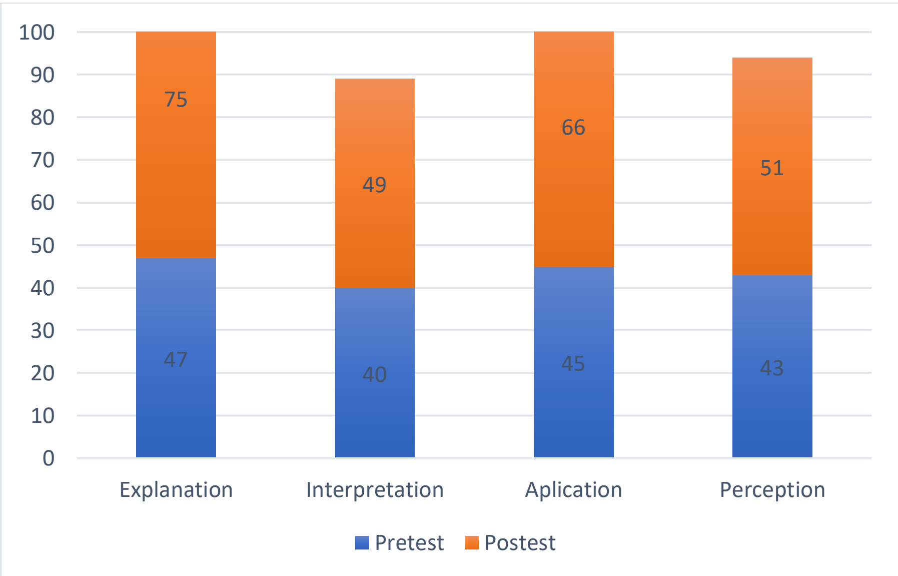

Figure 5. Pretest and Posttest Average Scores Per Aspect of the Experimental Class

As a result of the experiment class, the increase in grades occurred in all aspects. The aspect with the highest improvement is application, from a pretest score of 47 to a posttest score of 75. In the learning process, students carry out projects with the theme of waste management, which requires them to identify waste problems in the surrounding environment, formulate solutions, and present the projects they have made. Through this project, students are involved in discussions, information gathering, and the preparation of scientific explanations related to the causes and impacts of environmental problems they encounter. This contributes greatly to the improvement of the explanatory aspect, because students are required to convey explanations logically and scientifically based on the results of their observation and understanding.

The increase in the interpretation aspect is still relatively low, from 40 to 49. One of the reasons is that students have difficulty relating the data found to a deeper meaning or the long-term consequences of the environmental problems observed. In project activities, students' focus is often directed to the implementation of tasks and the preparation of practical solutions, so that the process of interpreting data or reflecting on cause-and-effect relationships has not been explored to the maximum.

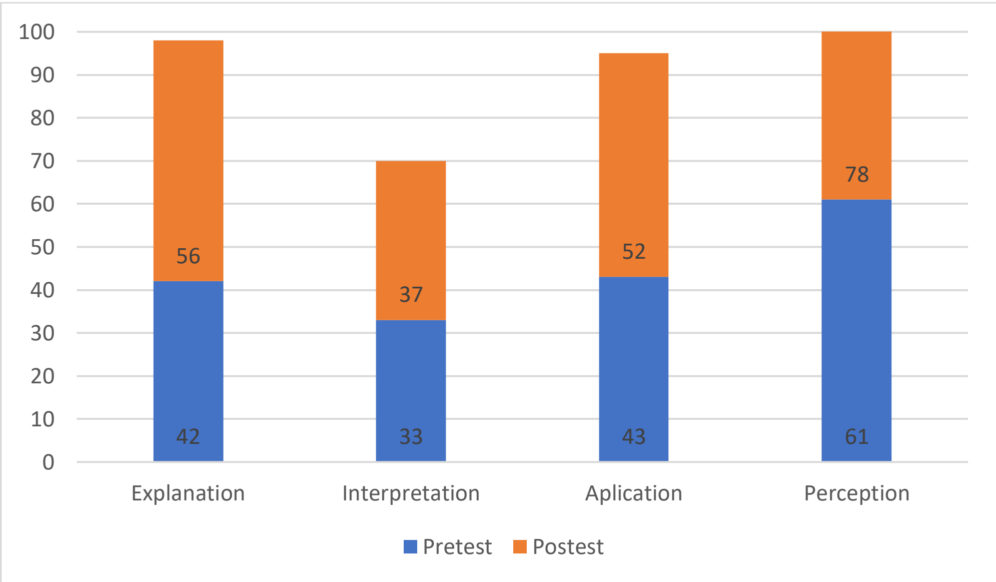

Figure 6. Pretest and Posttest Average Scores Per Control Class Aspect

The control class also showed improvements across all aspects, but the gains were not as substantial as those in the experimental class. The aspect with the highest increase in the control class was perspective, which improved from a score of 61 to 78. This indicates that, despite the use of printed LKPDs, students were still able to broaden their perspectives on environmental issues. However, the aspect with the lowest improvement was interpretation, which increased from 33 to 37. This suggests that students' ability to understand and interpret information has not developed as effectively as other skills, highlighting the need for further intervention in this area.

The following presents the average N-Gain learning outcomes of Wiggins' understanding for students in both the experimental and control classes.

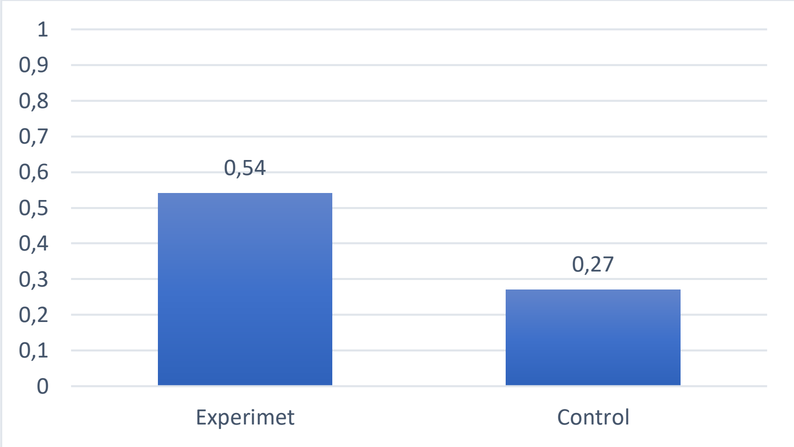

Figure 7. Average N-Gain Understanding of Students

Figure 7 shows the difference in the increase in the N-Gain value of students' Wiggins understanding learning outcomes between the control class and the experimental class. The N-Gain value of the experimental class was 0.54 with the criterion of medium, while the N-Gain value of the control class was 0.27 with the criterion of low. Based on the results of the data interpretation in Figure 3, it shows that there is a difference in the N-Gain value of the learning outcomes of Wiggins understanding students in the experimental class is higher than that of the control class, where the difference between the two is 0.27%.

3.1.2 Student Response to the Implementation of E-LKPD-Assisted PjBL in Biology Learning

Students' responses to the Application of the E-LKPD-assisted PjBL Model in Biology Learning were measured using a questionnaire given in class X.7 (experimental class). The questionnaire was prepared from 2 dimensions, namely students' responses to the PjBL learning model and students' responses to the use of E-LKPD.

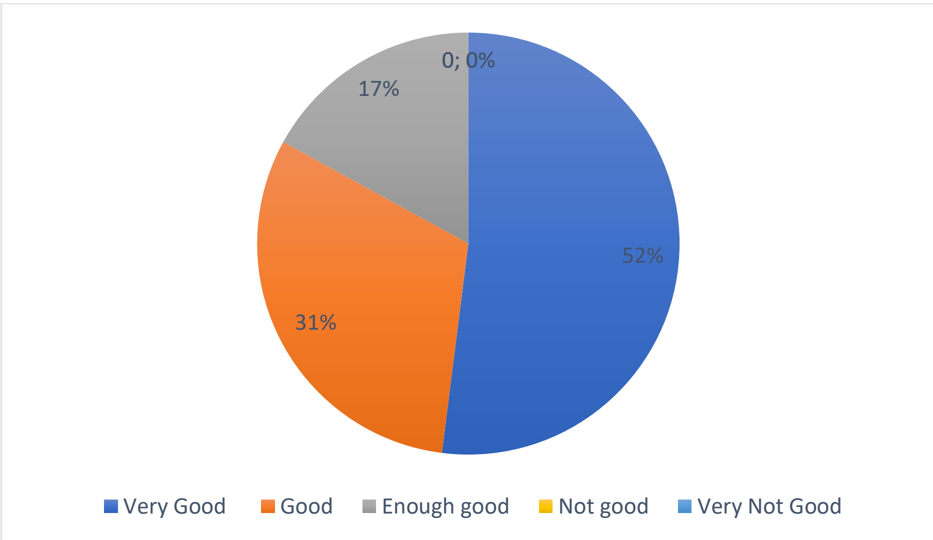

Figure 8. Students' Responses to the Implementation of the E-LKPD-assisted PjBL Model

Figure 8 shows the results of the percentage of student responses to the implementation of the E-LKPD-assisted PjBL learning model. Based on a recap of the 20-statement questionnaire data consisting of 10 positive statements and 10 negative statements given to

35 students, showed that Most students responded positively. The results interpreted that no student response indicated a poor and very lacking criterion. Students responded very well by 52%, 31% good, and 17% quite well, indicating that students accepted and responded very well to the E-LKPD Assisted PjBL model.

3.2 Discussion

3.2.1 Student Activities

Observation of student activities shows excellent results, where students are actively involved in all stages of project-based learning (Saputra, 2022). The PjBL model provides students with the opportunity to create real works through creative and diverse thinking processes, as well as develop problem-solving skills. The teacher acts as a facilitator who directs students to think critically and actively in completing meaningful projects (Mu & Nwdi, 2024).

Other research shows that the implementation of PjBL can improve students' collaboration skills and learning outcomes because the process demands intense interaction and cooperation in completing projects. (Suaidiah et al., 2024). In addition to improving critical thinking skills, this model also allows students to explore, gather facts, interpret information, and find solutions to contextual problems, such as waste treatment. (Jufri & Hasrijal, 2023).

The success of PjBL is also greatly influenced by the role of teachers as designers and implementers of learning. Teachers must be able to design learning activities, choose appropriate models, determine evaluations, and monitor student development thoroughly (Saputra, 2022). With the active involvement of teachers and students, the learning process will run effectively and have a positive impact on learning outcomes.

3.2.2 Habits of Mind Students

Based on statistical tests, it is known that the value of Asymp. The sig. (2-tailed) Student HOM result of 0.000 is smaller than 0.05, thus it can be said that there is a significant difference in the increase in student HOM in biology learning in the experimental and control classes.

The increase in HOM occurs because each syntax in PjBL provides a hands-on learning experience through project activities that train students' thinking skills. (Costa & Kallick, 2008). HOM supports the development of individual skills, self-regulation, and the ability to systematically formulate and test solutions (Costa & Kallic, 2009). Students who are used to reflective thinking tend to understand concepts more easily and overcome misconceptions in learning, so learning outcomes are significantly improved.

Some studies also emphasize the importance of thinking skills in the learning process. Gloria et al. (2018) states that critical thinking helps individuals relate knowledge to real behavior. Ariyati et al., (2024) Emphasizing that improving thinking habits needs to be integrated into learning so that students can understand the material more easily. Haka et al., (2022) added that HOM helps students manage time, hone intelligence, and foster motivation for continuous learning. Isfiani, (2022) also emphasizing that the thinking skills instilled through cognitive tasks should be directed to form the student's HOM.

Research by Zakiah & Fajriadi, (2020) shows that the Hybrid-PjBL model is effective in improving creative thinking skills and learning independence. Anggraini et al., (2024) also found that PjBL can increase students' creativity through six main learning strategies. Moreover Khoirotin & Shofiyah, (2024) shows that PjBL encourages students to think logically, solve problems, work together, and produce real products as learning outcomes, all of which reflect the reinforcement of aspects in HOM.

3.2.3 Wiggins Understanding of Students

Based on the statistical test using the Mann-Whitney test, it is known that there is a significant difference in the learning outcomes of students' Wiggins understanding in biology learning in the experimental class and the control class. UbD is an effective teaching approach that encourages deep understanding, collaboration, and the achievement of common goals (Ostinelli, 2024; Bilgileri, 2022). The six aspects of UbD help students build conceptual understanding (Wiggins & McTighe, 2005), while the rubric supports quality control and teacher self-assessment (Güneş Savul et al., 2024). With the principles of UbD, students can develop curiosity, critical thinking, and long-term success (Aslam et al., 2024).

Understanding by Design is effective in addressing social problems and increasing activeness and learning outcomes through a project-based approach. (Gilang et al., 2024; Sahid et al., 2024; Setyawan et al., 2024). UbD also encourages the development of critical thinking through a structured curriculum design (Zhang et al, 2024). The integration of formative assessments in UbD helps build students' understanding gradually and forms better thinking habits. (Gloria, 2023; Gloria et al., 2020).

Understanding by Design consists of three stages: setting goals, determining assessments, and designing learning activities (Fujioka-Ito, 2024; Serma Adi et al., 2024). The design also supports the development of students' self-awareness, empathy, and ethical maturity, which are essential for leadership and social responsibility (Shu-yuan & Li-hui, 2024).

Other research by From et al., (2024) The UbD strategy encourages students to have 6 abilities, namely explaining, interpreting, applying, perspective, empathizing, and having self-knowledge. The implications of UbD design have a significant influence on academics in higher education who are involved in curriculum design and the development of pedagogical approaches on a global scale (Dazeley et al., 2024).

The practical implications of this research are very important, especially for teachers as facilitators of contextual and meaningful learning, curriculum designers who want to integrate the UbD model and HOM reinforcement, and education policymakers who want to encourage the use of local digital media such as E-LKPD. However, this study has several limitations, including the limited number of samples in only one school, the potential bias of teachers' skills, and the limitations of the instruments in measuring interpretation aspects in the understanding of UBD.

The main purpose of this study is to analyze E-LKPD-based PjBL on the improvement of HOM and Wiggins' understanding of students. The results obtained support the hypothesis that this approach has a significant positive impact and shows a real contribution to the development of project-based contextual learning models. For further research, it is recommended that this learning model be applied to different schools and regional contexts to test external validity. In addition, it is necessary to develop more specific and in-depth UbD measurement instruments. Further research can also explore the influence of moderation variables such as students' digital literacy or learning motivation on the effectiveness of E-LKPD-assisted PjBL.

4. Conclusions

Student activities in learning using PjBL assisted by E-LKPD have very good criteria, there is a significant difference in HOM and Wiggins' understanding of students who take PjBL assisted by E-LKPD and those who do not use PjBL with E-LKPD. The students' response to the application of the PjBL model is included in the criteria for being very good.

Acknowledgments

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Conflict of Interest

The authors declare no conflicts of interest.

References

Anggraini, D. N., Nurwahyunani, A., & Rahayu, P. (2024). Kreativitas, minat belajar meningkatkan kreativitas dan minat belajar siswa materi perubahan lingkungan dengan menggunakan model project based learning. *Jurnal Biogenerasi*, *10*(1), 766–775.https://doi.org/10.30605/biogenerasi.v10i1.5194

Aslam, A., Ahamd, S., Siller, H. S., & Nasreen, A. (2024). Impact of the Understanding by Design Model on the Science Academic Achievement of Fifth Grade Students in Pakistan. In *Asia-Pacific Science Education* (Vol. 10, Issue 1). https://doi.org/10.1163/23641177-bja10078

Athur L.Costa and Bena Kallic. (2009). *Habits of mind across the curriculum : practical and creative strategies for teachers /*. https://eric.ed.gov/?id=ED444935

Ayuni, I.T.; Bumiarti, E & Roviati, E. (2025). Perception Teachers and Students about the Use of E-LKPD in Implementing the Project Based Learning Model. *Jurnal Biology Science & Education*, *14*(2), 122–133.https://doi.org/10.33477/bs.v14i2.8764

Bilgileri, M. (2022). *Erzincan Üniversitesi Eğitim Fakültesi Dergisi Erzincan University Journal of Education Faculty 2022*. *1*(2021), 138–150.https://doi.org/10.17556/erziefd.1510185

Costa, A. L., & Kallick, B. (2008). *Learning and leading with habits of mind: 16 essential characteristics for success*. ASCD.https://eric.ed.gov/?id=ED444935

Damayanti, et all. (2023). Strategi Pembelajaran Project Based Learning (Pjbl). *Jurnal Pendidikan Sosial Dan Humaniora*, *2*(2), 706–719.https://publisherqu.com/index.php/pediaqu/article/view/178

Dari, W., Hidayat, S., & Wulandari, E. (2024). The Understanding by Design Strategy in 21st-Century Education. *Biosfer: Jurnal Tadris Biologi*, *14*(2), 169.

https://doi.org/10.24042/biosfer.v14i2.15818

Darji, C. M. (2023). Impact of Constructivist Pedagogy in Developing RACE among Children. *Journal of Literature Language and Academic Studies*, *2*(01), 1–5. https://doi.org/10.56855/jllans.v2i1.278

Dazeley, R., Goriss-Hunter, A., Meredith, G., Sellings, P., Firmin, S., Burke, J., & Panther, B. (2024). Agile Backward Design: A Framework for planning higher education curriculum. *Australian Educational Researcher*, *52*(2), 1489–1508. https://doi.org/10.1007/s13384-024-00772-7

Desi, C. R., Hariyadi, S., & Wahono, B. (2023). Pengaruh Model PjBL Berbasis STEM terhadap Keterampilan Berpikir Kreatif dan Hasil Belajar Biologi Siswa SMA. *ScienceEdu*, *VI*(2), 132–138.https://doi.org/10.19184/se.v6i2.42227

Faridayanti, I., Nasrullah, A., Hidayat, A., & Kania, N. (2025). The Impact of the Discovery Learning Model on Mathematical Communication Skills and Study Habits of Junior High School Students. *Indonesian Journal of Teaching and Learning (INTEL)*, *4*(1), 16–29. https://doi.org/10.56855/intel.v4i1.1330

Firman, F., & Ida Bagus Putu Arnyana. (2023). Analysis of Basic Education Policies Related to Facilities and Infrastructure. *International Journal of Contemporary Studies in Education (IJ-CSE)*, *2*(1), 73–77. https://doi.org/10.56855/ijcse.v2i1.306

Fujioka-Ito, N. (2024). Fostering Intercultural Competence: A Case of an Asynchronous Online Japanese Language and Culture Course. *International Journal of Instruction*, *17*(1), 599–618. https://doi.org/10.29333/iji.2024.17131a

Gilang, M. I., Islam, U., & Fatmawati, N. (2024). *TRAINING ON MAKING MERDEKA ' S CURRICULUM TEACHING TOOLS THROUGH THE UNDERSTANDING BY DESIGN APPROACH FOR SOCIAL TEACHERS OF MADRASAH*. 79–87.https://doi.org/10.22219/jpbi.v1013. 36582

Gloria, R. Y. (2017). Efektivitas Pembelajaran Kapita Selekta Biologi Berbasis Masalah Untuk Membentuk Habits of Mind Mahasiswa Calon Guru. *Scientiae Educatia*, *6*(1), 8. https://doi.org/10.24235/sc.educatia.v6i1.1372

Gloria, R. Y. (2023). Improving The Prospective Biology Teachers' Understanding by Applying Formative Assessment in the Stages of Understanding by Design Learning. *Proceeding International Conference*, *00*(4). https://doi.org/10.14421/IJBER.tahun.volumeno

Gloria, R. Y., Sudarmin, S., Wiyanto, & Indriyanti, D. R. (2018). The effectiveness of formative assessment with understanding by design (UbD) stages in forming habits of mind in prospective teachers. *Journal of Physics: Conference Series*, *983*(1). https://doi.org/10.1088/1742-6596/983/1/012158

Gloria, R. Y., Sudarmin, Wiyanto, & Indriyanti, D. R. (2020). Formative assessment with understanding by design to improve students'habits of mind. *Journal of Physics: Conference Series*, *1521*(4). https://doi.org/10.1088/1742-6596/1521/4/042094

Grant Wiggins and Jay McTighe. (2005). Association for Supervision and Curriculum Development. In the Association for Supervision and Curriculum Development (ASCD). (Ed.), *The Praeger Handbook of Religion and Education in the United States: Volumes 1-*

2 (Vol. 1). https://doi.org/10.1097/00006199-195506000-00009

Güneş Savul, E., Doğan, S., & Yazıcılar Nalbantoğlu, Ü. (2024). Understanding by Design (UbD) Ünite Planı Değerlendirmeye ve Geri Bildirim Sağlamaya Yönelik Analitik Rubrik Geliştirme Çalışması. *İnönü Üniversitesi Eğitim Fakültesi Dergisi*, *25*, 807–829. https://doi.org/10.17679/inuefd.1446457

Haka, N. B., Nisa, K., & Masya, H. (2022). Improving the habits of mind of senior high school students toward biology learning through creative problem-solving learning model based on mind mapping: Pre-experimental study. *Assimilation: Indonesian Journal of Biology Education*, *5*(1), 39–50. https://doi.org/10.17509/aijbe.v5i1.44010

Hariri, D. D., & Kania, N. (2025). Mapping Critical Thinking Skills through Newman's Error Analysis in Secondary Students' Problem-Solving. *Jurnal Pendidikan MIPA*, *26*(3), 1464–1478. https://doi.org/10.23960/jpmipa.v26i3.pp1464-1478

Ilma Riksa Isfiani, B. E. (2022). Metacognition Profile on Habits of Mind in Biology Learning Submitted. *Теплоэнергетика*, *2*(8), 14–20. https://doi.org/10.56304/s0040363622080021

Isfiani, R. (2016). Profil Tingkatan Habits Of Mind Dan Kecemasan Kognitif Dalam Mata Pelajaran Biologi Pada Siswa SMADi Kota Bandung. *Biodidaktika*, *11*(2), 53–65.

Jufri, & Hasrijal. (2023). Implementasi Pendidikan Karakter Melalui Pembelajaran Berbasis Proyek. *Journal on Education*, *05*(04), 16523–16528.doi. 10.53889/jpig.v2i2.138

Kania, N., Saepudin, A., & Gürbüz, F. (2025). Assessing cognitive obstacles in learning number concepts: Insights from preservice mathematics teachers. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, 146–166. https://doi.org/10.23917/jramathedu.v10i3.8638

Khoirotin, A., & Shofiyah, N. (2024). Penerapan Model Project Based Learning terhadap Keterampilan Kerjasama Siswa. *Jurnal Biologi*, *1*(4), 1–11. https://doi.org/10.47134/biology.v1i4.2906

Komalasari, B. R., Setiadi, D., Kusuma, A. S. H. M., & Jufri, A. W. (2024). Pengaruh Model Project Based Learning Terhadap Literasi Sains Biologi Kelas X SMAN 7 Mataram Tahun Ajaran 2023/2024. *Jurnal Ilmiah Profesi Pendidikan*, *9*(2), 1237–1242. https://doi.org/10.29303/jipp.v9i2.2232

Masyitoh, M., Bahar, H., Suryadi, A., Bahri, S., Nisoh, A., Niwae, Y., Sama-alee, A., & Sundi, V. H. (2023). Quality Culture Model in Improving Development Madrasah Universitas Islam Negeri Jakarta Indonesia and Ma'had Al Ulum Addiniyah Thailand. *International Journal of Contemporary Studies in Education (IJ-CSE)*, *2*(3), 160–167. https://doi.org/10.56855/ijcse.v2i3.611

Mu, M. A., & Nwdi, A. (2024). PENGARUH MODEL PEMBELAJARAN PROJECT BASED LEARNING(PjBL) TERHADAP KEMAMPUAN BERPIKIR KREATIF SISWA KELAS XMA MU'ALLIMAT NWDI PANCOR. *CocosBio, Jurnal Ilmiah Pendidikan Biologi. Vol. 9, No.1, Hal: 31-35*, *9*(1), 31–35.https://doi.org/10.29408/cob.v9i1.26859

Nopriana, T., Herman, T., & Martadiputra, B. A. P. (2023). Prospective Mathematics Teachers'van Hiele's Geometry Thinking and Habits of Mind: A Description of Hard Skill and Soft Skill by Gender. *International Journal of Mathematics and Mathematics*

Education, 51–60. https://doi.org/10.56855/ijmme.v1i1.231

Nur, S. D. A., & Pratiwi, D. (2024). Establishing Collaboration Practice in an English Young Learner Classroom. *International Journal of Contemporary Studies in Education (IJ-CSE)*, *3*(1), 43–49. https://doi.org/10.56855/ijcse.v3i1.899

Ostinelli, G. (2024). Testing Understanding by Design. *Teachers' Work*, *21*(1), 104–119. https://doi.org/10.24135/teacherswork.v21i1.600

Putri, K. K., & Khadijatuzzahra, K. (2025). Students' Creative Thinking Abilities in Solid Geometry Topics. *International Journal of Geometry Research and Inventions in Education (Gradient)*, *2*(01), 27–41. https://doi.org/10.56855/gradient.v2i01.1397

Putri, Y., & Nurhuda, A. (2023). Hasan Al-Banna's Thought Contribution to the Concept of Islamic Education. *International Journal of Contemporary Studies in Education (IJ-CSE)*, *2*(1). https://doi.org/10.56855/ijcse.v2i1.185

Rustamana, A., Wahyuningsih, P., Azka, M. F., & Wahyu, P. (2024). Penelitian Metode Kuantitatif. *Sindoro Cendikia Pendidikan*, *5*(6), 1- 10

https://doi.org/10.9644/sindoro.v5i6.4186

Sahid, M. R. H., Arisnawati, A., & Saparuddin, S. (2024). Penerapan Model Project Based Learning Untuk Meningkatkan Hasil Belajar Peserta Didik Kelas Vii. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, *14*(1), 9–18. https://doi.org/10.24929/lensa.v14i1.336

Saputra, N. (2022). Pembelajaran Tematik. *Pauddikdasmen Kemendikbud*, 149.

Serma Adi, N. N., Nyoman Oka, D., & Surata, I. K. (2024). Implementasi Pendekatan Teaching At the Right Level (Tarl) Terintegrasi Konsep Understanding By Design (Ubd) Untuk Meningkatkan Motivasi Belajar Siswa Sma Pada Pembelajaran Biologi. *Jurnal Pendidikan Dan Pengajaran: Cendekia*, *25*(1), 157–172. https://doi.org/10.59672/widyadari.v25i1.3662

Setyawan, D. B., Sukomiarti, S., & Zulfikri, Z. (2024). Penerapan Metode Project Based Learning Dalam Meningkatkan Pemahaman Dan Hasil Belajar Siswa Kelas Vii. *IBERS : Jurnal Pendidikan Indonesia Bermutu*, *3*(1), 37–46. https://doi.org/10.61648/ibers.v3i1.107

Shu-yuan, C., & Li-hui, W. (2024). *UbD Framework in Teaching Confucian Filial Piety and Its Relevance in Modern Society* ·. *14*(11), 1048–1054. https://doi.org/10.17265/2159-5836/2024.11.014

Suaidiah, S., Jamaluddin, J., & Hardiana, H. (2024). Penerapan Model Pembelajaran Project Based Learning untuk Meningkatkan Keterampilan Kolaborasi dan Hasil Belajar Biologi di SMAN 7 Mataram Tahun Ajaran 2022/2023. *Jurnal Ilmiah Profesi Pendidikan*, *9*(1), 278–284. https://doi.org/10.29303/jipp.v9i1.1883

Sugiyono, F. X. (2017). *Neraca Pembayaran: Konsep, Metodologi dan Penerapan* (Vol. 4). Pusat Pendidikan Dan Studi Kebanksentralan (PPSK) Bank Indonesia. DOI:10.8734/mnmae.v1i2.359

Susanto, T. T. D., Solihin, R. R., Fauziyah, E. P., Yanti, N. V. I., & Ramadhania, A. P. (2024). Upaya Pemerintah Indonesia Dalam Meningkatkan Kualitas Guru Ditinjau Dari Hasil Pisa 2022: Sebuah Kajian Pustaka. *PERSPEKTIF Ilmu Pendidikan*, *38*(1), 57–

65.https://doi.org/10.21009/PIP.381.6

Trissa, M. A., Fuadiyah, S., Syamsurizal, S., & Anggriyani, R. (2022). Pengembangan lembar kerja peserta didik elektronik (E-LKPD) dengan pendekatan saintifik pada materi sistem koordinasi kelas xi sma. *Bioilmi: Jurnal Pendidikan*, *8*(2), 101–113. DOI: 10.19109/bioilmi.v8i2.13859.

Ubaidillah, M., Marwoto, P., Wiyanto, Rusilowati, A., Subali, B., Mindyarto, B. N., & Isnaeni, W. (2022). Development of Habits of Mind Instruments in the Context of Basic Physics Practicum: EFA and Rasch Model. In *Journal of Educational, Cultural and Psychological Studies* (Vol. 2022, Issue 26). https://doi.org/10.7358/ecps-2022-026-ubai

Wiggins, G., & McTighe, J. (2008). Put understanding first. *Educational Leadership*, *65*(8), 36. https://doi.org/10.4135/9781483343907

Zakiah, N. E., & Fajriadi, D. (2020). Hybrid-PjBL: Creative thinking skills and self-regulated learning of pre-service teachers. *Journal of Physics: Conference Series*, *1521*(3). https://doi.org/10.1088/1742-6596/1521/3/032072

Zhang, X., Su, X., Huang, S., Tian, H., Chen, J., Carvalho, R., & Slotta, J. D. (2024). Applying the Understanding by Design (UbD) Model to Support Critical Thinking and Multidisciplinary Inquiry in the Chinese High School Biology Curriculum. *Proceedings of the 18th International Conference of the Learning Sciences - ICLS 2024*, 2463–2464. https://doi.org/10.22318/icls2024.122460