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RESEARCH ARTICLE

Enhancing Scientific Literacy in Primary Education: A Novel Approach through Culturally Integrated Science Textbook Development

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ABSTRACT

The scientific literacy level of elementary school students in Buleleng Regency, Bali, Indonesia, is still relatively low. Local cultural concepts have been proven to help students understand and learn new concepts. For this reason, this research aims to develop teaching materials that integrate local Balinese culture, namely the *Tri Kaya Parisudha* concept, to improve the sanitary literacy skills of elementary school students in Buleleng. According to the objectives of this research, the method used to carry out this research is development research following the Borg and Gall development model. This research carried out several tests using this model, namely validation tests, limited trials, wider trials, and product effectiveness tests. The data analysis found that the textbook developed was proven to be valid with a high level of validity. Likewise, it was found that the textbooks developed had a high level of practicality. Judging from the results of the effectiveness test, it can be said that the textbooks developed can increase elementary school students' scientific literacy level. Based on the results obtained in this research, it can be concluded that this research has succeeded in developing teaching materials that integrate local culture and are proven to increase the scientific literacy of elementary school students.

INTRODUCTION

Science education is paramount in elementary school curricula, serving as a cornerstone for students to navigate the dynamic landscape of 21st-century scientific and technological advancements. Central to this paradigm is the multifaceted dimensions of science encompassing its conceptual frameworks, procedural methodologies, epistemic attitudes, and technological applications (Murniati & Erika, 2023; Sulthon, 2018; Sunyono, 2018). Consequently, the pedagogical emphasis transcends mere knowledge acquisition, necessitating active student engagement through inquiry-based learning, experimental validation, and innovative problem-solving, culminating in developing solutions pertinent to societal challenges (Aji et al., 2024; Alberida, 2020).

Therefore, science learning in schools is expected to be able to apply or implement scientific literacy in learning. However, students' scientific literacy in Indonesia is still relatively low, as indicated by the results of international surveys such as PISA and TIMSS (Busyairi et al., 2023; Naveed et al., 2023; Rutkowski et al., 2024). Based on data from PISA and TIMSS scores show that students' scientific literacy abilities are still relatively low. Low literacy is also supported by the 2022 education report card data related to literacy, showing that more than 50% of elementary school students throughout

Indonesia have not reached the minimum competency limit for reading literacy.
The low level of student literacy is also evident from a preliminary study conducted on 110 students in cluster III, Buleleng District, showing that literacy is in the low category with an average value (M) of 60.05 and a standard deviation (SD) of 4.65. The data obtained is in line with the results of research conducted by Meri et al. (2023) and Alman and Ituga (2023), which stated that, in general, the literacy abilities of elementary school students are still relatively low. The factor that causes low scientific literacy skills is the limited interesting learning materials (Febriana, 2021; Hasyim & Fitriyani, 2018; Setiawan et al., 2024). So far, science learning resources are still limited to textbooks or texts rather than direct learning (Haling et al., 2022).

Students' scientific literacy problems are influenced by several factors, including the lack of integration of content and local cultural context in science learning, as well as the use of learning methods that are not appropriate to students' characteristics (Fauziyah et al., 2021; Ramli et al., 2022; Sutrisna & Anhar, 2020). Meanwhile, the textbooks used in learning still do not accommodate the local cultural context, so learning tends to be less interesting and ineffective. Knowledge and application of scientific literacy that only relies on textbooks or texts has not fully touched students' souls. As a result, lessons become boring, and students do not understand the subject matter in the context of life.

Jegede and Aikenhead (1999) reviewed several studies on the relationship of culture to science learning in several non-Western countries. The results of these studies generally show that native students tend to be unable to cross cultural boundaries. In other words, students' cultural background is one of the limiting factors for students to understand (Western) school science concepts. In this regard, Stanley and Brickhouse (2001) suggested that science learning in schools balances Western science (modern science) with indigenous science (traditional science) using a cross-cultural approach. Aikenhead (2001) also expressed a similar opinion, stating that if the school science subculture is harmonious with students' daily lives, then science teaching will strengthen students' views of the universe.

Considering the importance of local culture in science learning, this research developed a science textbook integrated with local Balinese culture, especially the *Tri Kaya Parisudha* concept. The *Tri Kaya Parisudha* concept describes three main aspects of acquiring knowledge: thinking, speaking and doing. By developing textbooks that adopt the *Tri Kaya Parisudha* concept, it is hoped that students will be more actively involved in science learning and be able to relate lesson material to their cultural context. Specifically, this research has several objectives, including (a) to determine the validity of the content of science textbooks which are integrated with the local culture of *Tri Kaya Parisudha*, (b) to determine the practicality of using these textbooks in the field, and (c) to assess the effectiveness of the textbook in increasing students' scientific literacy. Thus, it is hoped that this research can contribute to efforts to improve science learning in elementary schools through a more contextual and local culture-based approach.

MATERIALS AND METHODS

Research design

This research is research and development (R&D), which refers to the Borg and Gall steps model. The stages of product development from Borg and Gall are shown in Figure 1 below.

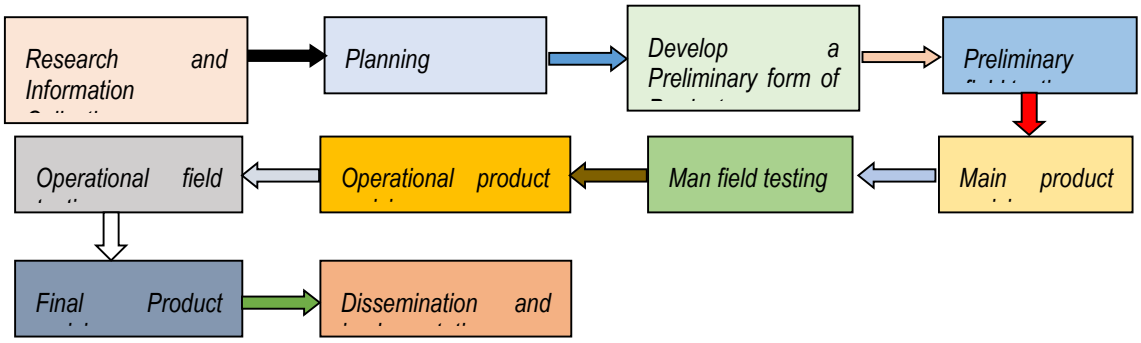

Figure 1: Borg and Hall Development Model (2007)

Research subjects

The subjects in this development research can be explained further as follows.

(1) Textbook validation test subjects

The expert test in this research used nine people, including experts and practitioners in their fields, especially in science. Of the nine people, those involved in the expert test consisted of 3 people as content experts from the lecturer and teacher practitioner elements at the elementary school level, three as media experts from the lecturer element and three as language experts from the lecturer element. Fifteen experts provided input in the process of validating the content of the *Tri Kaya Parisudha* local culture-integrated science textbook to improve students' scientific literacy and critical thinking skills.

(2) Limited trial subjects

At this stage of the research, 1 class group in class IV came from one of the schools in the Cluster 1 area of Buleleng District. This stage is a limited field trial, so input will be obtained from the trial results to improve the draft of the developed textbook.

(3) Broader trial subjects

Determining subjects at this research stage will use class IV elementary schools, samples obtained from the sampling process, and a population of class IV elementary schools in cluster 1 of the Buleleng sub-district. This stage is a wider field trial, so input will be obtained from the trial results to improve the draft of the developed textbook.

(4) Effectiveness test subjects

The subjects of this trial were the control group and the experimental group, which consisted of fourth-grade elementary school students, obtained from the results of population sampling from the population group of fourth-grade students in cluster III, Buleleng District.

Research instrument

The instruments in this research were used to collect data on the feasibility and effectiveness of the textbooks being developed. The instruments used in the research were textbook validity instruments, textbook practicality instruments and student literacy test instruments to measure the practicality of textbooks.

Data analysis

a. Product content validity

Product validity is carried out to validate the contents of textbooks and scientific literacy instruments developed using Aiken V's formula.

$$V = \frac{\sum s}{n(c-1)}$$

Note:
V = item validity index
s = r-lo
∑s= s1 + s2 + etc.
n = number of raters

b. Practicality of the product

Implementing the learning tools in the classroom measured the teaching materials' practicality. Data on textbooks' practicality was obtained from observations and teacher responses to the textbooks used. The data was then analyzed to obtain its practical value. The formula used was as follows.

$$M = \frac{\sum X}{N} (Bruning,\ 1997)$$

The average score from observers and teacher responses was converted to a theoretical ideal reference assessment, as in Table 1.

Table 1: Category table for assessment of theoretical ideal references.

No.	Interval	Category
1	Mi + 1,5SDi - Mi+3SDi	Very Good
2	Mi + 0,5SDi - Mi+1,5SDi	Good
3	Mi -0,5SDi - Mi+0,5SDi	Fair
4	Mi -1,5SDi - Mi-0,5SDi	Poor
5	Mi -3SDi - Mi-1,5SDi	Very Poor

Source: Nurkencana and Sunartana (1992)

c. The effectiveness of the product

The evaluation of product effectiveness centred on enhancing scientific literacy and critical thinking proficiencies among elementary school students. A meticulously crafted test aligned with the content of the culturally oriented science textbook *Tri Kaya Parisudha* served as the principal instrument. The research adopted an experimental design, specifically a pretest-posttest nonequivalent control group design, as proposed by Dantes (2017). Figure 2 illustrates the schematic representation of this design. The validation of hypotheses was accomplished through the application of the t-test methodology.

Group	Pre-Test	Treatment	Post-Test
Experiment	O1	X	O3
Control	O2	-	O4

Figure 2: Research design pretest-posttest nonequivalent control group design

Source: Dantes (2017)

Note:

X : Science textbook integrated with local culture, *Tri Kaya Parisudha*

O1 : Pre-test of scientific literacy and student character in the experimental group

O2 : Pre-test of scientific literacy and student character in the control group

O3 : Post-test of scientific literacy and student character in the experimental group

O4 : Post-test of scientific literacy and student character in the control group

RESULTS AND DISCUSSION

Textbook validity

Textbook validation entails a comprehensive assessment encompassing content, media, and language validation, with three validators assigned to each domain. The outcomes of these validation exercises are meticulously documented and presented in Tables 2, 3, and 4 for detailed scrutiny and analysis.

Table 2: Content validation results of the *tri kaya parisudha* local culture integrated science textbook.

No	Aspect	V index	Category
1	Cover	1	Very Valid
2	Lay out and writing	1	Very Valid
3	Content Structure	0.96	Very Valid
4	Content	0.95	Very Valid
5	Language	1	Very Valid

Source: Data Analysis Result

Table 3: Media validation results for culturally integrated science textbooks.

No	Aspect	V index	Category
1	Book size	0.96	Very Valid
2	Book cover design	0.92	Very Valid
3	Content design	0.91	Very Valid

Source: Data Analysis Result

Table 4: Summary of language validation results for science textbooks integrated with local culture, *tri kaya parisudha.*

No	Indicator	V index	Category
1	Straightforward	0.97	Very valid
2	Communicative	1.00	Very valid
3	Dialogic and interactive	1.00	Very valid
4	Suitability to student development	1.00	Very valid
5	Conformity to language rules	0.88	Very valid

Source: Data Analysis Result

Practicality of textbooks

Data regarding the practical applicability of the *Tri Kaya Parisudha* local culture-integrated science textbook were amassed through insightful feedback from students and teachers engaging with the developmental material. These responses were subjected to rigorous analysis, culminating in the categorization of values, as depicted in Table 5, providing a nuanced perspective on the textbook's practical utility.

Table 5: Criteria for practicality of textbooks.

No	Interval	Category
1	56,25 – 75	Very Good
2	43,75 – 53,25	Good
3	31,25 - 43,75	Fair
4	18,75 – 31,25	Poor
5	0 – 18,75	Very Poor

Source: Adapted from Nurkencana and Sunartana (1992)

The mean practicality score for the developed textbooks is 71.89, positioning them within the "very good" category. This designation underscores the high degree of practicality exhibited by the textbooks, affirming their efficacy and suitability for adoption by educators and students within the school environment.

Product effectiveness

The evaluation of textbook effectiveness employed a pretest-posttest nonequivalent control group design. Random selection constituted the experimental and control groups comprising 32 students. Students were instructed to use the local-culture-integrated science textbook *Tri Kaya Parisudha* in the experimental setup. At the same time, the control group relied on conventional textbooks available within the school curriculum. Statistical analysis conducted through SPSS yielded a significance value 0.000 (refer to Table 6). A significance value below 0.05 indicates a substantial variance in student literacy levels between cohorts exposed to the integrated local culture science textbook, *Tri Kaya Parisudha*, and those instructed using conventional science materials.

Table 6: Independent t-test results.

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	-5.662	62	.000	-.18156	.03207

Source: Data Analysis Result

Incorporating local culture into educational materials enhances students' understanding (Anggana et al., 2022; Trisnowati & Firmadani, 2020). This is because local culture is something that students are familiar with and even something that students encounter every day. Thus, using local culture activates students' prior knowledge and uses it to understand new things they learn (Kurniasari et al., 2020). By involving authentic things that students encounter daily, difficult concepts can be understood more quickly and better by students (Rofi'i et al., 2022).

Apart from that, local culture, such as folklore, local art, and other cultural tools that are part of students' identity, has also been proven to help students understand abstract concepts (Kesiman & Agustini, 2012). Using local culture makes it easier for students to understand abstract concepts because they experience them directly or have experience of these concepts in a real context (Agustini et al., 2018). In addition, using language or terms that students understand will make explanations more efficient and effective. Teachers does not need to explain these terms at length because the students already understand them. So, the teacher simply connects these terms with new concepts that are understood and places emphasis on things that are considered important.

From the results of this research and the explanation above, it can be understood that the use of local culture in learning has an important role. Local culture has been proven to help students understand the material being studied, and specifically, in this research, it has also been proven to increase students' scientific literacy. So, teachers need to apply local culture to make the material studied easier for students to learn and understand.

CONCLUSION

As stated previously, this research is aimed at developing teaching materials by integrating local Balinese culture, *Tri Kaya Parisudha*, to increase students' scientific literacy. From the research results obtained in this study, it can be concluded that this research has succeeded in developing teaching materials that integrate local culture, which have a high level of validity and practicality. Apart from that, this research has also succeeded in developing teaching materials that can increase students' scientific literacy by integrating the concept of *Tri Kaya Parisudha*. However, despite this, this research is only limited to developing teaching materials for implementing science learning in elementary schools. For this reason, further research must be carried out to apply local cultural integration to learning other subjects. Apart from that, this research only focuses on using teaching materials to increase students' scientific literacy. For this reason, other research that considers other factors or variables that theoretically can influence students' level of scientific literacy also needs to be carried out to obtain a more comprehensive understanding.

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Conflict of interests

The authors declare no conflict of interest in the publishing of this manuscript. The authors adhered to all ethical guidelines, including plagiarism, informed consent, misconduct, data fabrication, double publication, and redundancy.

Author contributions

I Ketut Suparya contributed to conceptualisation, methodology, preparation of the original draft of the paper, writing the reviewers' responses and editing the original manuscript; Wayan Suastra provided supervision in conceptualisation and data validation; Ketut Suma and Ida Bagus Putrayasa contributed to the supervision of the methodology, statistics and data validation. All authors have read and approved the published version of the manuscript

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