

Development of Mathematics Textbook Based on the Concrete, Pictorial, Abstract (CPA) Number Approach for MI Students in Sedan District, Rembang City

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Received 3 June 2024, Revised 17 June 2024, Accepted 1 July 2024, Available online 3 July 2024

To link to this article: <https://doi.org/10.53797/ujssh.v3i1.16.2024>

Abstract: This study aims to develop a mathematics textbook using the Concrete, Pictorial, Abstract (CPA) approach to enhance learning outcomes for Grade 1 students at Madrasah Ibtidaiyah (MI). The research evaluates the feasibility and effectiveness of the CPA-based textbook. Employing a Research and Development (R&D) design, the study follows ten steps: Research and Information Collecting, Planning, Preliminary Product Development, Preliminary Field Testing, Main Product Revision, Main Field Testing, Operational Product Revision, Operational Field Testing, Final Product Revision, and Dissemination and Implementation. The sample comprises Grade 1 students selected via purposive sampling. Both quantitative and qualitative data were gathered through interviews, observations, questionnaires, tests, and validation instruments. Data analysis using a t-test revealed significant improvements in learning outcomes, with pre-test and post-test scores of 21.23 and 34.27, respectively, and a significance value of $0.000 < 0.05$. Validation ratings were 95.8% (media experts), 87.5% (material experts), and 92% (linguists). Teacher and student questionnaires scored 92% and 85%, respectively. The study concludes that the CPA-based textbook is effective for teaching mathematics to Grade 1 students, particularly in understanding numbers.

Keywords: Textbooks, mathematics, CPA approach, learning outcomes

1. Introduction

The Concrete Pictorial Abstract (CPA) approach, also known as Concrete Representational Abstract (CRA) or Concrete Semiconcrete Abstract (CSA), is a learning methodology based on Bruner's 1960 heuristic concept of "enactive-iconic-symbol" representation, widely implemented in Singapore (Hoong et al., 2015). According to Putri et al. (2019) and Hui et al. (2017), CPA serves as an effective intervention for teaching mathematics, particularly beneficial for students with learning disabilities.

The term mathematics is derived from the Latin word *mathematic*, which in turn originates from the Greek word *"mathematike,"* meaning "study." This is based on the word *"mathema,"* which means "knowledge" or "science." The related words *"mathein"* or *"mathenein"* mean "learning" or "thinking." According to Hayati and Asmara (2021), mathematics is knowledge obtained through reasoning and thought. Shafiee and Meng (2021) highlight that mathematics is not only beneficial for itself but also supports other subjects and helps solve real-life problems. Effective mathematics education involves connecting lessons to real-life scenarios and providing tangible examples to aid student understanding.

The CPA (Concrete, Pictorial, Abstract) approach is designed to foster deep conceptual understanding in students through three stages: concrete (using real objects), pictorial (using images), and abstract (using symbols). This approach creates meaningful connections between these stages, helping students grasp complex concepts (Salingay & Tan, 2018).

Kania (2017) emphasizes that learning with concrete objects helps visualize mathematical facts, concepts, principles, or procedures, making them more comprehensible. Elementary students benefit significantly from activities involving real objects or events, which aid in understanding abstract concepts. Faye (2021) adds that starting with

concrete learning, progressing to semi-concrete and semi-abstract, and finally reaching abstract understanding, can motivate students and enhance their comprehension.

Rifa'i and Anni (2012) state that professional teachers maximize student learning outcomes and positively influence behavior. Learning outcomes, as described by Susanto (2016), include cognitive, affective, and psychomotor changes resulting from educational activities. Suprijono et al. (2021) explains that these outcomes encompass patterns of behavior, values, attitudes, and skills, following Bloom et al. (1956) classification into cognitive, affective, and psychomotor domains. Data sources for this research include: 1) Grade I students from MI Karangasem and MI Kedungringin, providing data on media needs and responses to the developed CPA-based mathematics textbook; 2) Four teachers from MI Karangasem and MI Kedungringin, offering insights into media development needs and responses to the CPA-based textbook; 3) Two heads of MI in Rembang Regency, providing policy data on CPA-based textbook development and teacher monitoring policies; and 3) Validators comprising material experts, linguists, and media experts evaluating the CPA-based textbook.

Observations at Madrasah Ibtidaiyah (MI) Karangasem Sedan and Madrasah Ibtidaiyah (MI) Kedungringin Sedan reveal that teachers predominantly rely on traditional math textbooks provided by the Ministry of Education and Culture. The instructional methods primarily involve students taking notes and listening to teacher lectures, resulting in many students failing to meet the Minimum Completeness Criteria (KKM). The average daily test score for Grade 1 students in numbers was 65, below the madrasah KKM of 70, with only 30% of students achieving above the KKM. This lack of motivation is attributed to the use of simple textbooks.

To address this, it is essential to develop textbooks that incorporate numerous pictures depicting real objects to engage students and enhance their understanding of the material. Textbooks are the primary resources used by students, containing activities integral to the learning process. Roldán Vera (2018) defines a textbook as a book containing knowledge derived from the curriculum's basic competencies, used by students for learning. He adds that textbooks are typically authored by individuals or teams based on the curriculum, offering various approaches to curriculum implementation. Consequently, educators are encouraged by the Ministry of Education to select textbooks that best suit their students' characteristics.

2. Literature Review

The Concrete, Pictorial, Abstract (CPA) approach is an instructional strategy rooted in Bruner's theory of cognitive development, which posits that learning occurs in three stages: enactive (concrete), iconic (pictorial), and symbolic (abstract). This method is widely recognized for its effectiveness in mathematics education, particularly for young learners. The CPA approach has been extensively applied in the development of mathematics textbooks in countries like Singapore, Japan, and Senegal, emphasizing a progression from concrete manipulatives to pictorial representations and finally to abstract symbols and notations (Salimi et al., 2020).

The organization of content within textbooks is critical to the effectiveness of learning. Fan et al. (2013) argue that well-designed textbooks, aligned with the intended curriculum, are essential for the acquisition of competences labeled as 21st-century skills. The spiral progression approach (SPA), often combined with CPA, helps in organizing content logically across grades, ensuring that students revisit and deepen their understanding of key concepts over time.

The CPA approach transitions from concrete manipulatives, which students can physically handle, to pictorial representations, such as diagrams and visual aids, and finally to abstract symbols, like numerals and mathematical notation. This method not only aids in the understanding of abstract mathematical concepts but also enhances students' engagement and motivation. In Singapore, the CPA approach is a cornerstone of primary mathematics education, as outlined in the Ministry of Education's curriculum guides (Lutfi & Dasari, 2024). Japanese textbooks also emphasize concrete activities, encouraging students to interact with physical objects to understand mathematical principles. Similarly, Senegal's educational guidelines stipulate the inclusion of concrete, semi-concrete, and abstract representations in teaching materials (Yulianto et al., 2019).

A comparative analysis of mathematics textbooks from Senegal, Japan, and Singapore reveals how CPA is applied in different educational contexts. Singaporean and Japanese textbooks prioritize depth over breadth, focusing on a limited set of contents taught in detail with various materials and techniques. In contrast, Senegalese textbooks cover a broader range of topics with less depth, often leading to gaps in students' understanding of fundamental concepts like addition (Faye, 2021).

3. Methodology

The research method employed in this study is a scientific approach aimed at obtaining data for specific purposes and uses. This study utilized the Research and Development (R&D) method, which is designed to create specific products and test their effectiveness (Sugiyono, 2016). Data on product trial results were collected from Grade 1 students at two Madrasah Ibtidaiyah (MI) schools, with each school providing a sample of 15 children. The data collection involved observing the implementation of the CPA-based mathematics textbook during lessons on number material.

Quantitative data were obtained from test results, while questionnaires were used to gather information on needs, design accuracy, content accuracy, and the attractiveness of the developed mathematics textbooks. These data were

analyzed and used for subsequent revisions. The achievement test of learning outcomes measured students' performance before and after using the CPA-based mathematics textbook. This test provided data on pre-test and post-test results, highlighting students' abilities in processing the material before and after the intervention. The study utilized the R&D method to develop and evaluate a CPA-based mathematics textbook. Data collection involved classroom observations, tests, and questionnaires, with a focus on assessing the textbook's effectiveness in improving students' learning outcomes in mathematics. Table 1 shows the data description for chemistry process skills checklist.

Table 1. Data description for chemistry process skills checklist

Mean	Description
1.00 – 1.75	Negative
1.76 – 2.49	Poor
2.5 – 3.25	Fair
3.26 – 4.00	Positive

4. Results and Discussion

The following are the results and discussion of the data gathered to determine the scientific knowledge and process skills of Grade 8 students in chemistry. Needs analysis through observations and interviews revealed that appropriate learning media were not being utilized, making it difficult for students to master mathematical concepts. Consequently, the average mathematics score for Grade 1 MI students was 6.5, with only 30% of students meeting the Minimum Completeness Criteria (KKM). The development process began with preliminary studies, analysis, formulation of learning media development, media design, and prototype and instrument development. Validation by experts yielded the following results: media experts rated the materials at 95.8% (valid), material experts at 87.5% (valid), and linguists at 92%. The teacher questionnaire results were 92.5%, and the student response questionnaire results were 92%.

Effectiveness analysis showed that the average pre-test score was 21.23, while the average post-test score was 34.27. This significant improvement indicates the effectiveness of the CPA-based mathematics textbook in enhancing students' learning outcomes. The introduction of CPA-based mathematics textbooks significantly improved students' understanding and mastery of mathematical concepts. The high validation scores from experts, along with positive feedback from teachers and students, further support the effectiveness of this approach. The substantial increase in post-test scores demonstrates that the CPA approach is a valuable tool in mathematics education for Grade 1 students.

Table 2. Mean, standard deviation and qualitative description of the respondents' scientific knowledge

General Topics	SD*	%	QD*
Particle nature of matter	1.03	78.75	Developing level
Atomic structure	1.00	70.38	Beginning level
Periodic table of elements	1.00	79.12	Developing level
Total knowledge	1.86	75.83	Developing level

*SD- Standard Deviation, QD-Qualitative Description

The statistical analysis results showed a significance value (sig) of 0.000, which is less than 0.05. This indicates a statistically significant effect on effectiveness, leading to the rejection of the null hypothesis (Ho) and acceptance of the alternative hypothesis (Ha). Therefore, the development of textbooks based on the Concrete, Pictorial, Abstract (CPA) approach is effective for teaching mathematics to Grade 1 students, specifically in the subject of numbers. In summary, the results confirm that the CPA-based mathematics textbooks significantly enhance learning outcomes in Grade 1 mathematics. The R&D process, adhering to the Borg and Gall model, was instrumental in systematically developing and validating the effectiveness of these educational materials. The substantial improvement in test scores, along with positive validation from experts and favorable feedback from teachers and students, underscores the value of the CPA approach in early mathematics education (Putri, 2015).

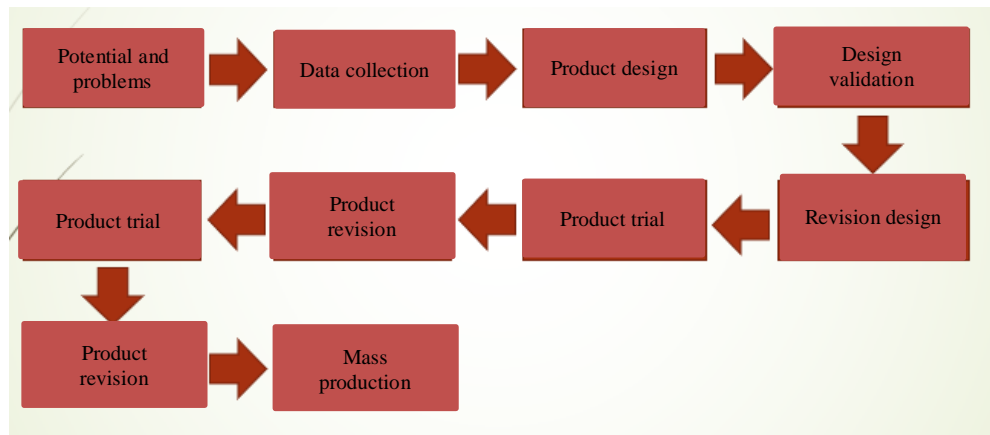


Figure 1. Descriptive themes

5. Conclusion

In conclusion, the development of CPA-based textbooks has shown to be effective in enhancing the learning outcomes of Grade 1 students in mathematics. Continued efforts in creative teaching material development and the support of educational leaders and researchers are crucial for sustained improvement in education.

Acknowledgement

The author extends gratitude to the participating Madrasah Ibtidaiyah institutions for their cooperation. Appreciation is also given to the postgraduate Universitas Muria Kudus for its guidance and constructive analysis of the research results.

Conflict of Interest

The authors declare no conflicts of interest

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