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The Effectiveness of Problem Based Learning Model in Improving Students' Higher Order Thinking Skills

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ABSTRAK

Penelitian ini dilatarbelakangi oleh rendahnya kemampuan siswa dalam memahami konsep ilmiah dan memecahkan masalah ilmiah. Tujuan penelitian ini adalah menganalisis efektivitas model pembelajaran PBL dalam meningkatkan kemampuan Higher Order Thinking Skills (HOTS). Pendekatan kuantitatif yang digunakan dalam penelitian ini dengan menggunakan metode Quasi Eksperimental dengan desain Non Equivalent Control Group untuk mengetahui efektivitas pembelajaran menggunakan model problem based learning (PBL) dalam meningkatkan kemampuan berpikir tingkat tinggi siswa pada kompetensi produk siswa SMK. Teknik pemilihan sampel yang digunakan adalah purposive sampling dengan memilih sampel sebanyak 200 siswa kelas III SMK. Pengumpulan data dilakukan dengan menggunakan metode pretest-intervensi-posttest. Uji yang dilakukan adalah uji normalitas, homogenitas, dan hipotesis. Hasil penelitian menunjukkan bahwa metode pembelajaran berbasis masalah efektif meningkatkan kemampuan berpikir tingkat tinggi secara signifikan dibandingkan dengan kemampuan kontrol menggunakan metode konvensional. Secara keseluruhan hasil belajar kognitif siswa dari pre-test dan post-test selalu meningkat, dimana pada kelas eksperimen meningkat dari 28,45 menjadi 68,6 sedangkan pada kelas kontrol meningkat dari 23,78 menjadi 55,32. Kemudian dilakukan uji Wilcoxon sebesar 0,000 (2-tailed sig <0,05) untuk mengetahui besarnya efek intervensi. Berdasarkan hasil pengujian, siswa yang mendapat intervensi dengan PBL mengalami peningkatan kemampuan berpikir tingkat tinggi kompetensi produk siswa SMK yang signifikan dibandingkan dengan siswa yang mendapat intervensi dengan metode konvensional.

ABSTRACT

This research was motivated by the low ability of students to understand scientific concepts and solve scientific problems. The aim of this research is to analyze the effectiveness of the PBL learning model in improving Higher Order Thinking Skills (HOTS) abilities. A quantitative approach was used in this research using the Quasi Experimental method with a Non Equivalent Control Group design to determine the effectiveness of learning using the problem based learning (PBL) model in improving students' high-level thinking skills in vocational school student product competencies. The sample selection technique used was purposive sampling by selecting a sample of 200 class III vocational school students. Data is collected by using is pretest-intervention-posttest. The test conducted in normality, homogeneity, and hypothesis tests. The results of the research show that the problem-based learning method is effective in improving high-level thinking abilities significantly compared to control abilities using conventional methods. Overall student cognitive learning outcomes from the pre-test and post-test always increase, where in the experimental class it increases from 28.45 to 68.6 while in the control class it increases from 23.78 to 55.32. Then a Wilcoxon test of 0.000 (2-tailed sig <0.05) was carried out to determine the magnitude of the intervention effect. Based on the test results, students who received intervention with PBL experienced a significant increase in high-level thinking skills in product competency for vocational school students compared to students who received intervention with conventional methods.

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1. INTRODUCTION

This problem in HOTS skills can be seen from their low ability to solve problems in the form of analyzing, evaluating, and creating which are HOTS components. The low HOTS ability can also be seen from the results of the daily test results for Grade 3 Vocational High School students, where 63.3% of students still have not completed the Minimum Completeness Criteria (KKM) (Mitani, 2021; Tambun et al., 2021). One of the causes of the low physics ability of students is because the learning process is still dominated by teachers. In addition, the average cognitive ability of students is still at the level of remembering, understanding and applying based on the questions given (Aston, 2023; Beckwith, 2019). This condition can be seen from the practice questions in the handbook used in class. According to Bloom's taxonomy that level of thinking ability is still classified as lower order thinking ability or Lower Order Thinking. Therefore, it is expected that there will be an increase in HOTS.

HOTS is needed in solving problems, especially in physics. HOTS is a process that requires students to process existing information and ideas so that they can give them new understanding. HOTS in the cognitive domain includes the ability to analyze, evaluate, and create (Ennis, 2018; Maiese, 2019). HOTS is the ability of students to think and connect the concepts learned with concepts they have not learned before. Therefore, to carry out the learning process, an appropriate learning model is needed. One learning model that can develop students' thinking skills or HOTS is Problem Based Learning (PBL) (Mitani, 2021; Noone & Hogan, 2018b). The PBL model can train students' thinking skills in solving real problems they face. Students' thinking skills in solving science problems are needed to train their HOTS. The PBL model involves students in solving real problems according to the steps of the scientific method so that students' HOTS can be developed (Noone & Hogan, 2018a; Suseelan et al., 2022). Students need to be trained in their HOTS skills so they can be creative and innovative in solving various problems they face.

One of the contents in the Indonesia Curriculum is that it requires students to be able to think at a higher level. Higher Order Thinking Skills (HOTS) are key elements of the Indonesia Curriculum. HOTS can be developed by maximizing readiness for the implementation of the Independent Curriculum (Daris Hadianto et al., 2022; Marhadi & Erlisnawati, 2018). This readiness can be seen in the focus of the Independent Curriculum which is reflected in each stage of the 5M activities, namely asking, observing, associating, seeking information, and communicating knowledge. Vocational High School is a school that has implemented the Independent Curriculum. The implementation of the Independent Curriculum is expected to improve the quality of education (Mukhdor, 2020; Renika & Dian, 2015). Good quality education is one of the factors that support the creation of quality human resources. In fact, this condition is still not clearly visible in the school. Based on the results of observations, there are still many vocational students who experience problems, especially in the learning process.

The observation results show that in physics subjects, students still experience difficulties in understanding physics concepts which according to them are still abstract and complicated, so that the learning process is not optimal (Hollis, 2023; Lo & Feng, 2020). Thinking skills in the cognitive domain according to the revised Bloom's Taxonomy are divided into six levels: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). The first three levels consist of C1, C2, and C3 which are Lower Order Thinking Skills (LOTS) levels, while the next three levels consist of C4, C5, and C6 which are HOTS levels. HOTS questions in the cognitive domain include the levels of analyzing (C4), evaluating (C5), and creating (C6) (Saido et al., 2018; Sheffield, 2018). The types of pre-test/post-test questions used to measure students' HOTS skills are essay questions, totaling 6 items. HOTS questions need to be prepared by taking into account the cognitive aspects that will be achieved during learning activities. Essay questions are used to measure HOTS skills because students need freedom in solving the given HOTS questions (D. Hadianto et al., 2021; Shpeizer, 2018). One way to improve higher-order thinking skills is when students are faced with a problem that has never been encountered before, this is where students' higher-order thinking processes will be trained. HOTS is very suitable to be taught with the PBL model.

The PBL model is a way of constructing and teaching courses using problems as a stimulus and focus for learner activity. The PBL model stage consists of 5 stages, namely 1) orienting students to problems, 2) organizing students for learning, 3) assisting independent and group investigations, 4) developing and presenting work, and 5) analyzing and evaluating the problem solving process (Moghadam et al., 2023; Noone & Hogan, 2018a). The stages in the PBL model are in accordance with constructivism theory, because students can build ideas, understand and give meaning to the information and events they experience. The PBL model has advantages, namely 1) student problem solving activities can generate critical thinking skills, 2) increase student activity in the learning process and 3) students have the opportunity to apply their knowledge to the real world (Sheffield, 2018; Shpeizer, 2018). Learning with the PBL model begins with a problem that uses the instructor as metacognitive training and ends with the presentation and analysis of students' work. Students are accustomed to solving problems, then it will train their thinking skills (Lee & Lai, 2017; Noone & Hogan, 2018a). The PBL model emphasizes the problem solving process. Through problem solving in PBL, students are directed to build new knowledge, solve problems in various contexts. The use of the PBL model was chosen because there were several studies that obtained good results. PBL is able to improve students' thinking skills in finding and finding their own solutions to problems. The purpose of this study was to measure whether there was a significant effect of HOTS on students who were taught using the PBL model and those who were taught using the conventional model.

Several previous studies have investigated the role of PBL in increasing student competence, including the PBL model which has been proven to be effective in increasing analytical abilities and critical thinking skills. In addition, research on PBL middle-level students has been shown to be effective in increasing students' ability to solve math problems with a fairly high level of difficulty (U. Khoiriyah et al., 2015; Syaiful et al., 2022). PBL also contributes to learning motivation and students' critical thinking skills in understanding biology subjects. The level of criticality of students can be seen in the questions and answers given after students get the intervention of the teaching process with PBL (Demircioglu et al., 2022; Wahono et al., 2020). The application of PBL is also carried out at the junior high school level which is proven to be able to improve students' critical thinking skills in science learning (A. J. Khoiriyah & Husamah, 2018; Kumar et al., 2023). In addition to the aspect of thinking ability, PBL learning also contributes positively to students' independent learning skills and positively contributes to critical thinking skills and understanding of biological concepts at the high school level (Hursen, 2021; Schaller et al., 2023).

The difference between this research and previous research is that this research focuses on investigating the role of PBL in improving critical thinking skills that can support competency in designing products for SMK students. In addition, an analysis is carried out in more detail on each competency that is included in higher-order thinking skills, such as competency analysis, evaluation, and creating products for SMK students. So, the purpose of this study was to analyze the effect of the PBL model on the competence of higher order thinking skills (HOTS) which can support product design competence of SMK students.

2. METHOD

The approach used in this research is a quantitative approach. The method used in this research is quasi-experimental using a non-equivalent control group. The Non Equivalent Control Group technique consists of two groups that are not randomly selected because the level of ability of students in a class is different (Lu, Yang, et al., 2021; Sheffield, 2018). The sample selection technique used was purposive sampling technique. The participants involved in this study were 200 third grade students of SMK who were divided into two groups, namely the experimental and control groups. The two classes were chosen because they have relatively the same level of understanding of the subject matter compared to the other classes. The pre-test is given to determine the students' initial abilities between the experimental class and the control class.

The results of the pre-test are said to be good if the values obtained by the experimental class are not significantly different from the values obtained by the control class. The design in this study is pretest-intervention-posttest. The data collection techniques used consisted of two types, namely test techniques and non-test techniques. Test techniques include pre-test and post-test HOTS tests, while non-test techniques are carried out by providing validation sheets. The test technique was carried out to obtain data through the results of the pre-test and post-test while the non-test technique was carried out to obtain the results of the instrument validation to be used.

The HOTS test used was an essay question consisting of 6 questions. Before being used in research, the test items were validated by an expert validator. The results of instrument validation were then analyzed through Rasch modeling with the help of the facets application, and the questions were valid. Data analysis techniques use prerequisites and hypothesis testing. The normality test is said to be normally distributed if the significant value is greater than $\alpha = 0.05$. Hypothesis testing is done by looking at the results of the normality and homogeneity tests, if the data is normally distributed and homogeneous, then a parametric hypothesis test will be carried out, but if one or both data are abnormal and homogeneous, a non-parametric hypothesis test will be carried out. The Ha hypothesis in this study is that there is a significant influence of HOTS on students who are taught using the PBL model with those who are taught using the conventional model. The results of the hypothesis test, if the sig value is obtained. (2-tailed) $< \alpha = 0.05$ then it is rejected or accepted. Conversely, if the sig. (2-tailed) $> \alpha = 0.05$ then accepted or rejected.

3. RESULT AND DISCUSSION

Result

Some results of data analysis are presented to answer the problem formulation of the effectiveness of the PBL model in increasing students' HOTS skills. The data presented includes a normality test to see the distribution of students in each phase and group, a hypothesis test to test the hypothesis as well as answer the m=formulation of the problem, the N-gain test to measure the increase in students' HOTS skills in each group, and finally the effect size test to see the size the resulting effect of the intervention on students' HOTS skills. Table 1 is presented and explained one by one the test results.

Table 1. Post-Test Normality Test

Pre-test	Sig. Kolmogorov-Smirnov
Experiment	0.251
Control	0.015
Post-test	**Sig. Kolmogorov-Smirnov**
Experiment	0.315
Control	0.020

Table 1 is an analysis of the normality test obtained from the post-test results of students in the experimental and control classes. Pre and Post-test data from the experimental class had a Kolmogorov-Smirnova significance greater than α = 0.05, while the control class had a Kolmogorov-Smirnova significance less than α = 0.05. The results of the normality test show that there is one significant value that is smaller than α = 0.05, meaning that the data is not normally distributed.

Table 2. Post-Test Homogeneity Test

Levene Statistic	df1	df2	Sig.
0.027	1	54	0.883

Table 2 is an analysis of the homogeneity test results of the post-test students in the experimental class and the control class. Post-test data from the experimental class and control class has a significant value of 0.0883. This significant value is greater than the value of α = 0.05, which means that the data from both classes are homogeneous. The hypothesis test is carried out after carrying out the normality test and homogeneity test. The results of the normality test are not normally distributed while the homogeneity test of the resulting data is homogeneous so that the hypothesis test used is a non-parametric hypothesis test. The non-parametric test used is the Wilcoxon test. The result is show in Table 3.

Table 3. Post-test Hypothesis Testing

Statistics	Pre-test – Results
Z	-9.317
Asymp. Sig. (2-tailed)	0.000
Statistics	**Post-test – Results**
Z	-7.462
Asymp. Sig. (2-tailed)	0.000

Table 3 is a hypothesis test on the post-test results of students in the experimental class and control class. Based on the test results, the negative Z value on the pretest is smaller than the value on the posttest (-9.317). Furthermore, based on the results of the Wilcoxon test, it also shows that there is a sig. (2-tailed) in the pretest data shows 0.012, which means the value is greater than α = 0.05. Because the sig value. (2-tailed) < α = 0.05. The Wilcoxon test results show a negative Z value (-7.462) which indicates the post-test value is greater than the pre-test. The Wilcoxon test results also show the presence of sig. (2-tailed) 0.000 which means the value is smaller than α = 0.05. Because the sig value. (2-tailed) < α = 0.05, the hypothesis that the PBL model can improve HOTS skills is accepted. So it can be concluded that there is a significant effect of HOTS on students who are taught using the PBL model with those who are taught using the conventional model. The results of the n-gain test analysis is show in Table 4.

Table 4. Results of the N-Gain Test Analysis

Class	N-Gain Value	Criteria
Experiment	0.82	High
Kontrol	0.52	Medium

Furthermore, the N-gain test was carried out to measure the increase in HOTS skills of students in the experimental class and control class. Based on Table 4, the N-gain test results for the experimental class were greater than those for the control class, where the N-gain value for the experimental class was 0.82 (high) and the N-gain value for the control class was 0.52 (moderate). These results are in line with previous research which showed that the application of the PBL model in the experimental class obtained higher learning outcomes than the conventional learning model.

Table 5. Effect Size Analysis Results

Class	Pretest	Posttest
Experiment	32.41	72.61
Kontrol	28.56	62.13
Class	**Effect Size**	**Criteria**
Experiment	5.24	High
Kontrol	1.76	Medium

Base on Table 5 show effect Size is done to see the effectiveness of the learning model on HOTS students. The average score of students' pre-test and post-test results increased, where in the experimental class it increased from 32,41 to 72,61 while in the control class it increased from 28,56 to 62,13. The increase in the average of students' pre-test and post-test results influences the effect size value, where the effect size value in the experimental class is 5.24, which is in the high category, while the effect size in the control class is 1.76, which is in the medium category. The higher the effect size value, the greater the influence of the PBL model on students' HOTS skills. The increase in HOTS of students in the experimental class and control class can be seen from the increase in the average pre-test and post-test scores, while the results of the analysis of students' HOTS skills can be seen from the average post-test. -test scores at the level of analyzing (C4), assessing (C5), creating (C6). Overall cognitive level in the posttest phase is show in Table 6.

Table 6. Overall Cognitive Level in the Posttest Phase

Group	Cognitive Level	*N*	Mean	SD	*t*	*p*
Experiment	Analysis	80	52.5	6.563	3.362	0,053
Control		80	34.8	7.424		
Experiment	Evaluative	80	68.7	6.762	3.478	0,043
Control		80	64.8	4.634		
Experiment	Creation	80	34.6	4.368	3.684	0,016
Control		80	18,8	5.462		
Experiment	All Competence	80	68.6	6.557	0.754	0,725
Control		80	55.32	4.364	0.653	0,342

Based on Table 6, overall the positive level in the posttest phase showed a significant increase. From the results of the post-test students in the experimental class and the control class at the analysis level (C4), had scores of 52.5 and 34.8, evaluating 68.7 and 64.8, and creating 34.6 and 18.8. Overall student in cognitive learning outcomes in the experimental class was 68.6 while in the control class was 55.32. The post-test results of the three cognitive aspects show that the order of scores from highest to lowest obtained by students in both classes is in the cognitive aspects of evaluating, analyzing, and creating. This increase shows that students are starting to be able to develop their HOTS even though their overall scores have not yet reached the KKM. Students need to be trained by applying appropriate learning so that their HOTS can continue to increase.

Discussion

According to the statistical data described in the previous section, HOTS is one of the thinking skills that are very important to train students to be able to face the various challenges that exist. HOTS in the cognitive domain is more than just remembering and understanding. In addition, students with high HOTS tend to be more successful in learning compared to students with low HOTS skills. The HOTS of students at each cognitive level can be seen by analyzing the cognitive learning outcomes of students. The cognitive level of students consists of analyzing, evaluating, and creating levels. Learners are trained to develop analytical thinking processes by solving problems given at the beginning of learning. Based on the problem solving result sheet, it can be seen that students are able to parse information by writing down what is known and asked according to what is meant in the problem and are able to use concepts to determine good steps for solving (Shpeizer, 2018; Suseelan et al., 2022). Indicators of analyzing problems can be seen from the way students solve questions, namely being able to describe information, understand concepts, and use appropriate problem solving steps (Kabataş Memiş & Çakan Akkaş, 2020; Podina et al., 2020). Students are able to solve problems if they are able to arrange and complete the steps to solve the problem correctly. Changes in attitudes, knowledge, and skills of students show their ability to solve problems (Southworth, 2022; Wahono et al., 2020). The ability of students to find knowledge on their own is important to be developed by the teacher through his role as a facilitator and mediator.

Students are able to solve problems in the evaluating aspect if they are able to describe the intent of the problem being worked on. Students in solving questions on the creative aspect are the lowest compared to the analyzing and evaluating aspects. In this aspect students still have difficulty in solving questions (Hwang et al., 2023; Lee & Lai, 2017; Loyens et al., 2023). One of the problems that is difficult for students to do is when asked about comparative proof, they have not been able to combine the three proofs that must be completed first before looking for comparisons (Limniou et al., 2018; Mitani, 2021). Students need to be trained to develop their ability to create concepts through the application of learning that requires them to be creative in the form of project assignments The PBL model used has not been able to fully influence the HOTS of students, especially for the evaluation and creation category (Prakash & Litoriya, 2022; Wijnen et al., 2022). The low pre-test/post-test results show that so far HOTS students have received little attention and have not been trained, especially at the secondary school level. In addition, the ability of students to solve HOTS questions (C4, C5, and C6) is still low, one of the reasons is the questions in textbooks that are used mostly (96.35%) are based on Bloom's taxonomy levels C1, C2 and C3.

With the syntax of the PBL model described above, students are trained to analyze problems, then solve problems, to make solutions to solve problems, so students will be trained in HOTS skills. As for the learning process, it is necessary to pay attention to the implementation of the PBL model syntax because students who tend to have low HOTS scores find it difficult in the third and fourth PBL model syntax, especially during the investigative and group discussion phases (Lo & Feng, 2020; Lu, Pang, et al., 2021). Because at that stage students were trained in their HOTS skills in the aspects of analysis and evaluation. The teacher in the PBL model process functions as a facilitator no longer as an ordinary teacher, so the teacher is no longer a center in learning if in the learning process the teacher is involved a lot in the learning process the learning outcomes are less than optimal in accordance with previous research where teachers are too involved in the PBL learning process in the investigation phase resulted in low students' high-order thinking skills, especially for aspects of low evaluating and creating abilities (Aston, 2023; Dolapcioglu, 2020; Ennis, 2018). The PBL model is a model that has the characteristics of a problem as a source or topic in learning. So, the teacher in planning the learning process of the PBL model must pay attention to the problems that will be presented in the learning process, if the problems presented are not appropriate then it will disrupt the learning process so that it results in learning outcomes which is less than optimal, in accordance with previous research where teachers experience learning planning obstacles in determining the problems to be presented (Danvers, 2021; Gottlieb, 2022).

In the learning process it is also found that if you think that it supports the implementation of the PBL model, to manage interactions between students, namely by placing problems as a source of interaction, so it is necessary to form small groups in the learning process. But there are factors that hinder the implementation of the PBL model, namely member feedback (Hollis, 2023; Prakash & Litoriya, 2022). Therefore, in the group work process it is necessary that members work together and the teacher is a good facilitator to produce good feedback. That is, the teacher can form heterogeneous groups wherein a group is not dominated by smart students or less smart students (Hwang et al., 2023; Limniou et al., 2018; Park & Song, 2020). The PBL model was student-centered learning so that students are required to be active in the learning process. In contrast to conventional methods, teachers dominated the learning process and students are encouraged to memorize the material, so they did not dare to express ideas during learning (Sheffield, 2018; Shpeizer, 2018). The PBL model can improve high-level thinking skills because in the learning process students was encouraged to solve high-level problems, so they are accustomed to using high-level thinking skills, such as the ability to analyze, evaluate and create. In accordance with previous research that an important factor in the success of the problem-based model is student participation (Lee & Lai, 2017; Suseelan et al., 2022).

This research has implications that teachers can use the PBL model to improve students' HOTS skills with the implementation adapted to the context of the material. This research has several limitations, including the sample which is still on a small scale, does not consider gender aspects, does not disclose qualitative data that strengthens the research results. Based on the limitations of this research, the researcher recommends a number of things for further research, including participants who should be involved preferably on a large scale and from various levels, consider gender aspects in investigating students' HOTS skills which may have a role in students' HOTS ability levels, and strengthen research data by qualitative data such as the results of interviews with students and teachers for feedback on the advantages and disadvantages of the PBL learning model.

4. CONCLUSION

The PBL learning model has a significant effect on the ability of Higher Order Thinking (HOTS). The increase shows an increase in HOTS skills scores in the pretest and posttest phases. In addition, the effect size test results for the experimental class had better HOTS skills than the control group. Increased ability in detail can be seen in the ability to analyze, evaluate, and create. So, the PBL model is more effective in improving students' HOTS skills than the conventional method.

5. REFERENCES

Aston, K. J. (2023). 'Why is this hard, to have critical thinking?' Exploring the factors affecting critical thinking with international higher education students. *Active Learning in Higher Education*. https://doi.org/10.1177/14697874231168341.

Beckwith, P. T. (2019). The HOTSHOT taxonomy and a signature pedagogy framework for operating department practice: The juxtaposition to the academic apartheid surrounding higher order thinking. *Journal of Perioperative Practice*, *29*(6), 185–192. https://doi.org/10.1177/1750458918820729.

Danvers, E. (2021). Individualised and instrumentalised? Critical thinking, students and the optics of possibility within neoliberal higher education. *Critical Studies in Education*, *62*(5), 641–656. https://doi.org/10.1080/17508487.2019.1592003.

Demircioglu, T., Karakus, M., & Ucar, S. (2022). Developing Students' Critical Thinking Skills and Argumentation Abilities Through Augmented Reality–Based Argumentation Activities in Science Classes. In *Science and Education* (Vol. 32, Issue 4). Springer Netherlands. https://doi.org/10.1007/s11191-022-00369-5..

Dolapcioglu, S. (2020). Action learning in teacher education for teaching twenty-first-century thinking skills. *Action Learning: Research and Practice*, *17*(3), 326–334. https://doi.org/10.1080/14767333.2020.1819611.

Ennis, R. H. (2018). Critical Thinking Across the Curriculum: A Vision. *Topoi*, *37*(1), 165–184. https://doi.org/10.1007/s11245-016-9401-4.

Gottlieb, J. (2022). The Higher-Order Map Theory of Consciousness. *Australasian Journal of Philosophy*, *100*(1), 131–148. https://doi.org/10.1080/00048402.2020.1861038.

Hadianto, D., Damaianti, V. S., Mulyati, Y., & Sastromiharjo, A. (2021). Does reading comprehension competence determine level of solving mathematical word problems competence? *Journal of Physics: Conference Series*, *1806*(1). https://doi.org/10.1088/1742-6596/1806/1/012049.

Hadianto, Daris, S. Damaianti, V., Mulyati, Y., & Sastromiharjo, A. (2022). Effectiveness of Literacy Teaching Design Integrating Local Culture Discourse and Activities to Enhance Reading Skills. *Cogent Education*, *9*(1), 0–13. https://doi.org/10.1080/2331186X.2021.2016040.

Hollis, H. (2023). Readers' experiences of fiction and nonfiction influencing critical thinking. *Journal of Librarianship and Information Science*, *55*(1), 18–32. https://doi.org/10.1177/09610006211053040.

Hursen, C. (2021). The effect of problem-based learning method supported by web 2.0 tools on academic achievement and critical thinking skills in teacher education. *Technology, Knowledge and Learning*, *26*, 515–533. https://doi.org/10.1007/s10758-020-09458-2.

Hwang, G. J., Zou, D., & Wu, Y. X. (2023). Correction to: Learning by storytelling and critiquing: a peer assessment-enhanced digital storytelling approach to promoting young students' information literacy, self-efficacy, and critical thinking awareness (Educational technology research and develop. *Educational Technology Research and Development*, *0123456789*, 11423. https://doi.org/10.1007/s11423-023-10204-5.

Kabataş Memiş, E., & Çakan Akkaş, B. N. (2020). Developing critical thinking skills in the thinking-discussion-writing cycle: the argumentation-based inquiry approach. *Asia Pacific Education Review*, *21*(3), 441–453. https://doi.org/10.1007/s12564-020-09635-z.

Khoiriyah, A. J., & Husamah, H. (2018). Problem-based learning: Creative thinking skills, problem-solving skills, and learning outcome of seventh grade students. *Jurnal Pendidikan Biologi Indonesia*, *4*(2), 151–160. https://doi.org/10.22219/jpbi.v4i2.5804.

Khoiriyah, U., Roberts, C., Jorm, C., & Van Der Vleuten, C. P. M. (2015). Enhancing students' learning in problem based learning: Validation of a self-assessment scale for active learning and critical thinking. *BMC Medical Education*, *15*(1), 1–8. https://doi.org/10.1186/s12909-015-0422-2.

Kumar, T., Soozandehfar, S. M. A., Hashemifardnia, A., & Mombeini, R. (2023). Self vs. peer assessment activities in EFL-speaking classes: impacts on students' self-regulated learning, critical thinking, and problem-solving skills. *Language Testing in Asia*, *13*(1). https://doi.org/10.1186/s40468-023-00251-3.

Lee, K. yuen, & Lai, Y. chi. (2017). Facilitating higher-order thinking with the flipped classroom model: a student teacher's experience in a Hong Kong secondary school. *Research and Practice in Technology Enhanced Learning*, *12*(1). https://doi.org/10.1186/s41039-017-0048-6.

Limniou, M., Schermbrucker, I., & Lyons, M. (2018). Traditional and flipped classroom approaches delivered by two different teachers: the student perspective. *Education and Information Technologies*, *23*(2), 797–817. https://doi.org/10.1007/s10639-017-9636-8.

Lo, C. O., & Feng, L. C. (2020). Teaching higher order thinking skills to gifted students: A meta-analysis. *Gifted Education International*, *36*(2), 196–217. https://doi.org/10.1177/0261429420917854.

Loyens, S. M. M., van Meerten, J. E., Schaap, L., & Wijnia, L. (2023). Situating Higher-Order, Critical, and Critical-Analytic Thinking in Problem- and Project-Based Learning Environments: A Systematic Review. In *Educational Psychology Review* (Vol. 35, Issue 2). Springer US. https://doi.org/10.1007/s10648-023-09757-x.

Lu, K., Pang, F., & Shadiev, R. (2021). Understanding the mediating effect of learning approach between learning factors and higher order thinking skills in collaborative inquiry-based learning. *Educational Technology Research and Development*, *69*(5), 2475–2492. https://doi.org/10.1007/s11423-021-10025-4.

Lu, K., Yang, H. H., Shi, Y., & Wang, X. (2021). Examining the key influencing factors on college students' higher-order thinking skills in the smart classroom environment. *International Journal of Educational Technology in Higher Education*. https://doi.org/10.1186/s41239-020-00238-7.

Maiese, M. (2019). Higher-Order Thought, Self-Identification, and Delusions of Disownership. *Review of Philosophy and Psychology*, *10*(2), 281–298. https://doi.org/10.1007/s13164-017-0369-9.

Marhadi, H., & Erlisnawati. (2018). Peningkatan Kemampuan Berpikir Tingkat TInggi/Higher Order Thinking Skill (HOTS) Mahasiswa PGSD FKIP UR. *PEDAGOGIKA, Jurnal Pendidikan Guru Sekolah Dasar*, *VI*(1), 69–78. https://doi.org/10.33558/pedagogik.v6i1.452.

Mitani, H. (2021). Test Score Gaps in Higher Order Thinking Skills: Exploring Instructional Practices to Improve the Skills and Narrow the Gaps. *AERA Open*, *7*(1). https://doi.org/10.1177/23328584211016470.

Moghadam, Z. B., Narafshan, M. H., & Tajadini, M. (2023). The effect of implementing a critical thinking intervention program on English language learners' critical thinking, reading comprehension, and classroom climate. *Asian-Pacific Journal of Second and Foreign Language Education*, *8*(1). https://doi.org/10.1186/s40862-023-00188-3.

Mukhdor, A. (2020). Peningkatan kemampuan berpikir tingkat tinggi siswa SMK melalui model pembelajaran berbasis masalah. *Jptm*, *10*(01), 52–61. https://doi.org/10.26803/ijlter.22.9.19.

Noone, C., & Hogan, M. J. (2018a). A randomised active-controlled trial to examine the effects of an online mindfulness intervention on executive control, critical thinking and key thinking dispositions in a university student sample. *BMC Psychology*, *6*(1), 1–18. https://doi.org/10.1186/s40359-018-0226-3.

Noone, C., & Hogan, M. J. (2018b). Improvements in Critical Thinking Performance Following Mindfulness Meditation Depend on Thinking Dispositions. *Mindfulness*, *9*(2), 461–473. https://doi.org/10.1007/s12671-017-0789-8.

Park, J., & Song, J. (2020). How Is Intuitive Thinking Shared and Elaborated During Small-Group Problem-Solving Activities on Thermal Phenomena? *Research in Science Education*, *50*(6), 2363–2390. https://doi.org/10.1007/s11165-018-9784-x..

Podina, I. R., Cosmoiu, A., Rusu, P., & Chivu, A. (2020). Positive Thinking is Not Adaptive Thinking: A Cognitive-Behavioral Take on Interpretation Bias Modification for Social Anxiety. *Journal of Rational - Emotive and Cognitive - Behavior Therapy*, *38*(3), 424–444. https://doi.org/10.1007/s10942-020-00344-5.

Prakash, R., & Litoriya, R. (2022). Pedagogical Transformation of Bloom Taxonomy's LOTs into HOTs: An Investigation in Context with IT Education. *Wireless Personal Communications*, *122*(1), 725–736. https://doi.org/10.1007/s11277-021-08921-2.

Renika, V., & Dian, R. N. (2015). Peningkatan Keterampilan Berpikir Tingkat Tinggi (HOTS) Menggunakan Model Problem Based Learning. *Riskesdas 2018*, *3*(1), 103–111. https://doi.org/10.33654/jph.v6i1.1038.

Saido, G. A. M., Siraj, S., DeWitt, D., & Al-Amedy, O. S. (2018). Development of an instructional model for higher order thinking in science among secondary school students: a fuzzy Delphi approach. *International Journal of Science Education*, *40*(8), 847–866. https://doi.org/10.1080/09500693.2018.1452307.

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.

Sheffield, C. B. (2018). Promoting Critical Thinking in Higher Education: My Experiences as the Inaugural Eugene H. Fram Chair in Applied Critical Thinking at Rochester Institute of Technology. *Topoi*, *37*(1), 155–163. https://doi.org/10.1007/s11245-016-9392-1.

Shpeizer, R. (2018). Teaching critical thinking as a vehicle for personal and social transformation. *Research in Education*, *100*(1), 32–49. https://doi.org/10.1177/0034523718762176.

Southworth, J. (2022). Bridging critical thinking and transformative learning: The role of perspective-taking. *Theory and Research in Education*, *20*(1), 44–63. https://doi.org/10.1177/14778785221090853.

Suseelan, M., Chew, C. M., & Chin, H. (2022). Higher-order thinking word problem-solving errors made by low-performing pupils: Comparative case study across school types in Malaysia. *Current Psychology*, *0123456789*. https://doi.org/10.1007/s12144-022-03271-z.

Syaiful, Huda, N., Mukminin, A., & Kamid. (2022). Using a metacognitive learning approach to enhance students' critical thinking skills through mathematics education. *SN Social Sciences*, *2*(4), 31. https://doi.org/10.1007/s43545-022-00325-8.

Tambun, T. A., Arifitriana, W., & Hasibuan, E. A. (2021). Upaya Meningkatkan Higher Order Thinking Skill (Hots) Siswa Menggunakan Metode Inquiry Pada Materi Bilangan Bulat. *JURNAL MathEdu (Mathematic Education Journal)*, *4*(3), 54–60. https://doi.org/10.37081/mathedu.v4i3.3164.

Wahono, B., Lin, P. L., & Chang, C. Y. (2020). Evidence of STEM enactment effectiveness in Asian student learning outcomes. *International Journal of STEM Education*, *7*(1), 1–18. https://doi.org/10.1186/s40594-020-00236-1.

Wijnen, F., Walma van der Molen, J., & Voogt, J. (2022). Primary teachers' attitudes towards using new technology and stimulating higher-order thinking in students: A profile analysis. *Education and Information Technologies*, *28*(6), 6347–6372. https://doi.org/10.1007/s10639-022-11413-w.