Science Education International
35(1), 61-70
https://doi.org/10.33828/sei.v35.i1.7

ORIGINAL ARTICLE

A Digital Instructional Book: A Tool for Improving Students' Learning Outcomes on the Reduction and Oxidation Reactions

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ABSTRACT

The rapid development of information and communication technology demands the production of digital products. This study aims to produce a digital instructional book based on Balinese local cultures to enhance the learning outcomes of high school students. The development of this book used the ADDIE model. The analysis phase included an analysis of the chemistry curriculum, teachers' and students' opinions about digital books, digital learning, and Balinese local cultures related to the chemistry content. The design phase included creating a framework and preparing a digital instructional book based on Balinese local cultures. The development phase included validation by content, language, and media experts. The implementation phase included testing the practicality and effectiveness of the book. The evaluation phase was carried out at all phases of the ADDIE model. The characteristics of this book were that it was made in a digital form and integrated with local Balinese cultures. It met the criteria of being a very valid category based on content, language, and media aspects. It also met a practical and effective category to improve students' learning outcomes. It is very useful to enhance chemistry learning outcomes in the era of the Industrial Revolution 4.0.

KEY WORDS: Blended learning; digital instructional book; learning outcomes; local cultures

INTRODUCTION

The development of information technology and the Internet in the era of the Industrial Revolution 4.0 takes place very rapidly. This development greatly impacts all lines of life (Berawi, 2019). One of the impacts observed is the rapid flow of information on social media, where people consume information without a good mastery of information literacy. This fast flow of information has positive and negative impacts (Zhu et al., 2013). The positive impact is that we can receive important information immediately. This will benefit all parties. Unfortunately, fake news and hate speech are increasingly prevalent on social media (Muhid et al., 2019). These are dangerous because they can destroy the country if not anticipated properly and immediately.

The era of the Industrial Revolution 4.0 has driven a revolution in the use of information and communication technology in education (Halili, 2019; Shahroom and Hussin, 2018). In addition, the coronavirus disease 2019 (COVID-19) pandemic has accelerated this revolution (Mhlanga and Moloi, 2020; Sá and Serpa, 2020). This can be seen from the Circular of the Minister of Education and Culture of the Republic of Indonesia Number 4 of 2020 concerning the Implementation of Education Policies in the Emergency Period of the Spread of COVID-19 so that the learning processes are carried out from home by online.

To support online learning, digital learning resources are needed. The use of such resources has recently received increasing attention. This is due to several reasons. First, they are easily reproduced and sent through digital media. Second, unlike printed learning resources, they do not need a special place to store them. Third, they are paperless (Bera, 2016), which encourages the green chemistry movement where they do not use paper raw materials derived from trees and do not produce waste. Fourth, they require very low costs.

The development of the 4.0 Industrial Revolution in the 21st century has caused a very rapid flow of information with no boundaries of space and time. One of these information flows is the entry of foreign cultures into a country (Wakhyuni et al., 2018), for example, Indonesia. The onslaught of foreign cultures has caused the Indonesian people, most of whom are school-age children, to admire foreign cultures more than their own (Leisch, 2002). This is because their cultures are less explored and globalized. In addition, they are less associated and used to strengthen national identity. In education, they are less linked and used to improve mastery of the subject matters learned in schools (Ramburuth and Tani, 2009).

Bali is very rich in local cultures. These Balinese local cultures are closely related to the subject matters at high schools, especially chemistry (Suardana, 2014). They can be a context for chemistry content. For example, the reduction and oxidation (redox) reactions topic has applications in making *Tape* (fermented sticky rice) for religious ceremonies in Bali, Indonesia. It is used as a means in Balinese traditional ceremonies, such as a ceremony on *Galungan and*

Kuningan Day (Maharani, 2020). On *Galungan Day,* people commemorate the victory of virtue over evil (Sucita, 2020). In contrast, on *Kuningan Day*, they celebrate the greatness of God in the form of holy spirits and heroes of truth who shape noble human morals (Wulandari, 2017). Another example is redox reactions in ripening bananas using husks that are burned before religious ceremonies (Suardana, 2014). The heat generated from this combustion accelerates the ripening of bananas. Likewise, redox reactions are also found in the *Ngaben* event (the cremation ceremony in Bali, Indonesia) (Suardana, 2014).

Integrating Balinese local cultures into chemistry instructional books (curriculum) has several advantages. First, we will be able to preserve the Balinese local cultures by passing on these cultures from generation to generation through learning at schools (Suardana, 2014). Second, we can globalize them in foreign cultural hegemony. Third, it is easier for students to understand the chemistry contents because they can be used as a context for the chemistry contents (Suardana, 2014). Fourth, students can master global sciences through local contexts (think globally and act locally).

The learning outcomes required in the curriculum 2013 are competencies that students must master. They are part of the national education goals, namely developing the potency of students to become human beings who believe in God Almighty, have noble characters, be healthy, knowledgeable, capable, creative, independent, and also become democratic and responsible citizens (Wahono, 2018). Therefore, it is vital to improve the students' learning outcomes achieved by developing learning models or learning resources. Several learning models or books were designed to enhance the students' learning outcomes (Peechapol, 2021; Redhana et al., 2021; Redhana et al., 2021; Redhana and Suardana, 2021; Tezer et al., 2021; Widiandari and Redhana, 2021a; Widiastari and Redhana, 2021b; and Wulan et al., 2020). On the other hand, recently, electronic instructional books have been developed by several researchers (Jung et al., 2012; Shin, 2011; and Tahara et al., 2018). The further development results were interactive electronic instructional books (Asrowi et al., 2019; Ebied and Rahman, 2015; Lim et al., 2020; and Pujiastuti and Haryadi, 2019). E-books were also combined with several learning strategies or conditions, such as problem-solving strategy-based e-books (Huang et al., 2018), concept maps-based e-books (Hwang et al., 2017), ARCS-based e-books (Turel and Sanal, 2018), hypermedia-based e-books (Awaludin et al., 2019), multi-representation-based e-books (Rasmawan, 2020), web 2.0-based e-books (Ibrahim and Alqahtani, 2018), and smartphone-based e-books (Hasbiyati et al., 2019; Muqarrobin and Kuswanto, 2016).

The integration of local cultures or wisdom into Newton's Laws packaged in an interactive electronic instructional book was carried out by Sukma et al. (2019). The local wisdom used was the traditional game of Manatana and Nikeran to explain Newton's Laws. Thus, students understand the subject matter more easily. Further studies on e-modules based on local wisdom were reported by several researchers, including an e-module based on Jambi's local wisdom at the Kindergarten level (Sofyan et al., 2020), an instructional book based on East Java local wisdom to improve the scientific literacy skills of elementary school students (Suryanti et al., 2020), and an android-based physics e-book using the local cultures of the Nekeran traditional game on the topic of momentum and impulse (Wardani and Mundilarto, 2021). These books were suitable for use in the learning process. However, Balinese local cultures were not integrated into high school chemistry subject matter packaged in digital books. This is important to prepare learning resources that support information technology-based learning in the 21st century and, at the same time, preserve Balinese local cultures.

Considering the advantages of digital instructional books and the integration of Balinese local cultures into subject matters (the chemistry curriculum), this study developed the Balinese local culture-based digital chemistry instructional book. The development of this book was carried out through research and development. It is useful in improving students' learning outcomes, and at the same time, it can preserve the Balinese culture and environment. In addition, it is also useful for overcoming problems in chemistry learning, such as misconceptions (Redhana et al., 2017; 2018).

This study aims to produce a digital chemistry instructional book based on Balinese local cultures that is valid, practical, and effective for improving high school students' learning outcomes. To achieve the objective, some guiding questions were posed as follows. (1) What are the characteristics of the digital chemistry instructional book based on Balinese local culture? (2) What is the digital chemistry instructional book's validity, practicality, and effectiveness based on Balinese local cultures in improving high school students' learning outcomes?

METHODS

Research Design

Research and development of the ADDIE model was used to produce the digital chemistry instructional book based on Balinese local cultures. This model was chosen because it was quite simple for creating educational products. It consists of five phases, namely (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation.

Research Samples

The research samples were categorized based on the phases of research and development. In the analysis phase, the samples were comprised chemistry teachers and high school students in Bali, Indonesia. The samples of chemistry teachers and high school students were drawn from a population of 656 chemistry teachers and 98,896 high school students in the province of Bali, Indonesia, respectively, in 2022. The sample size was drawn using a simple random sampling technique. There were 154 chemistry teachers involved as samples (63 males and 91 females) with 5–20 years of teaching

experience. Meanwhile, the 337 high school student samples came from classes X, XI, and XII, comprising 116, 127, and 94, respectively. Regarding gender, these students included 148 males and 189 females. These students were between the ages of 14 and 16 years.

A validity test of the digital instructional book involved two content experts from the Chemistry Education Study Program, a linguist from the Indonesian Language Education Study Program, and a learning media expert from the Learning Technology Study Program. All of these experts were from the Universitas Pendidikan Ganesha, Indonesia.

The research samples for the readability test were nine students. These students were divided into three categories, namely high, medium, and low academic abilities, 3 students each, respectively, of which three were male and six were female. The determination of the student samples was carried out using a purposive technique.

The practicality test was carried out in one of the senior high schools in Bali, Indonesia. This school was selected using a cluster sampling technique from 164 high schools in Bali Province, Indonesia, in 2022. The research was conducted in class X because the topic of redox reactions was taught in class X. The population of class X was six classes containing 205 people. Of these six classes, one class was selected as a research sample for the practicality test. The chosen class sample included 30 students consisting of 13 males and 17 females. These students are between 15 and 16 years old.

The effectiveness test was carried out in the same school as the practicality test, but the sample class chosen was different from the class used in the practicality test. Class selection was carried out using the cluster sampling technique. The selected class contained 36 students consisting of eight males and 26 females. The students in the research sample were 15–16 years old.

Research Instruments

The instruments used in this study depended on the phases of the research. In the analysis phase, the instruments used were document analysis sheets and questionnaires. The document analysis sheets were used to collect data related to literature studies, whereas questionnaires were used to collect data related to field studies. During the development phase, the required instruments were an expert validation test sheet, a readability test sheet, and a practicality test sheet. The expert validation included content, language, and media dimensions. The content dimensions included the content's relevance, correctness, and validity, the relevance of Balinese local cultures to the content, and presentation techniques. The dimensions of the language were straightforwardness, clarity, compliance with the Indonesian language rules, and students' level of development. The dimensions of the media included cover and content design. The dimensions of the readability included the availability of instructions for using the book, systematic clarity, ease of understanding the content, clarity of text, images, tables, symbols, and notations, as well as ease of understanding the context of Balinese local cultures. The dimensions of the practicality test sheets included the ease of use of the instructional book, ease of understanding the content of the instructional book, and efficiency of time, cost, and resources.

Instruments required during the implementation phase included a cognitive learning outcome test, a performance assessment rubric, and an attitude scale. The test blueprint for cognitive learning outcomes is shown in Table 1. The dimensions of the performance assessment rubric included practical skills

Table 1: The blueprint of the cognitive learning outcome test

Basic competencies	Indicators of competence achievement	Number of items
1. Explaining the development of the concept of redox reactions	• Explaining the development of redox reaction concepts	2
2. Determining the oxidation number of an atom in a molecule or ion	• Determining the oxidation number of an element contained in the compound	3
	• Determining the change in the oxidation number of an element before and after the reaction	2
	• Determining the oxidation number of an element that is the same as the element in other compounds	2
3. Determining the oxidizing and reducing agent in a redox reactions	• Determining the species that act as reducing or oxidizing agents	4
	• Determining whether the compound acts as a reducing or oxidizing agent in the given reaction	2
4. Determining redox and non-redox reactions and disproportionation and proportionation reactions	• Determining which reactions are redox reactions or non-redox reactions	2
	• Determining autoredox (disproportionation) or anti-autoredox (conproportionation) reactions	5
5. Identifying the application of the concepts of redox reactions in everyday life	• Identifying redox reactions in everyday life	3
	• Determining how redox reactions are applied in everyday life	
6. Determining the name or chemical formula of several compounds according to IUPAC rules based on their oxidation numbers	• Determining the name of the compound	2
	• Determining the chemical formula of the compound	3

(covering practicum preparation, practicum implementation, cleanliness of tools and places, data analysis, and conclusion of results) and presentation skills (covering group participation, presentation of discussion results, and group collaboration). Meanwhile, measured attitudes included curiosity, honesty, criticality, discipline, responsibility, and mutual respect.

The validity test sheet, the readability test sheet, the practicality test sheet, the performance assessment rubric, and the attitude scale used a scale from 1 to 5, which described very low to very high grades. On the other hand, the cognitive learning outcome test was an objective test consisting of 30 items. These instruments were validated among researchers, where one researcher drafted the instruments. Then, others provided input on the suitability of the dimensions, indicators, and statements with the required data.

In particular, the cognitive learning outcome test was tested empirically on 36 students in one of the high schools in Bali, Indonesia. The results of this empirical trial were as follows. Item validity ranged from 0.39 to 0.74, test reliability was 0.92, item difficulty index ranged from 0.23 to 0.65, and discriminatory power index ranged from 0.29 to 0.76. All test items were feasible to be used to measure cognitive learning outcomes.

Data Collection

Data collection was carried out from 2021 to 2023. The activity began with an analysis phase, which included literature and field studies. Activities carried out in the literature study included curriculum analysis, which included an analysis of core competencies and basic competencies to produce indicators of competency achievement and topics, as well as an analysis of the Balinese local cultures relevant to chemistry. On the other hand, the activities carried out in the field study were analyzing the needs of teachers and students on their opinions about digital instructional books, digital learning, and learning based on Balinese local cultures. The results of this field study were used as materials to design a digital chemistry instructional book based on Balinese local cultures. The design phase was carried out by formulating the objectives of developing this book, making the design of the book, which included choosing the software used to make the instructional book (Microsoft Word 19), determining the type, size, and color of letters, and determining images, and layouts. In addition, at this phase, a learning implementation plan and students' worksheets were also made. Then, drafts of the book were made. Drafting the book was done by typing text, inserting graphs, tables, and pictures according to the book's design that had been made previously. Activities carried out during the development phase included validation and readability of the developed book. The book was further validated by content, language, and media experts. All experts read the draft of the book separately and then gave an assessment and input on it. However, the readability test was carried out by distributing the book to students. The respective results on validity and readability were used to improve the book. The practicality and effectiveness test was carried out during the implementation phase. A chemistry teacher in class X from one of the high schools in Bali, Indonesia, conducted the practicality test. The learning process took place for 3 weeks (3 × 135 min) using a discovery learning model with a flipped classroom strategy. Two other chemistry teachers observed the learning process. The teacher and the observers assessed the practicality of this book. Then, through meetings with researchers, they evaluated the practicality of the draft book. In addition, the assessment was also carried out by 30 students who participated in the learning. On the other hand, the effectiveness test used a pre-experiment design with the type of one-shot case study involving 36 students. The effectiveness test was conducted by an experienced chemistry teacher (15 years). The book was used in the chemistry learning process. The learning took place for 6 weeks (6 × 135 min). The learning approaches, models, and strategies applied in this effectiveness test were scientific approaches, discovery learning models, and blended learning strategies of the flipped classroom type, respectively.

Learning began with online learning using Google Classroom. Students were divided into groups of 4–5 members. Students made observations of the phenomena presented in students' worksheets, then formulated problems, constructed hypotheses, and collected data. Learning was continued through face-to-face activities in class. In class, students collected data in groups, verified it, and made generalizations. Finally, students presented the group work results in front of the class. After learning, a post-test included cognitive, psychomotor, and affective learning outcomes measurements.

Data Analysis

The data obtained in this study were qualitative data during the analysis and design phases. These data were analyzed descriptively. In contrast, quantitative data were obtained from the development phase, including the validity, readability, and implementation phase, namely the practicality and effectiveness test. The data obtained in the validity, readability, and practicality tests were analyzed by calculating the means and standard deviations, and then they were converted into qualitative categories. The conversion of means into qualitative categories is presented in Table 2.

The effectiveness test produced learning outcomes scores, which included cognitive, psychomotor, and affective domains. Scores of students' cognitive, psychomotor, and affective learning outcomes were analyzed by hypothesis testing of

Table 2: Table of conversion of the means into the qualitative category

No.	Range of means	Categories
1.	$1.00 \leq \bar{X} 1.80$	Very invalid/very unreadable/very impractical
2.	$1.80 \leq \bar{X} 2.60$	Invalid/unreadable/impractical
3.	$2.60 \leq \bar{X} 3.40$	Neutral
4.	$3.40 \leq \bar{X} 4.20$	Valid/readable/practical
5.	$4.20 \leq \bar{X} 5.00$	Very valid/very readable/very practical

the one-sample proportion at the 5% significance level. This analysis was carried out with the help of the SPSS program version 16.

RESULTS

Research Results at the Analysis Phase

The first phase of research and development of the ADDIE model was the analysis phase. The analysis covered literature and field studies. The literature study assessed the core and basic competencies to produce indicators of competency achievement, topics, and Balinese local cultures relevant to chemistry. The results of this analysis are shown in Tables 3 and 4, respectively.

The next analysis was conducted on the opinions of teachers and students on digital instructional books and learning based on Balinese local cultures. The results of this analysis are shown in Tables 5 and 6, respectively.

Research Results at the Design Phase

The results obtained during the analysis phase were used to design a digital chemistry instructional book based on Balinese local cultures. The design of this book included the use of font type (Times New Roman), font size (11), and font color (black), components of this book consisting of the introduction (cover page, preface, table of contents, table list, and instructions), basic competencies, topics, competency achievement indicators, and concept maps), contents (introduction, content descriptions, chemistry information, problem examples, independent activities, and experiments), and closing (summary, competency test, glossary, and bibliography). In addition, the presentation of this book included descriptions equipped with the context of Balinese local cultures and pictures, and the layout consisted of two columns, namely the main column containing a description of the book, and an additional column containing pictures. The characteristics of the book developed were (1) it was made in a digital form and (2) it was based on Balinese local cultures.

Table 3: The results of the analysis of core competencies, basic competencies, indicators of competency achievement, and topics

Core competencies		**Core competencies**	
3	Understanding, applying, and analyzing factual, conceptual, and procedural knowledge based on students' curiosity about science, technology, art, culture, and humanities with insight into humanity, nationality, state, and civilization related to the causes of phenomena and events, as well as applying procedural knowledge in the field of specific study according to their talents and interests to solve problems	4	Processing, reasoning, and presenting in the concrete and abstract realms related to the development of what students learned in school independently and being able to use methods according to scientific rules
Basic competencies		**Basic competencies**	
3.9	Identifying redox reactions using the concept of the element oxidation number	4.9	Analyzing several reactions based on changes in oxidation numbers obtained from experimental data and/or through experiments
Indicators of competency achievement		**Indicators of competency achievement**	
3.9.1	Explaining the development of the concept of redox reactions	4.9.1	Designing experimental activities for redox reactions
3.9.2	Determining the oxidation number of an atom in a molecule or ion	4.9.2	Experimenting with redox reactions
3.9.3	Determining the oxidizing agent and reducing agent in redox reactions	4.9.3	Analyzing the results of the experimental activities of redox reactions
3.9.4	Determining redox and non-redox reactions and disproportionation and proportionation reactions	4.9.4	Concluding the results of data analysis of the experimental activity of redox reactions
3.9.5	Identifying the application of the concepts of redox reactions in everyday life	4.9.5	Presenting the results of the experimental activities of redox reactions
3.9.6	Determining the name or chemical formula of several compounds according to IUPAC rules based on their oxidation numbers		
Topics			
1. Development of redox reactions			
2. The oxidation number of an element in a compound or ion			
3. The concept of oxidizing and reducing agent			
4. Concept of proportionation and disproportionation reaction			
5. Application of the concept of redox reactions in the context of Balinese cultures			
6. Nomenclature of chemical compounds			

Table 4: The Balinese local cultures relevant to chemistry on the topic of redox reactions

No.	Balinese local cultures	Description
1.	*Ngaben*	*Ngaben* is a traditional Balinese Hindu *Pitra Yadnya* ceremony. In this *Pitra Yadnya* ceremony, the bodies of people who have died are burned to ashes.
2.	*Nyekeb biyu*	*Nyekeb biyu* is the process of ripening bananas. Unripe bananas are ripened using the heat generated from burning the husks. The banana ripening process, a redox reaction, takes place more quickly in this process. These ripe bananas are used for Balinese Hindu traditional ceremonies.
3.	*Arak* and B*erem*	*Arak* and *Berem* drinks are used in a traditional Balinese Hindu *Bhuta Yadnya* ceremony. *Arak* is made from fermented sap produced by palm or coconut trees. On the other hand, *Berem* is made from fermented black or white glutinous rice. The *Bhuta Yadnya* ceremony is a ceremony to neutralize negative forces so as not to interfere with humans in carrying out their activities.
4.	*Padupan*	*Padupan* is a means used for the Balinese traditional *Dewa Yadnya* ceremony. *Padupan* is produced by burning *Majegau* wood (wood that gives off a fragrant smell) in a small clay container.

Table 5: The opinion of chemistry teachers on digital instructional books and learning based on Balinese local cultures

No.	Statements	Responses	Percentage
1.	The experience of chemistry teachers in implementing learning based on Balinese local cultures	Ever	53.34
		Never	46.66
2.	Students' responses to the integration of Balinese local cultures in learning	Very good	42.10
		Good	47.37
		Good enough	10.53
		Not good	0.00
3.	The experience of chemistry teachers using digital instructional books as learning resources	Ever	79.21
		Never	20.79
4.	Students' responses to the use of digital instructional books as learning resources in chemistry learning	Very good	16.34
		Good	46.78
		Good enough	16.67
		Not good	20.21

Table 6: The opinion of students on digital instructional books and learning based on Balinese local cultures

No.	Statements	Responses	Percentage
1.	Student experience using digital chemistry instructional books	Ever	71.61
		Never	28.39
2.	The usefulness of digital instructional books in helping students' learning process	Beneficial	87.18
		Useless	12.82
3.	Students' experience following Balinese local culture-based learning	Ever	15.51
		Never	84.49
4.	Students' experience following digital learning	Ever	56.24
		Never	43.76
5.	The usefulness of digital learning for students	Beneficial	73.69
		Useless	26.31

Research Results at the Development Phase

This book was then validated by content, language, and media experts. The results of the expert validation are shown in Table 7. Meanwhile, the readability test results showed that the mean of 4.15 belonged to the readability category.

Table 7: The results of the validation test of the digital chemistry instructional book based on Balinese local cultures

No.	Validation	Means	Categories
1.	Contents	4.46	Very valid
2.	Language	4.21	Very valid
3.	Media	4.45	Very valid

Research Results at the Implementation Phase

Two tests were conducted in the implementation phase: practicality and effectiveness. The results of the practicality test are shown in Table 8.

The effectiveness of the digital book was tested by applying it to chemistry learning. It was measured based on achieving the classical minimum completeness criteria for class (MCCC) of 85% with the individual minimum completeness criteria (IMCC) of 70 for the learning outcome scores of cognitive, psychomotor, and affective domains. The test used was the hypothesis testing of one sample proportion. Before testing the hypothesis, it was necessary to test the assumptions, namely the normality test of the data distribution. The normality test on the distribution of learning outcome scores in the cognitive, psychomotor, and affective domains resulted in a probability value of more than 0.05 ($p > 0.05$), respectively. This meant that the scores of cognitive, psychomotor, and affective domains were normally distributed. Because the data were normally distributed, the hypothesis testing of the one-sample proportion for learning outcome scores could be carried out. The hypotheses tested were as follows.

H_0: $p \leq 0.85$ = The proportion of students who achieve a minimum score of 70 is ≤85%.

H_a: $p > 0.85$ = The proportion of students who achieve a minimum score of 70 is more than 85%.

Table 9 shows descriptive statistics of students' learning outcomes covering three domains. Meanwhile, the results of the hypothesis testing of one sample proportion for learning outcomes in the cognitive, psychomotor, and affective domains are shown in Table 10.

Table 8: The results of the practicality test of the digital chemistry instructional book based on Balinese local cultures

No.	Practicality	Means	Categories
1.	Teachers	3.85	Practical
2.	Students	4.16	Practical

Table 9: Data on students' learning outcomes taught with the digital chemistry instructional book based on Balinese local cultures

Domains	Number of students	Means	SD
Cognitive	36	90.22	6.54
Psychomotor	36	80.39	2.94
Affective	36	85.72	6.43

Table 10: One sample proportion hypothesis test results

No.	Domains	IMCC	MCCC (%)	Sig.
1.	Cognitive	70	85	0.000
2.	Psychomotor	70	85	0.000
3.	Affective	70	85	0.000

IMCC: Individual minimum completeness criteria, MCCC: Minimum completeness criteria for class

The probability value for cognitive, psychomotor, and affective domains in hypothesis testing was 0.000 ($p < 0.05$). This meant that students' cognitive, psychomotor, and affective learning outcomes exceeded the MCCC. Thus, it could be concluded that the digital book based on Balinese local cultures effectively improves students' learning outcomes in the cognitive, psychomotor, and affective domains.

DISCUSSION AND CONCLUSION

The results showed that the digital chemistry instructional book based on Balinese local cultures has the following characteristics. First, it is made in the digital form. It provides several advantages (Jung et al., 2012; Shin, 2011), namely, it is easy to store and distribute because it is in the form of PDF files, does not require special storage areas, can be saved, can be read on digital devices such as laptops and smartphones, and does not require special software to read files (only PDF reader). It is paperless, so the cutting of trees can be reduced. This will reduce global warming (Ming et al., 2014). Furthermore, it reduces paper waste products (Tahara et al., 2018) to reduce environmental pollution. In addition, the file size is very small, and images or illustrations are displayed in color. Second, it is made based on Balinese local cultures. Integrating Balinese local cultures into the instructional book provides the following advantages. Local cultures can be the context of the chemistry contents taught to students. This makes it easier for students to understand chemistry because the local cultural context closely relates to their daily lives. Students love their own cultures more than foreign cultures. The Balinese local cultures can be preserved from generation to generation so they do not experience extinction. They can be globalized. Meanwhile, the Balinese cultures are already very well known worldwide, but it still needs to be globalized (promoted throughout the world). The publication of the results of this study in reputable international journals is also an effort to globalize Balinese local cultures.

The results showed that the digital chemistry instructional book based on Balinese local cultures is categorized as valid and practical. It is reasonable that it was made through a very good and careful study. It is based on the needs of teachers and students. Need analysis is an assessment to collect data used to make product designs. The products based on need analysis are going to produce products that are appropriate and acceptable to users.

The results also showed that the instructional book effectively improves students' learning outcomes. All students have exceeded the IMCC of 70. The instructional book in digital form (PDF) affects students' comfort in learning because it can be stored on a laptop or smartphone. Students can study anytime and anywhere. Students spend more time studying it because of the flexibility of place and time. Studying time affects the mastery of the subject matter.

Several researchers have reported the effectiveness of the digital chemistry instructional book in improving learning outcomes. E-books can improve students' achievement and motivation (Al-Mashaqbeh and Al-Shurman, 2015; Awaludin et al., 2019; Turel and Sanal, 2018) and democratic values (Nafi'ah et al., 2019). In addition, the e-book can also reduce students' anxiety levels. On the other hand, interactive e-books can improve students' academic achievement (Asrowi et al., 2019; Ebied and Rahman, 2015; Huang et al., 2018; Hwang et al., 2017; Lim et al., 2020; Pujiastuti and Haryadi, 2019). Multiple representation-based e-books can improve students' mastery of subject matters (Rasmawan, 2020). Meanwhile, a smartphone-based e-book can improve students' learning outcomes (Hasbiyati et al., 2019; Mingsiritham and Chanyawudhiwan, 2018; Muqarrobin and Kuswanto, 2016), and web 2.0-based e-books can improve students' learning skills (Ibrahim and Alqahtani, 2018).

Integrating the Balinese local cultures will give context to students' chemistry contents. This context relates to the contents of the redox reactions, including, among others, the *Ngaben ceremony* (a cremation ceremony in Bali, Indonesia), making *Tape* (fermented glutinous rice), and the ripening of bananas before *Galungan Day* (a traditional ceremony in Bali, Indonesia), and making *Arak* and *Berem* (a fermented drink) for the *Bhuta Yadnya ceremony* (offering ceremony to neutralize negative forces in Bali, Indonesia). This context is very close to the daily life of students. As a result, students can understand the relationship between the chemistry contents studied and their context in everyday life. This Balinese local cultural context assists students in understanding chemistry contents (redox reactions). Thus, students can master chemistry

content well. Results have proven that the integration of local cultures into the curriculum (instructional books) can improve students' learning outcomes (Fitriyani et al., 2016; Hartini et al., 2017) and critical thinking skills (Güney and Seker, 2012; Suryanti et al., 2020). In addition, local cultures can concretize abstract science concepts so they can be learned quickly (Delima et al., 2018).

The integration of local cultures or wisdom in various forms to improve students' learning outcomes has been reported by several researchers. Suastra (2017) explored and reconstructed the Balinese local cultures and developed a learning model based on them for science learning. The physics learning model based on Balinese local wisdom can improve the character of high school students (Suastra et al., 2017). Furthermore, instructional books based on local wisdom significantly affect students' higher-order thinking skills (Hadi et al., 2019) and learning outcomes (Sofyan et al., 2020). In addition, these instructional books can also increase learning motivation, cooperation, discipline, love of reading, learning achievement, and problem-solving. A social study learning model based on local wisdom effectively increased students' knowledge and social attitudes (Uge et al., 2019). Furthermore, worksheets based on STEM and local wisdom can improve students' critical thinking skills (Prasadi et al., 2020). On the other hand, Riana and Putriani (2021) developed a local wisdom-based CAI media to help students understand the subject matter. Meanwhile, an electronic book based on local wisdom has been designed by Sukma et al. (2019). Then, Samri et al. (2020) reported that e-books based on local cultures affect students' understanding of concepts. Likewise, Wardani and Mundilarto (2021) developed an android-based e-book using the Nekeran local traditional games. All of these are done to give satisfaction to students (Redhana et al., 2019).

Besides learning to use the contexts of Balinese local cultures, students become more acquainted with and militant with their own cultures. They can ward off the onslaught of external cultures that are massively spreading through social media. Loving one's culture is honoring the ancestors who inherited noble cultures.

Improving learning outcomes is very important because they (in the form of indicators of competency achievement) are derivatives of basic competencies. In addition, developing higher-order thinking skills is also important to achieve. Several researchers have studied the development of higher-order thinking skills. Critical thinking skills have been improved through the development of the 7E learning cycle model based on local cultures (Suardana et al., 2018), the multi-representation-based teaching book (Widiastari and Redhana, 2021a), and the case study-based teaching book (Widiandari and Redhana, 2021b). On the other hand, creative thinking skills have been enhanced through the multiple intelligence-based learning models (Abdi and Rostami, 2012), the synectics and brainstorming (Aiamy and Haghani, 2012), and the creative problem-solving programs (Çetinkaya, 2014).

However, this study still had limitations. First, this was only conducted on redox reactions. Second, the book's effectiveness test was only conducted in a high school.

The development of information technology and the Internet in the era of the Industrial Revolution of 4.0, which is very rapid, requires learning that utilizes technology and the Internet. This requires digital or digital learning resources. The digital chemistry instructional book based on Balinese local cultures answers these problems. The developed digital book has the following characteristics. First, it is made in digital form. This will be advantageous because it is easy to carry, use, store, and reproduce (copy). Besides, it is cheap. Second, it is made based on Balinese local cultures. Balinese local cultures can be a context for chemistry content so students can understand it more easily. In addition, they know their own culture better than foreign cultures. Furthermore, Balinese cultures can be preserved from generation to generation. The development of this book produces a book that is valid, practical, and effective in improving students' learning outcomes.

This study has the following implications. The developed book supports the implementation of 21st-century learning, where this learning uses technology and the Internet as the main facilities. For the successful implementation of this book, a strong Internet connection and the competencies of teachers and students in using technology need to be prepared.

The suggestions for implementing this book using blended learning are as follows. Schools need to provide a strong enough Internet connection so that learning can occur well. In addition, the competencies of teachers and students in utilizing technology in learning need to be improved. Next, this research needs to be carried out on more topics and involves a larger number of samples and a wider range of regions so that the results of this study can be more accountable.

ACKNOWLEDGMENT

This study was funded by the Directorate of Research, Technology and Community Service, Directorate General of Higher Education, Research and Technology, Ministry of Education, Culture, Research and Technology [grant number 050/E5/PG.02.00.PL/2023].

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