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Application of *Games Based Learning* Based on *Culturally Responsive Teaching* to Improve Mathematics Learning Outcomes

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Abstract
This study aims to improve the mathematics learning outcomes of grade II elementary school students through the implementation of the Game-Based Learning (GBL) model integrated with the Culturally Responsive Teaching (CRT) approach. The background of this research is the low level of student achievement and engagement in mathematics learning, which often lacks contextual and culturally relevant content. The combination of GBL and CRT is considered effective because it creates an active, enjoyable, and meaningful learning environment while connecting learning materials to students' cultural backgrounds. This Classroom Action Research employed the Kurt Lewin model, conducted in two cycles consisting of pre-cycle, Cycle I, and Cycle II stages, involving 28 students of grade IIA at SDN Bandungrejosari 3 Malang City. Data were collected using observation sheets, documentation, and mathematics learning outcome tests. The results showed a significant improvement in students' learning outcomes, with mastery learning increasing from 38.46% in the pre-cycle to 67.85% in Cycle I, and reaching 85.71% in Cycle II. The integration of GBL and CRT not only enhanced student achievement but also increased students' activeness, participation, and enthusiasm during mathematics lessons. These findings indicate that the combined application of the GBL model and CRT approach is effective in improving mathematics learning outcomes in elementary schools.

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Introduction

Basic education plays a strategic role in shaping the intellectual, emotional, and social intelligence of learners as a foundation for lifelong learning (Enjelina et al., 2024). One of the important subjects in this level is mathematics, because it plays a role in developing logical thinking, analytical, and problem-solving skills. However, various studies show that mathematics subjects are still often considered difficult and boring by elementary school students, thus having an impact on low student learning outcomes (Fernando et al., 2024).

The results of initial observations in grade IIA of Bandungrejosari 3 Public Elementary School Malang show that learning is still dominated by lecture methods, lacks the use of varied learning models, and has not related the material to the cultural context and real experiences of students. This condition causes low completeness of student learning outcomes, where most students have difficulty understanding abstract mathematical concepts. This situation is in line with the findings of Jasmaniah et al. (2022) who stated that monotonous conventional learning inhibits active student engagement.

One of the efforts to overcome these problems can be done through the implementation of Games Based Learning (GBL). This model presents elements of play in the learning process so as to create an interactive, fun, and active student involvement atmosphere (Muna et al., 2025). Additionally, game-based learning can help students understand math concepts concretely through age-appropriate activities.

However, learning math isn't enough to just have fun. The relevance of the material to the cultural background of the students is also important so that learning is meaningful. Culturally Responsive Teaching (CRT) is an approach that integrates local cultural values in the learning process, so that students feel valued and motivated to be actively involved (Sya'Bana et al., 2024). The application of CRT has been shown to be effective in increasing students' learning interest, active engagement, and learning outcomes because the material is associated with their social and cultural realities.

Although research on the application of the GBL model and the CRT approach separately has been carried out at various levels of basic education, studies that specifically integrate the two strategies in mathematics learning in grade II of elementary school are still very limited. In addition, there has been no research that utilizes the CRT approach based on Malang's local culture to support the GBL model in grade II elementary mathematics subjects. Most previous research focused more on the upper class level or other subjects. This is the research gap in this study.

Therefore, this study offers novelty in the form of the integration of the Games Based Learning model with the CRT approach in mathematics learning in grade II of elementary school. The combination of these two strategies is expected to not only create a fun learning atmosphere, but also provide a learning experience that is relevant to the student's culture. Thus, this study aims to assess the effectiveness of the application of the GBL model integrated with the CRT approach in improving the mathematics learning outcomes of grade II elementary school students.

Method

This study uses the Kurt Lewin model Classroom Action Research method which aims to improve the mathematics learning outcomes of grade IIA students of Bandungrejosari 3 Public Elementary School, Malang in the second semester of the 2024/2025 school year. The research subjects amounted to 28 students. This research consists of two phases, namely pre-cycle to identify problems and two action cycles. Each cycle consists of four stages, namely (1) planning, including the preparation of lesson plans, games media based on GBL which contains elements of local Malang culture such as cultural puzzle games, puzzles of city icon drawings, and folklore-based counting games, as well as the preparation of observation instruments, documentation, and learning outcome tests validated through expert judgment by two PGSD lecturers and one elementary mathematics teacher; (2) the implementation of actions, namely mathematics learning with the GBL model that is integrated with the CRT approach through Malang culture-themed games used to solve mathematics problems based on local contexts; (3) observation, namely observation of student activities using engagement observation sheets and documentation in the form of photos and field notes; and (4) reflection, which is the analysis of the results of observations, documentation, and tests to evaluate the success and obstacles of learning actions which are then used for improvement in the next cycle. The research instruments included observation sheets, documentation, and multiple-choice learning outcome tests of 10 questions that were tested for reliability through try outs to other class students and Alpha Cronbach's calculations. Data was analyzed through the data reduction stage, presentation of data in the form of tables or diagrams, and drawing conclusions based on the achievement of success indicators, namely at least 80% of students achieved a score of ≥75 and there was an increase in active student involvement on the observation sheet. The calculation of learning completeness uses the average formula and the percentage of completeness of learning outcomes.

Results and Discussion

Results

The results of the research carried out through Classroom Action Research consisting of the pre-cycle, cycle I, and cycle II stages showed an increase in students' mathematics learning outcomes after the application of the GBL model with the CRT approach. In the pre-cycle stage, learning is still carried out by lecture method without involving elements of local culture or game activities. The test results showed that of the 26 students, only 10 people (38.46%) achieved learning completeness with a score of ≥ 75, while 16 people (61.53%) had not completed it. The results of the observation showed that most of the students looked passive, lacked enthusiasm, and only a few students actively asked questions or answered. Based on these findings, corrective actions were taken through the application of the GBL model with the CRT approach in cycle I.

Table 1. Percentage of Learning Outcomes of Pre-Cycle Students

Number of Students	Percentage	Information
16	61,53%	Incomplete
10	38,46%	Conclusion

In the first cycle, learning was carried out through simple calculation games based on Malang culture, such as Traditional Market number puzzles and folklore puzzles, which were combined with mathematical problems about numbers and estimating many objects. The results of the pretest before the action showed that in the number material, 11 students (39.28%) achieved completeness, while 17 students (60.71%) had not completed it. In the material estimating many objects, completeness increased to 13 students (46.42%) and 15 students (53.57%) were still incomplete. After the action was taken, the posttest results showed a significant improvement. In the number material, completeness reached 23 students (82.14%), while those who had not completed were only 5 students (17.85%). In the material estimating many objects, the completeness reached 14 students (50%), indicating an increase but still needed strengthening. During the learning process, based on the observation sheet, it can be seen that students begin to be enthusiastic about participating in games, ask more active questions, and show better group cooperation. Photo documentation shows students who are more cheerful when playing culturally-based counting games.

Table 2. Percentage of Student Learning Outcomes Cycle 1

Criteria	First Meeting of the Pretest	The second meeting of the pretest predicts a lot of things
Finished (>75)	11 students (39.28%)	13 students (46.42%)
Incomplete	17 students (60.71%)	15 students (53.57%)

Furthermore, in cycle II, improvements were made in the form of adding variations of games such as the Malangan Mask Number Card and the Traditional Number Guessing Game, as well as the use of concrete media for material to estimate many objects. The results of the pretest showed that the initial completeness of students in the material was more than and less than reaching 22 students (78.57%), while 6 students (21.42%) had not completed it. In the material comparing two or more numbers, completeness increased to 24 students (85.71%), while those who had not completed were 4 students (14.28%). Based on the results of observations during the second cycle of learning, almost all students were actively involved in the game, enthusiastic in discussing, and were able to solve problems related to the local cultural context. The documentation notes a more lively classroom atmosphere and students show confidence in presenting answers. These results show that the application of the GBL model with the CRT approach succeeded in significantly increasing students' mathematics learning outcomes from 38.46% in the pre-cycle to 85.71% at the end of the second cycle. In addition, it creates a learning atmosphere that is fun, interactive, and in accordance with the character and culture of the students. These findings are in line with the research of Wati & Anam (2024) and Rahayu et al. (2024) who stated that game-based learning is effective in increasing student learning interest, active engagement, and learning outcomes. The GBL model facilitates gradual mathematics learning through six stages ranging from game selection, explanation of concepts and rules, game implementation, conclusion formulation, reflection, and evaluation. The integration of CRT in games is able to connect students' cultural identities

with learning materials so that the learning experience becomes more contextual and meaningful.

Table 3. Percentage of Learning Outcomes of Cycle 2 Students

Criteria	First Meeting Pretest Over and Less Than	Second Meeting of Pretest Comparing Two or More Numbers
Conclusion	22 students (78.57%)	24 students (85.71%)
Incomplete	6 students (21.42%)	4 students (14,28)

Discussion

The results of this study show that the application of the GBL model integrated with the CRT approach can improve the mathematics learning outcomes of grade II elementary school students. The increase in the completeness of learning outcomes from 38.46% in the pre-cycle to 85.71% in the second cycle proves that these two approaches are able to create a learning atmosphere that is fun, interactive, and at the same time relevant to the cultural experience of students. These findings are in line with Enjelina et al. (2024) who stated that CRT can increase motivation, facilitate conceptual understanding, and create an inclusive learning environment. By linking math materials into local cultural contexts such as the Traditional Market number puzzle game and the Malangan Mask Number Card, students become more enthusiastic, active, and easy to remember math concepts because they are close to their daily environment.

From the results of observations during the learning, it can be seen that the classroom atmosphere is much more lively than during the pre-cycle. Students seem enthusiastic about participating in the game, dare to ask questions, discuss, and understand the material faster. This is reinforced by research by Jasmaniah et al. (2024) which shows that a combination of GBL and CRT can motivate students to be more active and increase engagement in learning. However, a more in-depth analysis of the results per indicator shows that not all materials experience the same increase. The material on counting, reading, and writing numbers up to 100 and comparing numbers showed the highest increase in completeness by 47.28%. This indicates that the basic concepts of numbers are relatively easier for students to understand through culture-based games. On the other hand, in the material estimating many objects, the increase in completeness is still lower. Some students still have difficulty in understanding the concept of estimation, which may be due to the lack of concrete media used during learning.

These findings indicate that although the combination of GBL and CRT is effective in improving learning outcomes, its implementation is not yet fully optimal. There are still 14.28% of students who have not completed in cycle II. The factors that cause it include differences in students' basic abilities, concentration levels during play, and limitations in the concrete media used in games. In addition, not all students have the same strong local cultural experience, so it is necessary to adapt cultural content to really suit the background of all students.

In terms of research limitations, this study was only conducted in one class in a span of two cycles, so it could not be generalized widely. In addition, the test instruments used were only multiple-choice without involving more complex description questions or problem-solving tasks. This limits the space for measuring learning outcomes to the aspect of concept understanding only, not to include the aspect of application and mathematical reasoning. The instrument validation process is also limited to testing the validity of the content through expert

judgment, without further empirical tests such as the validity of the question items and the statistical reliability of the instrument.

Thus, although the application of the GBL model with the CRT approach has been proven to be able to improve student learning outcomes, activeness, and motivation, future implementation needs to consider some improvements. First, the use of concrete media that is more varied to support the understanding of certain materials, especially the concept of estimation. Second, it is necessary to adapt culture-based games to be more inclusive for students who have different cultural backgrounds. Third, the development of learning outcome assessment instruments should involve questions with various forms and cognitive levels so that the measured learning outcomes are more comprehensive. This research proves that the combination of GBL and CRT can be an alternative to mathematics learning strategies in elementary schools, especially in creating interactive, contextual, and meaningful learning for students. However, to achieve optimal results and sustainability, the implementation of this strategy needs to continue to be evaluated and adjusted to the conditions and characteristics of students in each school.

Conclusion

Based on the results of the research that has been conducted, it can be concluded that the application of the Games Based Learning model combined with the CRT approach has proven to be effective in improving the mathematics learning outcomes of grade II elementary school students. This is shown by the increase in the completeness of learning outcomes from 38.46% in the pre-cycle to 85.71% in the second cycle. The Games Based Learning model is able to create an interactive, fun, and motivating learning atmosphere for students to be more actively involved, while the CRT approach makes learning materials more relevant to students' lives and local cultures, making it easier to understand mathematical concepts. Practically, this research contributes to elementary school teachers in providing alternative learning models that combine educational games based on local culture to create contextual, meaningful, and educational learning experiences that increase students' learning motivation. The practical implication is that teachers are expected to develop culture-based game designs according to the characteristics of their respective regions to increase student activity and learning outcomes.

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Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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