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Implementation of Project-Based Learning Method to Enhance Critical Thinking Skills of Secondary School Students

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Abstract

This research paper explores the efficiency of Project-Based Learning (PBL) to improve critical thinking among the students studying at the secondary schools. In acknowledging the growing needs of teaching methods that would lead to teaching that results in higher-order thinking, this study attempts to give empirical approaches to the PBL process as a way of developing the analytical, evaluative, and reflective thinking skills in students. Data were collected using a classroom observation, semi-structured interviews with students and teachers with the method of a qualitative research design; the content of the research project output documents were also analyzed. Thematic analysis showed four major findings and included (1) active work with authentic problem-solving tasks is a trigger of increased analytical thought; (2) cooperation evokes critical reflection on the exchange of various views; (3) independence of students constitutes stimulation of responsible behavior and self-reflection learning; and (4) continuous feedback stimulates reflective thought and metacognition. This data agrees with the created literature confirming the efficacy of PBL as the tool that facilitates critical thinking and provides new-found answers specific to the Indonesian case of secondary learning. This research proposes that teachers should use a strategic approach to PBL to combine the impact of PBL with informed guidance and feedback so as to make PBL most effective in transforming the cognitive world of students. The outcome also makes clear the importance of the policies that support teacher training and curriculum implemented on the critical thinking on PBL basis.

INTRODUCTION

Education is one of the key constituents of the society, which determines the destiny of individuals and societies. Developing development of critical thinking is one of the educational outcomes that have a lot of focus in recent years. Being able to analyze, examine, and synthesize information, in other words, having situational understanding, is one of the main determinants of success in the twenty first century. Therefore, there has been research by teachers on ways of teaching that

nurture these competencies in students. Educational systems are the major country-building tools since it is by the means of education that the high-quality human resources can be created. According to the study by Nejmaoui (2019), the development of students should be one of the primary goals of education since it implies growing holistically and, in particular, developing critical thinking. Skillful critical thinking cannot be left out when preparing the learner to face complicated reality issues that include problem-solving, making decisions, and effective communication (Tang et al., 2020).

The study by Dabbagh (2019) proves that a deeper understanding of the effects that project-based learning (PBL) can have on the critical-thinking ability of students allows teachers to make learning activities effective and meaningful. The results obtained in the course of this research underlie the development of policy measures toward achieving high-quality schooling at secondary school. PBL is one of the most energetic and interactive teaching/learning methods described by de la Torre-Neches et al. (2020). Such method necessitates students to work in longer term projects, which explore and find solutions to complex questions, problems, or challenges. Here, the learners will not only obtain project-related explicit knowledge and skills but also advance their critical-thinking skills via long-term inquiry, reflection and groupworking (Cortazjar et al., 2021).

The review conducted by Nadeak and Naibaho (2020) reveals that the questions of PBL efficacy in developing critical thinking have taken a central place in scholarly studies of instruction. Studies have shown that PBL can lead to improvements in students' ability to think critically, as they are required to analyze information, make connections, and apply their learning to real-world situations. However, there is a need for further research to explore the specific impact of PBL on critical thinking skills, particularly in the context of secondary education (de Oliveira Biazus & Mahtari (2022).

It has been recognized that Project-Based Learning (PBL) is an instructional approach that encourages the development of critical-thinking skills (Sari & Prasetyo, 2021). In the secondary-school environment, PBL can foster the development of the said competencies, as they are being developed by the learners forming the academic identities and academic abilities (Taconis & Bekker, 2023). The approach promotes active learning, critical issues identification, and problem solving in groups, which strengthens critical-thinking skills. Although promising, there are a few challenges that face the implementation of PBL in secondary-school classrooms. According to Comber et al. (2019), the design of lessons, allocation of time and scaffolding of student inquiry are burdensome tasks to carry out by the teachers. Therefore, a much more drastic empirical research on how PBL can effectively support the development of critical-thinking skills among students in secondary schools needs to be conducted to inform practitioners on how best they can achieve this instructionally.

The study in question embraces a qualitative methodology in order to investigate the impact of PBL on secondary students in regard to critical-ness. Information will be collected by means of classroom observations and interviews with students and educators and by the analysis of documents (Deng et al., 2020). The paper aspires to provide a total picture of how PBL can enhance such competencies by combining various information firms (Plummer et al., 2022).

The proposed study aims to fill the gap above by studying the usefulness of PBL in enhancing critical thinking among secondary school students. It attempts to present a qualitative account of the contribution PBL makes to the critical-thinking of the students. The results of this research should add up to the already available base of knowledge relating to PBL and critical thinking, and educate those in charge of

educational policy on the possible advantage of adopting PBL in high-school education.

It is believed that the results of this study will deemed to contribute greatly to the field of educational theory and practice. Knowing more about the ways in which PBL can be used to develop the critical thinking ability in pupils, teachers will be able to organize more meaningful and efficient learning processes. Also, the outcomes of the research may be used as the reasons to formulate an improved education policy with an emphasis on the enhancement of the secondary level education quality.

Finally, this research work will also aim at illuminating the utility of the PBL in teaching critical thinking skills to secondary school learners. This paper can assist in the discussion of the innovative teaching methods and their effects to the student learning outcomes by giving empirical evidence, based on the experience of the teachers and the students.

Literature Review

In the educational research, Project-Based Learning (PBL) has become a hot topic, and some leading scholars believe that PBL is one of the best ways to develop students thinking critically. PBL is a type of pedagogy that is student centred and more of a long term project activity that means that students will be expected to explore and answer a complex question, problem or challenge. In this way, it helps the student to think critically and analyze data, draw correlations, and use his learning in the real world.

The effect of PBL on developing critical thinking ability has been examined in a number of studies, and most of them are based on secondary school level. To illustrate, Manuaba et al. (2022) did a meta-analysis research on 22 studies to conclude that PBL positively influenced students in building their critical thinking skills. In the same way, Al Najjar et al. (2021) used a study in which they examined the critical thinking of the students who enrolled in both a PBL course and traditional lecture course. The findings revealed that students who took PBL course had higher critical thinking.

Besides the development of the critical thinking processes, PBL also has various advantages associated with use among students. Following a study conducted by Khairani et al. (2020), PBL was observed to enhance the problem solving capabilities of students, their ability to collaborate and the desire to learn. In a similar study, Wijnia et al. (2024) reviewed 20 studies and revealed that the positive effect of PBL is that its content knowledge and retention influence the students.

Nevertheless, implementation of PBL in secondary education is not always easy although the benefits of PBL are numerous. The time and work spent on lesson planning and management of the projects are among the key issues (Nicholas & Steyn, 2020). Also, the teachers might not be able to efficiently guide the student learning and give the feedback promptly within the PBL setting (Hmelo Ol Silver et al., 2019).

Researchers have recommended a number of approaches to PBL implementation in order to tackle these issues. The necessity of disclosing the definite instructions and scaffolding of the students to facilitate their learning. Liu et al. (2021) suggest that teachers should follow a facilitative model referring to the role of the facilitator, which implies helping students with the PBL process without letting them assume control of their learning.

In order to make the research experience easy, there is need to establish a strong basis to strengthen analysis. In order to analyze the problems the author raises we,

obviously, have to know in advance about the concept of each problem and which theory is relevant to be applied in analyzing this problem.

Project Based Learning (PBP)

Project-based learning (PBP) is a learning model, which puts projects at the heart of the learning activities. In PBP, the learners will be engaged in completing authentic projects which can be relevant to our daily lives or other contexts in the real world. This is not the same as the traditional approach to learning whereby one may learn theory without certain practical applications. PBP enables students to study more actively and more demanding, as they need to use their knowledge and skills in the cases which are alike to the real ones.

The sole benefit of PBP is that it has the ability to expand student input in learning. With interesting and pertinent projects you can get students more engaged in studying and acquiring new knowledge and skills. As well, PBP may aid the students in acquiring critical thinking, creativity, working with others and communicating abilities which are indeed crucial as part of their readiness to be prepared in life and work after school. In this way, PBP has gained rapid followers in terms of learning practice in schools worldwide.

METHODS

This work was carried out using qualitative research design that was aimed at examining the level to which Project-Based Learning (PBL) contributes to the development of critical thinking by students in secondary schools. The reason why qualitative approach was considered to be suitable is that directly through it, one can get in-depth insight into the processes, experiences and perceptions of students and teachers who engage in PBL implementation. By means of qualitative inquiry, the present study aims to record rich and detailed information based on which the complexity of the influence of PBL on the cognitive development of students in the context of their critical thinking abilities could be seen.

In this study, the students and teachers in secondary schools in the adopted study schools that had adopted teaching PBL were used as the participants. The purposive sampling method was employed by the participants with an aim of interviewing only those who had actively participated in the activity of PBL during the past academic year. It was a sampling strategy that guaranteed that the data obtained would be closely associated with the research aims since it would involve people who had the first-hand experience with PBL.

Data gathering was performed in three major forms: classroom observation, semi-structured interview and document analysis that were aimed at highlighting different features of PBL-driven learning. The observation classroom introduced the researcher into the studies of learning, dynamics of the student involvement in the process and critical-thinking processes developing in their natural setting, which provided the researcher with contextual information on the manner PBL promoted or hindered the development of critical-thinking skills. It was done using semi-structured interviews that obtained learner and teacher stories, considerations, and viewpoints with regards to the impact of PBL on analysis, assessment, as well as problem solving. Document analysis, in its turn, implied analyzing project artifacts of students, their reflective journals and assessment records in order to triangulate the results of observations and interviews so that they supported the validity and reliability of data.

The thematic analysis of the resulting datasets was conducted. The process included a methodic process of recognizing, dissecting, and reporting patterns, i.e. themes, found within the data that described how PBL led to the development of critical thinking. The first stage of coding returned discrete thematic elements that were then

summarized by broader themes by repetitive analysis. The cross-validation of these themes with the literature on PBL and critical thinking was undertaken to make sure there is congruence with existing theory.

Reliability and trustworthiness were ensured during the process through triangulation, member checking and reflexivity. Triangulation, through using the evidential sources to obtain the data of observations, interviews and documents, created the layered data matrix which provided depth and consistency. Member checking helped the researcher to ascertain emergent results with interviewees and observers; reflexivity made him pay close attention to his self-assumptions and prejudice. Member checking was done by giving the first preliminary findings to participants to determine accuracy and credibility. The researcher was able to uphold reflexivity in the study by regularly reflecting on the issues of possible biases in the study and how they may affect the data collection and data analysis procedures.

Last but not least, ethics was greatly taken into account during this research. Participants signed an informed consent and schools gave their respective permissions. Interviewees were promised to keep it confidential, their names were not disclosed they used pseudonyms. All the data were safely stored and used only within the frames of this research.

RESULTS AND DISCUSSION

The research involved secondary schools in which Project-Based Learning (PBL) had been adopted by the school to constitute one of their teaching strategies. This was mainly done to examine how PBL impacts on the ability of the students to think critically, especially by the direct participation of students in inquiry based, collaborative and problem solving which are present in the real world context. The respondents were teachers and students that had been taking part in PBL projects throughout a semester. The Project-Based Learning was implemented in various activities such as science, social studies and language lessons where students had to work in groups and could complete projects that required critical thinking, problem-solving and reflection. Such projects aimed at simulating real life problems, so that students should explore problems, suggest solutions and make written reports and presentations. The classification of data consisted of classroom observation, semi-structured interviews with teachers and students as well as project outputs of students. With such multiple sources of data, this study attempted to find trends in the way that PBL caused the development of critical thinking skills among students, specifically, the approach to their problem-solving, how they approached information, how they collaborated with their peers, and how they reflected on the process of their learning.

Following the literature that highlights PBL as a promising strategy to develop critical thinking (Hmelo-Silver et al., 2019; Liu et al., 2021; Sari and Prasetyo, 2021; Cortazar et al., 2021; Hussein, 2021), the given research tried to provide empirical evidence on this issue in the setting of Indonesian secondary schools, where PBL is just developing. The analysis of the findings was done in a thematic approach to find out any patterns that are common in every participant.

Proactive Participation in Problem Resolving Activities

The initial theme which was identified through the process of data analysis emphasizes the satisfactory manner in which Project-Based Learning (PBL) was successful in encouraging students to actively take part in essential research of multifaceted, real-world problems. In the PBL context, students habitually received assignments that forced them to think beyond the ken of superficial knowledge and indulge in probing and critical thinking. Participants continuously claimed that they were more engaged and curious in the authenticity of the projects, where they had

to think more strategically and look at more solutions to the problem. This was also seen when students do their reflection on their learning experiences. Having said that, a student who was more engaged with the learning process and inclined to come up with creative and rational solutions complained that with the problems seemed relative to their everyday life or local communities, they were further engaged and more willing to find not only solutions but also creative ones. The fact that the structure of the projects was open ended enabled the students to experiment and thus make some decisions and also to assess the effects of the decisions that they made, which are main premises of critical thinking. Students were not forced to absorb information but learn to ask questions, collect and analyze data, and evaluate the functionality of various strategies. Teachers also noticed this increased degree of involvement, the observation suggested that the students were more inquisitive and tenacious when confronted with tasks that were unknown to them. According to one of the informed teachers, students had learnt to be post-assumptive and optimistic and this was an indicator they had stopped being scholars and were now problem-solving agents.

The theme brings out the transitional power of PBL in developing intellectual participation. PBL would provide conditions that would support critical thinking as an interactive and ongoing process by locating learning in real situations of the world. The (naturally) improved motivation of the students and desire to delve deeply into the materials indicates that the problem-based and authentic tasks are effective to enhance the intellectual understanding, as well as to shape the habits of mind in the thoughtful and analytical reasoning.

For instance, one student explained:

> *"If the problem is connected to something real, like the environment, I feel more challenged to think deeper because I know the answer is not obvious." (Student Interview)*

Teachers also observed that students showed higher persistence when dealing with challenging problems during PBL activities. One teacher noted:

> *"When students work on projects, they automatically ask more critical questions, not just accepting information but wanting to find out the 'why' and 'how'." (Teacher Interview)*

Such finding is consistent with other prior studies that have repeatedly emphasized the significant positive correlation between Project-Based Learning (PBL) and the boost development of the problem-solving skills of students to be developed via conducting the tasks of a real-life characteristic. Research on PBL in the studies conducted by Hmelo-Silver et al. (2019), Plummer et al. (2022), or Sari and Prasetyo (2021) points out that PBL leads to the learning environment that challenges students with complex problems, which call upon them to engage in deep thinking and apply their knowledge to practical situations. Additionally, the similar study by Dabbagh (2019) and the research by de la Torre-Neches et al. (2020) confirms the existence of the hypothesis that the authenticity of PBL tasks activates higher-order thinking on the part of students and makes them want to analyze, synthesize, and evaluate the information. All these studies prove that PBL does not only improve the content knowledge of students but also foster their thinking skills because they are required to put themselves into the situations in which they have to develop the solutions and make informed decisions and introspect on the repercussion of their decisions.

Collaboration as a Catalyst for Critical Reflection

The second theme deals with the importance of collaboration in developing the critical thinking in students. The results showed that the students appreciated the

importance of collaborating with peers in their work because it helped the students to view problems in different angles. Group discussion and a collaborative decision-making process allowed students to study various points of view and lines of argumentation that forced them to question their assumptions made at the very beginning. Such a group dynamic prompted them to re-examine and polish their own ideas, dig further into analysis and attain more considered and rational conclusions. The interactions through sharing views, debating various points of view and resolving issues together helped in developing their ability in making critical judgements and thinking thoughts. On the whole, cooperation in the context of the PBL framework supported not only joint learning but also essentially contributed to the critical approach of students in the context of dealing with complex issues. As one student reflected:

> *"Sometimes my friend's opinion is very different from mine, and we have to discuss it seriously to find the best solution. This makes me rethink my arguments." (Student Interview,)*

Teachers similarly recognized how collaboration prompted critical dialogue:

> *"They learn how to defend their ideas with reasons, and at the same time they learn to listen and reconsider when others present stronger arguments." (Teacher Interview)*

It is not the first time that this conclusion is presented in literature, as numerous works on critical thinking have been supporting the importance of collaboration in the development of the critical thinking skills. Through collaborative learning, the student learns to have a meaningful conversation, positive debate, and reflective discussion that is crucial in developing higher-order thinking (Cortazar et al., 2021; Hussein, 2021; Taconis & Bekker, 2023; Liu et al., 2021; Sweet and Michaelsen, 2023). In these interactions, students do not just share ideas, and they dynamically negotiate meaning, contest each other assumptions, and cocreate new meanings. The act of collaborative thinking and mutual exploration becomes a trigger to enhance intellectual activity in the sense that students need to improve on their arguments, invite other perspectives of thinking, and eventually learn to become a better thinker. In this respect, cooperation becomes not a mere way to complete tasks but it turns into a kind of intellectual game that trains analytical, evaluative and reflective abilities of students who are the critical thinking elements.

Increased Student Autonomy and Ownership of Learning

The third thematic area was on Project-Based Learning (PBL) as an agent of change to encourage independence and responsibility of students to academic environments. The participants attested that participating in PBL elicited a superior level of empowerment on the part of making decisions involved in their own learning. This type of empowerment was demonstrated in covering the timing of the project, picking the suitable resources and determining the course of their investigation. To this extent, through PBL, students are allowed to take ownership of their work as well as their learning strategies as opposed to teacher-centered instructional model where instructions are usually spelt out clearly.

Students became aware of the fact that such widened freedom enabled them to be more independent and critical about their decisions. The fact that they were more cognizant of the effects of their decision-making enhanced a greater sense of accountability towards their learning outcomes. Through this developmental course, the self regulatory capacity, initiative, and autonomous problem solving were developed, all of which are directly connected to fostering critical thinking.

In line with the above that has been observed, the faculty members have reported that student motivation and engagement changed when the authority was

transferred to students. Students had to make decision-based judgments on the intricacies surrounding their projects, defend those choices, and monitor their paths consistently. This increased the evaluative and analytical thinking skills. PBL, therefore, did not only promote academic development but also enhanced learning competencies necessary in lifelong learning. One student commented:

> *"The teacher doesn't give us step-by-step instructions. We decide together what steps we need. It makes us think more carefully and independently." (Student Interview)*

Teachers observed that this autonomy led to higher motivation and deeper engagement:

> *"When they manage their projects themselves, students become more responsible and think critically about every decision they make." (Teacher Interview)*

This observation conforms to other studies that define the significance of autonomy in developing critical thinking among students. Some authors have insisted that, when provided with the possibility to own their learning, students are more likely to approach the learning process critically, reasonably, and reflectively (Khairani et al., 2020; Almulla, 2020; Hmelo -Silver et al., 2019; Razak et al., 2022; Nadeak & Naibaho, 2020). Autonomy gives students a chance to decide on their own ways of dealing with the assignments, resolving a problem, and their strategies of learning. In this way of independent decision making, it makes them think analytically, examine their progress and own up their results. This is why independence is considered to play a significant role in the development of the habits of reflection and evaluation as the most crucial components of critical thinking. Through supporting the feeling of ownership of learning, PBL does encourage active learning, as well as enables strengthening the skills of students to think in a critical and independent way.

Development of Reflective Thinking through Continuous Feedback

At the execution of PBL, the teachers played the significant role of providing formative feedback at any given point in the project by the students. Such feedback was not only aimed at correcting but it was developed in such a way that it would make the students become more aware of how they think and make them reflect more on how they are progressing in learning.

The feedback provided regularly through this allowed the students to make critical reflection about the quality of their work and revisit of the strategies used to perform better on their project continuously. The feedback was not regarded as a sentence of discharge by the students but they realised that it was part of the learning process- the feedback was viewed as the instrument that would assist them to understand the weak areas in their arguments, straighten their problem solving patterns, and make their end products smack and more clear. The facilitative role was also played by teachers since questions asked by teachers were probing and challenged students to stand their choices and reason more critically the way they learned. Consequently, students became more involved in self-evaluation and showed better understanding of development of their learning during time. The given reflective practice helped them to develop better critical thinking skills not only but also based on it, fostered the growth of metacognition skills, helping the students themselves to observe their learning processes and control it in a more effective manner. One student reflected on this process:

> *"When our teacher asks us questions like 'why did you choose this solution?' or 'what could you improve?', it makes us think again about our work, and we realize things we didn't see before." (Student Interview)*

Teachers emphasized the role of feedback in pushing students beyond superficial answers:

> *"Feedback during projects is not about giving the right answer, but asking questions that make students reflect deeper about their process and outcomes." (Teacher Interview)*

The same results are supported by the previous studies focused on the significant role of immediate and formative comments helping to promote the development of students reflective and critical thinking skills. As it has been identified by Plummer et al. (2022), Deng et al. (2020), Schaller et al. (2023), Wijnia et al. (2024), and Liu et al. (2021), structured and ongoing feedback does not only help students improve their work and get a better idea of how to do so but also foster their more in-depth understanding of how they learn. By means of this reflective act, with the assistance of specific feedback, the students are provided with more insights into their thought processes and have more capabilities to analyze and tuning their thoughts. Such increased metacognitive awareness is crucial in enhancing their ability to think and solve problems critically which in turn contributes to the overall objective of making independent and thoughtful learners.

Table 1. Summary of Key Findings with Interview Illustrations

Theme	Student/Teacher Voice	Literature Support
Active Engagement in Problem-Solving	"I feel more challenged to think deeper because I know the answer is not obvious."	Hmelo-Silver et al., 2019; Plummer et al., 2022
Collaboration and Critical Reflection	"We have to discuss it seriously to find the best solution."	Cortázar et al., 2021; Hussein, 2021
Student Autonomy and Ownership	"We decide together what steps we need."	Khairani et al., 2020; Almulla, 2020
Reflective Thinking through Feedback	"It makes us think again about our work."	Plummer et al., 2022; Deng et al., 2020

The study was expected to investigate the role of Project-Based Learning (PBL) plan implementation in developing your critical thinking skills in studying among the secondary school students. On the basis of the qualitative analysis of classroom observations, student and teacher interviews, and project documentation four major themes have been retrieved: active participation in the process of solving problems, collaboration as the driving force, student autonomy and reflective thinking via constant feedback. The findings are critically discussed below as compared to literature which exists.

The findings have revealed that PBL has been effective in attracting students to the complex problems solving activities that require students to think by employing the higher order thinking. Such engagements can be explained by the authenticity and relevance of the issues proposed in the PBL projects, which is supported by findings by Hmelo-Silver et al. (2019), Plummer et al. (2022), and Dabbagh (2019) who emphasize the fact that realistic, ill-structured problems facilitate more serious investigations and judgment. As observed by the students who participated in this study, they felt motivated and curious about addressing new situations in a real-life setting as well as they acknowledged that real-life problems evoked their interest which is considered through past studies (Sari & Prasetyo, 2021; de la Torre-Neches et al., 2020). The present research supports the idea that by means of studying problem-based and located in authentic situations, students build more powerful analytical abilities.

Another result is found in the fact that group work during PBL helps develop critical thinking because difference of opinion may be expressed, defended, and reviewed. It agrees with the findings of Cortazar et al. (2021), Hussein (2021) and Taconis & Bekker (2023) arguing that collaborative learning contexts allow critical dialogue, meaning making and reflection.

It has been demonstrated in the current research that the student autonomy plays a powerful role in the development of critical thinking. In project-based learning (PBL) environments, the participants demonstrated a higher ownership of the learning pathway, a fact that coincides with the claims of Almulla (2020) and Khairani et al. (2020) on the ability of student-based exercises to foster self-regulation and choice-making, both of which are also directly linked to critical thinking. This finding is supported by the team of Razak et al. (2022) and Nadeak & Naibaho (2020): they also mention that autonomy enhances the skills of students to evaluate information critically, take the first steps, and approach new circumstances independently. Findings of the study under consideration affirm that providing learners with the right to guide their own learning provides them with greater depth of analysis, longer durations of inquiry, and the presence of reflective judgment because all mentioned are critical components of the higher-order thinking.

Moreover, this study has pointed out to the importance of the ongoing feedback in the generation of the reflective thought processes in the PBL settings. The ideas of teachers on formative questioning and feedback influenced the students to question their approaches, critique the work, and determine the improvement of their products. Supportive evidence in Plummer et al. (2022), Deng et al. (2020), and Schaller et al. (2023) also highlights the importance of feedback in leading to critical reflection skills and more strong metacognitive development. In addition, Wijnia et al. (2024) and Liu et al. (2021) maintain that the feedback provokes self-evaluation and consciousness about their way of thinking that are also unavoidable to develop effective critical thinking skills in adulthood. This paper therefore confirms the vital nature of reflective feedback loops in helping students develop skills of critical thinking in an internalized manner.

CONCLUSION

This inquiry has surveyed the integration of project-based learning (PBL) as the method of reinforcing the critical-thinking skills of secondary education students. Through qualitative research of interviews, classroom observations and analysis of documents, researchers identified four key themes: active participation in the problem solving process; collaboration as a driving force to reflection; emergence of higher levels of student independence; and importance of continuous feedback and how it fosters reflection. All these together show that PBL is a good learning environment that allows students to engage in critical thinking, design solutions to genuine problems and deliberate much about how they learn to learn.

The study has gone beyond what has been done by other researchers by building more of the argument that there is indeed potential in the use of PBL as a pedagogical approach towards developing higher-order thinking abilities. It provides empirical data especially on a minor level on the Indonesian secondary education on how the critical-thinking by students would be significantly boosted in the case that they participated in genuine and collaborative and reflective learning activities. Also, the study shows the critical importance of educators in controlling, mediating, and continuously giving feedback to the PBL process, meaning that successful practice requires planning and planning. To teachers, the findings give them workable information on how to plan and conduct PBL exercises that promote critical thinking skills. To the policymakers, the study concludes by asserting the need to assist schools and teachers regarding professional-development programmes that

emphasized PBL and integration of critical-thinking. However, the research is cognizant of the limitations of the study especially due to the scope and the sample size which is likely not to give a complete representation of experiences in the various education environments. In the future studies, these findings could be extrapolated through mixed-methods research or larger-scale studies to further entrench their credibility and extend the knowledge base in how PBL affects the cognitive development of students as they grow over time.

REFERENCES

Al Najjar, H., Khalil, A. I., & Bakar, S. A. A. (2021). Nursing Students' Critical Thinking, Problem Solving and Self Directive Learning Skills: The Effect of Problem-Based Learning (PBL) Versus Lecture Based Learning (LBL). *Issues and Development in Health Research Vol*, *5*, 100-120. https://doi.org/10.9734/bpi/idhr/v5

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), 2158244020938702. https://doi.org/10.1177/2158244020938702

Comber, O., Motschnig, R., Mayer, H., & Haselberger, D. (2019, April). Engaging students in computer science education through game development with unity. In *2019 ieee global engineering education conference (educon)* (pp. 199-205). IEEE. https://doi.org/10.1109/EDUCON.2019.8725135

Cortázar, C., Nussbaum, M., Harcha, J., Alvares, D., López, F., Goñi, J., & Cabezas, V. (2021). Promoting critical thinking in an online, project-based course. *Computers in Human Behavior*, *119*, 106705. https://doi.org/10.1016/j.chb.2021.106705

Dabbagh, N. (2019). Effects of PBL on critical thinking skills. *The Wiley Handbook of Problem-Based Learning*, 135-156. https://doi.org/10.1002/9781119173243.ch6

de la Torre-Neches, B., Rubia-Avi, M., Aparicio-Herguedas, J. L., & Rodríguez-Medina, J. (2020). Project-based learning: an analysis of cooperation and evaluation as the axes of its dynamic. *Humanities and Social Sciences Communications*, *7*(1), 1-7. https://doi.org/10.1057/s41599-020-00663-z

de Oliveira Biazus, M., & Mahtari, S. (2022). The impact of project-based learning (PjBL) model on secondary students' creative thinking skills. *International Journal of Essential Competencies in Education*, *1*(1), 38-48. https://doi.org/10.36312/ijece.v1i1.752

Deng, L., Wu, S., Chen, Y., & Peng, Z. (2020). Digital game-based learning in a Shanghai primary-school mathematics class: A case study. *Journal of Computer Assisted Learning*, *36*(5), 709-717. https://publons.com/publon/10.1111/jcal.12438

Hmelo-Silver, C. E., Bridges, S. M., & McKeown, J. M. (2019). Facilitating problem-based learning. *The Wiley handbook of problem-based learning*, 297-319. https://doi.org/10.1002/9781119173243.ch13

Hussein, B. (2021). Addressing collaboration challenges in project-based learning: The student's perspective. *Education Sciences*, *11*(8), 434. https://doi.org/10.3390/educsci11080434

Khairani, S., Suyanti, R. D., & Saragi, D. (2020). The Influence of Problem Based Learning (PBL) Model Collaborative and Learning Motivation Based on Students' Critical Thinking Ability Science Subjects in Class V State Elementary School 105390 Island Image. *Budapest International Research*

and Critics in Linguistics and Education (BirLE) Journal, *3*(3), 1581-1590. https://doi.org/ https://doi.org/10.33258/birle.v3i3.1247

Liu, M., Shi, Y., Pan, Z., Li, C., Pan, X., & Lopez, F. (2021). Examining middle school teachers' implementation of a technology-enriched problem-based learning program: Motivational factors, challenges, and strategies. *Journal of Research on Technology in Education*, *53*(3), 279-295. https://doi.org/10.1080/15391523.2020.1768183

Liu, Y., & Pásztor, A. (2022). Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis. *Thinking Skills and Creativity*, *45*, 101069. https://doi.org/10.1016/j.tsc.2022.101069

Manuaba, I. B. A. P., -No, Y., & Wu, C. C. (2022). The effectiveness of problem based learning in improving critical thinking, problem-solving and self-directed learning in first-year medical students: A meta-analysis. *PloS one*, *17*(11), e0277339. https://doi.org/10.1371/journal.pone.0277339

Nadeak, B., & Naibaho, L. (2020). THE EFFECTIVENESS OF PROBLEM-BASED LEARNING ON STUDENTS'CRITICAL THINKING. *Jurnal Dinamika Pendidikan*, *13*(1), 1-7. https://doi.org/10.51212/jdp.v13i1.1393

Nejmaoui, N. (2019). Improving EFL Learners' Critical Thinking Skills in Argumentative Writing. *English language teaching*, *12*(1), 98-109. https://doi.org/10.5539/elt.v12n1p98

Nicholas, J. M., & Steyn, H. (2020). *Project management for engineering, business and technology*. Routledge. https://doi.org/10.4324/9780429297588

Plummer, K. J., Kebritchi, M., Leary, H. M., & Halverson, D. M. (2022). Enhancing critical thinking skills through decision-based learning. *Innovative Higher Education*, *47*(4), 711-734. https://doi.org/10.1007/s10755-022-09595-9

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

Sari, D. M. M., & Prasetyo, Y. (2021). Project-based-learning on critical reading course to enhance critical thinking skills. *Studies in English Language and Education*, *8*(2), 442-456. https://doi.org/10.24815/siele.v8i2.18407

Schaller, M. D., Gencheva, M., Gunther, M. R., & Weed, S. A. (2023). Training doctoral students in critical thinking and experimental design using problem-based learning. *BMC medical education*, *23*(1), 579. https://doi.org/10.1186/s12909-023-04569-7

Sweet, M., & Michaelsen, L. K. (Eds.). (2023). *Team-based learning in the social sciences and humanities: Group work that works to generate critical thinking and engagement*. Taylor & Francis. https://doi.org/10.4324/9781003447528

Taconis, R., & Bekker, T. (2023, August). Challenge Based Learning as authentic learning environment for STEM identity construction. In *Frontiers in Education* (Vol. 8, p. 1144702). Frontiers. https://doi.org/10.3389/feduc.2023.1144702

Tang, T., Vezzani, V., & Eriksson, V. (2020). Developing critical thinking, collective creativity skills and problem solving through playful design jams. *Thinking*

Skills and Creativity, *37*, 100696. https://doi.org/10.1016/j.tsc.2020.100696

Wijnia, L., Noordzij, G., Arends, L. R., Rikers, R. M., & Loyens, S. M. (2024). The effects of problem-based, project-based, and case-based learning on students' motivation: A meta-analysis. *Educational Psychology Review*, *36*(1), 29. https://doi.org/10.1007/s10648-024-09864-3

Zhan, Z., Shen, W., & Lin, W. (2022). Effect of product-based pedagogy on students' project management skills, learning achievement, creativity, and innovative thinking in a high-school artificial intelligence course. *Frontiers in Psychology*, *13*, 849842. https://doi.org/10.3389/fpsyg.2022.849842