



The implementation of independent curriculum on mover schools

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ARTICLE INFO

Article history

Received 2022-09-15

Revised 2022-11-10

Accepted 2022-12-01

Published 2022-12-12

Keywords

Independent Curriculum

Mover Schools

Elementary School

TPACK

Project-Based Learning

ABSTRACT

This research aims to describe the implementation of independent curriculum-based learning in mover schools. This research used a qualitative approach. The type of research used is phenomenology. The subjects of this study were selected based on purposive considerations. The participants of this study were targeted representatives of principals, teachers, students, and the relevant communities. Data collection in this study was carried out using interviews, observations, and documentation. The data was collected based on the needs of the research topic, namely independent curriculum-based learning in mover schools. The data of this study were analyzed using qualitative analysis techniques in the form of interactive analysis. The results of this study, one of the driving schools has implemented an independent curriculum. This can be seen from several key aspects of the independent curriculum, namely 1) the flow of learning objectives, 2) learning scenarios, 3) learning media that contain elements of TPACK, 4) Student Worksheets, and 5) the evaluation used. This can be used as a reference in the implementation of the independent curriculum, which in several schools is still trying to find the best pattern in its application in order to achieve the desired educational and learning goals.



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1. Introduction

In Indonesia, the Covid-19 pandemic forced the formal education process to be carried out online, resulting in a loss of learning (learning loss). The reason is that the learning process with the system is still adaptive. Therefore, to restore learning, starting from 2022 to 2024, the Ministry of Education, Culture, Research, and Technology published a new curriculum, namely the prototype curriculum. The Ministry of Education and Culture provides three curriculum policy options that academic units can implement in learning: the 2013 curriculum, the emergency curriculum, and the prototype curriculum. So far, the prototype curriculum has been implemented in 2,500 academic units members of the Driving School and SMK Center of Excellence programs in 2021. However, starting in 2022, academic units that do not include mover schools are also given the option to be able to implement a prototype curriculum. Meanwhile, in the Special Region of Yogyakarta, one of them is Muhammadiyah Kleco 1 Elementary School, Yogyakarta, for elementary school levels that have implemented the curriculum.

In the prototype curriculum structure, 20-30 percent of the class hours are used for the character development of Pancasila learners' profiles through project-based learning. Project-based learning is essential for character development because it provides an opportunity to learn through experiential learning, integrating the essential competencies learned by learners from different disciplines and

flexible learning structures [1]–[3]. It is excellent when schools understand the importance of strengthening the character and profile of Pancasila students—faith and devotion, global diversity, cooperation, independence, and critical and creative reasoning—to develop 21st-century learning. To this, school readiness regarding the development of digital schools must also be considered because this is vital in the prototype curriculum.

At Muhammadiyah Kleco 1 Elementary School, Yogyakarta, for example, the development of a digital school is designed in the roadmap of Muhammadiyah Kleco Elementary School. These development steps are manifested in the form of IT GTK Internet facilities, google classroom accounts used in hybrid learning and blended learning, Kleco radio, Kleco TV, learning modules to facilitate kinesthetic student differentiation, and complete IT access learning interconnection services center inspiration to the point of boiling down to intelligent schools. Seeing this fact and the status of the school as a driving school, SD Muhammadiyah Kleco 1, Yogyakarta, can be categorized as an educational institution that is ready to change and accept changes in the era of information technology.

However, what happens in curriculum changes often causes new problems, so there are technical obstacles at the implementation stage. Moreover, schools, as organizers of the formal education process, more or less require significant energy to know and understand the content and purpose of the new curriculum. Based on the facts outlined above, the educational institution can undoubtedly be an example of other schools implementing a curriculum that accommodates changes in this era. It also emphasizes the importance of conducting this research. Therefore, the formulation of this research problem is how to implement independent curriculum-based learning in mover schools in Yogyakarta. Meanwhile, this study aims to describe the implementation of independent curriculum-based learning in mover schools in Yogyakarta.

2. Method

This research used a qualitative approach of the phenomenological type. This research utilized actual lived experiences as the primary data of reality. It is a problem that exists in the application of independent curriculum-based learning in mover schools in Yogyakarta. This research was carried out in elementary schools in Yogyakarta that have implemented a prototype curriculum in the school's academic program, namely SD Muhammadiyah Kleco, Yogyakarta. This research was conducted in the even semester of the 2021/2022 Academic Year. Therefore, the research will be carried out in April – September 2022. The subjects of this study were selected based on purposive considerations. The selection of informants used the criteria of knowledge and competencies related to implementing project-based learning in the prototype curriculum at the mover school in Yogyakarta, SD Muhammadiyah Kleco, Yogyakarta. The informants of this study targeted were representatives of principals, teachers, students, and related communities.

Data collection in this study was carried out using interviews. In addition, the data obtained from the interview was also supported by data collection carried out through observation and documentation. The data was collected based on the needs of research topics, namely project-based learning in the prototype curriculum at mover schools in Yogyakarta. The data of this study were analyzed using qualitative analysis techniques. The technique chosen was the technique suggested by Miles & Huberman in the form of interactive analysis, which includes data collection, condensation, data presentation, verification, and conclusion. In addition, to ensure the validity of the data, this study triangulated the data.

3. Results and Discussion

The independent curriculum is a curriculum innovation introduced by the Ministry of Education and Culture as one of the options chosen by the education unit for learning recovery during a pandemic. The independent curriculum is part of the national curriculum implemented since 2021 in mover schools. According to the Ministry of Education and Culture, starting in 2022, the national curriculum has three curriculum options that the education unit can choose for learning recovery during the Covid-19 pandemic, namely the 2013 Curriculum, the Emergency Curriculum (simplified 2013 Curriculum), and the Prototype Curriculum [4]. The independent curriculum has been tested and applied in 2,500 schools that are members of the Mobilizing School Program and SMK Center of

Excellence. However, the independent curriculum will only be applied in academic units interested in using it as a tool to carry out learning transformation. In other words, it is optional. Academic units not using this curriculum can choose the 2013 and 2013 Curriculum options. However, this curriculum still requires all schools in Indonesia to implement it based on their readiness.

Based on this, educators should study an independent curriculum in learning development. The independent curriculum is a development of the 2013 curriculum [5]. This independent curriculum continues developing the previously holistically oriented curriculum by combining the realms of academic and nonacademic skills; mapping and developing based on competencies, not materials; and adjusting to the situation and conditions of the educational unit. In addition, the curriculum is expected to provide a vast space for students to develop their character and abilities [6]. According to the Ministry of Education and Culture [7], the independent curriculum has the main characteristics to support learning recovery, namely (1) character development, (2) focus on essential materials, and (3) flexibility in curriculum planning and preparation of learning plans. In detail, the three main characteristics of the independent curriculum are described in Fig. 1.

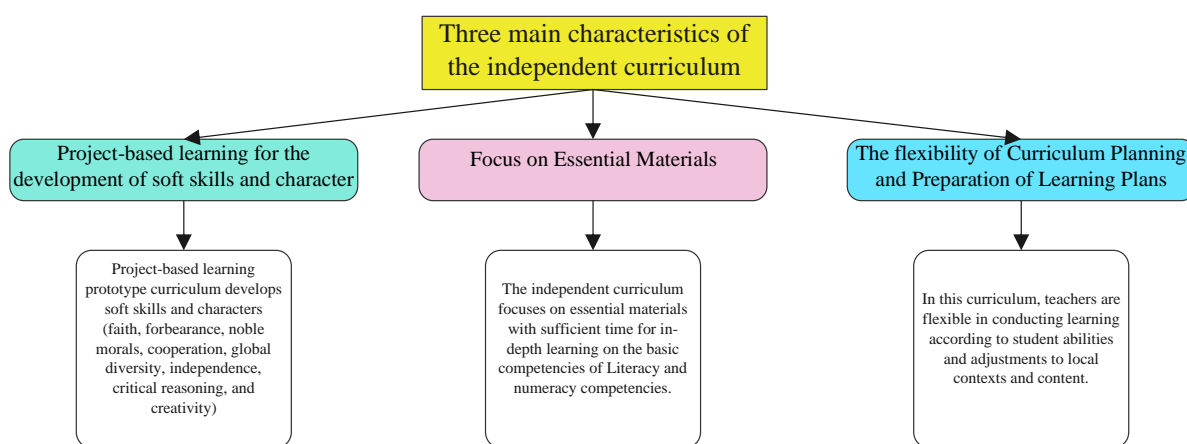


Fig. 1. Three main characteristics of the independent curriculum

3.1. Learning Objectives Flow

At the planning stage, understanding the curriculum is crucial for planning and implementing learning. Educators are expected to be adaptive to developing government policies related to the curriculum. Increased emphasis on project-based learning to develop learners' thinking and creativity skills. The flow of learning objectives in the preparation of learning tools shows that learning outcomes consist of learning abilities and materials. Teachers need to understand how to take learning outcomes and derive them in the flow of learning objectives and learning objectives. Of course, what is intended contains all the desired competencies. The flow of learning objectives in setting jarring themes shows that teachers already understand that the independent curriculum is no longer based on themes but returns to subjects.

Therefore, teachers must be able to connect one theme with another in learning. In addition to being related to the preparation of learning tools and the determination of theme nets, in the implementation of an independent curriculum in the aspects of the flow of learning objectives, there is also a phase analysis in learning outcomes. Based on the research that has been carried out, it can be seen that teachers had previously attended In-House Training for several days before they started to develop learning tools or teaching modules. Therefore, teachers in one phase meet to formulate learning outcomes at each grade level so as not to overlap. Such a culture and work program must be applied in each academic unit so that teachers, as facilitators of learning, understand the concepts and how to implement an independent curriculum. In the observations carried out in grade 1, it was found that the implementation of the learning process begins with the delivery of learning objectives. From the observations of observers, teachers still use the theme network.

3.2. Learning Scenarios

The learning scenarios used by the teacher in the classroom use scientific methods where the teacher asks students to observe the available images and gives explanations related to the pictures so that students see, hear, and listen well. In this stage, students are invited to discuss questions and answers related to what objects are in the picture. Students are enthusiastic about answering every question from the teacher, but no student has dared to ask the teacher back. It is very noticeable when the teacher asks the students, "does anyone want to ask?" the students immediately fall silent and shake their heads. After the students observe the media, the teacher distributes the student worksheets. The students are asked to draw objects according to the media and count the number of objects appearing in the media. Other than that, the students are asked to bold the dotted lines in the shape of numbers 1-10. On such assignments, activities are carried out individually. However, in the results of the observations made by the observer, they have not found reasoning and presenting activities, so after the students had done the worksheets, they were asked to collect them at the front of the class.

3.3. Scientific and Elemental 4C

Several things must be considered when compiling learning scenarios, including scientific learning, diversity learning, learning models, 4C elements, and forming Pancasila student profiles. Scientific learning is learning that emphasizes critical thinking processes where the learning steps contain the stages of observation, questioning, experimentation, processing information, and communicating [8]–[11]. The question related to scientific learning is whether the teacher's learning model contains data collection activities through observation, questioning, experimentation, processing information or data, and then communicating.

The question has the same substance as in the 2013 curriculum. It is the basis for creating learning scenarios. To equip 21st-century learning, teachers must understand scientific concepts in learning. At Muhammadiyah Kleco 1 Elementary School, especially in grade 1, scientific learning activities continue to run only in their respective subjects, not thematic. Also implemented was the PBL method. Implementing a problem-based learning model is, of course, not implemented every meeting but twice each semester. It can be understood because students are still in the 1st grade of elementary school, where they have not grown yet when viewed from the side of cognition. Thus, it will make students in the implementation of a problem-based learning model. Meanwhile, the implementation of the project-based learning model has not been applied in grade 1. Many considerations make this learning model unenforceable. Project-based learning requires students to be active and creative in solving problems in the form of products through projects. For such activities, grade 1 students will have difficulties accepting and developing, although they are carried out collaboratively between students.

The second aspect is related to diversity learning. Diversity learning refers to the infinite variety of life experiences and attributes a child brings to their formal learning at school. All students with diverse learning needs have the right to access a complete and exciting education on the same basis as their peers. Catholic schools strive to empower learners by celebrating differences and providing educational opportunities aimed at eliminating discrimination and focusing on growth and progress for all [12]–[16]. In the application of diversity learning, the question that needs to be considered is whether teachers' pay attention to differences in various things from students, for example, in terms of language, culture, socioeconomics, learning styles, abilities, and others in designing learning scenarios. At Muhammadiyah Kleco 1 Elementary School, the aspect of diversity learning pays attention to and is applied in the preparation of learning designs and at the time of learning. However, it can be seen that the learning activities that occur always start from the diagnostic assessment to find out the abilities and characteristics of each student.

Therefore, students are slow to learn to receive special treatment in the form of different assignments and the use of media that suits their needs. In the independent curriculum, some values must be developed, namely the profile of Pancasila Students. In this aspect, it can be explained as related to whether, in learning, teachers have tried to build the character of students who are devoted to God, independent, critical reasoning, creative, global diversity, and work together. At Muhammadiyah Kleco 1 Elementary School, a profile of Pancasila students is developed through intracurricular and extracurricular activities. The extracurricular activities include the habituation of joint worship, praying in learning, and *ISMUBA* lessons (Islam, *Kemuhammadiyah*, and Arabic).

Meanwhile, for extracurricular activities, such as HW, BTAQ, and Music (there are 14 extras). These activities are designed and optimized to achieve the goal's value.

3.4. Project-Based Learning Model

One of the characteristics of the prototype curriculum is to apply project-based learning to support character development in the profile of Pancasila learners. Based on the research in the prototype curriculum, schools are given the flexibility and independence to provide learning projects that are relevant and close to the student environment or are contextual [17]. In the project-based learning model, contextual learning improves students' abilities and creates more meaningful and quality learning [18]. This statement is also supported by Bangun *et, al* research which shows that project-based learning models have a good effect on the learning outcomes of elementary school students [19]. It is because the model contains the principles of attention and motivation, activeness, direct/experienced engagement, repetition, challenges, reversals, reinforcements, and individual differences. In project-based learning, the project made should be related to the needs of the community, for example, a simple water pump to help the community to obtain clean water, organic fertilizer from the surrounding environment, bag models from household plastic waste materials, films about environmental damage.

However, the project can also be a prototype or a simple product, for example, an inscription for a local newspaper or a wall magazine about environmental issues. The successful application of project-based learning in learning in the 2013 curriculum became the basis for the implementation of an independent curriculum. In this study, researchers will examine the implementation of project-based learning, especially in the prototype curriculum, as a support for learning during the Covid-19 pandemic in mover schools in Yogyakarta. In addition, this study also aims to describe the problems faced in project-based learning in the applied prototype curriculum.

The following learning scenario is related to the learning model used. It can be known that in the independent curriculum, problem-based learning and project-based learning models are emphasized. Both models are seen as learning models that can increase cooperation, creativity, collaboration, and students' critical thinking power. Problem-based learning is one of the learning models that emphasize students' ability to solve a problem [20]–[25]. Different things are related to the project-based learning model, where this type of learning model emphasizes the project as the core of the learning process and products as a solution to the problems presented at the beginning [26]–[31]. Project-Based Learning (PBL) is a recommended learning model in the 2013 Curriculum. The independent curriculum, as a development of the 2013 Curriculum, shows its peculiarities, one of which is project-based learning as the development of soft skills and character. PBL is a learning method that uses projects/activities as a medium.

Learners explore, assess, interpret, synthesize, and inform to produce various forms of learning outcomes. Ardianti *et al*, explained that project-based learning is carried out to deepen the knowledge and skills gained by making works or projects related to teaching materials and competencies expected to be possessed by students [29]. Utari *et al*, stated that project-based learning or structured tasks are a learning approach that requires a comprehensive learning environment [30]. The student's learning environment is designed to investigate authentic problems, including deepening the material of one subject matter and carrying out other colored tasks. Project-based learning as a learning model that provides teachers with opportunities to manage classroom learning by involving project work [32]. Based on experts' opinions, it can be emphasized that project-based learning is a learning model that uses projects to deepen students' knowledge and skills, using problems as the first step in collecting and integrating new knowledge based on their experience in actual activities.

Project-Based learning has distinctive characteristics and is in line with the 2013 curriculum. The characteristics of project-based learning include: (1) student-centered; (2) developed by questions; (3) assessments of various types and forms; (4) related to the real life of the student; (5) students' knowledge is demonstrated through products and performance; (6) relates to technology; and (7) varied learning strategies [33]. The learning scenario at Muhammadiyah Kleco 1 Elementary School related to the existence of 4C elements in the learning that teachers do has included some personal and social skills that exist in 21st-century learning, namely critical thinking, creativity, collaboration, and communication [34]–[39]. In addition, every learning is pursued through presentations,

exhibitions, visits to the industry, training from outside and guardians of students, and the use of IT in learning.

3.5. Learning Media

Learning media in implementing an independent curriculum plays an important role. There are a few things to note related to how the media is combined. First, it is related to the approaches, strategies, methods, and learning models that teachers often use in the learning process in the classroom. Based on the research that has been carried out, it can be seen that the learning process varies in the use of learning methods, and there are times when projects make products, outdoor activities, class discussions, and so on. The media used by teachers is based on student needs. The understanding and implementation are based on student needs, minimum standards of LCD projectors, and product project media made by students. There are two types of books: government package books and books from publishers. Most of the learning media used have utilized media based on TPACK elements, see Fig 1. TPACK is the integration of technology into learning activities [40]–[44]. Every class has an LCD, and each student uses the internet as needed. Additionally, there is a computer lab used interchangeably.



Fig. 2. Use of TPACK-Based Media

The learning process often involves the usage of TPACK-related media by teachers. The image is displayed using an LCD projector so that it can be ensured that all students see the image.

3.6. Learner Worksheets

Student worksheets are one of the vital things that the teacher must develop. In its development, teachers must pay attention to several factors, namely, (1) encouraging active learning. Do student worksheets create an active learning process? Based on the research that has been done, it can be seen that the student worksheets that are arranged are in the form of worksheets. As for worksheets, students buy from publishers. The use of these worksheets has been proven to be able to activate students; (2) solving problems. Do the learner worksheets that the teacher compiles directly for the learners to solve the problem? In consequence, each worksheet has a problem that students must solve, see Fig 3.



Fig. 3. Worksheets Encourage Active Learning

Therefore, it is connected to the used learning model. If it is project-based, the impact will be positive. It is in line with the research results, particularly the development of student worksheets based on project-based learning and the proportion of projects (20-30% or 36 hours) every semester. In the worksheets given by the teacher, they use active learning individually. First, students are asked to work on worksheets, namely, drawing objects according to the media and counting the number of objects that appear in the media. Meanwhile, other students are asked to bold the lines of dots in the form of numbers 1-10. In this activity, students take a shower to do their assignments, but the teacher still provides guidance and supervision by going around the classroom.

3.7. Evaluation

Evaluation is a planned activity to measure and assess a learning program's success, Fig. 4 is authentic evaluation. In the independent curriculum, the assessment instrument must contain elements of HOTS. At Muhammadiyah Kleco 1 Elementary School, it was identified that the test questions were not full of HOTS. It is validated from the interview results that the evaluation is still in the HOTS-based pursuit stage. However, the type of assessment used is included in the detailed assessment. There is no KKM but an activity assessment rubric in the form of an assessment scale. Reports already have an application. Students can't move up their grades, which is different from the 2013 Curriculum.



Fig. 4. Authentic evaluation

The teacher uses an authentic system or direct assessment at the evaluation stage. Overall, the implementation of the learning process in grade 1 has gone well, the teacher gives a lot of appreciation to students, and regular class conditioning makes it easier for students to interpret the learning process.

4. Conclusion

This study describes how the implementation of the independent curriculum in driving schools. At each stage of learning, it has represented an independent curriculum, although several aspects still need to be addressed, especially related to the assessment instruments used. Several main aspects of the independent curriculum have been pursued, namely, 1) the flow of learning objectives—preparation of learning tools, determination of theme nets, and phase analysis in learning outcomes, 2) learning scenarios that have been scientifically based, diversity learning, application of project-based learning models, containing 4C elements, and seeking to develop a Pancasila student profile, 3) the media used already has a combination of media with methods and models learning, media based on student needs, and containing elements of TPACK, 4) student worksheets can encourage active learning and problem solving, and 5) the evaluation used is of the authentic assessment type with where at the question level hots is still pursued.

Acknowledgment

The authors thank the Yogyakarta State University, Indonesia, for supporting and facilitating this research. In addition, the authors thank the parties involved, especially SDN Kleco Yogyakarta, who have agreed to become partners in this research.

Declarations

- Author contribution** : Each author in the article is a researcher in this study, and each researcher contributes to preparing proposals, collecting data, analyzing data, and writing research reports.
- Funding statement** : The research is funded under DIPA UNY Project No: B/197/UN34.11/HK.03/2022
- Conflict of interest** : The authors declare no conflict of interest.
- Additional information** : No additional information is available for this paper.

References

- [1] A. Zaafour and M. S. Salaberri-Ramiro, "Incorporating Cooperative Project-Based Learning in the Teaching of English as a Foreign Language: Teachers' Perspectives," *Educ. Sci.*, vol. 12, no. 6, pp. 1–12, 2022. doi: [10.3390/educsci12060388](https://doi.org/10.3390/educsci12060388)
- [2] S.-Y. Lu, C.-C. Lo, and J.-Y. Syu, "Project-based learning oriented STEAM: The case of micro-bit paper-cutting lamp," *Int. J. Technol. Des. Educ.*, vol. 32, no. 5, pp. 2553–2575, 2022. doi: [10.1007/s10798-021-09714-1](https://doi.org/10.1007/s10798-021-09714-1)
- [3] A. Saad and S. Zainudin, "A review of Project-Based Learning (PBL) and Computational Thinking (CT) in teaching and learning," *Learn. Motiv.*, vol. 78, p. 101802, 2022. doi: [10.1016/j.lmot.2022.101802](https://doi.org/10.1016/j.lmot.2022.101802)
- [4] A. Wisnu, "Scrutinizing Emergency Curriculum in an Elementary School: A Case Study at SDN Wonotingal Semarang," *JENIUS (Journal Educ. Policy Elem. Educ. Issues)*, vol. 3, no. 1, pp. 1–11, Jun. 2022, doi: [10.22515/jenius.v3i1.4966](https://doi.org/10.22515/jenius.v3i1.4966).
- [5] S. Suyanto, "A reflection on the implementation of a new curriculum in Indonesia: A crucial problem on school readiness," in *AIP Conference Proceedings*, 2017, vol. 1868, no. 1, pp. 1–10, doi: [10.1063/1.4995218](https://doi.org/10.1063/1.4995218).
- [6] A. Tohri, A. Rasyad, M. Sururuddin, and L. M. Istiqlal, "The urgency of Sasak local wisdom-based character education for elementary school in East Lombok, Indonesia," *Int. J. Eval. Res. Educ.*, vol. 11, no. 1, pp. 333–344, Mar. 2022, doi: [10.11591/ijere.v11i1.21869](https://doi.org/10.11591/ijere.v11i1.21869).
- [7] H. Helda and S. Syahrani, "National Standards of Education in Contents Standards and Education Process Standards in Indonesia," *Indones. J. Educ.*, vol. 3, no. 2, pp. 257–269, Mar. 2022, doi: [10.54443/injoe.v3i2.32](https://doi.org/10.54443/injoe.v3i2.32).
- [8] W. I. Novili, S. Utari, and Saepuzaman, "Penerapan Scientific Approach untuk Meningkatkan Literasi Saintifik dalam Domain Kompetensi Siswa SMP pada Topik Kalor," *J. Penelit. Pengemb. Pendidik. Fis.*, vol. 2, no. 1, pp. 51–56, 2016, doi: [10.21009/1.02108](https://doi.org/10.21009/1.02108).
- [9] J. Ortiz-Revilla, I. M. Greca, and I. Arriasecq, "A theoretical framework for integrated STEM education," *Sci. Educ.*, vol. 31, no. 2, pp. 383–404, 2022. doi: [10.1007/s11191-021-00242-x](https://doi.org/10.1007/s11191-021-00242-x)
- [10] C. Blanka, B. Krumay, and D. Rueckel, "The interplay of digital transformation and employee competency: A design science approach," *Technol. Forecast. Soc. Change*, vol. 178, p. 121575, 2022. doi: [10.1016/j.techfore.2022.121575](https://doi.org/10.1016/j.techfore.2022.121575)
- [11] W. Sumarni, S. Sudarmin, S. S. Sumarti, and S. Kadarwati, "Indigenous knowledge of Indonesian traditional medicines in science teaching and learning using a science–technology–engineering–mathematics (STEM) approach," *Cult. Stud. Sci. Educ.*, pp. 1–44, 2022. Available at: [Google Scholar](https://scholar.google.com/).
- [12] M. Ferreira, "A Theoretical Essay about Inclusion and the Role of Teachers in Building an Inclusive Education," *Eur. J. Educ. Pedagog.*, vol. 3, no. 3, pp. 97–104, 2022. doi: [10.24018/ejedu.2022.3.3.353](https://doi.org/10.24018/ejedu.2022.3.3.353)
- [13] N. F. Abidin and F. I. Laskar, "Managing Diversity in History Learning Based on the Perspective of Kakawin Ramayana," *Paramita Hist. Stud. J.*, vol. 30, no. 2, pp. 192–207, 2020, doi: [10.15294/paramita.v30i2.23690](https://doi.org/10.15294/paramita.v30i2.23690).

- [14] J. Hunter, "Challenging and disrupting deficit discourses in mathematics education: positioning young diverse learners to document and share their mathematical funds of knowledge," *Res. Math. Educ.*, vol. 24, no. 2, pp. 187–201, 2022. doi: [10.1080/14794802.2022.2088607](https://doi.org/10.1080/14794802.2022.2088607)
- [15] E. Gheysens, C. Coubergs, J. Griful-Freixenet, N. Engels, and K. Struyven, "Differentiated instruction: The diversity of teachers' philosophy and praxis to adapt teaching to students' interests, readiness and learning profiles," *Int. J. Incl. Educ.*, vol. 26, no. 14, pp. 1383–1400, 2022. doi: [10.1080/13603116.2020.1812739](https://doi.org/10.1080/13603116.2020.1812739)
- [16] K. H. Chua and W. K. Bong, "Providing inclusive education through virtual classrooms: a study of the experiences of secondary science teachers in Malaysia during the pandemic," *Int. J. Incl. Educ.*, pp. 1–18, 2022. doi: [10.1080/13603116.2022.2042403](https://doi.org/10.1080/13603116.2022.2042403)
- [17] M. P. N. Rozady and Y. P. Koten, "Scratch Sebagai Problem Solving Computational Thinking dalam Kurikulum Prototipe," *Increate-Inovasi Dan Kreasi Dalam Teknol. Inf.*, vol. 8, no. 1, pp. 11–17, 2022. Available at: [Google Scholar](https://scholar.google.com/).
- [18] M. Liyanawatta, S. Yang, Y. Liu, Y. Zhuang, and G. Chen, "Audience participation digital drama-based learning activities for situational learning in the classroom," *Br. J. Educ. Technol.*, vol. 53, no. 1, pp. 189–206, Jan. 2022, doi: [10.1111/bjet.13160](https://doi.org/10.1111/bjet.13160).
- [19] S. R. Bangun, W., Degeng, I. N. S., Praherdhiono, H., & Lestari, "The effect of blended project-based learning for enhancing student's scientific literacy skills: An experimental study in University," *Pegem J. Educ. Instr.*, vol. 13, no. 1, pp. 223–233, Jan. 2023, doi: [10.47750/pegegog.13.01.24](https://doi.org/10.47750/pegegog.13.01.24).
- [20] M. Munawaroh, N. S. Setyani, L. Susilowati, and R. Rukminingsih, "The Effect of E-Problem Based Learning on Students' Interest, Motivation and Achievement," *Int. J. Instr.*, vol. 15, no. 3, pp. 503–518, Jul. 2022, doi: [10.29333/iji.2022.15328a](https://doi.org/10.29333/iji.2022.15328a).
- [21] W. Darmawan and N. Harjono, "Efektivitas Problem Based Learning dan Two Stay Two Stray dalam Pencapaian Hasil Belajar," *J. Basicedu*, vol. 4, no. 2, pp. 402–411, 2020, doi: [10.31004/basicedu.v4i2.364](https://doi.org/10.31004/basicedu.v4i2.364).
- [22] K. Ulger, "The Effect of Problem-Based Learning on the Creative Thinking and Critical Thinking Disposition of Students in Visual Arts Education," *Interdiscip. J. Probl. Learn.*, vol. 12, no. 1, 2018, doi: [10.7771/1541-5015.1649](https://doi.org/10.7771/1541-5015.1649).
- [23] S. Mahmudah, T. Kirana, and Y. S. Rahayu, "Profile of Students' Critical Thinking Ability: Implementation of E-Modul Based On Problem-Based Learning," *IJORER Int. J. Recent Educ. Res.*, vol. 3, no. 4, pp. 478–488, 2022. doi: [10.46245/ijorer.v3i4.231](https://doi.org/10.46245/ijorer.v3i4.231)
- [24] T. Gomez-del Rio and J. Rodriguez, "Design and assessment of a project-based learning in a laboratory for integrating knowledge and improving engineering design skills," *Educ. Chem. Eng.*, vol. 40, pp. 17–28, 2022. doi: [10.1016/j.ece.2022.04.002](https://doi.org/10.1016/j.ece.2022.04.002)
- [25] Y. Yulkifli, Y. Yohandri, and H. Azis, "Development of physics e-module based on integrated project-based learning model with Ethno-STEM approach on smartphones for senior high school students," *Momentum Phys. Educ. J.*, vol. 6, no. 1, pp. 93–103, 2022. doi: [10.21067/mpej.v6i1.6316](https://doi.org/10.21067/mpej.v6i1.6316)
- [26] W. Yunita, M. Zaim, H. Syarif, and Y. Zainil, "The Effectiveness of Project-Based Learning through Vlog to Improve Pre-Schoolers' Vocabulary Mastery," *J. Obs. J. Pendidik. Anak Usia Dini*, vol. 6, no. 5, pp. 4661–4668, 2022. doi: [10.31004/obsesi.v6i5.2232](https://doi.org/10.31004/obsesi.v6i5.2232)
- [27] D. V. Sigit, R. H. Ristanto, and S. N. Mufida, "Integration of Project-Based E-Learning with STEAM: An Innovative Solution to Learn Ecological Concept," *Int. J. Instr.*, vol. 15, no. 3, pp. 23–40, 2022. doi: [10.29333/iji.2022.1532a](https://doi.org/10.29333/iji.2022.1532a)
- [28] S. Li, Y. Liu, and Y.-S. Su, "Differential analysis of teachers' technological pedagogical content knowledge (TPACK) abilities according to teaching stages and educational levels," *Sustainability*, vol. 14, no. 12, p. 7176, 2022. doi: [10.3390/su14127176](https://doi.org/10.3390/su14127176)
- [29] S. D. Ardianti and S. A. Raida, "The Effect of Project Based Learning with Ethnoscience Approach on Science Conceptual Understanding," *J. Innov. Educ. Cult. Res.*, vol. 3, no. 2, pp. 207–214, Feb. 2022, doi: [10.46843/jiecr.v3i2.89](https://doi.org/10.46843/jiecr.v3i2.89).

- [30] D. Utari and A. R. Afendi, "Implementation of Pancasila Student Profile in Elementary School Education with Project-Based Learning Approach," *EduLine J. Educ. Learn. Innov.*, vol. 2, no. 4, pp. 456–464, Nov. 2022, doi: [10.35877/454RI.eduline1280](https://doi.org/10.35877/454RI.eduline1280).
- [31] F. Bakri and A. K. Sunardi, "The TPACK Implementation in Physics Textbook with Augmented Reality: Enhance The 4C Skills at Mechanics Wave Concept," in *Journal of Physics: Conference Series*, 2022, vol. 2377, no. 1, p. 12080. doi: [10.1088/1742-6596/2377/1/012080](https://doi.org/10.1088/1742-6596/2377/1/012080)
- [32] S. Chan, A. Sarkar, B. Muir, and K. Neill, "Project-Based Learning with Contributions from Inquiry and Problem-Based Learning," 2022, pp. 211–231. doi: [10.1007/978-3-031-12168-5_12](https://doi.org/10.1007/978-3-031-12168-5_12)
- [33] B. N. El-Mowafy and A. M. Hassan, "A Problem and Project-Based Learning Strategy to Promote Students' Motivation in Post-pandemic Graduation Design Studio: A Prospective Comparative Study," 2023, pp. 89–106. doi: [10.1007/978-3-031-20601-6_8](https://doi.org/10.1007/978-3-031-20601-6_8)
- [34] M. Wiandita, H. Suwono, and Y. Affriyenni, "Development of digital teaching materials in human excretion system," in *AIP Conference Proceedings*, 2023, vol. 2569, no. 1, p. 60014. doi: [10.1063/5.0112282](https://doi.org/10.1063/5.0112282)
- [35] L. I. González-Pérez and M. S. Ramírez-Montoya, "Components of Education 4.0 in 21st century skills frameworks: systematic review," *Sustainability*, vol. 14, no. 3, p. 1493, 2022. doi: [10.3390/su14031493](https://doi.org/10.3390/su14031493)
- [36] I. Gede Sudirtha, I. Wayan Widiana, K. Setemen, N. W. Sukerti, N. K. Widiartini, and N. Santiyadnya, "The Impact of Blended Learning Assisted with Self-Assessment toward Learner Autonomy and Creative Thinking Skills," *Int. J. Emerg. Technol. Learn.*, vol. 17, no. 6, 2022. doi: [10.3991/ijet.v17i06.29799](https://doi.org/10.3991/ijet.v17i06.29799)
- [37] I. Finkelstein, S. Soffer-Vital, Y. Shraga-Roitman, R. Cohen-Liverant, and T. Grebelsky-Lichtman, "An Integrative Multi-Dimensional Model of Culturally Relevant Academic Evaluation for the 21st Century," *Int. J. High. Educ.*, vol. 11, no. 1, pp. 187–200, 2022. doi: [10.5430/ijhe.v11n1p187](https://doi.org/10.5430/ijhe.v11n1p187)
- [38] M. Jannah, L. D. Prasajo, and M. A. Jerusalem, "Elementary School Teachers' Perceptions of Digital Technology Based Learning in the 21st Century: Promoting Digital Technology as the Proponent Learning Tools," *Al Ibtida J. Pendidik. Guru MI*, vol. 7, no. 1, p. 1, 2020, doi: [10.24235/al.ibtida.snj.v7i1.6088](https://doi.org/10.24235/al.ibtida.snj.v7i1.6088).
- [39] W. Rahimah, M. Zaini, and B. Halang, "Work Sheet Development of High School Students Biology Based on Critical Thinking Skills on the Motion Systems Concept," *BIO-INOVED J. Biol. Pendidik.*, vol. 2, no. 2, p. 100, 2020, doi: [10.20527/bino.v2i2.8474](https://doi.org/10.20527/bino.v2i2.8474).
- [40] D. Oktasari, D. Hediandah, J. Jumadi, and W. Warsono, "Instructional Technology: Teacher's Initial Perception of TPACK in Physics Learning," *J. Penelit. Pengemb. Pendidik. Fis.*, vol. 6, no. 1, pp. 131–138, 2020, doi: [10.21009/1.06115](https://doi.org/10.21009/1.06115).
- [41] K. D. Barišić, B. Divjak, and V. Kirinić, "Education systems as contextual factors in the technological pedagogical content knowledge framework," *J. Inf. Organ. Sci.*, vol. 43, no. 2, pp. 163–183, 2019, doi: [10.31341/jios.43.2.3](https://doi.org/10.31341/jios.43.2.3).
- [42] N. Nurdiani, N. Y. Rustaman, W. Setiawan, and D. Priyandoko, "Reasoning patterns and modes of prospective biology teachers on embryology learning with TPACK framework," *JPBI (Jurnal Pendidik. Biol. Indones.)*, vol. 5, no. 1, pp. 93–100, 2019, doi: [10.22219/jpbi.v5i1.7375](https://doi.org/10.22219/jpbi.v5i1.7375).
- [43] I. Lyublinskaya and A. Kaplon-Schilis, "Analysis of Differences in the Levels of TPACK: Unpacking Performance Indicators in the TPACK Levels Rubric," *Educ. Sci.*, vol. 12, no. 2, 2022, doi: [10.3390/educsci12020079](https://doi.org/10.3390/educsci12020079).
- [44] H. Akram, Y. Yingxiu, A. S. Al-Adwan, and A. Alkhalifah, "Technology Integration in Higher Education During COVID-19: An Assessment of Online Teaching Competencies Through Technological Pedagogical Content Knowledge Model," *Front. Psychol.*, vol. 12, no. August, pp. 1–11, 2021, doi: [10.3389/fpsyg.2021.736522](https://doi.org/10.3389/fpsyg.2021.736522).