BRAIN GYM MATH DEVELOPMENT BASED ON LOCAL WISDOM USING THE CRA (CONCRETE, REPRESENTATIONAL, ABSTRACT) METHOD TO IMPROVE STUDENTS' CREATIVE PROBLEM SOLVING

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Abstract: The background of this research is based on the importance of the readiness of prospective early childhood teachers in developing creative thinking and problem-solving skills through meaningful and contextual mathematics learning. This research aims to develop Brain Gym Math based on local wisdom using the Concrete, Representational, Abstract (CRA) approach in improving the creative problem-solving abilities of early childhood education students. The research method used is Research and Development (R&D) with the Borg & Gall development model that has been adjusted in several main stages: needs analysis, design, product development, limited trials, revisions, and extensive trials. The developed Brain Gym Math media integrates brain gymnastics movements with contextual mathematics activities based on local culture to provide a fun and meaningful learning experience. The results of the study indicate that the use of the CRA method in Brain Gym Math based on local wisdom can significantly improve students' creative problem-solving abilities. This development is expected to be an innovation in mathematics learning in early childhood teacher education as well as an alternative learning media that is adaptive to local values and the needs of the 21st century.

Keywords: Brain Gym Math, local wisdom, CRA method, creative problem solving, early childhood education teacher education.

INTRODUCTION

Higher order thinking skills, especially in terms of Creative Problem Solving (CPS), are an essential need in facing the challenges of 21st century mathematics learning, at the university level, students are required not only to understand mathematical concepts theoretically, but also to be able to apply them creatively and adaptively in solving complex problems (Hasria Syafitri et al., 2025; Ulya, 2024). In practice, many students still face difficulties in developing mathematical thinking creativity, which leads to reliance on procedural approaches and lack of conceptual understanding (Luzano, 2025; S. Cajandig & Ledesma, 2025).

Research shows that learning that integrates creativity and applicability can significantly improve student learning outcomes, but is often not implemented in classrooms (Nahdi, 2019; Rarastika et al., 2024). This limitation indicates the need for more interactive and participatory curriculum development to equip students with the skills needed in problem solving (Hasanah, 2023).

This problem is exacerbated by the lack of innovative learning approaches that can stimulate affective and cognitive aspects simultaneously, in many universities, learning is still dominated by monotonous lecture methods and minimal contextual exploration, especially those that link mathematics content with local values (Kılıç et al., 2022; Nahdi, 2019; Rahmadi & Lavicza, 2021). This causes learning to be less relevant to students' real lives and inhibits creative problem-solving skills (Novitasari et al., 2023; Cajandig & Ledesma, 2025). Therefore, it is important to develop teaching methodologies that integrate local experiences in mathematics learning to improve engagement and learning outcomes (Del Rosario & P. Rosario, 2023).

The main problem in this study lies in the low ability of students in applying mathematical understanding to solve problems creatively. This shows that there is a gap between concept understanding and application ability in real contexts which requires a learning approach that is able to integrate cognitive, psychomotor, and affective dimensions (Ismail et al., 2020; Rudyanto, 2019). These elements can support each other to form complex abilities needed in the real world, so the development of a comprehensive and integrated learning model is very important, thus, the solution offered must be able to bridge between theory and practice, and equip students with skills that can be applied in everyday life (S. Cajandig & Ledesma, 2025).

This research aims in general to develop a local wisdom-based Brain Gym Math learning model using the CRA approach to improve students' Creative Problem Solving skills. In addition, the absence of a learning model that combines the CRA method with local content, such as local wisdom, makes learning detached from the socio-cultural reality of students (Hasria Syafitri et al., 2025; Ulya, 2024). The development of learning tools that are integratively able to bridge between formal mathematics concepts and local socio-cultural contexts to improve students' creative problem solving skills (Rarastika et al., 2024). Efforts to decolonialise learning by integrating local wisdom will provide new nuances that are relevant to students in understanding mathematics (A. Novitasari et al., 2023).

The main concepts in this study include Brain Gym Math, CRA and CPS. Brain Gym is a motorised approach that aims to integrate brain and body functions to support the learning process (Rahmadi & Lavicza, 2021; S & Ngurah Japa, 2022). Brain Gym Math in this context is a movement-based physical activity designed to support mathematics learning through sensory and motor stimulation (Hasria Syafitri et al., 2025).

The CRA method is used as a pedagogical approach that allows students to build concept understanding from real objects (concretes), visual representations, to symbolic abstractions, with the development of learning models that utilise Brain Gym Math and CRA, it is expected that students can be more actively and creatively involved in the learning process (Luzano, 2025; Rarastika et al., 2024).

The main innovation of this research is the integration of Brain Gym Math with local wisdom using the CRA approach, which has not been widely researched in the realm of higher education (Nahdi, 2019; S. Cajandig & Ledesma, 2025). This research not only focuses on understanding mathematical concepts, but also on improving students' creative thinking skills in solving problems through structured and contextualised brain and body movements (Chileva, 2019).

The contribution of this research also lies in efforts to decolonise mathematics learning, namely by presenting local wisdom as an integral part of the learning process, thus providing new nuances in the contextual learning approach, where students can connect local cultural experiences with abstract mathematical concepts through fun and meaningful activities (Nugraheni et al., 2025; Rarastika et al., 2024).

There are not many studies that comprehensively examine the effect of integrating Brain Gym Math, local wisdom, and CRA on students' Creative Problem Solving ability, and generally, research only focuses on one aspect, such as the use of CRA in learning or the utilisation of local culture in the curriculum. This absence of an approach that brings together cognitive, affective, physical, and cultural dimensions suggests a conceptual and methodological gap that needs to be filled through this research.

The urgency of this research lies not only in its contribution to the development of mathematics education science, but also in its significance in strengthening pedagogical practices in the era of Merdeka Belajar and Merdeka Curriculum, which encourage contextual, creative, and local potential-based learning. Practically, the results of this study can be a reference for lecturers and curriculum developers in designing mathematics learning that is more comprehensive and has an impact on the development of students' higher order thinking skills.

METHOD

This research is a type of development research *(Research and Development/R&D).* The research design refers to the Borg & Gall development model modified according to the needs of the learning context in higher education. The research was conducted in two main stages: product development stage and effectiveness testing stage. The research subjects were 68 students of PG-PAUD Study Programme of Bengkulu University. The research location was carried out in lecture classes relevant to early childhood cognitive development courses.

Development procedure: 1) Needs analysis (literature study, initial observation, and interviews with lecturers/students).2) Planning and initial design of *Brain Gym Math* media based on CRA and local wisdom. 3) Expert validation (media experts, material experts, local culture experts). 4) Revision based on expert input. 5) Small group limited trial. 6) Further revision and wide-scale trial.7) Evaluation of the effectiveness of the model on students' *creative problem solving*.

Data collection techniques used observation to observe student involvement during the learning process using the *CRA* method. Questionnaires in capturing student responses to understandability, usefulness, and involvement in the *CRA* method. CPS ability test conducted during *pre-test* and *post-test* to measure the improvement of students' *creative problem solving* ability. Documentation in the form of photos / videos of development activities and trials of the CRA method.

The research instruments used are: 1) Product validation sheet for material experts, media experts, and cultural experts. 2) Observation sheet of student learning activities in the CRA method. 3) Student response questionnaire (Likert scale) in applying the CRA method. 4) CPS creative problem test questions (made based on indicators of creative thinking and mathematical problem solving).

Data analysis techniques are descriptive in the form of averages and percentages for expert validation results and student responses. Paired sample t-test or gain test to see the improvement of CPS ability.

RESULT AND DISCUSSION

Before the Brain Gym Math model based on CRA and local wisdom is applied in the learning process, it is important to analyse the feasibility in terms of content, method, and cultural context. Expert validation is a strategic step to ensure that media development not only fulfils the theoretical aspects, but is also pedagogically feasible and culturally relevant. This validation is also a bridge between conceptual design and implementative readiness, and reflects the quality and integration of the components in the media.

Table 1. Results of Expert Validation of Brain Gym Math Model Based on CRA and Local Wisdom

No	Assessed Aspect	Score	%
1	Suitability of material with learning outcomes	4,5	90%
2	Integration of Brain Gym elements, CRA, and local wisdom	4,4	88%
3	Clarity of learning flow in the media	4,3	86%
4	Media display and visual design	4,2	84%
5	Language and readability	4,5	90%
Total Average		4,38	87,6%

Rating scale: 1-5; converted to percentage with categories: Very Feasible (≥85%), Feasible (70-84%), Fair (55-69%), Inappropriate

The validation results showed that the model had a high level of feasibility (87.6%). This indicates that the model developed has successfully integrated three main domains: cognitive (CRA), physical (Brain Gym), and affective-cultural (local wisdom). The high scores on the material and readability aspects show that the media content has been organised systematically and communicatively. The score on the visual aspect (84%) implies that the development of visual aesthetics can still be improved to strengthen the attractiveness of the media. This validation is an early indicator of the success of integrating a holistic approach in learning mathematics at the higher education level.

Expert validation ensures the feasibility of the model, it is important to evaluate the responses of direct users, in this case students as learning subjects. The analysis of student responses provides empirical data on the perception, acceptance, and potential of the model in creating meaningful learning experiences. In addition, the assessment from students also represents the practicality aspect and the potential for long-term implementation in the world of early childhood education.

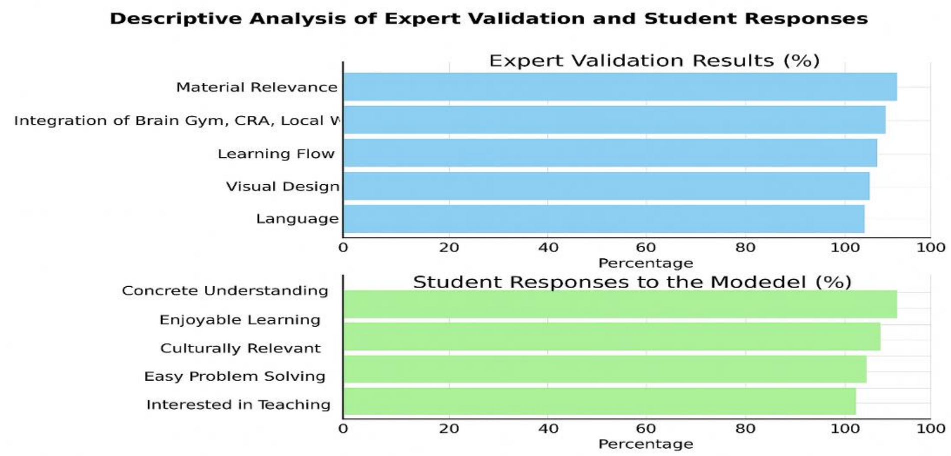
Table 2 Student Response to the Implementation of the CRA-Based Brain Gym Math Model

No	Statement in Questionnaire	Average Score	Percentage of Positive Response
1	This model helps me understand mathematics concretely	4,6	92%
2	I find learning more fun	4,5	90%
3	Integration of local culture makes learning feel close	4,4	88%
4	I find it easier to solve problem solving problems	4,3	86%
5	I am interested in using this model when teaching PAUD	4,2	84%
Total Average		**4,4**	**88%**

Likert Scale 1-5: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

The data showed that students responded positively to the implementation of the model, with an average score of 88%. The highest responses appeared in the aspects of understanding mathematics concretely and enjoyable learning experience. This confirms that the CRA approach is effective in reducing mathematical abstraction, which is often the main obstacle in learning. The positive response to the local cultural elements (88%) indicates a contextualisation effect that strengthens the connection between the material and students' social reality. This reinforces that culture-based learning is not just a complementary tool, but essential in building cognitive and affective bridges.

Figure 1. Expert Validation and Student Response



The graph shows an aligned trend between expert judgement and student response. This indicates consistency between the theoretical design and practical implementation. The high degree of congruence between these two perspectives strengthens the external validity of the model and demonstrates its great potential for replication in similar educational contexts.

Table 3. Normality Test

One-Sample Kolmogorov-Smirnov Test

		Unstandardised Predicted Value
N		68
Normal Parameters[a,b]	Mean	87.1470588
	Std. Deviation	1.21797360
Most Extreme Differences	Absolute	.080
	Positive	.060
	Negative	-.080
Test Statistic		.080
Asymp. Sig. (2-tailed)		.200[c,d]

The normality test results show a significance value of p = 0.200, which means that the distribution of the data follows a normal curve. This reinforces the validity of the parametric analysis approach used, as well as indicating that the learning outcome data contains no significant deviations. This normality also reflects that the data collection process was homogeneous and systematic.

Table 4. Homogeneity Test

		Levene Statistic	df1	df2	Sig.
Problem Solving	Based on Mean	1.973	19	38	.037
	Based on Median	.980	19	38	.502
	Based on Median and with adjusted df	.980	19	18.434	.518
	Based on trimmed mean	1.901	19	38	.045

The homogeneity test showed varying significance depending on the approach, but most of the results showed p> 0.05. This indicates that the data has a relatively homogeneous variance, so it is feasible to proceed to the effectiveness test, to determine the effectiveness of the Brain Gym Math model based on CRA, a parametric test of the average between the pretest and posttest of students' creative problem solving skills after the intervention was conducted.

Table 5. Pretest and Posttest Table Development of Brain Gym Math Based on Local Wisdom Using Cra (Concrete, Representational, Abstract) Method in Improving Student Creative Problem Solving.

	n	Mean± s.b.	Mean difference s.b.	IK95%	*p*
Brain gym math pretest CRA method	68	59,39±5,26	22,63±6,81	20,98±24,28	0,001
Brain gym math posstest CRA method	68	82,02±4,24			

The test results showed a significant increase between the pretest (mean 59.39) and posttest (mean 82.02) scores with a p value = 0.001 ($p < 0.05$), the results indicated that the developed model was effectively able to improve creative problem solving skills.

The results of this study are in line with research showing that concrete experience has a positive impact on student understanding (Yasa et al., 2023). Students engage in activities that allow them to manipulate real objects, they are more likely to understand the connection between mathematical ideas and the real world, strengthening their arguments in solving problems (Wahyuningsih et al., 2020). The use of concrete media can also encourage creativity and flexibility in responding to various problem-solving situations (Jonsson et al., 2022).

The representation stage continues from the concrete stage to the visualisation stage. Here, students are taught to depict mathematical ideas and concepts in the form of diagrams, drawings, or other graphical information. Research shows that visual representations can help students in solving problems because they provide alternative ways to understand information (D. Novitasari et al., 2020). The context of local wisdom is very important for representations that are appropriate to the students' culture or environment can improve the connection between concepts and their application (Supriatin et al., 2020).

Research shows that abstraction skills are key to the development of creative problem solving among students, as it allows them to apply principles that have been learnt in new contexts (Syarifah & Agoestanto, 2023). In addition, creativity in mathematics should be seen from the point of view of developing students' critical and analytical thinking skills (Lin & Cho, 2011).

The application of the CRA method combined with elements of local wisdom has the potential to produce creativity that enriches the learning process without losing the relevance of the context known to students. This creates a learning atmosphere that focuses not only on the end result but also on the creative process of problem solving, with the use of the CRA method supporting the development of a more inclusive and diverse learning culture (Lee & Chan, 2019; Ngiamsunthorn, 2020).

The results of this study have significant implications in the context of early childhood teacher education and higher education curricula. The CRA-based Brain Gym Math model can be adopted as an alternative learning strategy that is adaptive to the needs of 21st century students who demand holistic and contextualised learning.

The pedagogical implication is the need for training for lecturers and early childhood teacher educators to be able to design learning that combines elements of movement, culture, and conceptual thinking stages. In the context of the Merdeka Belajar curriculum, this model supports local cultural values while facilitating character development and students' creative thinking skills. In the future, the development of the Brain Gym Math model based on CRA and local wisdom needs to be continued on a wider scale, both geographically and across study programmes.

The use of this approach can be developed in various pedagogical courses and is not limited to mathematics alone. It is hoped that this model can contribute to strengthening the identity of Indonesian education which is not only superior in academic aspects, but also contextual, inclusive, and rooted in local values that educate as a whole.

CONCLUSION

The Brain Gym Math model based on local wisdom with the CRA approach is proven to be able to improve students' creative problem solving skills. Expert validation and positive student responses show that this model is feasible, practical, and effective to use in learning mathematics. The significant increase in learning outcomes shows that the approach that integrates physical movement, visual representation, and local culture is able to build conceptual understanding more deeply and contextually. This indicates that holistic and local wisdom-based mathematics learning is relevant to develop 21st century skills more optimally.

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