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State of the Art Review: The Effectiveness of Implementing Problem Based Learning (PBL) Models in Improving Science Learning

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Abstrak

Problem-Based Learning (PBL) merupakan pendekatan pembelajaran yang berpusat pada siswa dan mendorong pembelajaran aktif serta pengembangan keterampilan berpikir tingkat tinggi dalam pembelajaran IPA. Namun, hasil penelitian sebelumnya menunjukkan temuan yang beragam terkait efektivitas PBL dalam meningkatkan hasil belajar. Oleh karena itu, penelitian ini bertujuan untuk mengevaluasi efektivitas model PBL terhadap peningkatan hasil belajar IPA. Penelitian ini menggunakan metode meta-analisis dengan data sekunder kuantitatif yang diperoleh dari artikel ilmiah. Pencarian literatur dilakukan melalui database EBSCO, Google Scholar, dan Taylor & Francis untuk artikel yang diterbitkan pada tahun 2019–2023. Proses seleksi menggunakan kerangka PRISMA dengan kriteria inklusi berupa artikel full-text dengan desain observasional menggunakan kata kunci "problem-based learning", "education", dan "science learning outcomes". Analisis data dilakukan menggunakan aplikasi Review Manager 5.3. Hasil penelitian menunjukkan bahwa model PBL secara signifikan meningkatkan hasil belajar siswa dibandingkan dengan model non-PBL, dengan nilai effect size sebesar 1,09 ($P < 0,001$; 95% CI: 0,29–1,89; $I^2 = 94\%$). Kesimpulannya, PBL merupakan strategi pembelajaran yang efektif dalam meningkatkan hasil belajar IPA serta mendukung proses pembelajaran yang aktif dan kritis.

Kata Kunci: *Problem-Based Learning* (PBL); Hasil Belajar; Meta-Analisis; Pendidikan IPA.

Abstract

Problem-Based Learning (PBL) is a student-centered approach that promotes active learning and higher-order thinking skills in science education. However, previous studies have reported inconsistent findings regarding its effectiveness in improving learning outcomes. Therefore, this

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study aims to evaluate the effectiveness of the PBL model in enhancing science learning outcomes. This research employed a meta-analysis method using secondary quantitative data from published articles. Literature was collected from EBSCO, Google Scholar, and Taylor & Francis databases for studies published between 2019 and 2023. The selection process followed the PRISMA framework with inclusion criteria limited to full-text observational studies using keywords "problem-based learning," "education," and "science learning outcomes." Data were analyzed using Review Manager 5.3. The results show that the PBL model significantly improves students' learning outcomes compared to non-PBL approaches, with an effect size of 1.09 ($P < 0.001$; 95% CI: 0.29–1.89; $I^2 = 94\%$). In conclusion, PBL is an effective instructional strategy for improving science learning outcomes and supporting active and critical learning processes.

Keywords: *PBL; Science Learning Outcomes; Science Education; Meta-Analysis Study.*

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INTRODUCTION

Education in the 21st century emphasizes not only knowledge acquisition but also the development of higher-order thinking skills, including critical thinking, creativity, collaboration, and problem-solving (Septikasari, 2018). In this context, science education plays a strategic role as it is closely related to real-life phenomena and provides opportunities for students to develop analytical and innovative thinking skills. However, current practices in science learning still tend to emphasize memorization and teacher-centered approaches, which limit students' active engagement and thinking processes (Huwaida, Asihanngtyas, & Alviah, 2020); (Aditya Tri Saputra, 2023). As a result, students' learning outcomes and higher-order thinking skills remain suboptimal.

To address this issue, innovative learning models are needed to facilitate active and meaningful learning. Problem-Based Learning (PBL) has been widely recognized as an effective student-centered approach that uses real-world problems to stimulate critical thinking and problem-solving skills (Maryati, 2018; (Karmaham *et al.*, 2026); (Tahir, Tati, & Rahayu, 2023). Empirical studies have shown that PBL can significantly improve students' learning outcomes compared to conventional methods (Azer, 2011; Pourshanazari et al., 2012). These findings suggest that PBL has strong potential to enhance both cognitive achievement and student engagement.

Nevertheless, existing studies on PBL are often limited to specific contexts and yield inconsistent results. Moreover, there is a lack of comprehensive synthesis studies that systematically evaluate the effectiveness of PBL in science learning using recent empirical evidence. This indicates a clear research gap that necessitates further investigation. Therefore, this study aims to analyze the effectiveness of the Problem-Based Learning model in improving science learning outcomes through a systematic review and meta-

analysis. This study is expected to provide robust evidence regarding the impact of PBL and contribute to the development of effective instructional strategies in science education.

METHODS

a. Research Studies

Study this aim for look effectiveness application model problem based learning in learning where could increase results study student. This type of research is meta-analysis using secondary data and quantitative for interesting conclusion which accurate form *effect sizes* with literature search of the EBSCO database, Google Scolar and Taylor & Francis. Cross study keywords sectional is as follows: "Problem based learning " and" education " and" science learning outcomes". Analysis and reading of articles were obtained using a search procedure with the PRISMA Technique (Preferred Reporting Items for Systematic Reviews&Meta-analyses)(David Moher *et al.*, 2009) as follows:

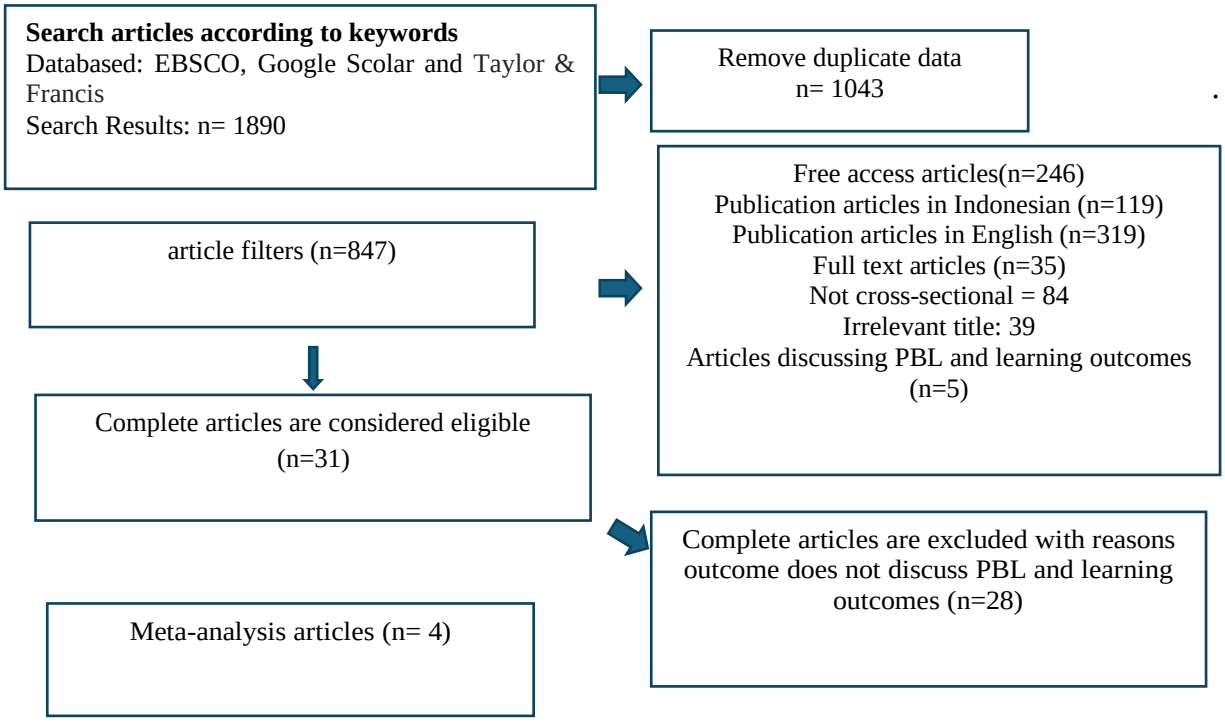

Figure 1. PRISMA Flowchart.

b. Population and sample

The population and sample are the articles included in the research, namely articles that have been published from 2019-2023, the articles studied are full text articles with an observational research design. The research sample was school students who applied the PBL model, the research data

was multivariate and the final result of the study was influence.

c. Criteria inclusion and exclusion

Exclusion in research is a criterion for research subjects not being able to represent the sample because they do not meet the requirements as a research sample (Syahra, 2010) , while inclusion criteria are exclusion criteria, also known as rejection criteria, which are conditions that cause subjects who meet the inclusion criteria cannot be included in the study (Muhtarom, 2015). Inclusion and exclusion criteria in study this is free access articles, articles publication in Indonesian and English, full text articles, no cross-sectional, relevant title

d. Definition operational variable

The operational definition of the variable is discussing PBL and learning outcomes with data analysis carried out use Review application Manager 5.3 with count score effect sizes and heterogeneity for determine model studies combined and form results end from meta-analysis plot forest (Wijiwinarsih *et al.*, 2019).

RESULTS AND DISCUSSION

1. Results

The literature search was conducted using the EBSCO, Google Scholar, and Taylor & Francis databases for articles published between 2019 and 2023. Based on the initial keyword search, a total of 1,890 articles were identified. After applying inclusion and exclusion criteria, 847 articles were retained. Following further screening using the PRISMA framework, only 4 articles met the eligibility criteria and were included in the meta-analysis.

The selected studies originated from two continents, namely Asia and Europe, as illustrated in Figure 2. The meta-analysis was performed using Review Manager 5.3.

The Forest Plot results indicate that students who were taught using the Problem-Based Learning (PBL) model achieved higher learning outcomes compared to those taught using non-PBL models, with a standardized mean difference of 1.09 ($P < 0.001$; 95% CI: 0.29–1.89; $I^2 = 94\%$). This result suggests a statistically significant effect of the PBL model on science learning outcomes.

The heterogeneity test shows a high level of variability among the included studies ($I^2 = 94\%$), indicating substantial differences across study results. In addition, the Funnel Plot analysis (Figure 3) suggests no significant publication bias.

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Figure 2. Map of the Research Study Area

2. Discussion

The significant effect of PBL on students' learning outcomes can be explained by its student-centered approach, which actively engages learners in problem-solving processes. According to constructivist learning theory, knowledge is built through active interaction with the environment. In this context, PBL provides opportunities for students to develop critical thinking, problem-solving skills, and independent learning.

The use of real-world problems in PBL encourages students to connect theoretical knowledge with practical situations, thereby enhancing understanding and retention. This is consistent with cognitive learning theory, which emphasizes meaningful learning through active engagement. Furthermore, PBL facilitates collaborative learning, allowing students to exchange ideas and construct knowledge socially.

Based on the 4 articles analyzed using review manager 5.3, it shows an interpretation: from the results of the forest

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plot it is known that students who are given learning by applying the PBL model have 1.09 units higher to get good learning outcomes compared to students who are given the application of non-PBL models, namely assessment The meta-analysis resulted in the application of the PBL heterogeneity model. The heterogeneity of this article was evaluated using the I^2 parameter. According to ReVMan analysis, we determined I^2 is 93% classification 100% which has good heterogeneity. It was found that to improve learning outcomes using the PBL model is a better model to apply in learning <0.10 (p <0.001; 95% CI: 0.29 – 1.89; I2 = 94%) in Figure 3.

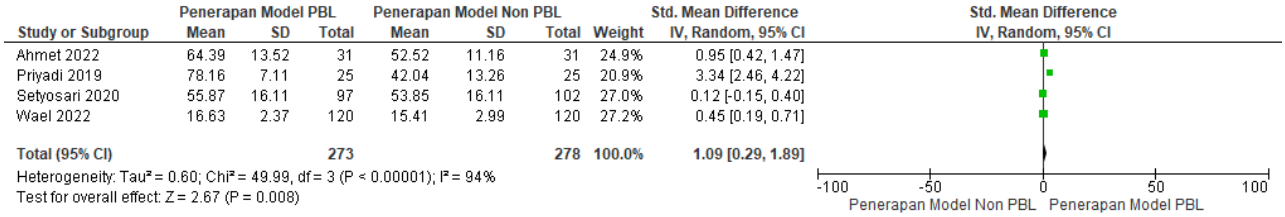

Figure 3. Forest plot the effectiveness of the PBL model on science learning outcomes

Based on research results (Endah Amalia et al., 2022), the use of the PBL model results from hypothesis testing with the t-test showing a significant average of less than 0.05, which means that the use of the PBL model is effective in increasing problem solving abilities. In the meta-analysis study, it was shown that the application of the PBL model was significantly more effective than conventional learning methods in critical thinking in assessing knowledge (p = 0.29), problem solving aspects (p = 0.47), and self-directed learning aspects (p = 0.47). (0.34) (Manuaba et al., 2022).Developing abilities in science learning is very important because these abilities are used in various aspects of everyday human life, an alternative learning model that can develop *critical abilities thinking* and learning outcomes is the PBL model (Widowati, 2009) .

In the problem-solving ability at the end of the study, the mean problem-solving ability of the experimental class was 80.15 while that of the control class was 73.01, meaning that the application of Problem Based Effective learning on problem solving abilities(Dzulfikar et al., 2012). There was a significantly higher increase in the cognitive abilities of students in the experimental class that were treated with the application of the PBL learning model using exe -learning compared to the control class that used the lecture model(Syefriyani, 2018). This is supported by the Funnel from journal 4 funnel plots, it is known that there is no publication bias in Figure 3.

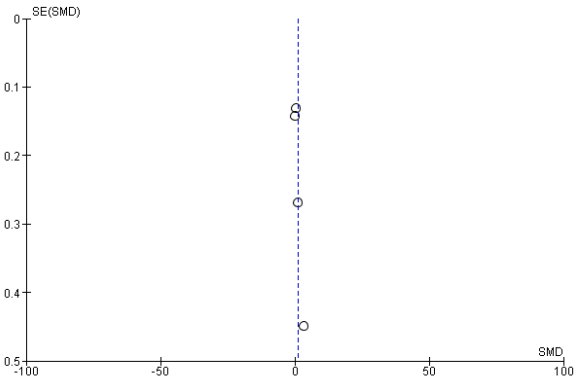

Figure 3. PBL model effectiveness funnel plot.

Based on systematic reviews and meta-analytic research on influence application of *problem based learning* models and results study student own effective influence to results study student . According to the *problem based learning model* could increase results study student (Ningsih & Prasetyo, 2020) , (Ilham, 2018). According to Arends (Trianto , 2009), PBL is a learning model in which students work on problems authentic build knowledge they own , develop inquiry and thinking , develop independence and trust self . PBL was developed According to theory psychology modern cognitive, learning is a process where student in a manner active build his knowledge with interact with environment learn. PBL (*Problem Based Learning*) is a possible learning model student study in a manner structured with solve problems in the real world , so expand knowledge student (Sari, 2014). The application of the PBL model resulted in a significant increase in learning motivation with percentages of 93% and 98% compared to lectures using the traditional method of 78% (Klegeris & Hurren, 2011).

CONCLUSION

This study demonstrates that Problem-Based Learning (PBL) is effective in improving students' science learning outcomes, with significantly higher performance compared to non-PBL approaches ($P < 0.001$; 95% CI: 0.29–1.89; $I^2 = 94\%$). These findings provide robust evidence supporting PBL as an effective instructional strategy for promoting higher-order thinking and enhancing learning outcomes in science education.

REFERENCES

Anusca Ferrari, R. C., & Yves Punie. (2009). Innovation And Creativity In Education And Training In The Eu Member States: Fostering Creative Learning And Supporting Innovative Teaching. Literature Review On Innovation And Creativity In E&T In The Eu Member States (Iceac). *European Commission's Joint Research Centre*, *1*, 1–54.

Aditya Tri Saputra. (2023). Analisis Permasalahan Pembelajaran IPA Di Sekolah Dasar (Secara Umum) Di SDN Susukan 06 Pagi Jakarta Timur. *JPNM Jurnal Pustaka Nusantara Multidisiplin*, *1*(4). https://doi.org/10.59945/jpnm.v1i4.64

Astuti, T., Suwatra, I. W., & Tegeh, I. M. (2019). Pengaruh Model Pembelajaran Kooperatif Tipe Crh Berbantuan Media Question Card Terhadap Hasil Belajar Ipa. *Indonesian Journal Of Educational Research And Review*, *2*(2), 240.

Https://Doi.Org/10.23887/Ijerr.V2i2.17633

Azer, S. A. (2011). Learning Surface Anatomy: Which Learning Approach Is Effective In An Integrated Pbl Curriculum? *Medical Teacher*, *33*(1), 78–80. Https://Doi.Org/10.3109/0142159x.2011.530704

Chanani, U. L., & Wibowo, U. B. (2019). A Learning Culture And Continuous Learning For A Learning Organization. *Kne Social Sciences*, *48*(3), 591–598. Https://Doi.Org/10.18502/Kss.V3i17.4686

David Moher, Alessandro Liberati, Jennifer Tetzlaff, Douglas G. Altman, & The Prisma Group. (2009). Preferred Reporting Items For Systematic Reviews And Meta-Analyses: The Prisma Statement. *Plos Med*, *6*(7), 1–6. Https://Doi.Org/10.1371/Journal.Pmed.1000097

Dzulfikar, A., Asikin, M., & Hendikawati, P. (2012). Keefektifan Problem Based Learning Dan Model Eliciting Activities Terhadap Kemampuan Pemecahan Masalah. *Journal Of Mathematics Education*, *1*(1), 1–6. Https://Doi.Org/10.15294/Ujme.V1i1.252

Endah Amalia, Edi Surya, & Edi Syahputra. (2022). The Effectiveness Of Using Problem-Based Learning (Pbl) In Mathematics Problem-Solving Ability For Junior High School Students. *Alphamath : Journal Of Mathematics Education*, *8*(2), 185. Https://Doi.Org/10.30595/Alphamath.V8i2.15047

Fauzia, H. A. (2018). Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Hasil Belajar Matematika Sd. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *7*(1), 40. Https://Doi.Org/10.33578/Jpfkip.V7i1.5338

Hidayat, R., & Ristinofa, R. (2020). Perbedaan Hasil Belajar Melalui Penerapan Model Inkuiri Terbimbing Dan Student Team Achievement Divisions Pada Pelajaranilmu Pengetahuan Alam. *Pedagogika: Jurnal Pedagogika Dan Dinamika Pendidikan*, *5*(1), 44–55. Https://Doi.Org/10.30598/Pedagogikavol5issue1page44-55

Huwaida, A. N., Asihanngtyas, F., & Alviah, S. N. (2020). Pengaruh Intelegensi dalam Pendidikan Anak. *Jurnal Pendidikan Dan Ilmu Sosial*, *2*(1).

Ilham, H. (2018). Problem Based Learning Dengan Strategi Konflik Kognitif Meningkatkan Kemampuan Berpikir Kritis Matematis. *Eduma : Mathematics Education Learning And Teaching*, *7*(1). Https://Doi.Org/10.24235/Eduma.V7i1.2887

Karmaham, A. D., Mediatati, N., Kristen, U., Wacana, S., Kritis, B., & Demokrasi, K. (2026). *Penerapan metode pembelajaran pbl untuk meningkatkan kemampuan berpikir kritis dan karakter demokrasi*. *7*(1), 41–50.

Klegeris, A., & Hurren, H. (2011). Impact Of Problem-Based Learning In A Large Classroom Setting: Student Perception And Problem-Solving

Skills. *Advances In Physiology Education*, *35*(4), 408–415. Https://Doi.Org/10.1152/Advan.00046.2011

Kusuma, T. C. (2022). *Pengaruh Pendekatan Proyek Terhadap Berpikir Kritis Anak Kelompok B Di Tkit Adzkia I Padang*. *6*, 13.

Manuaba, I. B. A. P., -No, Y., & Wu, C.-C. (2022). The Effectiveness Of Problem Based Learning In Improving Critical Thinking, Problem-Solving And Self-Directed Learning In First-Year Medical Students: A Meta-Analysis. *Plos One*, *17*(11), E0277339. Https://Doi.Org/10.1371/Journal.Pone.0277339

Maryati, I. (2018). Penerapan Model Pembelajaran Berbasis Masalah Pada Materi Pola Bilangan Di Kelas Vii Sekolah Menengah Pertama. *Mosharafa: Jurnal Pendidikan Matematika*, *7*(1), 63–74. Https://Doi.Org/10.31980/Mosharafa.V7i1.342

Mindarta, E. K., Sutadji, E., Irdianto, W., & Putra, E. R. (2021). Upaya Peningkatan Hasil Belajar Fisika Teknik Dengan Pendekatan Problem Posing Melalui Kegiatan Lesson Study. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *18*(1), 1. Https://Doi.Org/10.23887/Jptk-Undiksha.V18i1.26093

Muhtarom, T. (2015). Sekolah Inklusi Sebagai Sebuah Solusi Bagi Kesulitan Bersosialisasi Pada Siswa Berkebutuhan Khusus. *Proseding Seminar Nasional Pgsd Upy*, 130–113.

Ningsih, R. I., & Prasetyo, D. E. (2020). *Pengaruh Model Pembelajaran Snowball Throwing Terhadap Hasil Belajar Matematika Siswa Sd : Studi Literatur*. 6.

Novak, J. D. (1988). Learning Science And The Science Of Learning. *Studies In Science Education*, *15*(1), 77–101. Https://Doi.Org/10.1080/03057268808559949

Nuryadi, & Peni Rahmawati. (2018). Student Perceptions About *Implementation* Of Project Based Learning Model Viewed From Creativity And Student Learning Outcomes. [Data Set]. In *Jurnal Mercumatika* (Vol. 3, Issue 1, Pp. 53–62).

Pourshanazari, A. A., Roohbakhsh, A., Khazaei, M., & Tajadini, H. (2012). Comparing The Long-Term Retention Of A Physiology Course For Medical Students With The Traditional And Problem-Based Learning. *Advances In Health Sciences Education : Theory And Practice*, *18*. Https://Doi.Org/10.1007/S10459-012-9357-0

Sari, D. P. (2014). Pengaruh Model Problem Based Learning Terhadap Hasil Belajar Siswa Pada Pendidikan Kewarganegaraan Sekolah Dasar. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa*, *5*(12), 1–11.

Septikasari, M. (2018). *Status Gizi Anak Dan Faktor Yang* Mempengaruhi (1st Ed., Vol. 1). Uny Press.

Syahra, R. (2010). Eksklusi Sosial: Perspektif Baru Untuk Memahami Deprivasi Dan Kemiskinan. *Jurnal Masyarakat & Budaya*.

Syefriyani, D. (2018). Perbandingan Kemampuan Pemahaman Konsep Siswa Yang Diajar Dengan Model Pembelajaran Pencapaian Konsep Dan Model Pembelajaran Luar Kelas. *Jurnal Pendidikan Matematika Raflesia*, *3*(2), 7.

Tabacaru, C. D. (2019). *Understanding Learning. Exploring The Concept Of Learing* (1st Ed.). Editorial Universidad De Almeira. Https://Www.Researchgate.Net/Publication/335160260_Understanding_Learning_Exploring_The_Concept_Of_Learning_Develop_A_Passion_For_Learning_If_You_Do_You_Will_Never_Cease_To_Grow_What_Is_Learning

Tahir, N., Tati, A. D. R., & Rahayu, A. (2023). Penerapan Model Pembelajaran Problem Based Learning Terhadap Hasil Belajar Ipa Kelas Iv Sekolah Dasar. *Pinisi Journal Pendidikan Guru Sekolah Dasar*, *3*(3), 1120. https://doi.org/10.70713/pjp.v3i3.52353

Tujantri, H., Wulandari, T., Prasetyo, O. D., & Saputra, N. W. (2022). Peningkatan Literasi Sains Menggunakan Problem Based Learning Berbasis Pembelajaran Smart Classroom Pada Matakuliah Ilmu Alamiah Dasar. *Jurnal Muara Pendidikan*, *7*(2), 255–261.

Widowati, A. (2009). Pengembangan Critical Thinking Melalui Penerapan Model Pbl (Problem Based Learning) Dalam Pembelajaran Sains. *Prosiding Seminar Nasional Penelitian, Pendidikan Dan Penerapan Mipa*, *1*(1), 84–89.

Wulandari, T., Putra, R. E., Hakiki, M., Apdoludin, A., & R, H. (2021). Penerapan Model Pembelajaran Koperatif Tipe Jigsaw Untuk Meningkatkan Proses Dan Hasil Belajar Siswa Kelas V Di Sdn 188/Viii Wiroto Agung Kabupaten Tebo. *Jurnal Inovasi Pendidikan Dan Teknologi Informasi (Jipti)*, *2*(2), 84–92. Https://Doi.Org/10.52060/Pti.V2i02.625