JPPIPA 10(3) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

A Novel Learning Model, Integration of Challenge-Based and Differentiated Learning: A Preliminary Study

Anak Agung Inten Paraniti[1], I Wayan Redhana[2*], I Nyoman Suardana[2], Ketut Suma[2]

[1] Doctoral Program, Educational Science Study Program, Postgraduate, Universitas Pendidikan Ganesha, Singaraja, Indonesia.
[2] Postgraduate, Universitas Pendidikan Ganesha, Singaraja, Indonesia.

Received: September 8, 2023
Revised: January 15, 2024
Accepted: March 25, 2024
Published: March 31, 2024

Corresponding Author:
I Wayan Redhana
wayan.redhana@undiksha.ac.id

DOI: 10.29303/jppipa.v10i3.5245

Abstract: This research aims to explore the need to design a challenge-based learning model (CBLM) integrated with differentiated learning strategies (DLS). The result of this integration is called a differentiated challenge-based learning model (DCBLM). A descriptive research design (survey) was applied in this study. A total of 46 high school teachers who taught science classes (biology, chemistry, and physics) throughout Bali participated in this study. The research results showed that high school teachers have attempted to implement various innovative learning models. Five innovative learning models and their implementation problems were also found and discussed in this study. Teachers fervently hope that DCBLM will exist to enhance and maximize CBLM's assets. Regarding 21st-century learning, DCBLM is highly pertinent, and the Merdeka Curriculum is implemented in Indonesia to shape students' character according to the Pancasila students' profile.

Keywords: Challenge-based learning; Differentiated learning; Merdeka Curriculum; 21st century learning

Introduction

The Indonesian Minister of Education introduced a policy regarding the use of a new curriculum called the Merdeka Curriculum (MC) as an alternative to restore the state of education in Indonesia until early 2022, following the COVID-19 pandemic that required all activities, including the learning process, to be carried out online. Because of its increased flexibility and emphasis on the needs of the individual students, the MC enables learners to pursue their interests and learn at their speed.

The introduction of a new curriculum into the Indonesian educational system would undoubtedly require fresh research, especially for academic institutions. This is because it will undoubtedly have an immediate effect on how education is conducted in classrooms (Rizaldi et al., 2021; Setiawati, 2022). One of the government's initiatives to enhance learning circumstances in Indonesia, particularly during the COVID-19 pandemic, is the socialization process, which is part of an accelerated rollout of the MC. Around the globe, especially in Indonesia, this epidemic has had a noticeable effect on schooling (Siahaan, 2020). The way that education is delivered has evolved dramatically, with all educational processes now being conducted online or through "learning from home" initiatives. This is why educators need to adjust to new technologies and get students comfortable with project-based learning at home (Nurhayati et al., 2020). This abrupt adaptation process makes it impossible for teachers and students to continue the learning process and effectively meet the previously established goals. The government aims to introduce and familiarize educators and students with these systems to ensure that they do not just rely on one-way learning systems and are used in classrooms. This was one of the concepts for creating the MC for education following the COVID-19 pandemic.

The MC incorporates a variety of intracurricular learning experiences and prioritizes content to allow students to explore ideas and hone their skills (Purnawanto, 2022; Rahimah, 2022). To tailor instruction to each student's interests and learning

How to Cite:
Paraniti, A. A. I., Redhana, I. W., Suardana, I. N., & Suma, K. (2024). A Novel Learning Model, Integration of Challenge-Based and Differentiated Learning: A Preliminary Study. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 1299–1308. https://doi.org/10.29303/jppipa.v10i3.5245

needs, teachers are free to select from various instructional aids (Martati, 2022). Implementation of the MC has essentially started in all education levels. Hasim (2020) lends credence to this, saying that the government's decision to develop and implement the MC was seen as an excellent way to address issues with education that arose during Indonesia's COVID-19 pandemic. Furthermore, Priantini et al. (2022) underscore that the implementation of the MC aligns with endeavors to establish a superior educational environment, hence enabling the production of a future generation capable of adjusting to contemporary advancements.

Simply said, this curriculum hasn't been used extensively in madrasas or schools. According to government targets, the MC will be fully implemented in Indonesian schools by 2024, beginning with primary and secondary education (Barlian et al., 2022). According to Jojor et al. (2022), one of the things that is supported and prioritized in the MC is giving project-based learning—which students can do outside of the classroom—more of a priority. This is corroborated by Marisa (2021), who claims that the idea of autonomous learning is highly appropriate in today's world because civilization 5.0 seeks to integrate the social needs of individual life with the advancements in technology that can help solve problems.

The MC in Indonesia incorporates a problem-based learning model (PBLM) and a project-based learning model (PjBLM), integrated with differentiated learning strategies. These strategies are designed to pay attention to students' individual learning needs and interests. The curriculum emphasizes learner-centered approaches, where students actively and constructively engage in real and relevant problems, allowing teachers to interpret the curriculum and create a learning atmosphere that is free, comfortable, and tailored to students' natural talents and interests (Retnaningrum et al., 2023). The MC provides flexibility for schools, local governments, and teachers to plan, implement, and evaluate educational programs while adhering to the curriculum's principles, allowing for the formation of student character in accordance with global diversity, independence, cooperation, critical thinking, and creativity, and the application of differentiated learning (Rizaldi et al., 2022). This approach aims to encourage creativity and innovation among teachers, allowing them to develop learning materials and methods that suit the needs and interests of their students (Asfiati, 2023).

Students who participate in PBLM, a student-centered method of instruction, collaborate to find solutions to real-world issues. Although PBL offers numerous benefits, like fostering critical thinking, creative thinking, problem-solving, and teamwork abilities (Ali, 2019; Razak et al., 2022), there are certain restrictions or drawbacks to this methodology. PBLM's primary disadvantage is that it can be labor-intensive and necessitates a large amount of teacher preparation time (Zhao et al., 2020). Furthermore, not every student is a good fit for PBLM because some may find the open-ended nature of the tasks difficult to solve or may find group work uncomfortable (Abraham et al., 2019). PBLM may not be appropriate for all subjects or topics since some may need more direct instruction or may not lend themselves well to problem-solving exercises (Yew & Goh, 2016). Finally, because PBLM may require access to resources or technology that not all schools or classrooms have, it might not be appropriate for all learning situations (Ghufron & Ermawati, 2018; Juver & Prasetya, 2023).

On the other hand, there are benefits to PjBLM as well. These include encouraging students to be creative in their projects since learning occurs best when an artefact is created that has personal meaning for them (Illahi et al., 2022), PjBLM is a hands-on instruction model that can enhance learning over traditional lectures (Hafeez, 2021), PjBLM involves students in the creative process rather than viewing them as passive recipients of knowledge, which increases engagement and promotes active learning (Yamin et al., 2020), and PiBLM clarifies the practical applications of the knowledge and skills they are learning (Shraideh et al., 2018). In addition to its benefits, PjBLM has drawbacks and restrictions. These include PjBLM can be time-consuming to implement, and students might not immediately embrace this different style of learning (Almulla, 2020; Maros et al., 2023), and PjBLM may not be appropriate for all subjects or topics, as some subjects may require more direct instruction and may not lend themselves easily to a project-based approach (Schaddelee & McConnell, 2018).

To overcome the limitations of PBLM and PjBLM, it is necessary to look for new. The challenge-based learning model (CBLM) is a learning model that is considered to be more powerful than the two previous learning models (Ambrosi & Hermsen, 2023).

To optimize the implementation of CBLM in the MC, this learning model needs to be integrated with differentiated learning strategies (DLS). Therefore, this research aims to explore needs analysis to develop CBLM design that is integrated with DLS so that it can be applied to achieve the learning objectives in the MC.

The results of this research will contribute to new learning models that can be applied in the MC. This learning model is expected to achieve learning outcomes in the MC, namely, students with

competence and character, especially the Pancasila Student Profile.

Method

This study used a descriptive (survey) method to obtain an overview of teachers' experiences in implementing CBLM, CBLM-like, or DLS, as well as teachers' perceptions of DCBLM at the senior high school level. This crucial data was gathered to create a DCBLM conceptual design, namely as a design for a new learning framework that will be applied in science learning.

Questionnaires were used as an instrument in this study and distributed online via Google Forms. This questionnaire consisted of three dimensions related to teachers' experience in implementing innovative learning models, teachers' experiences in implementing CBLM or CBLM-like, types of innovative learning models implemented by teachers, and challenges educators confront when putting new learning methods into practice.

The research sample was high school teachers in Bali who are members of the science field groups, namely biology, chemistry, and physics. Geographically, the respondents (teachers) are spread across nine districts in the province of Bali. A total of 46 high school teachers from public and private schools participated in filling out the research questionnaire. A method known as purposive sampling was used to choose this sample. This sample was selected based on the teacher's knowledge of CBLM or CBLM-like and DLS. The survey research flow can be seen in Figure 1.

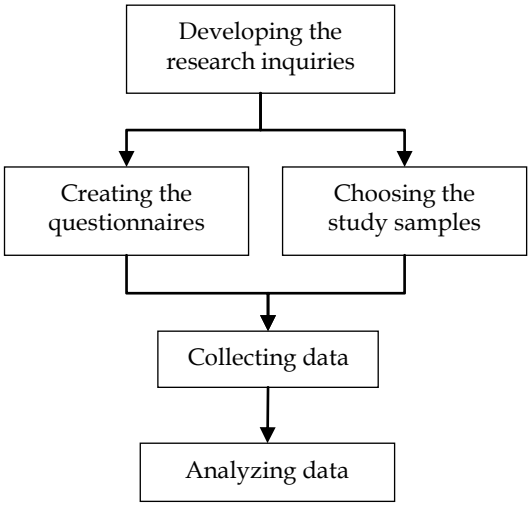

Figure 1. Survey research flow

Information on fields of study, teaching experience, and teachers' certification status are presented in Figures 2, 3, and 4, respectively. The teachers completed and returned the most questionnaires based on their fields of study (Figure 2), teaching experiences (Figure 3), and teachers' certification status (Figure 4).

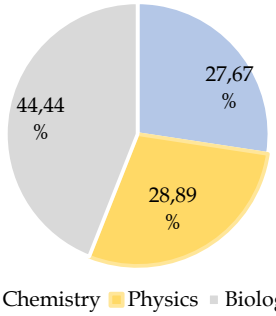

Figure 2. Respondent information categorized by study fields

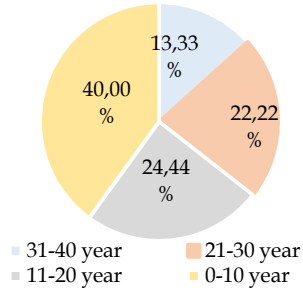

Figure 3. Respondents' teaching experiences

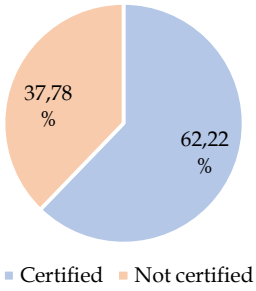

Figure 4. Teachers' certification status

Descriptive data analysis was performed by tabulating the opinions of each respondent and determining the percentage using the following formula:

$$P = \frac{x}{n} . 100\% \quad (1)$$

with: P = percentage (%), x = number of opinions, n = number of respondents

Result and Discussion

Result

The experiences and opinions of teachers in implementing innovative learning, especially CBLM or CBLM-like, DLS, and DCBLM, are presented in Figure

5. This figure shows that the learning models/strategies that teachers most and least applied were DLS and CBLM, respectively.

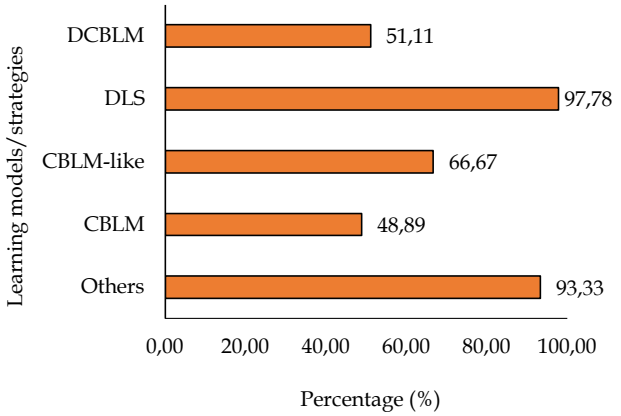

Figure 5. Teachers' experiences in implementing various innovative learning models

Subsequently, Figure 6 delineates the quintessential innovative learning models implemented by educators: PBLM, PjBLM, inquiry learning model (ILM), discovery learning model (DLM), and scientific learning model. In the meantime, the MC's DLS feature was combined with the five learning models mentioned before.

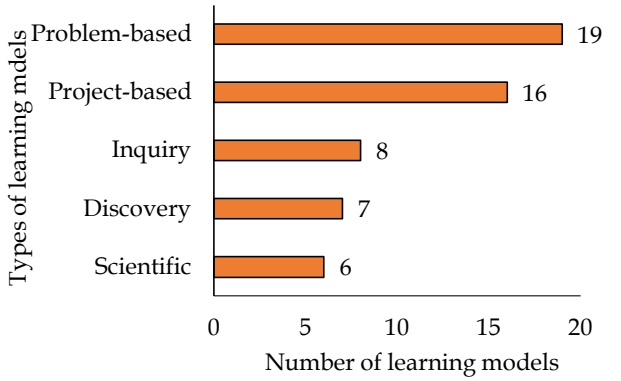

Figure 6. The top five creative learning models

This study also outlined the common issues teachers encountered while putting DLS and creative learning models into practice. Table 1 provides a summary of these issues.

The research results also showed that 100% of teachers agree and support the development of a new innovative learning model, namely DCBLM. The teachers' full support was due to the nature of DCBLM, which was in accordance with the characteristics of life in the 21st century and in line with the MC implemented in Indonesia.

Table 1. Problems in Implementing Innovative Learning Models and DLS

Problems
Difficulty in adapting content to learning models
Difficulty in designing the core activities of the learning models
Difficulty in establishing initial diagnostic tests and selecting appropriate methods
Difficulty in adjusting the assessment to the learning models
Difficulty in designing learning models that consider differences in students' abilities
Difficulty in designing Learning models that consider the characteristics among students
Difficulty in taking time off in PjBLM
Incompatibility of the planned learning phases with the learning stages implemented
Difficulty in finding relevant ideas to foster critical thinking
Insufficient time in implementing differentiated learning, specifically process differentiation
Difficulty in making an assessment rubric in product differentiation

Discussion

In collecting data related to CBLM or CBLM-like and DLS, teachers were given descriptions and examples of implementing CBLM and DLS. This was intended so that teachers understand CBLM and DLS; perhaps some do not know it yet but have implemented it fully, partially, or not at all. Based on the DLS description, more than 90% of teachers stated that they had implemented DLS. This makes sense because currently schools in Indonesia, including high schools, the MC is being implemented (Muaziyah et al., 2023; Rosmiati et al., 2022; Swandana & Tindangen, 2023). The MC's implementation of the DLS is one of its features (Butsiani, 2023; Marlina et al., 2022; Mukhibat, 2023). DLS is a learning strategy that considers the differences in students' needs (Smets et al., 2022; Suprayogi et al., 2017). Learning that is tailored to the needs of the students will help them absorb the information more fully (Barata et al., 2016; Bondie et al., 2019; Smale-Jacobse et al., 2019; Valiandes & Neophytou, 2017), developing critical thinking skills (Bondie et al., 2019) and creative thinking skills (Anggareni & Hidayat, 2022). Apart from that, DLS can also improve learning outcomes (Smale-Jacobse et al., 2019), independent learning (Bondie et al., 2019), interest, motivation, and persistence in learning (Kieran & Anderson, 2019).

DLS is a learning strategy that can be integrated with various innovative learning models, for example PjBLM (Anazifa & Djukri, 2017; Z. Anwar & Sukiman, 2023; Seechaliao, 2017; Yustina et al., 2020), PBLM (Anazifa & Djukri, 2017; Khairiyah et al., 2023; Kwangmuang et al., 2021; Serdyukov, 2017), and ILM (Lai, 2018; Onyema et al., 2019; Serdyukov, 2017;

Zubaidah et al., 2017). Nonetheless, out of the various learning models that can be utilized to apply DLS in the MC, the Ministry of Education, Culture, Research, and Technology, Republic of Indonesia, recommends PjBLM (Kementerian Pendidikan, Kebudayaan, 2022)

Regarding CBLM, the teachers do not understand and have never implemented CBLM. Teachers' misunderstandings of the CBLM syntax—which consists of key ideas, crucial issues, challenges (including learning materials, leading questions, and activities), tests, and publications—make this evident (Nichols & Cator, 2008). PBLM syntax, on the other hand, consists of giving students an overview of the issue, setting up a learning environment, directing individual or group research, creating and presenting findings, and assessing the problem-solving procedure (Arends, 2012). Another reason is that no teacher wrote down CBLM when teachers were asked about what innovative learning models had been implemented. This clearly confirms that not a single teacher understands CBLM.

The five learning models that instructors use—from most frequently to least frequently—are PBLM, PjBLM, ILM, DLM, and the scientific learning models. These are based on their experiences adopting innovative learning models. Among these five educational frameworks, the teacher believes there is one error: despite scientific learning being a technique, it is perceived as a learning paradigm. Through scientific stages such as observation, problem-solving, formulation of hypotheses, data collection, analysis, conclusion-making, and communication, students actively develop concepts, methods, laws, or principles through the scientific learning methodology (Inayah et al., 2020; Pahrudin & Pratiwi, 2019; Paraniti & Noviyanti, 2019). In implementing this learning approach, learning models are needed, for example, PBLM, PjBLM, ILM, and DLM.

Given that these five learning models were suggested in both the 2013 Curriculum (C-13) and the Education Unit Level Curriculum (EULC), the top five learning models used by instructors (Figure 5). In EULC, it is recommended to use learning cycles, including exploration, elaboration, and confirmation (Permendiknas, 2007). In C-13, the scientific learning approach is recommended that can be applied to learning models, such as PBLM, PjBLM, ILM, and DLM (Permendikbud, 2013). Meanwhile, the MC recommends PjBLM (Kementerian Pendidikan, Kebudayaan, 2022). These innovative learning models have the same principle, namely student-centered learning. PBL and PjBL are more often chosen because these two models can hone 21st-century skills, such as critical and creative thinking in group learning processes that lead students to take responsibility and organize learning independently (Anggraeni et al., 2023; Aryulina & Riyanto, 2016; Redhana, 2012). Similarities exist between PBL and PBL stages in terms of leading individual investigations and producing and presenting results, as well as between PjBLM and PBLM stages in terms of critical and creative student activities related to project design and product evaluation (Suradika et al., 2023).

CBLM is an amalgam innovative learning model that is more powerful than PBLM and PjBLM. This is because the problems presented are more contextual, global, and related to sustainable development goals, namely quality learning. The findings of the study demonstrate that CBLM can enhance learning outcomes (Farizi et al., 2023; Legaki et al., 2020), critical thinking skills (Farizi et al., 2023), creative thinking skills (Nufus et al., 2018), higher order-thinking skills (Santos et al., 2015; Torres-Barreto et al., 2020), and learning interest (Ifenthaler et al., 2020; Nufus et al., 2018).

Concerning the MC, CBLM is integrated with DLS to produce DCBLM. With this integration, Students can reach their learning objectives more quickly and simply by optimizing their learning process with the help of DCBLM. Additionally, DCBLM helps students' acquire social skills and higher-order thinking necessary for the twenty-first century. Students will be able to achieve learning competency according to their learning speed.

In implementing innovative learning models, teachers face several difficulties, such as difficulties in determining the core activities of the learning models, making initial diagnostic tests, choosing the right methods, designing learning models that pay attention to differences in students' abilities, and creating an assessment rubrics related to product differentiation. Teachers should not be surprised by this challenge; it stems from their inability to comprehend and effectively implement novel learning paradigms. These results concur with the published research findings reported by Azizah et al. (2017) and Susila and Aryasuari (2023) that there are some obstacles in implementing innovative learning.

There are still gaps in this research. When applying learning models, research has not taken into account the impact of gender, field of study, teaching experiences, or teachers' certification status. In addition, the number of samples that returned online questionnaires was still limited.

Conclusion

Based on the research findings, the following conclusion can be drawn. Teachers think they have

implemented CBLM, even though what is implemented is PBLM. This can be seen from the learning syntax put forward by the teachers. PBL and PjBLM are two popular creative learning models that science teachers use in their lessons. CBLM is a flexible learning model rooted in the PBLM and PjBLM models. CBLM integrated with DLS can overcome the problems of implementing other innovative learning models, such as PBLM and PjBLM.

Acknowledgements
To all the high school teachers who took part in this study as respondents, the author would like to thank you. We also thank Ni Luh Casmini, the headmaster of SMAN 1 Pupuan Tabanan Bali, for his assistance in gathering research data.

Author Contributions
Anak Agung Inten Paraniti developed questionnaires, collected and analyzed data, and wrote a manuscript. I Wayan Redhana conceptualized a research idea, and reviewed and edited the manuscript. Ketut Suma provided sources and reviewed the manuscript. I Nyoman Suardana analyzed the data and reviewed the manuscript. All authors have read and approved the published version of the manuscript.

Funding
The Directorate of Research, Technology, and Community Service provided funding for this project under grant number 1515/UN48.16/LT/2023.

Conflicts of Interest
No conflicts of interest are disclosed by the writers.

References

Abraham, R. R., Frambach, J. M., Verheggen, M., & Dolmans, D. H. J. M. (2019). Exploring the Dimensions of Group Discussion in Problem-based Learning among a Diverse Group of International Students: A Qualitative Study. *Journal of Clinical & Diagnostic Research*, *13*(1). https://doi.org/10.7860/JCDR/2019/40867.13123

Ali, S. S. (2019). Problem-Based Learning: A Student-Centered Approach. *English Language Teaching*, *12*(5), 73–78. https://doi.org/10.5539/elt.v12n5p73

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

Ambrosi, G., & Hermsen, E. (2023). *Implementing Challenge-Based Learning for University Teachers*. University of Twente. Retrieved from www.utwente.nl/en/cbl/

Anazifa, R. D., & Djukri. (2017). Project-Based Learning and Problem-Based Learning: Are They Effective to Improve Student's Thinking Skills? *Jurnal Pendidikan IPA Indonesia*, *6*(2), 346–355. https://doi.org/10.15294/jpii.v6i2.11100

Anggareni, P., & Hidayat, A. F. (2022). Students' Creative Thinking Skills on Differentiated Instruction. *International Journal of Trends in Mathematics Education Research*, *5*(4), 365–373. https://doi.org/10.33122/ijtmer.v5i4.161

Anggraeni, D. M., Prahani, B. K., Suprapto, N., Shofiyah, N., & Jatmiko, B. (2023). Systematic Review of Problem-Based Learning Research in Fostering Critical Thinking Skills. *Thinking Skills and Creativity*, *49*, 101334. https://doi.org/10.1016/j.tsc.2023.101334

Anwar, R. N. (2022). Persepsi Guru PAUD terhadap Pembelajaran Paradigma Baru melalui Kurikulum Merdeka. *Azzahra: Jurnal Pendidikan Anak Usia Dini*, *3*(2), 98–109. Retrieved from https://ejournal.staidarussalamlampung.ac.id/index.php/azzahra/article/view/384/376

Anwar, Z., & Sukiman, S. (2023). Literatur Review: Pembelajaran Berdiferensiasi dalam Kurikulum Merdeka di Madrasah Ibtidaiyah. *Mitra PGMI: Jurnal Kependidikan MI*, *9*(2), 80–89. https://doi.org/10.46963/mpgmi.v9i2.1004

Arends, R. I. (2012). *Learning to Teach* (9th Edition). The McGraw Hill Companies, Inc.

Aryulina, D., & Riyanto, R. (2016). A Problem-Based Learning Model in Biology Education Courses To Develop Inquiry Teaching Competency of Pre-service Teachers. *Jurnal Cakrawala Pendidikan*, *1*(1), 47–57. https://doi.org/10.21831/cp.v1i1.8364

Asfiati. (2023). Merdeka Curriculum : Encouraging Creativity and Innovation of Islamic Religious Education Teachers in Madrasah. *Al-Hayat: Journal of Islamic Education*, *7*(2), 681–698. https://doi.org/10.35723/ajie.v7i2.525

Azizah, U., Suyono, S., & Yonata, B. (2017). Peningkatan Kompetensi Guru Kimia Melalui Pelatihan Model-Model Pembelajaran Inovatif di Banyuwangi. *Jurnal ABDI*, *2*(2), 91–95. https://doi.org/10.26740/ja.v2n2.p91-95

Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2016). Studying Student Differentiation in Gamified Education: A Long-Term Study. *Computers in Human Behavior*, *71*, 1–36. https://doi.org/10.1016/j.chb.2016.08.049

Barlian, U. C., Solekah, S., & Rahayu, P. (2022). Implementasi Kurikulum Merdeka dalam Meningkatkan Mutu Pendidikan. *Journal of Educational and Language Research*, *1*(12), 2105–2018. https://doi.org/10.21608/pshj.2022.250026

Bondie, R. S., Dahnke, C., & Zusho, A. (2019). How Does Changing "One-Size-Fits-All" to

Differentiated Instruction Affect Teaching? *Review of Research in Education*, *43*(1), 336–362. https://doi.org/10.3102/0091732X18821130

Butsiani, S. N. (2023). Efforts to Improve Capabilities PAI Teacher in Implementing Differentiated Learning Using the Method Coaching and Media Google Sites in the Kurikulum Merdeka. *Edumaspul: Jurnal Pendidikan*, *7*(1), 243–252. https://doi.org/10.33487/edumaspul.v7i1

Farizi, S. F., Umamah, N., & Soepeno, B. (2023). The Effect of the Challenge-Based Learning Model on Critical Thinking Skills and Learning Outcomes. *Anatolian Journal of Education*, *8*(1), 191–206. https://doi.org/10.29333/aje.2023.8113a

Ghufron, M. A., & Ermawati, S. (2018). The Strengths and Weaknesses of Cooperative Learning and Problem-Based Learning in EFL Writing Class: Teachers and Students' Perspectives. *International Journal of Instruction*, *11*(4), 657–672. https://doi.org/10.12973/iji.2018.11441a

Hafeez, M. (2021). Project-Based Versus Traditional Lecture Teaching Methods. *EDUTEC : Journal of Education And Technology*, *4*(4), 544–559. https://doi.org/10.29062/edu.v4i4.220

Hasim, E. (2020). Penerapan Kurikulum Merdeka Belajar Perguruan Tinggi di Masa Pandemi Covid-19. *E-Prosiding Pascasarjana Universitas Negeri Gorontalo*, 68–74. Retrieved from https://ejurnal.pps.ung.ac.id/index.php/PSI/article/view/403

Ifenthaler, D., Gibson, D., & Zheng, L. (2020). Attributes of Engagement in Challenge-Based Digital Learning Environments BT-Online. In P. Isaias, D. G. Sampson, & D. Ifenthaler (Eds.), *Online Teaching and Learning in Higher Education. Cognition and Exploratory Learning in the Digital Age* (pp. 81–91). Springer International Publishing. https://doi.org/10.1007/978-3-030-48190-2_5

Illahi, P. C., Fitri, R., & Arsih, F. (2022). The Effect of Project Based Learning Model on Creative Thinking Ability in Biology Learning. *Journal of Digital Learning and Education*, *2*(3), 171–177. https://doi.org/10.52562/jdle.v2i3.441

Inayah, N., Hidayat, M. T., & Nur, M. (2020). Efektivitas Pembelajaran Berorientasi Pendekatan Saintifik pada Materi Hereditas terhadap Kreativitas Ilmiah Siswa SMA. *Jurnal Penelitian Pendidikan Sains*, *10*(1), 1857–1873. Retrieved from https://journal.unesa.ac.id/index.php/jpps/article/view/9904/4706

Jojor, A., & Sihotang, H. (2022). Analisis Kurikulum Merdeka dalam Mengatasi Learning Loss di Masa Pandemi Covid-19 (Analisis Studi Kasus Kebijakan Pendidikan). *Edukatif : Jurnal Ilmu Pendidikan*, *4*(4), 5150–5161. https://doi.org/10.31004/edukatif.v4i4.3106

Juver, Z. A., & Prasetya, W. (2023). Indonesian Undergraduate Students' Perceptions of Problem-Based Learning Implementation in an ELT Class: A Small-Scale Survey. *English Journal of Merdeka: Culture, Language, and Teaching of English*, *7*(2), 254–263. https://doi.org/10.26905/enjourme.v7i2.9032

Kementerian Pendidikan, Kebudayaan, R. dan Teknologi. (2022). *Keputusan Kepala Badan Standar, Kurikulum, dan Asesmen Pendidikan Nomor 008/H/KR/2022 tentang Capaian Pembelajaran pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar dan Jenjang Pendidikan Menengah pada Kurikulum Merdeka*. Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi.

Khairiyah, U., Gusmaniarti, Asmara, B., Suryant, Wiryanto, & Sulistiyono. (2023). Fenomena Penerapan Kurikulum Merdeka dalam Pembentukan Karakter Profil Pelajar Pancasila Siswa Sekolah Dasar. *Elementary School Education Journal*, *7*(2), 172–178. https://doi.org/10.30651/else.v7i2.196924 Kata

Kieran, L., & Anderson, C. (2019). Connecting Universal Design for Learning With Culturally Responsive Teaching. *Education and Urban Society*, *51*(9), 1202–1216. https://doi.org/10.1177/0013124518785012

Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The Development of Learning Innovation to Enhance Higher Order Thinking Skills for Students in Thailand Junior High Schools. *Heliyon*, *7*(6), e07309. https://doi.org/10.1016/j.heliyon.2021.e07309

Lai, C.-S. (2018). Using Inquiry-Based Strategies for Enhancing Students' STEM Education Learning. *Journal of Education in Science, Environment and Health*, *4*(1), 110–117. https://doi.org/10.21891/jeseh.389740

Legaki, N. Z., Xi, N., Hamari, J., Karpouzis, K., & Assimakopoulos, V. (2020). The Effect of Challenge-Based Gamification on Learning: An Experiment in the Context of Statistics Education. *International Journal of Human Computer Studies*, *144*, 102496. https://doi.org/10.1016/j.ijhcs.2020.102496

Marisa, M. (2021). Inovasi Kurikulum "Merdeka Belajar" di Era Society 5.0. *Santhet: Jurnal Sejarah, Pendidiikan Dan Humaniora*, *5*(1), 66–78. https://doi.org/10.36526/js.v3i2

Marlina, L., Dariyani, N., Sriyanti, I., Sudirman, S., & Meilinda, M. (2022). Development of Differentiated Physics Teaching Modules Based on Kurikulum Merdeka. *Jurnal Penelitian*

Pendidikan IPA, *8*(5), 2286–2292. https://doi.org/10.29303/jppipa.v8i5.2061

Maros, M., Korenkova, M., Fila, M., Levicky, M., & Schoberova, M. (2023). Project-Based Learning and Its Effectiveness: Evidence from Slovakia. *Interactive Learning Environments*, *31*(7), 4147–4155. https://doi.org/10.1080/10494820.2021.1954036

Martati, B. (2022). Penerapan Project Based Learning dalam Pembelajaran di Sekolah Dasar. *Conference of Elementary Studies*, 13–22. Retrieved from http://journal.um-surabaya.ac.id/index.php/Pro/article/view/14907

Muaziyah, S. E. S., Hidayat, T., Sriyati, S., & Lutianasari, L. (2023). Implementation of the Merdeka Curriculum Using Citizen Science Project Weather-it to Improve Critical Thinking Skills of Junior High School Students. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1470–1479. https://doi.org/10.29303/jppipa.v9i3.2277

Mukhibat, M. (2023). Developing of Module Challenge Based Learning in Environmental Material to Empower the Critical Thinking Ability. *QALAMUNA: Jurnal Pendidikan, Sosial, Dan Agama*, *15*(1), 73–82. https://doi.org/10.37680/qalamuna.v15i1.2386

Nichols, M. H., & Cator, K. (2008). *Challenge-Based Learning White Paper*. Apple, Inc.

Nufus, H., Duskri, M., & Bahrun, B. (2018). Mathematical Creative Thinking and Student Self-Confidence in the Challenge-Based Learning Approach. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *3*(2), 57–68. https://doi.org/10.23917/jramathedu.v3i2.6367

Nurhayati, E., Rizaldi, D. R., & Fatimah, Z. (2020). Pencegahan Penyebaran Covid-19 melalui Inaktivasi Virus dalam Kajian Kinetika, Termodinamika, dan Kesetimbangan. *Jurnal Ilmiah Profesi Pendidikan*, *5*(2), 102–107. https://doi.org/10.29303/jipp.v5i2.121

Onyema, E. M., Deborah, E. C., & Anthonia, U. O. (2019). Potentials of Mobile Technologies in Enhancing the Effectiveness of Inquiry-Based Learning Approach. *International Journal of Education (IJE)*, *2*(1), 1–25. Retrieved from https://www.researchgate.net/publication/337051363

Pahrudin, A., & Pratiwi, D. D. (2019). *Pendekatan Saintifik dalam Implementasi Kurikulum 2013 dan Dampaknya terhadap Kualitas Proses dan Hasil Pembelajaran pada MAN di Provinsi Lampung*. Pustaka Ali Imron. Retrieved from http://repository.radenintan.ac.id/11440/

Paraniti, A. A. I., & Noviyanti, P. L. (2019). Evaluasi Rencana Pelaksanaan Pembelajaran pada Pelaksanaan PPL terhadap Pemahaman Mahasiswa. *Jurnal Bakti Saraswati*, *08*(01). Retrieved from https://e-journal.unmas.ac.id/index.php/baktisaraswati/article/view/503/478

Permendikbud. (2013). *Peraturan Menteri Pendidikan dan Kebudayaan Indonesia Nomor 65*. Kementerian Pendidikan Dan Kebudayaan. Retrieved from https://luk.staff.ugm.ac.id/atur/bsnp/Permendikbud65-2013SI.pdf

Permendiknas. (2007). *Permendiknas Republik Indonesia Nomor 41 Tahun 2017*. Kementerian Pendidikan Nasional.

Priantini, D. A. M. M. O., Suarni, N. K., & Adnyana, I. K. S. (2022). Analisis Kurikulum Merdeka dan Platform Merdeka Belajar untuk Mewujudkan Pendidikan yang Berkualitas. *Jurnal Penjaminan Mutu*, *8*(2), 243–250. https://doi.org/10.25078/jpm.v8i02.1386

Purnawanto, A. T. (2022). Perencanaan Pembelajaran Bermakna dan Asesmen Kurikulum Merdeka. *Jurnal Pedagogy*, *20*(1), 75–94. Retrieved from https://www.jurnal.staimuhblora.ac.id/index.php/pedagogy/article/view/116/107

Rahimah. (2022). Peningkatan Kemampuan Guru SMP Negeri 10 Kota Tebingtinggi dalam Menyusun Modul Ajar Kurikulum Merdeka. *Jurnal Ansiru PAI*, *6*(1), 92–106. https://doi.org/10.30821/ansiru.v6i1.12537

Razak, A. A., Ramdan, M. R., Mahjom, N., Zabit, M. N. M., Muhammad, F., Hussin, M. Y. M., & Abdullah, N. L. (2022). Improving Critical Thinking Skills in Teaching through Problem-Based Learning for Students: A Scoping Review. *International Journal of Learning, Teaching and Educational Research*, *21*(2), 342–362. https://doi.org/10.26803/ijlter.21.2.19

Redhana, I. W. (2012). Model Pembelajaran Berbasis Masalah dan Pertanyaan Socratik untuk Meningkatkan Keterampilan Berpikir Kritis Siswa. *Cakrawala Pendidikan*, *31*(3), 351–365. https://doi.org/10.21831/cp.v0i3.1136

Retnaningrum, E., Widyatiningtyas, R., Sari, A. R., Sapulete, H., Solissa, E. M., & Sujana, I. G. (2023). Teacher's Paradigm in Interpreting the Birth of the Merdeka Curriculum Policy. *Journal of Education Research*, *4*(2), 435–442. https://doi.org/10.37985/jer.v4i2.174

Rizaldi, D. R., Doyan, A., Makhrus, M., Fatimah, Z., & Nurhayati, E. (2021). Adaptation to New Normal Conditions: Students Physics Learning Outcomes Using the Blended Learning Model. *International Journal of Asian Education*, *2*(3), 369–376. https://doi.org/10.46966/ijae.v2i3.171

Rizaldi, D. R., Fatimah, Z., Susilawati, S., & Makhrus, M. (2022). Student Responses Related to Face-to-Face Learning Policies to Overcome Learning Loss Condition. *Journal of Science and Science Education*, *3*(1), 9–16. https://doi.org/10.29303/jossed.v3i1.1309

Rosmiati, I., Agustina, N. S., Maulana, Y., & Widodo, A. (2022). Analysis of the Nature of Science in the "Merdeka" Curriculum and Elementary Science Books and Their Comparison Between Countries. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1618–1626. https://doi.org/10.29303/jppipa.v8i3.1701

Santos, A. R., Sales, A., Fernandes, P., & Nichols, M. (2015). Combining Challenge-Based Learning and Scrum Framework for Mobile Application Development. *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE*, *2015 June*, 189–194. https://doi.org/10.1145/2729094.2742602

Schaddelee, M., & McConnell, C. (2018). Analysing Student Perceptions to Enhance Engagement: An Interdisciplinary, Project-Based Learning Programme. *Journal of International Education in Business*, *11*(2), 161–177. https://doi.org/10.1108/JIEB-09-2017-0034

Seechaliao, T. (2017). Instructional Strategies to Support Creativity and Innovation in Education. *Journal of Education and Learning*, *6*(4), 201–208. https://doi.org/10.5539/jel.v6n4p201

Serdyukov, P. (2017). Innovation in Education: What Works, What Doesn't, and What to Do About It? *Journal of Research in Innovative Teaching & Learning*, *10*(1), 4–33. https://doi.org/10.1108/jrit-10-2016-0007

Setiawati, F. (2022). Dampak Kebijakan Perubahan Kurikulum terhadap Pembelajaran di Sekolah the Impact of Curriculum Change Policy on Learning Activities at School. *Nizamul 'Ilmi: Jurnal Manajemen Pendidikan Islam*, *7*(1), 1–17. Retrieved from https://ejournal.staisyamsulului.ac.id/index.php/nizamulilmi/article/view/124/109

Shraideh, M., Drieschner, C., Betzwieser, B., Kienegger, H., Utesch, M., & Krcmar, H. (2018). Using a Project-Based Learning Approach for Teaching Emerging Technologies. *IEEE Global Engineering Education Conference, EDUCON*, *2018-April*, 2047–2051. https://doi.org/10.1109/EDUCON.2018.8363489

Siahaan, M. (2020). Dampak Pandemi Covid-19 terhadap Dunia Pendidikan. *Jurnal Kajian Ilmiah*, *Edisi khus*(1), 73–80. https://doi.org/10.31599/jki.v1i1.265

Smale-Jacobse, A. E., Meijer, A., Helms-Lorenz, M., & Maulana, R. (2019). Differentiated Instruction in Secondary Education: A Systematic Review of Research Evidence. *Frontiers in Psychology*, *10*(November), 1–23. https://doi.org/10.3389/fpsyg.2019.02366

Smets, W., De Neve, D., & Struyven, K. (2022). Responding to Students' Learning Needs: How Secondary Education Teachers Learn to Implement Differentiated Instruction. *Educational Action Research*, *30*(2), 243–260. https://doi.org/10.1080/09650792.2020.1848604

Suprayogi, M. N., Valcke, M., & Godwin, R. (2017). Teachers and Their Implementation of Differentiated Instruction in the Classroom. *Teaching and Teacher Education*, *67*, 291–301. https://doi.org/10.1016/j.tate.2017.06.020

Suradika, A., Dewi, H. I., & Nasution, M. I. (2023). Project-Based Learning and Problem-Based Learning Models in Critical and Creative Students. *Jurnal Pendidikan IPA Indonesia*, *12*(1), 153–167. https://doi.org/10.15294/jpii.v12i1.39713

Susila, I. K. D., & Aryasuari, I. G. A. I. (2023). Penerapan Pembelajaran Berdiferensiasi pada Pengajaran ESP dalam Kemerdekaan Belajar. *Widya Balina*, *8*(1), 585–592. https://doi.org/10.53958/wb.v7i1.233

Swandana, H., & Tindangen, M. (2023). High School Students ' Perceptions about Implementation of the Merdeka Curriculum in Biology Lessons in Samarinda. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 8235–8244. https://doi.org/10.29303/jppipa.v9i10.4585

Torres-Barreto, M. L., Castaño, G. P. C., & Melgarejo, M. A. (2020). A Learning Model Proposal Focused on Challenge-Based Learning. *Advances in Engineering Education*, *8*(2), 1–23. https://doi.org/10.18260/3-1-1153-36023

Valiandes, S., & Neophytou, L. (2017). Teachers' Professional Development for Differentiated Instruction in Mixed-Ability Classrooms: Investigating the Impact of a Development Program on Teachers' Professional Learning and on Students' Achievement. *Teacher Development*, *22*(1), 123–138. https://doi.org/10.1080/13664530.2017.1338196

Yamin, Y., Permanasari, A., Redjeki, S., & Sopandi, W. (2020). Project-Based Learning to Enhance Creative Thinking Skills of the Non-Science Students. *Jhss (Journal of Humanities and Social Studies)*, *4*(2), 107–111. https://doi.org/10.33751/jhss.v4i2.2450

Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of Its Process and Impact

on Learning. *Health Professions Education*, *2*(2), 75–79. https://doi.org/10.1016/j.hpe.2016.01.004

Yustina, Syafii, W., & Vebrianto, R. (2020). The Effects of Blended Learning and Project-Based Learning on Pre-Service Biology Teachers' Creative Thinking Skills through Online Learning in The COVID-19 Pandemic. *Jurnal Pendidikan IPA Indonesia*, *9*(3), 408–420. https://doi.org/10.15294/jpii.v9i3.24706

Zhao, W., He, L., Deng, W., Zhu, J., Su, A., & Zhang, Y. (2020). The Effectiveness of the Combined Problem-Based Learning (PBL) and Case-Based Learning (CBL) Teaching Method in the Clinical Practical Teaching of Thyroid Disease. *BMC Medical Education*, *20*(1), 1–10. https://doi.org/10.1186/s12909-020-02306-y

Zubaidah, S., Fuad, N. M., Mahanal, S., & Suarsini, E. (2017). Improving Creative Thinking Skills of Students through Differentiated Science Inquiry Integrated with Mind Map. *Journal of Turkish Science Education*, *14*(4), 77–91. https://doi.org/10.12973/tused.10214a