International Journal of Elementary Education
Volume 8, Number 2, Tahun 2024, pp. 314-323
P-ISSN: 2579-7158 E-ISSN: 2549-6050
Open Access: https://doi.org/10.23887/ijee.v8i2.73250

Teaching at the Right Level-based Project-based Learning on Mathematical Connections of Fourth Grade Elementary School Students

Anisa Khayati Nur Kafah[1*], Ariefa Efianingrum[2], Lulu Kholifah[3], Anggit Pangestu[4], Ujang Sugara[5]

[1,2,3,4]Magister Pendidikan Dasar, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
[3]Pendidikan Profesi Guru, Universitas Sarjanawiyata, Yogyakarta, Indonesia

ARTICLE INFO

Article history:
Received December 29, 2023
Accepted April 10, 2024
Available online May 25, 2024

Kata Kunci:
Model PjBL, TaRL, Koneksi Matematis

Keywords:
PjBL model, TaRL, Mathematical Connections

ABSTRAK

Pembelajaran di sekolah dasar pada saat ini mengikuti arahan dari Kurikulum Merdeka yang mengedepankan merdeka belajar sesuai dengan kemampuan peserta didik itu sendiri. Koneksi matematis masih menjadi hal penting yang harus dimiliki peserta didik untuk kehidupan sehari-hari mereka. Penelitian ini bertujuan untuk menganalisis pengaruh implementasi model PjBL berbasis TaRL terhadap koneksi matematis terutama pada mata pelajaran matematika. Studi quasi eksperimen ini menggunakan sampling jenuh dari 18 siswa kelas IV. Desain grup pretest-posttest digunakan dalam satu kelompok. Penelitian menggunakan tes. Dalam penelitian ini, teknik analisis deskriptif digunakan untuk analisis data, yang menggunakan uji sampel berurutan t. Sebelum uji hipotesis, uji prasyarat seperti uji normalitas dan homogenitas dilakukan. Jika dibandingkan dengan siswa sebelum perawatan, penerapan model PjBL berbasis TaRL terbukti dapat meningkatkan koneksi matematis mereka. Selanjutnya pengolahan data dilakukan dengan $t_{hitung} \geq t_{tabel}$ *(5.702 >* t_{tabel} *2.10982) yang mengindikasikan bahwa* H_0 *ditolak dan* H_1 *diterima, berarti terdapat pengaruh positif dari model PjBL berbasis TaRL terhadap koneksi matematis siswa di kelas IV sekolah dasar.*

ABSTRACT

Learning in primary schools currently follows the direction of the *Merdeka* Curriculum which prioritises independent learning according to the learners' own abilities. Mathematical connections are still important things that students must have for their daily lives. This study aims to analyse the effect of implementing the TaRL-based PjBL model on mathematical connections, especially in mathematics subjects. This quasi-experimental study used saturated sampling of 18 grade IV students. A pretest-posttest group design was used in one group. The research used tests. In this study, descriptive analysis technique was used for data analysis, which used sequential sample t test. Before hypothesis testing, prerequisite tests such as normality and homogeneity tests were conducted. When compared to students before treatment, the application of TaRL-based PjBL model was proven to improve their mathematical connection. Furthermore, data processing was carried out with $t_{count} \geq t_{table}$ 5.702 > t_{table} 2.10982) which indicates that H_0 is rejected and H_1 is accepted, meaning that there is a positive effect of the TaRL-based PjBL model on students' mathematical connections in class IV elementary schools

1. INTRODUCTION

The independent curriculum is a development in the field of education as a means of equipping students with relevant competencies in order to have competitiveness according to the demands of 21st century development. The advantages of the *Merdeka* Curriculum focus more on essential material and the development of learner competencies in its phase so that students can learn deeply, meaningfully, enjoyably, and not in a hurry (Hadi et al., 2023; Sholeh et al., 2023). Learning is carried out through projects that provide wider opportunities for students to actively explore actual issues and encourage the development of character and competence of the Pancasila learner profile. The independent curriculum no longer demands the achievement of minimum completeness but emphasises the quality of learning in order to realise quality students, have the character of Pancasila learner profiles, and have the competence of Indonesian human resources who are ready to face global challenges. The idea of the independent concept seeks to restore the orientation of education according to the ideals of Ki Hadjar Dewantara, who wanted free learning so that students could learn independently and creatively (Hufron &

*Corresponding author.
E-mail addresses: anisakhayati.2022@student.uny.ac.id (Anisa Khayati Nur Kafah)

Juanedi, 2021; Vhalery et al., 2022). Freedom in learning as a means of collaboration fosters and develops the independent character of learners through exploration and construction of knowledge gained from learning experiences.

The independent curriculum uses the principles of new paradigm learning where students are at the centre of the learning process. The new paradigm learning design is realised through simpler and holistic learning outcomes through the implementation of a differentiated learning approach. Differentiated learning is able to bridge differences in obtaining information, creating ideas, and expressing what learners learn (Magableh & Abdullah, 2020; Onyishi & Sefotho, 2020). Differentiated learning allows teachers to design activities that can reduce learning barriers while ensuring educational equity for every learner. Each learner has a unique learning preference that reflects their tendency to receive, process and remember information, so these diverse learner characteristics require different actions from the teacher (Sheromova et al., 2020; Soboleva et al., 2020). Differentiated learning is a response to the different learning needs of learners. Teachers can apply the Teaching at the Right Level (TaRL) approach so that each learner has the opportunity to learn efficiently according to their learning needs. The TaRL teaching approach takes learners' learning readiness as the main reference. This approach allows teachers more freedom to customise learning to suit learners' capacities by considering the results of diagnostic assessments (Heng & Song, 2020; Lindner & Schwab, 2020).

The implementation of the independent curriculum in education units is given choices and freedom by the Ministry of Education, Culture, Research and Technology (Kemendikbudristek) by considering various factors that support implementation while at the same time can produce innovative creative learning. Teachers are given the freedom to use various teaching tools and carry out learning so that everything is tailored to the learning needs and interests of students (Morze et al., 2021; Oliveira et al., 2021). This is intended so that students can get more meaningful learning. In line with this opinion, mathematics learning as part of the curriculum must also be able to be realised in effective and enjoyable learning activities. Maths is a science that must be mastered by primary school students. Learning mathematics helps learners develop logical, analytical, systematic, critical, and creative thinking processes (Setiana & Purwoko, 2021; Yayuk, Purwanto, Rahman, et al., 2020). The independent curriculum provides objectives for learning mathematics, one of which is for students to have mathematical connection skills (Putri et al., 2023; Radite & Retnawati, 2023). The policy challenges the implementation of mathematics learning to encourage the development of mathematical connection skills. The development of students' mathematical connection skills needs to be facilitated through learning activities that stimulate the development of their thinking skills (Setiana & Purwoko, 2021; Sheromova et al., 2020). The emphasis of these activities is so that students can connect the material learned with contextual problems. Learners who have mathematical connection skills can understand the material as a whole and last long because they are able to see the relationship between topics in mathematics, outside of mathematics, and in the context of everyday life (Çelik & Özdemir, 2020; Hafni et al., 2020). The application of learning models is also a crucial part of the teaching and learning process. The learning model applied must facilitate all students to be actively involved in every learning activity. The right learning model will help students more easily understand lessons from teachers (Rafiepour & Faramarzpour, 2023; Rasmitadila et al., 2020, 2021; Syafri et al., 2021). Learners can improve their abilities to the maximum and manage their learning experience well so that quality learning is realised. To improve students' mathematical connection skills, one of the variables that can be used is the learning model. The learning model is designed to support the mathematics learning process to be fun (Kasneci et al., 2023; Sumarni & Kadarwati, 2020).

In addition to application, models, approaches are also an important part of the learning process. One type of learning approach is the TaRL (Teaching at the Right Level) approach. TaRL is one of the learning approaches by orienting students to carry out learning according to the ability level of students consisting of low, medium, and high ability levels not based on grade level or age (Ningrum et al., 2023; Prihandini et al., 2023). The TaRL approach has been implemented in various countries, one of which is India. A learning innovation organisation from India introduced the TaRL approach because research revealed that learners' literacy and numeracy were lacking. With the TaRL approach, learning takes into account the capacity of students (Banerji & Chavan, 2020; Maruyama, 2023).

The use of the Project Based Learning (PjBL) learning model with the TaRL approach is an innovative learning alternative that can provide meaningful learning that is fun while facilitating the diverse abilities of students because learning activities can be adjusted to the conditions of students. The PjBL model involves students in problem-solving activities and provides opportunities for students to work independently to construct their own learning experiences. The advantages of project-based learning include increasing motivation, activity, problem-solving ability which is closely related to mathematical connection skills (Simbolon & Koeswanti, 2020; Yunus et al., 2021). A teacher must pay attention to three elements in implementing the TaRL approach in learning, including a) the content that students learn, b) the process that students will go through to obtain information and make ideas about the things they learn, and c) the product that represents the things learned by students. These three elements are often referred to as differentiated learning. The application of differentiated learning has the opportunity to maximise the potential of each learner in mathematics (Alam & Mohanty, 2023; Attard & Holmes, 2022).

The survey conducted by Trends in International Mathematics and Science Study (TIMSS) shows that mathematics learning in Indonesia is limited to emphasising basic skills (Hamidy et al., 2020; Muhtadi et al., 2022). The results of observations made in class IV at one of the elementary schools also show a similar thing that the ability of students to connect ideas between mathematics is still low as evidenced by the results of evaluations with indicators of mathematical connection skills which include aspects of 1) integrating information, 2) making connections within and between mathematical materials, 3) determining the formula to be used to solve problems, and 4) solving non-routine problems. Learners are unable to put into practice the understanding of mathematical concepts to solve problems relevant to everyday life. The assessment results show that students have different initial abilities that have not been facilitated to the fullest and have an impact on their understanding of basic mathematics concepts. Learners who do not have an understanding of basic concepts result in low mathematical connection skills. This results in students tending to be more passive when participating in learning, even though mathematical connections are skills that must be learnt and built. Good mathematical connection skills will help students to know the relationship between various concepts in mathematics and be able to apply mathematics in everyday life. Students who can master mathematical connections will feel the benefits of learning mathematics (Diana et al., 2020; Rodríguez-Nieto et al., 2022). The results of learning mathematics will stick to students' memories and last long. This is in line with the explanation of Ausubel's theory, namely that learning activities must be meaningful by connecting information or subject matter to the cognitive structure they have (Haris et al., 2021; Tian et al., 2020).

The existence of problems regarding the lack of students' mathematical connection skills and the importance of PjBL as an effort to improve students' mathematical connection skills is one of the goals to be achieved in the independent curriculum. The independent curriculum that focuses on essential materials and the development of students' character, one of which is through project-based learning activities, can provide a more inclusive and enjoyable learning climate while stimulating the improvement of students' learning competencies. Through learning activities using the PjBL model with the TaRL approach, it is hoped that it can bridge the differences in the initial abilities of students so that it will improve their mastery of basic concepts and their mathematical connection skills. Based on the problems that occur, this study aims to analyse the implementation of the use of the PjBL model with the TaRL approach in relation to the mathematical connections of grade IV students in the school SD Negeri Tegalpanggung.

The novelty of this study is the combination of the use of the Project Based Learning (PjBL) learning model with the TaRL approach. In previous studies, the use of the PjBL model and the TaRL approach were carried out separately. The merger of PjBL with TaRL provides novelty and provides a more holistic and integrated learning experience for students. PjBL emphasizes on project-based learning to strengthen students' skills practically, whereas TaRL is known for focusing on understanding the material at a level that suits the student's abilities. The collaboration between PjBL and TaRL also has the potential to match the level of understanding of students in mathematical context skills. The collaboration between PjBL and TaRL in mathematics learning in grade IV can open up the potential for developing new learning methods that are more effective in improving students' mathematical connection skills. The results of this study also have an impact on enriching the literature on mathematics education through empirical evidence on the integration of PjBL with TaRL in improving students' mathematical connections.

2. METHOD

In the 2022/2023 academic year, this study was conducted at Tegalpanggung State Elementary School, Yogyakarta, in grade IV. All fourth-grade students were included in the sample of this study using nonprobability sampling technique. This technique is used using saturated sampling with sampling that draws samples from the entire population, in this study using nonprobability sampling methodology. A total of 18 students were sampled in this study. The type of quantitative research used in this study. The method used was an experimental method involving one class. This research uses an experiment with a one group pretest-posttest design. One group pretest-posttest design is a technique to determine the effect of activities before and after treatment (Sugiyono., 2019). Then this research design is show in Table 1.

Tabel 1. Research Design Scheme.

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2

The independent variable (X) is learning with the TaRL-based PjBL model, and the dependent variable (Y) is mathematical connection. Test is a tool used to collect data. Students' mathematical connection ability is measured through this test. Before the action is taken and after the action is taken, this test instrument is given at the beginning of learning. Before the treatment, three meetings were conducted to see the class teacher about mathematical connections, especially in mathematics. Students then received actions using learning devices with TaRL-based PjBL models for five meetings. to find out how students' mathematical connections in class IV of SD Negeri Tegalpanggung. using essay questions to assess the mathematical connection test. The mathematical connection instrument in Table 2.

Tabel 2. Mathematical Connection Ability Indicator.

No	Indicators of Mathematical Connection Ability
1.	Integrating information
2.	Make connections within and between mathematics
3.	Establishing formulas
4.	Solving non-routine problems

The test results were collected and the number of scores of each learner was calculated and then distributed in the score range table. After the score of each learner is known, the data is used to determine the class average. Through this data, the percentage of the success rate of each indicator can also be identified. The category of classification of mathematics connection ability scores in this study refers to the opinion which is contained in Table 3.

Tabel 3. Category of Maths Connection Ability Score.

No	Criteria	Category
1	85 – 100	Very Good
2	70 - 84	Good
3	55 – 69	Fair
4	40 – 54	Less
5	0 – 39	Very Poor

The data analysis approach in this study combines inferential and descriptive analysis methods with the t test. The research hypothesis was assessed using inferential analysis, and the collected data were summarised using descriptive analysis. Prerequisite tests consisting of homogeneity and normality tests were conducted before evaluating the hypotheses.

3. RESULT AND DISCUSSION

Result

This study uses two variables consisting of one independent variable in the form of the application of the Teaching at the Right Level approach (X) with the dependent variable in the form of mathematical connection skills. Data on mathematical connection skills were obtained from pre-test and post test scores. Pre-test data on the achievement of students' mathematical connection skills is based on four aspects of indicators and classified according to Table 4.

Tabel 4. Distribution of Mathematical Connection Ability Score on Pre-Test.

No	Indicator of Mathematical Connection Ability	Average Score	Category
1	Integrate information	72	Good
2	Making connections within and between mathematics	60	Fair
3	Determining formulas	60	Fair
4	Solving non-routine problems	72	Good
	Mathematical Connection Variable	**61**	**Fair**

Base on Table 4 shows that the mathematical connection skills of fourth grade students of SDN Tegalpanggung are included in the sufficient category with a score of 61. The indicator of the ability to integrate information shows a score of 72 (good), the indicator score of the ability to make connections within and between mathematics is 60 (sufficient), the indicator score of the ability to determine the formula is 60 (sufficient), and the score of the ability to solve non-routine problems reaches a score of 72 and is included in the good category. Data in Table 5 shows the mathematical connection skills after being given the learning treatment using the TaRL approach.

Table 5. Distribution of Maths Connection Ability Score on Post Test.

No	Indicator of Mathematical Connection Ability	Average Score	Category
1	Integrate information	80	Good
2	Making connections within and between mathematics	66	Fair
3	Determining formulas	66	Fair
4	Solving non-routine problems	79	Good
	Mathematical Connection Variable	**73**	**Good**

Base on Table 5 shows an increase in mathematical connection skills after treatment. Students' mathematical connection skills have increased to 73 and are included in the good category. The acquisition of each aspect score also shows an increase. The indicator of the ability to integrate information obtained a score of 80 including in the good category, the indicator of the ability to make connections within and between mathematics obtained a score of 66 including in the sufficient category, the indicator of the ability to determine the formula obtained a score of 66 including in the sufficient category, and the indicator of the ability to solve non-routine problems obtained a score of 79 and included in the good category. A comparison of the score achievement of each indicator in the pretest and post-test is presented in Figure 1.

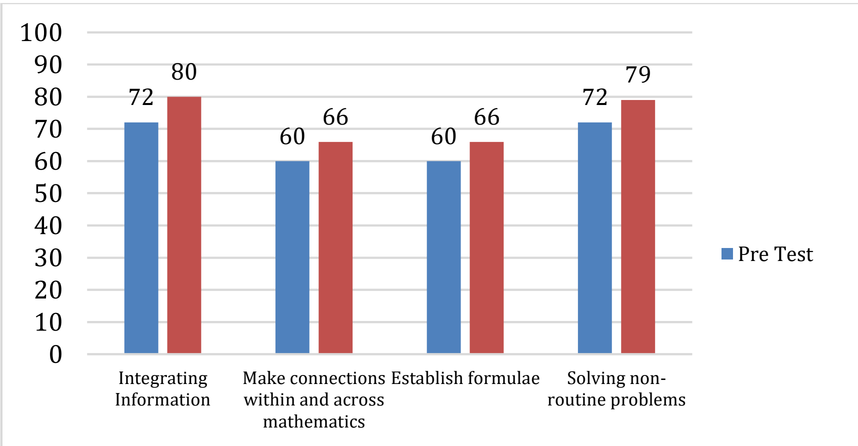

Figure 1. Comparison Diagram of Score Distribution

The research results obtained were also analysed with inferential statistics. The initial hypothesis begins with testing the prerequisites of analysis including normality and homogeneity tests. The normality test is used to determine whether the data that has been collected is normally distributed or not. The criteria used are declared normal if the significance or coefficient value (P-value) in the One Sample Kolmogorov-Smirnov output is greater than the specified alpha of 0.05. The normality test results show that the mathematical connection data before and after treatment are normally distributed. The test results are presented in Table 6.

Tabel 6. Normality Testing Results.

Type of test	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre_Test	0.144	18	0.200	0.967	18	0.735
Post_Test	0.246	18	0.005	0.900	18	0.057

The homogeneity test is used to determine whether some variants of the data population are the same or not. The homogeneity test criterion is if the significance value is greater than 0.05, it can be said that the variants of the two existing data are the same. The results of testing the homogeneity of variance show the results that the data analysed in this study are homogeneous. The test results are presented in Table 7.

Tabel 7. Variance Homogeneity Test Results.

Dependent Variable	Statistics Parameters	Levene Statistic	df1	df2	Sig.
Mathematical Connections	Based on Mean	1.403	1	34	0.244
	Based on Median	1.528	1	34	0.225
	Based on Median and with adjusted df	1.528	1	31.654	0.226
	Based on trimmed mean	1.439	1	34	0.239

Hypothesis testing in this study used t-test. Based on the previous prerequisite test, namely the data proved to be normally distributed and homogeneity, the next step is hypothesis testing / t-test which is carried out to determine whether the proposed hypothesis can be accepted or rejected. The results of hypothesis testing can be seen in Table 8.

Tabel 8. Paired Sample T Test

Paired Group		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre_Test - Post_Test	-12.944	9.631	2.270	-17.734	-8.155	-5.702	17	0.000

Table 8 shows that the t_{count} value is 5.702, the negative t_{count} value is due to the average value before treatment is lower than after treatment, which means that the negative t_{count} value is positive. The sig value. (2-tailed) 0.000 <0.05. Based on the t_{count} value of 5.702 > t_{table} 2.10982, indicates that H_0 is rejected and H_1 is accepted so that there is an effect of using the TaRL flow-based PjBL learning model on mathematical connection skills in class IV students.

Discussion

Based on the results of the study, it is known that there are differences in mathematical connection skills after obtaining mathematics learning using the TaRL approach. The average score of mathematical connection skills has increased and reached the good category.TaRL approach is learning that is designed by considering the level of achievement of students to make it easier for students to master certain competencies in a subject, which in this case is the competence of mathematical connection (Nabella et al., 2023; Tarling & Gunness, 2021). The difference in the average score of students' mathematical connections between before and after getting the PjBL learning model with the TaRL approach is also due to the emphasis given by the teacher in connecting the mathematics material being studied with the reality faced by students. The learning process has an impact on students' thinking patterns that try to link the material being studied with all aspects they encounter in real life. The existence of this process makes students' mathematical connection skills slowly form and change for the good. This is also in line with previous research which resulted in the PjBL learning model having a good effect on improving students' mathematical connection skills as evidenced by an increase in the initial average score from 12, 37 to 20.67 (Abidin, 2020).

The TaRL approach that has an effect on improving students' mathematical connection skills is also supported by other studies that produce research in the form of the effect of the TaRL approach on student learning outcomes (Alfiana et al., 2023; Jauhari et al., 2023). The advantages of the TaRL approach are that 1) learners participate in discussions and share understanding with a partner according to their ability. This combination creates a highly participatory learning environment that makes learners feel involved and responsible for their own learning. 2) Learners are directed to be able to think more deeply related to the problem or material learnt both independently and collaboratively. This encourages the development of critical and analytical thinking skills which are very important in the real world 3)

Learners are encouraged to work together in small groups. This enhances their collaboration, communication and social skills.

Two indicators of students' mathematical connection ability that have not been maximised can be caused by several factors. First, the implementation of PjBL with the TaRL approach does not always ensure the automatic formation of mathematical connections. Although students are involved in projects, the development of these skills requires guidance and deep reflection from educators (Almulla, 2020; Sumarni & Kadarwati, 2020). Secondly, the success of PjBL depends on the project design, if not well designed, the project may not provide sufficient mathematical challenge (Martins & Gresse Von Wangenheim, 2022; Yunita et al., 2021). Thirdly, changes in mathematical connection skills take longer and are not always directly measurable after being exposed to the PjBL learning model. Thus, it needs to be emphasised that the effectiveness of PjBL in improving students' mathematical connection skills requires careful planning, appropriate guidance, and continuous reflection so that students can understand and apply mathematical concepts in real contexts, and make connections between mathematics and various other topics or disciplines.

Although there is an average difference in students' mathematical connections between before and after students use the PjBL learning model with the TaRL approach, when viewed from 4 indicators that are used as benchmarks of mathematical connection ability variables, there are still two indicators, namely making connections within and between mathematics and determining formulas that are not optimal so that there needs to be improvement and variation in the next mathematics learning process. The existence of indicators that have not been maximised still indicates the low mathematical connection skills of students in elementary schools. The non-achievement of the indicators of students' mathematical connection ability indicates the need to emphasise learning that is oriented towards the ability of learners (Susanta et al., 2022; Yayuk, Purwanto, As'Ari, et al., 2020).

The Teaching at the Right Level (TaRL) approach combined with Project-Based Learning (PjBL) can enhance students' mathematical connectivity. Students are better able to see the relationships between different mathematical concepts and apply them in various situations. This approach allows teachers to tailor their teaching methods to the individual understanding levels of students. It can reduce learning gaps and ensure that each student receives attention according to their needs. However, this study has limitations because the success of this approach can vary depending on the school context and the quality of implementation. Factors such as class size, administrative support, and access to resources can influence the outcomes.

4. CONCLUSION

Based on the results of the research conducted, it can be concluded that the application of the PjBL model with the TaRL approach can improve and affect the mathematical connection skills of fourth grade elementary school students, especially mathematics subjects. There was a good change in the mathematical connection skills of students before and after treatment. This can be an alternative solution in overcoming the problem of mathematical connection skills of grade IV students by applying the PjBL model with the concept of the TaRL approach, especially in mathematics subjects.

5. REFERENCES

Abidin, Z. (2020). Efektivitas Pembelajaran Berbasis Masalah, Pembelajaran Berbasis Proyek Literasi, Dan Pembelajaran Inkuiri Dalam Meningkatkan Kemampuan Koneksi Matematis. *Profesi Pendidikan Dasar*, *7*(1), 37–52. https://doi.org/10.23917/ppd.v7i1.10736.

Alam, A., & Mohanty, A. (2023). Cultural beliefs and equity in educational institutions: exploring the social and philosophical notions of ability groupings in teaching and learning of mathematics. *International Journal of Adolescence and Youth*, *28*(1). https://doi.org/10.1080/02673843.2023.2270662.

Alfiana, F., Wahyuningsih, R., & Jamaluddin, J. (2023). Peningkatan Hasil Belajar Peserta Didik Melalui Pembelajaran Kooperatif Tipe TPS dengan Pendekatan TaRL Pada Materi Perubahan Lingkungan. *Jurnal Ilmiah Profesi Pendidikan*, *8*(4), 2800–2804. https://doi.org/10.29303/jipp.v8i4.1783.

Almulla, M. A. (2020). The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning. *SAGE Open*, *10*(3). https://doi.org/10.1177/2158244020938702.

Attard, C., & Holmes, K. (2022). An exploration of teacher and student perceptions of blended learning in four secondary mathematics classrooms. *Mathematics Education Research Journal*, *34*(4), 719–740. https://doi.org/10.1007/s13394-020-00359-2.

Banerji, R., & Chavan, M. (2020). A twenty-year partnership of practice and research: The Nobel laureates and Pratham in India. *World Development*, *127*, 104788. https://doi.org/10.1016/j.worlddev.2019.104788.

Çelik, H. C., & Özdemir, F. (2020). Mathematical Thinking as a Predictor of Critical Thinking Dispositions of Pre-service Mathematics Teachers. *International Journal of Progressive Education*, *16*(4), 81–98. https://doi.org/10.29329/ijpe.2020.268.6.

Diana, N., Suryadi, D., & Dahlan, J. A. (2020). Analysis of students' mathematical connection abilities in solving problem of circle material: transposition study. *Journal for the Education of Gifted Young Scientists*, *8*(2), 829–842. https://doi.org/10.17478/jegys.689673.

Hadi, A., Ngindana, R., Sulaiman Kurdi, M., & Sulaiman Kurdi, M. (2023). New Paradigm of Merdeka Belajar Curriculum in Schools. *Jurnal Pendidikan*, *15*(2), 1497–1510. https://doi.org/10.35445/alishlah.v15i2.3126.

Hafni, R. N., Herman, T., Nurlaelah, E., & Mustikasari, L. (2020). The importance of science, technology, engineering, and mathematics (STEM) education to enhance students' critical thinking skill in facing the industry 4.0. *Journal of Physics: Conference Series*, *1521*(4), 42040. https://doi.org/10.1088/1742-6596/1521/4/042040.

Hamidy, A., Jailani, J., & Rahman, F. (2020). The Effect of National Examination and Curriculum on Students' Performance in Solving TIMSS Model Mathematics Problems. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *8*(1), 1. https://doi.org/10.33394/j-ps.v8i1.1991.

Haris, Z. A., Widiastuti, R., & Sumiadji. (2021). Meaningful Learning: Improving Students' Accounting Knowledge and Skills Through Learning Computer Accounting Practice Courses. *Proceedings of 2nd Annual Management, Business and Economic Conference (AMBEC 2020)*, *183*(Ambec 2020), 70–76. https://doi.org/10.2991/aebmr.k.210717.015.

Heng, T. T., & Song, L. (2020). A proposed framework for understanding educational change and transfer: Insights from Singapore teachers' perceptions of differentiated instruction. *Journal of Educational Change*, *21*(4), 595–622. https://doi.org/10.1007/s10833-020-09377-0.

Hufron, M., & Juanedi, M. (2021). Reflection of Ki Hajar Dewantaraâ€™s Character Education Philosophy on Independent Learning. *Edukasia Islamika*, *6*(2), 226–243. https://doi.org/10.28918/jei.v6i2.2625.

Jauhari, T., Rosyidi, A. H., & Sunarlijah, A. (2023). Pembelajaran dengan Pendekatan TaRL untuk Meningkatkan Minat dan Hasil Belajar Matematika Peserta Didik. *Jurnal PTK Dan Pendidikan*, *9*(1). https://doi.org/10.18592/ptk.v9i1.9290.

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., … Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*(February). https://doi.org/10.1016/j.lindif.2023.102274.

Lindner, K. T., & Schwab, S. (2020). Differentiation and individualisation in inclusive education: a systematic review and narrative synthesis. *International Journal of Inclusive Education*, *0*(0), 1–21. https://doi.org/10.1080/13603116.2020.1813450.

Magableh, I. S. I., & Abdullah, A. (2020). On the effectiveness of differentiated instruction in the enhancement of jordanian students' overall achievement. *International Journal of Instruction*, *13*(2), 533–548. https://doi.org/10.29333/iji.2020.13237a.

Martins, R. M., & Gresse Von Wangenheim, C. (2022). Findings on Teaching Machine Learning in High School: A Ten - Year Systematic Literature Review. *Informatics in Education*. https://doi.org/10.15388/infedu.2023.18.

Maruyama, T. (2023). Using evidence to improve and scale up development program in education: A case study from India. *World Development Perspectives*, *32*, 100542. https://doi.org/10.1016/j.wdp.2023.100542.

Morze, N., Varchenko-Trotsenko, L., Terletska, T., & Smyrnova-Trybulska, E. (2021). Implementation of adaptive learning at higher education institutions by means of Moodle LMS. *Journal of Physics: Conference Series*, *1840*(012062). https://doi.org/10.1088/1742-6596/1840/1/012062.

Muhtadi, A., Assagaf, G., & Hukom, J. (2022). Self-Efficacy and Students' Mathematics Learning Ability in Indonesia: A Meta Analysis Study. *International Journal of Instruction*, *15*(3), 1131–1146. https://doi.org/10.29333/iji.2022.15360a.

Nabella, D. G. K., Rinaningsih, & Setyawati, L. D. (2023). Improving Students' Analytical Skills and Learning Interest Through the Tarl and CRT Approaches with The PBL Model on Chemical Buffer Material. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 10715–10720. https://doi.org/10.29303/jppipa.v9i12.4720.

Ningrum, M. C., Juwono, B., & Sucahyo, I. (2023). Implementation of the TaRL Approach to Increase Student Learning Motivation in Physics Learning. *PENDIPA Journal of Science Education*, *7*(1), 94–99. https://doi.org/10.33369/pendipa.7.1.94-99.

Oliveira, G., Grenha Teixeira, J., Torres, A., & Morais, C. (2021). An exploratory study on the emergency remote education experience of higher education students and teachers during the COVID-19 pandemic. *British Journal of Educational Technology*, *52*(4), 1357–1376. https://doi.org/10.1111/bjet.13112.

Onyishi, C. N., & Sefotho, M. M. (2020). Teachers' perspectives on the use of differentiated instruction in inclusive classrooms: Implication for teacher education. *International Journal of Higher Education*, *9*(6), 136–150. https://doi.org/10.5430/ijhe.v9n6p136.

Prihandini, D. R., Azizah, S. A., & Atikah, I. (2023). Sinergi Antara Pelaksanaan Pembelajaran Berdiferensiasi dengan Teaching at The Right Level dalam Menghadirkan Lingkungan Belajar Inklusif. *Jurnal Teknologi Pendidikan*, *1*(2), 11. https://doi.org/10.47134/jtp.v1i2.76.

Putri, K. E., Nurmilawati, M., & Zunaidah, F. N. (2023). Developing an Integrated Mathematics and Science Module with Merdeka Curriculum for Elementary School. *AL-ISHLAH: Jurnal Pendidikan*, *15*(4). https://doi.org/10.35445/alishlah.v15i4.3681.

Radite, R., & Retnawati, H. (2023). Mathematics Teacher Competencies and Self-Efficacy in Implementing National Curriculum. *Jurnal Didaktik Matematika*, *10*(2), 187–204. https://doi.org/10.24815/jdm.v10i2.32653.

Rafiepour, A., & Faramarzpour, N. (2023). Investigation of the mathematical connection's ability of 9th grade students. *Journal on Mathematics Education*, *14*(2), 339–352. https://doi.org/10.22342/jme.v14i2.pp339-352.

Rasmitadila, Aliyyah, R. R., Rachmadtullah, R., Samsudin, A., Syaodih, E., Nurtanto, M., & Tambunan, A. R. S. (2020). The perceptions of primary school teachers of online learning during the covid-19 pandemic period: A case study in Indonesia. *Journal of Ethnic and Cultural Studies*, *7*(2), 90–109. https://doi.org/10.29333/ejecs/388.

Rasmitadila, Widyasari, Prasetyo, T., Rachmadtullah, R., Samsudin, A., & Aliyyah, R. R. (2021). General teachers' experience of the Brain's natural learning systems-based instructional approach in inclusive classroom. *International Journal of Instruction*, *14*(3), 95–116. https://doi.org/10.29333/iji.2021.1436a.

Rodríguez-Nieto, C. A., Font Moll, V., Borji, V., & Rodríguez-Vásquez, F. M. (2022). Mathematical connections from a networking of theories between extended theory of mathematical connections and onto-semiotic approach. *International Journal of Mathematical Education in Science and Technology*, *53*(9), 2364–2390. https://doi.org/10.1080/0020739X.2021.1875071.

Setiana, D. S., & Purwoko, R. Y. (2021). The Application of Mathematics Learning Model to Stimulate Mathematical Critical Thinking Skills of Senior High School Students. *European Journal of Educational Research*, *10*(1), 509–523. https://doi.org/10.12973/eu-jer.10.1.509.

Sheromova, T. S., Khuziakhmetov, A. N., Kazinets, V. A., Sizova, Z. M., Buslaev, S. I., & Borodianskaia, E. A. (2020). Learning styles and development of cognitive skills in mathematics learning. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(11). https://doi.org/10.29333/EJMSTE/8538.

Sholeh, M. ibnu sholeh, Habibur Rohman, Eko Agus Suwandi, Akhyak, Nur Efendi, & As'aril Muhajir. (2023). Transformation Of Islamic Education: A Study Of Changes In The Transformation Of The Education Curriculum. *Jurnal Pendidikan Agama Islam*, *20*(1), 39–56. https://doi.org/10.14421/jpai.v20i1.6770.

Simbolon, R., & Koeswanti, H. D. (2020). Comparison Of Pbl (Project Based Learning) Models With Pbl (Problem Based Learning) Models To Determine Student Learning Outcomes And Motivation. *International Journal of Elementary Education*, *4*(4), 519–529. https://doi.org/10.23887/ijee.v4i4.30087.

Soboleva, E. V., Suvorova, T. N., Zenkina, S. V., & Bocharov, M. I. (2020). Professional self-determination support for students in the digital educational space. *European Journal of Contemporary Education*, *9*(3), 603–620. https://doi.org/10.13187/ejced.2020.3.603.

Sugiyono. (2019). *Metode Penelitian Pendidikan Pendekatan Kuantitaif, Kualitatif, dan R&D.* Alfabeta.

Sumarni, W., & Kadarwati, S. (2020). Ethno-stem project-based learning: Its impact to critical and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 11–21. https://doi.org/10.15294/jpii.v9i1.21754.

Susanta, A., Koto, I., & Susanto, E. (2022). Teachers' ability in writing mathematical literacy module based on local context. *Education Quarterly Reviews*, *5*(3), 173–179. https://doi.org/10.31014/aior.1993.05.03.536.

Syafri, F. S., Isran, D., & Nurhikma. (2021). The Relationship Between Mathematical Problem-Solving Ability, Mathematical Connection Ability, and Ability to Read the Qur'an. *Proceedings of the International Conference on Educational Sciences and Teacher Profession (ICETeP 2020)*, *532*(532), 186–191. https://doi.org/10.2991/assehr.k.210227.033.

Tarling, I., & Gunness, S. (2021). Educators' Beliefs, Perceptions and Practices Around Self-Directed Learning, Assessment and Open Education Practices. *Radical Solutions for Education in Africa: Open Education and Self-Directed Learning in the Continent*, 187–209. https://doi.org/10.1007/978-981-16-4099-5_10.

Tian, Z., Zhang, K., Zhang, T., Dai, X., & Lin, J. (2020). Application of Ausubel cognitive assimilation theory in teaching/learning medical biochemistry and molecular biology. *Biochemistry and Molecular Biology Education*, *48*(3), 202–219. https://doi.org/10.1002/bmb.21327.

Vhalery, R., Setyastanto, A. M., & Leksono, A. W. (2022). Kurikulum Merdeka Belajar Kampus Merdeka: Sebuah Kajian Literatur. *Research and Development Journal of Education*, *8*(1), 185. https://doi.org/10.30998/rdje.v8i1.11718.

Yayuk, E., Purwanto, As'Ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, *9*(3), 1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281.

Yayuk, E., Purwanto, P., Rahman, A., & Subanji, S. (2020). Primary School Students' Creative Thinking Skills in Mathematics Problem Solving. *European Journal of Educational Research*, *9*(3), 1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281.

Yunita, Y., Juandi, D., Kusumah, Y. S., & Suhendra, S. (2021). The effectiveness of the Project-Based Learning (PjBL) model in students' mathematical ability: A systematic literature review. *Journal of Physics: Conference Series*, *1882*(1), 012080. https://doi.org/10.1088/1742-6596/1882/1/012080.

Yunus, M., Setyosari, P., Utaya, S., & Kuswandi, D. (2021). The influence of online project collaborative learning and achievement motivation on problem-solving ability. *European Journal of Educational Research*, *10*(2), 813–823. https://doi.org/10.12973/EU-JER.10.2.813.