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PBL-TARL-CRT: INTEGRATING INNOVATIVE APPROACHES TO IMPROVE SCIENCE LEARNING OUTCOMES IN GRADE 8

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ABSTRACT

This study investigated the effectiveness of integrating Problem-Based Learning (PBL) with teaching at the right level (TaRL) and culturally responsive teaching (CRT) in improving student learning outcomes in science education. This experimental study was conducted with 32 second-grade junior high school students at 25 Semarang, Indonesia. The study used qualitative and quantitative approaches, with data collected from formative assessments and interviews to measure the impact of the intervention. Quantitative analysis using ANOVA showed a difference in learning outcomes between the experimental and control groups. Qualitative findings showed significant improvements in motivation, engagement, and conceptual understanding among students using the integrated PBL-TaRL-CRT learning model. Interviews highlighted the effectiveness of aligning learning with students' cultural level and context while enhancing teacher-student interaction. This research underscores that the combined PBL-TaRL-CRT approach fosters a dynamic, student-centered environment, improving academic performance and character development. The findings suggest that applying this integrated model can optimize learning practices, especially in diverse classrooms, by promoting active learning, cultural relevance, and targeted instruction.

INTRODUCTION

Education is the pillar of the country's development, in addition to the formation of an intelligent and characterful generation. Educational development is highly dependent

on the effectiveness of the learning methods applied. The learning model that is getting more attention is problem-based learning (PBL), which is integrated with the Teaching at the Right Level (TaRL) approach and culturally responsive teaching (CRT). PBL is a learning model that puts students at the center of learning by providing real challenges to solve (Amalia et al., 2024). The Teaching at the Right Level (TaRL) approach is a learning approach that orients students to learn according to their ability level, consisting of low, medium, and high ability levels, not based on grade level or age (Banerji & Chavan, 2020). CRT is a learning approach that uses cultural knowledge, students' experiences, and students' learning styles to create more meaningful learning (Handayani & Anwar, 2022).

As a teacher, you need to remember that students are targeted with improved learning outcomes and need character education to form a good personality. The basis of education, according to Ki Hajar Dewantara, is also related to the development of character, character, and character, meaning that education does not only improve students' competence in the concept of science but also leads them to become individuals with character and culture by the culture of their nation (Febriyanti, 2021). Integrating students' cultural backgrounds is an effort to bring students closer to the learning context and students' awareness of their cultural identity. So far, the learning often applied in schools, especially in Junior High School 25 Semarang, is uniform learning for all students, both from learning resources and learning processes. According to Busyairi & Kusuma (2023), applied teaching will affect each student differently, related to their abilities. In this class, some students can understand the material quickly, but some are slow, so it must be repeated many times. However, this becomes ineffective in terms of learning time.

This research was conducted to show that learning not only provides academic knowledge about student achievement but also describes the extent to which it can apply the knowledge gained in real-world situations and how to shape student character well. Therefore, this evaluation does not only focus on giving grades but also on developing skills, understanding of concepts, and student character. The research by Deveci et al. (2022) shows that implementing PBL in science learning can positively impact concept understanding, critical thinking skills, and student learning motivation. In addition, the advantages of PBL are that it brings up ideas and encourages students to argue about the

issues discussed (Ismail et al., 2018). Students are also directed to argue the need for scientific evidence that supports the answer (Jumadi et al., 2021). Teachers provide direction during learning and a clear understanding of the topics discussed to achieve these learning objectives. This shapes students' character, provides learning motivation, and provides space for them to show themselves (Clark et al., 2009).

As a Teacher Professional Program (PPG) student who currently teaches at Junior High School with Natural Science teaching materials, I have carried out research activities on 8th-grade junior high school students for 4 weeks. During the study, experimental research was conducted, especially using the PBL learning model to improve students' communication skills, learning motivation, morale, and learning outcomes. Research results from Gök & Boncukçu (2023a) are related to the main problem of our research, which is that this experimental approach positively impacts student learning outcomes. The results of a study of 114 second-grade junior high school students on science materials showed that PBL was more effective in developing environmental attitudes than curriculum-based teaching. In addition, Destiranda (2023), in the study using PBL-based teaching modules with a CRT approach, can improve the biology learning outcomes of class X students of Senior High School 12 Pekanbaru. Research from Amalia et al. (2024) has shown that using TaRL and CRT can improve student motivation and learning outcomes. Then, it stated that using TaRL can improve student learning outcomes.

Furthermore, research by Maryono et al. (2021) and Taher (2023) shows that CRT learning gives students the courage and confidence to express opinions to teachers and teachers. In the study, the environment-based PBL method increased students' literacy during learning. Baharsyah et al. (2023): This method is an effort to foster students' literacy attitudes, which are starting to decline. They are also supported by Datreni (2022), the act of using PBL methods impacting the learning process. Based on the interview results, all respondents agreed that PBL is an excellent approach because the learning activities are exciting and different from the usual learning environment.

The purpose of this study is not only to focus on improving student learning outcomes but also to reflect on the teacher's ability to improve the quality of learning and make the teacher more competent. This research discusses the difference between conventional learning in the form of lectures and the use of PBL in increasing learning motivation, student learning outcomes, and character through a series of assessments. The

results of this study are expected to be valuable input and contribution in determining the suitable learning model and approach for teachers and educators.

MATERIALS AND METHODS

This research used experimental methods with qualitative and quantitative approaches. The research was conducted at Junior High School 25 Semarang, Semarang, Indonesia. The subjects in this study were 32 second-grade junior high school students in science learning. There are three types of instruments used, namely:

Formative Assessment

This instrument refers to the quantitative assessment of students in science learning from the materials of elements, compounds, and mixtures. The value will then be tested. Analysis of Variance (ANOVA) will be used to see the effect of the PBL learning model and the TaRL and CRT approaches on student learning outcomes (Creswell, 2014). If the ANOVA shows a significant difference, then the Duncan test is continued to determine the difference between groups (Johnson & Christensen, 2019).

Student and teacher perceptions of science learning consist of four aspects.

Teacher, Teaching Materials, Implementation, and Roles and Responsibilities (Keiler, 2018). This perception instrument is a simple interview with 10 questions based on aspects of science learning (Lathif et al., 2019). Unstructured interviews with teachers and students regarding perceptions of science learning. Researchers prepared queries set beforehand; it's just that in this interview, without telling respondents if they were being interviewed. In addition, there is no text to support during the interview process, Méndez (2021). This purpose is expected to get quality interview results about teachers' and students' beliefs, thoughts, perceptions, and experiences. In addition, it aimed to flow like a natural conversation (Seraj et al., 2022).

The analysis of this data started by calculating the quantitative data on students' formative assessments. Qualitative data obtained through interviews with teachers and students were managed in tandem with quantitative data. It aims to make the data easy to understand, analyze, and interpret in terms of suitability by making a research flow. This research wants to see and describe the differences in learning outcomes from formative assessments (learning outcomes), learning motivation, and student character (Figure 1).

This flow is adopted from León et al. (2021), experimental research that focuses on improving learning practices through concrete actions in the classroom and cycles of planning, implementation, observation, and reflection.

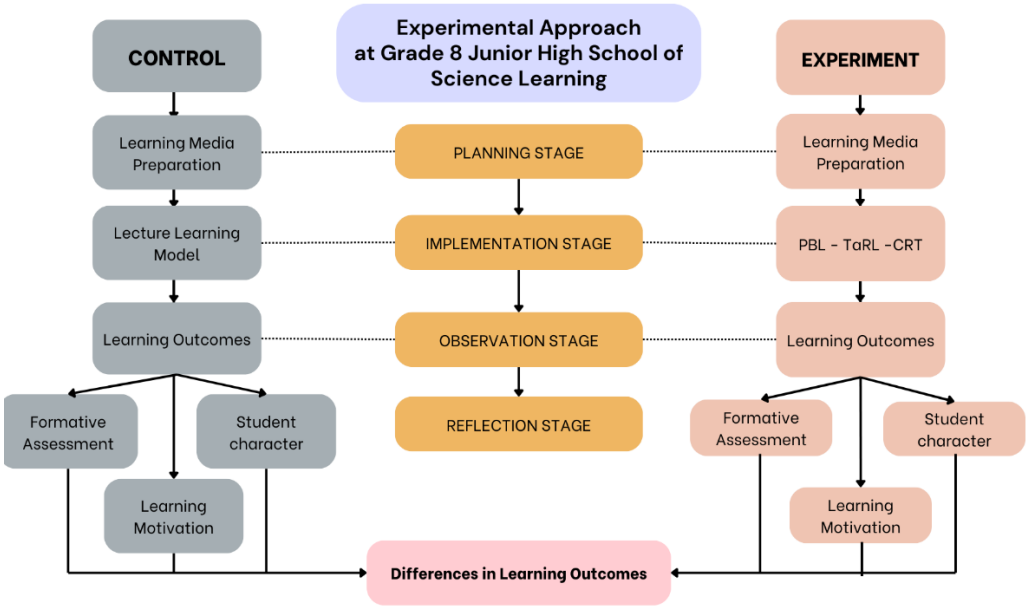

Figure 1. Experimental Research Flow

RESULTS AND DISCUSSION

Formative Assessment Analysis Results

Student learning motivation has an important role in determining their learning outcomes. Muafiah, (2020). The existence of learning motivation can have a positive impact on behavior in the learning process. This is in line with the scores obtained during the learning process, seen in Figure 1. The comparison of the scores of science learning outcomes in the experiment class with PBL, TaRL, and CRT methods has increased significantly compared to the control class, which only uses conventional learning methods of theory and lecture. In this context, quantitative analysis is carried out on student learning outcomes data. The results of the normality test in Table 1 obtained a significance value > 0.05 on all five learning outcomes, including control, so the data is normally distributed. Then the data can be continued using a homogeneity test (Pallant, 201.6)

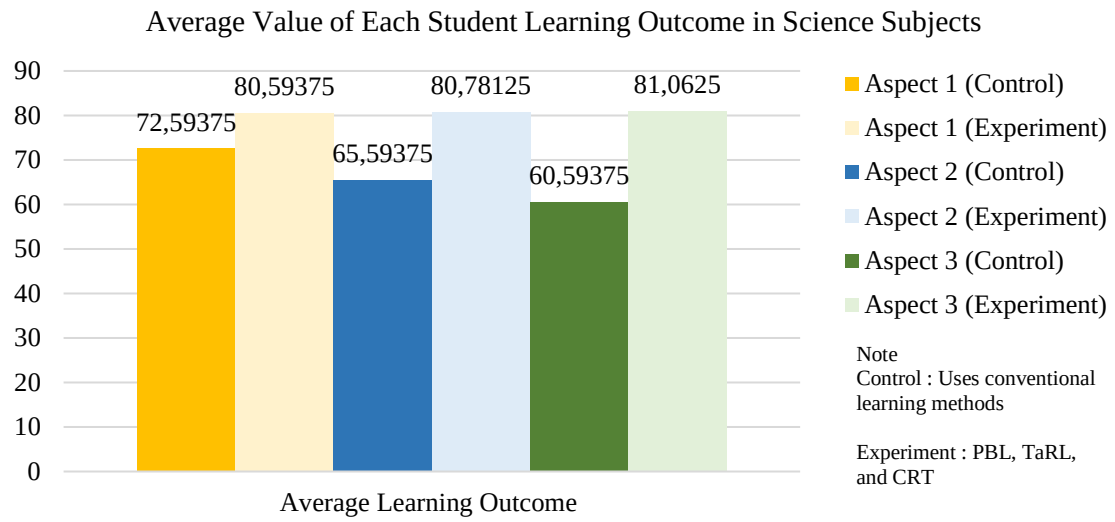

Figure 1. Average Value of Each Student Learning Outcome

Table 1. Test of Learning Outcomes Normality

Kolmogorov-Smirnov[a]				
	Learning_Materials	Statistic	df	Sig.
Result_of_Study	Control	.119	32	.100*
	Elements, Compounds and Mixtures	.137	32	.143*

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Tabel 2. Test of Homogeneity of Learning Outcomes Variance

		Levene Statistic	df1	df2	Sig.
Result_of_Study	Based on Mean	2.206	4	150	.071
	Based on Median	1.882	4	150	.116
	Based on Median and with adjusted df	1.882	4	124.975	.118
	Based on trimmed mean	2.136	4	150	.079

Table 4. ANOVA of Learning Outcomes

Result_of_Study	Sum of Squares	df1	Mean Square	F	Sig.
Between Groups	.000	4	.000	.000	1.000
Within Groups	45426.440	150	3-2.843		
Total	45426.440	154			

The normality and homogeneity test results yielded significance values of 0.143 (Table 1) and 0.071 (Table 2). These values indicate that the assumptions of normality and homogeneity in the treatment and control groups were met (sig. > 0.05). Therefore, an ANOVA test was conducted to determine the treatment's impact, resulting in a significance value of 1.00 > 0.05 (Table 3). This result showed no statistically significant

difference between the treatment and control groups, indicating that the treatment did not have an essential quantitative effect on students' learning outcomes. However, a more in-depth qualitative analysis revealed that integrating the problem-based learning (PBL) model with the teaching at the right level (TaRL) and culturally responsive teaching (CRT) approaches contributed to improved learning outcomes among class 8 at Junior High School 25 Semarang.

This improvement in learning outcomes is inseparable from the synergy between PBL, TaRL, and CRT. The PBL model promotes active learning by encouraging students to solve real-life problems collaboratively. Integrating the TaRL approach ensures that students receive instruction that is aligned with their current learning level, making the learning process more effective and targeted. The CRT component adds another layer of engagement by connecting the curriculum to students' cultural backgrounds and experiences, thus fostering a sense of relevance and belonging in the classroom. Combining these approaches creates a conducive learning environment where students are motivated, supported, and can engage deeply with the subject matter.

In line with these findings, Lestari et al. (2022) argue that combining PBL with CRT can significantly improve students' cooperation skills and overall learning outcomes, as shown in their study with 7th grade students. Similarly, Apriyoanda (2023) highlighted that integrating the PBL model with the TaRL approach can significantly improve student activity and learning outcomes. Desriyanti (2016) also emphasized the positive impact of using PBL with CRT, noting the improved learning outcomes observed in her study. Based on these research results and supporting literature, implementing the PBL-TaRL-CRT model improves student learning outcomes, especially in diverse classrooms. Integrating these three approaches meets the needs of diverse students, promoting academic growth and personal development.

Interview Analysis Results

The interview asked teachers and students ten simple questions about science learning. It included teacher behavior, teaching materials, implementation, and roles and responsibilities (Keiler, 2018). The interview was conducted in an unstructured manner. The researcher prepared pre-determined questions in Table 5 and Table 6 only in this interview, without informing the respondents that they were being interviewed. In addition, there was no text to support teachers and students during the interview process

(Méndez, 2021). The aim was to get quality results regarding the authenticity of teachers' and students' answers, beliefs, thoughts, perceptions, and experiences. In addition, it aims to flow like a natural conversation (Seraj et al., 2022).

The interview results confirm the findings obtained from the analysis of learning outcomes—teachers and students gave answers. Students' answers are very diverse; the main obstacles they encounter when learning science are enthusiasm, learning difficulties, not understanding the material explained, monotony, lack of two-way interaction, and lack of exploring or asking the extent of their understanding. In terms of teachers, based on the results of interviews, it is known that there is no novelty in every teaching, less communicative, monotonous teaching media, only sticking to packet book literature, lack of teaching innovation, teaching implementation is only the teacher explaining, and there is no active interaction between students and teachers. Students only take notes, and the teacher's role in the science learning process still needs to be improved in exploring or connecting material with students' daily lives or interacting further regarding which learning objectives have yet to be achieved. From here, it can be seen that learning motivation, student character building during learning, and student learning outcomes cannot increase. Learning that raises concrete problems makes students more interested and understanding, like in the PBL learning model. It is also supported by Robi et al. (2023), who state that PBL can effectively improve student communication skills during learning.

Tabel 4. Questionnaire Questions on Teachers' Perception of Science Learning

No	Question
1	What methods are used for learning Science, especially grade 8 in the Merdeka Curriculum Module?
2	What media to support learning are used?
3	Is the media effective enough in the learning process?
4	Have you ever tried using videos or others in science subjects?
5	Do students show enthusiasm during learning?
6	Are learning motivation, enthusiasm, courage in expressing opinions and even learning outcomes in line with expectations and learning outcomes?
7	What are the main problems with students, according to the teacher? How to follow up on this?
8	What is the teacher's practical way of conditioning the class during learning? What is the role and responsibility of the teacher?
9	During science learning, are there active children who pay attention to learning? How does the teacher respond to trigger other students?
10	When assessments are held in class, are the scores as expected? Is there a student in each class who stands out and is used as an example for others?

(Keiler, 2018)

Tabel 5. Questionnaire Questions on Student Perceptions of Science Learning

No	Question
1	Can students receive science learning by the learning objectives?
2	Can students understand the material presented by the teacher easily?
3	Are there any obstacles during the learning process?
4	What makes students uninterested in science learning?
5	If there are difficulties, do students ask the teacher to re-explain?
6	Does the teacher explain interactively during science learning?
7	How is the teacher's behaviour during science learning?
8	How is the teacher every day when explaining Science learning in class?
9	What if students need help understanding and asking the teacher what the teacher's reaction is?
10	Students who experience difficulties, is there any further action from the science teacher?

(Keiler, 2018)

The results of this study provide valuable insights into how the integration of problem-based learning (PBL), teaching at the right level (TaRL), and culturally responsive teaching (CRT) contributes significantly to improving student learning outcomes. Unique school and classroom conditions play an essential role in determining the effectiveness of these learning methods. However, after implementing the PBL-TaRL-CRT approach, qualitative data from interviews and assessments indicated a positive change in students' understanding of the material. It is supported quantitatively by the ANOVA results showing a significant improvement in learning outcomes (Table 4), reinforced by the graphical representation in Figure 1.

From a research perspective, integrating PBL with TaRL and CRT strategies promotes active learning, where students are encouraged to solve real-world problems in a culturally relevant context while being taught at an appropriate skill level. León et al. (2021) suggest that this dynamic learning environment increases cognitive engagement and intrinsic motivation, ultimately leading to better learning outcomes. The motivational impact of the approach was evident from interviews with students, who highlighted increased curiosity and interest due to the interactive and problem-oriented learning methods used. This statement is in line with the findings of Renninger & Hidi (2016), who state that student motivation is significantly influenced by engaging, fun, and interactive learning processes. By making learning more contextual and relatable through CRT and adjusting the difficulty level by using TaRL, this approach ensures that all students progress according to their abilities. In addition, the experimental learning framework combined with PBL creates a stimulating learning atmosphere that further motivates students to participate actively in the learning process (Chao et al., 2022).

Technology integration also plays a vital role in supporting this innovative and character-based approach, increasing student engagement and retention of the material (Haleem et al., 2022). Therefore, this study contributes to a broader understanding of how combining PBL, TaRL, and CRT can optimize learning practices by promoting academic success and positive character development.

Teachers are also critical in the learning process (Keiler, 2018). In addition, based on the interview results, several aspects of teacher behavior need to be improved, including the need for more novelty in teaching, lack of communication, and reliance on monotonous teaching methods. Teachers tend to center on something other than textbook literature without making teaching innovations that can increase student engagement. Supported by Gök & Boncukçu (2023b). Teachers' less interactive behavior and lack of use of engaging teaching media are also obstacles to creating a fun and productive learning environment. As a teacher, it is necessary to motivate class and individual students who may be below other students because it will give students the enthusiasm to improve their learning outcomes (Utari, 2023).

The teaching materials presented in the classroom need to be carefully considered. Teachers often present materials conventionally without considering students' needs and interests. The explanations could be more precise, and the material presented rarely relates to students' daily lives. Jauhari et al. (2023) emphasized the need to prepare teaching materials that are communicative, easy to understand, and relevant to students' real-world experiences to increase interest and understanding in science learning. The main obstacles to effective learning are more interactive teaching and student engagement. Teachers tend to focus on explanations without letting students actively participate in the learning process. Ningrum et al. (2023) also highlighted that the need for two-way interaction and innovative teaching methods can demotivate students. This problem contrasts with implementing a learning model that integrates PBL, TaRL, and CRT, which fosters a dynamic and student-centered learning environment.

The PBL-TaRL-CRT model allows teachers to align lessons with students' current understanding and cultural context, providing scaffolding through contextual problem-solving. In the PBL approach, students are actively involved in problem identification, investigation, and solution generation. When integrated with TaRL, which focuses on the actual level of student learning, teachers can adjust the complexity of tasks to suit

individual abilities. CRT further enriches this by incorporating students' cultural backgrounds into the learning process, making it more relevant and engaging. The syntax of the PBL-TaRL-CRT model usually follows a structured process that enhances interactive learning. In the initial stage, the teacher presents a culturally relevant problem (CRT) that can be connected to students' daily experiences. After that, the class is divided based on students' learning levels (TaRL) to ensure the tasks are challenging enough.

Students then collaborate in groups, where the teacher facilitates discussions to encourage critical thinking and perspective sharing (PBL). The teacher acts as a guide, fostering an inclusive environment where students from different backgrounds can participate equally. The model ends with a reflection session where students present their findings, receive feedback, and connect the lesson to real-life contexts. The role and responsibility of the teacher in this integrated model are crucial (Keiler, 2018). Teachers should explore students' understanding, relate the material to everyday life, and provide opportunities for students' active participation. In addition, they must create a supportive yet challenging environment and provide constructive feedback to improve the quality of learning. Alhadi et al. (2023) state that student motivation increases when teachers innovate; therefore, creativity in delivering science lessons is essential. Changing teaching behaviors and refining learning materials in line with PBL-TaRL-CRT can significantly improve student learning outcomes.

CONCLUSION

The integration of problem-based learning (PBL), teaching at the right level (TaRL), and culturally responsive teaching (CRT) in this study provides a synergistic framework that can significantly improve student learning outcomes. This approach promotes a more inclusive and effective learning environment by aligning learning content with students' cultural backgrounds and individual abilities. Qualitative and quantitative findings show that the PBL-TaRL-CRT model improves understanding and increases student motivation and engagement. Teachers play an essential role in this model by facilitating a contextually relevant and appropriately challenging learning process. However, teachers must innovate, adapt their teaching methods, and use engaging materials to benefit fully. The findings of this study underscore the need for

continuous improvement in teaching practices, especially in creating an interactive and student-centered learning environment. Ultimately, this integrated approach promises to optimize classroom practices by bridging academic success with character development, thus contributing to a holistic and equitable educational experience for all students.

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