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EXPLORATION OF NUMERACY IN DIGITAL CULTURAL CONTENT

ДОСЛІДЖЕННЯ МАТЕМАТИЧНОЇ ГРАМОТНОСТІ В ЦИФРОВОМУ КУЛЬТУРНОМУ КОНТЕНТІ

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ABSTRACT

The PISA results of 2022 awarded Indonesian students poor scores in literacy and numeracy. Previous studies have suggested that numeracy skills can be improved by applying game-based learning to ethnomathematics. Therefore, a similar strategy was explored, in the form of digital content based Culturally Responsive Teaching (CRT).

Purpose. *This study aims to develop digital content for numeracy learning based on culturally responsive teaching, in order to present numeracy through the introduction of a cultural perspective that is valid,*

Програма міжнародного оцінювання учнів – Programme for International Student Assessment (PISA) 2022 року – надала індонезійським учням низькі бали з грамотності та лічби. Попередні дослідження показали, що навички лічби можна покращити шляхом застосування ігрового навчання до етноматематики. Тому було досліджено подібну стратегію з урахуванням культурно-адаптивного викладання (CRT) на основі цифрового контенту.

Мета. *Це дослідження спрямоване на розробку цифрового контенту для навчання лічби на основі культурно-адаптивного викладання, щоб представити лічбу через її впровадження з культурного погляду, що є*

practical, and effective for elementary school students.

Methodology. *The research method was the ADDIE development model, whose acronym refers to the five stages it encompasses: analysis, design, development, implementation, and evaluation. In this research paper, validation from media experts and teachers was used, and student response questionnaires were employed to calculate scores.*

Results. *The results show that the CRT-based digital content numeracy flipbook for elementary school students presents a reasonably good outcome in terms of validity and appeal. This media is suitable for supporting teachers in navigating numeracy learning in elementary schools.*

Conclusions. *The digital content flipbook can support elementary school students in numeracy. Based on the result of data analysis from the development research, it can be concluded that this e-book is an effective tool in the numeracy learning process for elementary school students. Based on the validity and practical test, this e-book is classified as 'interesting and effective' based on criteria such as visual design, students' questionnaires, and teachers' assessments. The criteria were visual display, ease of use, language, implementation, and the Culturally Responsive Teaching learning model.*

Keywords: *digital content, culture, CRT, numeracy, elementary school.*

сучасним, практичним та ефективним для учнів початкової школи.

Методологія. *Методом дослідження була модель ADDIE, що охоплює п'ять етапів: аналіз, проєктування, розробка, впровадження та оцінка. У роботі було застосовано оцінювання медіа-експертами та вчителями, а для підрахунку балів використовувалися анкети відповідей учнів.*

Результати. *Результати показують, що фліпбук для учнів початкової школи на основі цифрового контенту для читання з урахуванням культурно-адаптивного викладання демонструє достатньо хороші результати з погляду змістової обґрунтованості та привабливості. Ця книга є ефективним засобом підтримки викладання лічби вчителями початкової школи.*

Висновки. *Цифровий контент фліпбука може допомогти учням початкової школи навчитися рахувати. На основі результатів аналізу даних дослідницької розробки можна дійти висновку, що ця електронна книга є ефективним інструментом у процесі навчання лічби для учнів початкової школи. За результатами достовірності та практичного випробування електронну книгу можна класифікувати як «цікаву та ефективну» відповідно до критеріїв візуального дизайну, зручності у використанні, мовного оформлення, а також відповідності моделі навчання культурному контексту.*

Ключові слова: *цифровий контент, культура, культурно-адаптивне викладання, лічба, початкова школа.*

INTRODUCTION

Culture and education are interconnected. Cultural aspects support program organization and educational implementation. Efforts to promote education go hand in hand with promoting culture, and vice versa (Putra & Indriani, 2017). Indonesia is well known for its cultural diversity. Indonesian culture extends widely, embracing Sabang to Merauke. However, Indonesian local culture is overshadowed by foreign cultures that have entered Indonesian society as a result of globalization.

Education plays an important role in preserving Indonesian culture. Integrating culture into education is one way to preserve it: it is an invaluable subject in the field of education. According to Holmes (2020), culture profoundly impacts knowledge acquisition, learning methodologies, and how students understand information, thereby enhancing the significance and relevance of education, while promoting cultural identity and cognitive abilities.

Contemporary educational strategies must adapt to the influence of globalization. The Industrial Revolution 4.0 and the technological advancements of Society 5.0 require the education sector to integrate renewable technologies and adapt to learning patterns that reconcile the needs of students and teachers (Prijanto & de Kock, 2021). Teachers must have the opportunity to observe, reflect and experience how digital technology can be used in teaching and learning activities (Valverde-Berrocoso et al., 2021).

The use of digital learning resources is one example. To make math lessons engaging, teachers must create effective and efficient teaching materials, particularly in mathematics (Wibowo et al., 2021): teachers' openness to technology, which could be considered akin to seeking professional growth in the field of technology, was associated with greater integration of technology in teaching (Collie & Martin, 2024). Previous studies have also highlighted the low mathematical literacy skills of Indonesian students (Zulkardi et al., 2019; Thien et al., 2015).

It is clear that there is an urgent need to improve students' mathematical literacy through effective and efficient teaching and learning models, including digital education platforms and online resources for education, enhancing sustainable development and innovation capabilities in education (Zhao et al., 2022). Digital content has become an educational innovation that motivates students, especially with regard to maths. Research indicates that digital content can enhance numeracy skills. Digital resources incorporating culturally relevant content and contexts improve student engagement and the practical application of mathematical concepts, helping them understand the relevance of mathematics in their lives and communities (Budiarto et al., 2019).

The emphasis on digital and cultural integration in mathematics education is crucial due to the role it plays in cognitive development and problem-solving. Mathematics enhances analytical, methodological, and critical thinking skills, making early proficiency a must (Simanjuntak & Listiani, 2020). As a universal science, mathematics underpins technological advancements, everyday problem-solving and numeracy (the ability to apply mathematical knowledge in real-world situations). It is also useful for analyzing quantitative information and applying practical problem-solving skills (Zhang et al., 2019; D'Agostino et al., 2021; Ruijia et al., 2022).

This aligns with PISA's mathematics assessment goal for 2021, which focuses on assessing students' numeracy. Teachers can support this by developing learning plans, methods, materials, modules, and media related to numeracy skills (Solikhah, 2022). Numeracy, requiring the ability to gather, analyze, and communicate information both deductively and inductively, improves when contextualized within students' cultural frameworks and supported by digital tools.

Integrating mathematical concepts, a cultural context and digital innovation fosters a learning environment that connects abstract thinking to students' experiences, whilst taking advantages of technological developments. Cultural integrating practices can increase students' motivational beliefs toward mathematics in these situations. Understanding the nuances of culturally responsive practices, including identifying which practices are used by staff and which are most important to students, can help programs better meet and address the diverse needs of today's youth and foster positive development (Yu et al., 2022).

Current research in mathematics education has underscored the inherent interconnection between education and culture, with cultural aspects supporting educational programming, and the promotion of education promotion fostering cultural development (Putra & Indriani, 2017). Needs assessments indicate the importance of designing educational approaches that meaningfully incorporate students' cultural backgrounds and address issues of equity, social justice, and the unique learning needs of learners (Kieran & Anderson, 2019).

This is particularly significant for learners whose mathematical experiences may be detached from their daily lives, as current curriculum and pedagogical approaches often neglect their unique backgrounds and cultural ways of knowing (Budiarto et al., 2019; Supiyati & Halqi, 2020). The findings also reveal several critical elements that justify the need for digital content in mathematics. These include modifications to mathematical processes, the role of digital data in the workplace, the incorporation of digital data into education, and the relevance of digital information in everyday life (Sakurai & Goos, 2023).

All of these major factors underscore the significance of acquiring digital literacy, where students are able to read and analyze quantitative data created by digital tools to meet the changing needs of 21st-century skills (Sakurai & Goos, 2023). By addressing these points, it becomes clear that there is a need to not only teach digital skills but also adapt to the digital world through digital content.

However, surveys of existing educational resources have revealed gaps in the investigation into how to measure and adapt culture-based digital content to diverse cultural contexts without compromising its effectiveness. Several studies have explored the development of educational e-books in mathematics. Kadarisma et al. (2024) developed a digital pocketbook and found that it was valid, practical, well-received, and effective in improving students' numeracy skills.

Similarly, research by Elfina et al. (2024) and Ziyyanuddin & Widodo (2022) demonstrated the efficacy of e-books in improving learning outcomes and the competencies of numeracy and literacy. However, these studies primarily focused on specific subjects like science and mathematics, leaving room for an exploration of culture integration into digital content.

Purpose. This study aims to develop digital content in numeracy based on culturally responsive teaching to introduce numeracy through a cultural context using content that is valid, practical, and effective for elementary school students.

METHODOLOGY

The developmental research design was used for this research and focused on the development of digital content in numeracy, based on culturally responsive teaching. It employed the R&D method, utilizing the ADDIE development model. Digital content was created for this study, in the form of media based on culturally responsive teaching. It will serve as complementary material for numeracy learning in elementary schools.

The research procedure adhered to the ADDIE framework: analysis, design, development, implementation, and evaluation. The analysis phase evaluated student attributes, requirements, and the curriculum to inform storyboard development. The design step encompassed content creation, implementing components from

applications such as *Canva*, *Microsoft Word* and *Flip PDF Pro*. The validation of research instruments was employed.

Experts validated the product during development and made any necessary modifications. Implementation entailed product testing with students to evaluate its appeal and reduce errors, followed by field testing and additional modifications informed by student feedback. The evaluation step examined product suitability, validity, and appeal, which allowed for final adjustments where necessary. This methodical methodology guaranteed a comprehensive creation and revision method for the educational product.

The subjects of this development research were upper-grade elementary school students. This class was chosen based on the learning outcomes outlined in the module materials designed for students from grades five and six. The subject selection was conducted using the purposive sampling technique. The data collection methods used included questionnaires and documentation. The development of the tool was conducted through validation by media specialists.

The tools used in this research included the following:

(1) Digital content e-book validation sheet. The validation sheet in this developmental research was used to gather data from media specialists and mathematics educators, serving as a basis for assessing the e-book. The acquired data was used to assess the viability of the e-book. The e-book validation sheet was used to gather data regarding product feasibility, including visual display components, user-friendliness, language, implementability, and CRT.

(2) Practicality assessment questionnaire for educators and learners. The practicality assessment questionnaire for educators concerning the e-book used a Likert scale: STS (Strongly Disagree), S (Agree), TS (Disagree), and SS (Strongly Agree), with corresponding scores of 1 for STS, 2 for TS, 3 for S, and 4 for SS. The practicality assessment questionnaire for students used the Guttman scale with questions that required a “Yes/No” response.

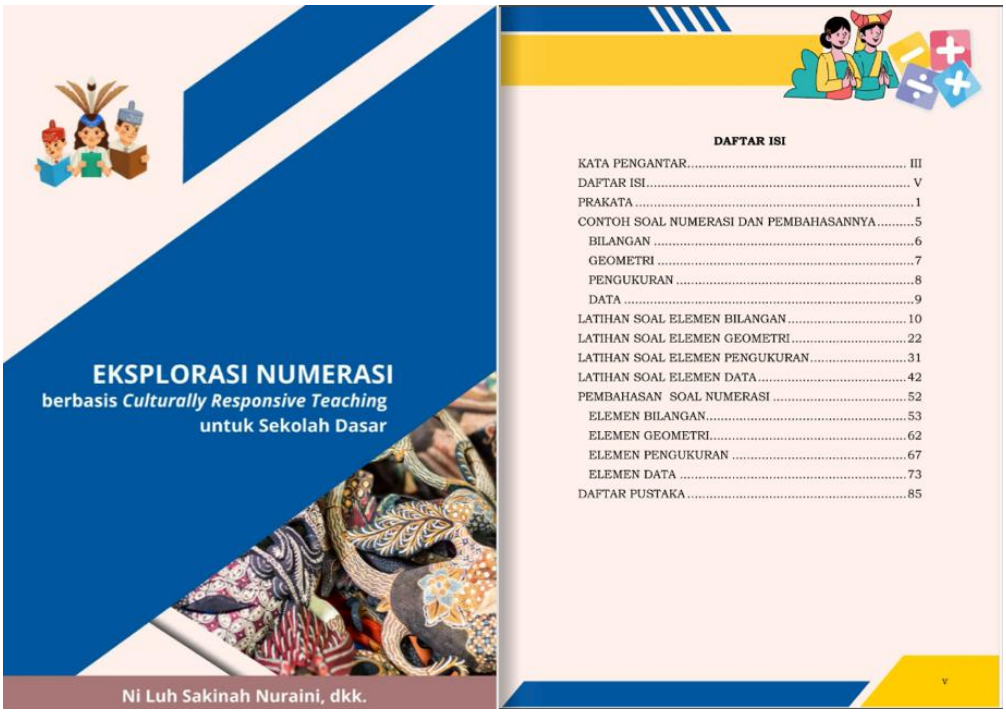
The data in this study were analyzed using a combination of qualitative and quantitative descriptive analysis techniques. Responses and recommendations based on the findings of assessments conducted by professionals, educators, and students were processed using qualitative descriptive analytic techniques; quantitative analysis techniques were used to examine questionnaire data in the form of a score from the media assessment results.

RESULTS

This research conducted the preliminary design of the CRT-based digital content e-book, which is illustrated in Figure 1. At the design stage, the required resources were determined, schedule preparation was carried out, and validation instruments were prepared.

The media validation instruments included validation instruments for material experts, media experts, teachers, and student response questionnaires. After that, a product prototype was designed.

Figure 1.
Design of the CRT-based digital content e-book



Analysis of E-book Feasibility Validation Results

After the media was developed and consulted, a validation test process was carried out by experts and teachers. The aspects evaluated were presentation, ease of use, language, implementation, and CRT. The results show an average score of 4.05 (81%) which is presented in table 1. This score shows that the e-book is valid. The validation questionnaire for digital content e-book was examined by obtaining average ratings from expert evaluators, encompassing content, subject matter, and language experts.

The validity evaluation data for the e-book was evaluated through the subsequent steps: The e-book assessment sheet for media professionals was completed in accordance with the guideline that SB (Very Good) received a score of 5, B (Good) a score of 4, C (Satisfactory) a score of 3, K (Poor) a score of 2, and SK (Very Poor) a score of 1. The quantitative scores were transformed into qualitative values through score conversion to assess the quality feasibility of the e-book. The teaching material was deemed valid for the subsequent trial phase if its validity score met the minimum acceptable threshold.

Analysis of the Practicality of E-book User Validation Results (Teacher)

Table1
Product Media Validation Result by Teacher (User)

No.	Aspect	Indicator	Score
1.	Visual Display	1. Cover	4
		2. Attractive appearance	4
		3. Design of text, images, and content	4
		4. Color selection	3

2.	Ease of use	5. Font selection	4
		6. Readability of text	4
		7. Presentation of content	4
		8. Presentation of questions	4
		9. Image proportions	3
		10. Flexibility	3
		11. Effectiveness and efficiency	4
		12. Practicality	4
		13. Easy to operate	4
3.	Language	14. Clarity of language	5
		15. Suitability of language	5
4.	Implementation	16. Attractive appearance	3
		17. Clarity of material and questions	4
5.	Culturally Responsive Teaching	18. Inclusion of cultural content	5
		19. Use of students' culture to convey mathematical concepts	5
		20. Encouraged students to appreciate differences	5
Mean 4,05			
Percentage 81 %			
Qualification: feasible			

Recapitulation of teacher (user) validation results showed a validation result of 81%. The aspects assessed included visual presentation, ease of use, language, implementation, and the Culturally Responsive Teaching learning model. According to Akbar (2023), the average result of the percentage of material expert validation was 81% which was included in the interval range of 64.00-84.00% with a valid predicate.

At the subsequent implementation stage, the trial was carried out on a small scale, which involved 18 grade 5 elementary school students. Students accessed the product in the classroom with the help of LCD projectors and reviewed the contents of the e-book which appeared in the product. This trial aimed to find out students' responses to the media. The results were presented in the analysis to explain the practicality of using e-books by students and obtained an average score of 16.4 (91.20%). The score indicated that the product was valid and suitable for use in an educational environment.

Analysis of the Practicality of E-book User Validation Results (Students)

The e-book practicality assessments sheet was given to students after they had finished using the e-book for acquiring numeracy skills. The analysis of the students' practicality assessment sheet was carried out based on the following steps:

(1) Recapitulating each item of the students' assessment sheet statement to the book.

(2) Students determined the answer by ticking “Yes” (a score of 1) or the “No” (a score of 0).

(3) Changing the average score of all aspects into a qualitative score in accordance with the assessment criteria described.

Based on the results of the practicality test for the e-book, namely MI Sunan Gunung Djati students, Malang City, the digital content of the e-book was found to have been used to practice learning numeracy with a percentage gain of 91.20%.

The following descriptors were used: The first indicator was how attractive the e-book presentation was: 88.89% of students agreed that the e-book was interesting. The second indicator was the clarity and attractiveness of the questions in the e-book: 94.44% of students agreed that the e-book contained clear and interesting questions.

The third indicator was how easy it was to understand the contents of the e-book: 88.89% of students agreed that the e-book was easy to understand. The fourth indicator was the readability of the text in the e-book: 94.44% of students agreed that the text in the e-book was clear. The fifth indicator was how easy it was to understand the language in the e-book: 100% agreed that the language in the e-book was easy to understand.

The sixth indicator was how much easier the e-book made it for students to learn mathematics: 88.89% of students agreed that e-book make it easier to learn mathematics. The seventh indicator was to what degree the questions in the e-book were related to the cultural context of each student: 100% of the students agreed that the questions in the e-book were related to their local culture. The eighth indicator was how easy it was for students to understand the meaning of the mathematics questions related to culture: 77.78% of students agreed that the mathematics questions related to culture were easy to understand.

The ninth indicator was how clear the images in the e-book were: 100% of students agreed that the images in the e-book were clear. The tenth indicator was to what extent the images helped students to read/do the questions: 100% of students agreed that the images in the e-book were helpful. The eleventh indicator was to what extent the use of color in e-book helped engage students’ attention: 77.78% of students agreed that the use of color on the e-book helped them engage with the content. And the last indicator was how interested students’ were in using the e-book to practice numeracy: 88.89% of students agreed that e-book make them interested in practicing numeracy.

The result of media expert validation included visual appearance, ease of use, language, implementation, and a Culturally Responsive Teaching learning model in the e-book. In terms of media validity, the digital content e-book met expectations with regard to language, ease for use, and CRT-based content. In terms of visual appearance, it was considered to have an attractive appearance in terms of the cover design, illustrations, and images to help students more easily understand numeracy.

DISCUSSION

The validation results of the CRT based e-book demonstrate the successful integration of culture, digital technology, and mathematics education. The overall expert validation score of 81% not only aligns with Akbar's (2023) criteria for valid educational materials but also supports Holmes (2020) assertion that culture significantly impacts the value of knowledge, learning methodologies, and the understanding of information. This

integration becomes particularly relevant in the Indonesian context, where, as noted by Putra & Indriani (2017) cultural aspects inherently support educational implementation and organization.

The criteria for this e-book are in accordance with the Culturally Responsive Teaching learning model, which means it honors students' cultural backgrounds to make learning of more interest to them (Olefirenko et al, 2019), (Olefirenko et al, 2020). The use of cultural contexts and examples that are familiar to students can make the learning experience interesting (Makhmudov, 2023).

The criteria for the e-book with regard to how students are more interested in learning where attractive images are used, aligns with previous studies which suggest that one method of encouraging people to read is content, material, cover image, attractive illustrations, and reading innovations that are different from printed books in general or technology that supports reading knowledge and comprehension (Kumnuansin & Khlaisang, 2015).

The high student practicality score of 91.20% reflects the successful adaptation to what Prijanto & de Kock (2021) describe as the necessary integration of renewable technologies in response to Industry 4.0 and Society 5.0.

This adaptation is particularly evident in the strong positive response to digital content integration, supporting Wibowo et al (2021), with an emphasis on creating effective and efficient teaching materials in mathematics. The perfect score (100%) for cultural context integration aligns with the findings of Debnam et al (2024) that digital resources incorporating culturally relevant examples enhance student engagement and improve the practical application of mathematical concepts.

The e-book's effectiveness in supporting the development of numeracy skills corresponds with the emphasis Simanjuntak & Listiani (2020) place on the role of mathematics in developing analytical, methodological, and critical thinking skills. The strong validation results in practical implementation (91.20%) support the definition of Litkowski et al (2020), that numeracy is the ability to apply mathematical knowledge to real-world situations. This is particularly significant given PISA's focus on numeracy assessment.

The study's findings with regard to cultural integration align with research by Kieran & Anderson (2019) on the importance of incorporating students' cultural backgrounds into teaching approaches. The perfect scores in the elements related to cultural responsiveness confirm the assertions by Debnam et al (2024) about the importance of connecting mathematical experiences to students' daily lives and cultural ways of knowing.

Visualization of abstract concepts through images makes it easier for students to understand and remember the material being studied (Sastradika et al., 2021). Then, as digital content flipbooks adapt to advances in technology, there is increasing interest in exploring the potential of customized pictorial content to meet a variety of learning needs, enhance the learning experience, and improve analytical thinking and understanding of complex topics (Kwangmuang et al., 2024). Apart from that, this e-book is also useful for teachers and students in learning numeracy.

However, low levels of cultural understanding of mathematics were identified by Sakurai & Goos (2023) as an important element in the integration of digital content in

mathematics. These findings suggest the need for further investigation into more effective methods of integrating cultural context with mathematical concepts while meeting digital literacy needs.

The study's implications align with current research trends identified by Sakurai & Goos (2023) regarding the importance of digital literacy in mathematics education. Future research should focus on addressing the identified gaps in visual design elements and exploring ways to strengthen the connection between cultural contexts and mathematical concepts. This aligns with the broader educational goal of adapting to the digital world while maintaining cultural relevance, as emphasized by current research in mathematics education.

These findings suggest that the e-book successfully bridges traditional numeracy education with cultural responsiveness and digital innovation, creating an engaging and effective learning tool. The results validate the theoretical frameworks proposed by multiple researchers regarding the interconnection of culture, education, and digital technology in mathematics education (Lebedeva, Norik, Lebedev, 2022; Tkachov, Tkachova, Shcheblykina, 2023). Future studies would be valuable in assessing the long-term impact of CRT-based e-books to improve numeracy skills, particularly in the context of evolving digital literacy requirements and cultural preservation needs.

CONCLUSIONS

The digital content flipbook can support elementary school students in numeracy. Based on the result of data analysis from the development research, it can be concluded that this e-book can be used effectively in the numeracy learning process for elementary school students. Based on the validity and practical test, this e-book is classified as “interesting and effective” with regard to visual appearance criteria, students’ questionnaires, and teacher assessment.

The criteria are visual display, ease of use, language, implementation, and the Culturally Responsive Teaching learning model. Future researchers are expected to focus more on color selection, design, and content layout to encourage students to use e-books for numeracy learning.

CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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