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Culture-based Learning: A Way to Improve Students' Cognitive Learning Outcome in Denpasar City

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ABSTRACT

Background: One of the learning objectives is to develop a cognitive process dimension seen in cognitive learning outcomes. This has not been implemented optimally in the learning process. The Balinese culture-based biology learning model is seen as an alternative to developing the cognitive process dimension. This study aims to reveal the Balinese culture-based biology learning model's effect through the cognitive learning outcomes of high school students in Denpasar City. Methods: This study was conducted using a non-equivalent pretest-posttest control group design with a sample of 144 students. The data collection instrument was in the form of multiple-choice questions categorized into questions of lower-order thinking skills (LOTS) and questions of higher-order thinking skills (HOTS). Results: The results of data analysis showed that: 1) there was a significant difference in cognitive learning outcomes between the experimental class and the control class ($p<0.05$); 2) the Balinese culture-based biology learning model increased students' cognitive learning outcomes by 18.21%; 3) the Balinese culture-based biology learning model improves lower-order thinking skills (LOTS) by 8.44% and higher-order thinking skills (HOTS) by 17.92%. Conclusions: This study concludes that the Balinese culture-based biology learning model improves cognitive learning outcomes and can develop higher-order thinking skills of high school students in Denpasar City. Further research is needed to reveal this learning model's effect specifically on other higher-order thinking skills such as critical thinking skills, creative thinking skills, and problem-solving skills.

Pembelajaran Berbasis Budaya: Satu Cara untuk Meningkatkan Hasil Belajar Kognitif Siswa di Kota Denpasar

Kata kunci:
Budaya Bali
Hasil belajar kognitif
Model pembelajaran biologi

ABSTRAK

Background: Salah satu tujuan pembelajaran adalah untuk mengembangkan dimensi proses kognitif yang dilihat dari hasil belajar kognitif. Faktanya, hal tersebut masih belum terlaksana secara optimal dalam pembelajaran di sekolah. Model pembelajaran biologi berbasis budaya Bali dipandang dapat menjadi alternatif untuk mengembangkan dimensi proses kognitif. Penelitian ini bertujuan untuk mengungkap pengaruh model pembelajaran biologi berbasis budaya Bali terhadap hasil belajar kognitif siswa SMA di Kota Denpasar. **Metode:** Penelitian ini dilaksanakan dengan *non-equivalent pretest-posttest control group design* dengan sampel 144 siswa. Instrumen pengumpulan data berupa soal pilihan ganda yang dikategorikan menjadi soal keterampilan berpikir tingkat rendah (*LOTS*) dan soal keterampilan berpikir tingkat tinggi (*HOTS*). **Hasil:** Hasil analisis data menunjukkan bahwa: 1) terdapat perbedaan hasil belajar kognitif yang signifikan antara kelas eksperimen dan kelas kontrol ($p<0{,}05$); 2) model pembelajaran biologi berbasis budaya Bali meningkatkan hasil belajar kognitif siswa sebesar 18,21%; 3) model pembelajaran biologi berbasis budaya Bali meningkatkan keterampilan berpikir tingkat rendah (*LOTS*) sebesar 8,44% dan keterampilan berpikir tingkat tinggi (*HOTS*) sebesar 17,92%. **Simpulan:** Penelitian ini menyimpulkan bahwa model pembelajaran biologi berbasis budaya Bali meningkatkan hasil belajar kognitif dan berpotensi untuk mengembangkan keterampilan berpikir tingkat tinggi siswa SMA di Kota Denpasar. Lebih lanjut, diperlukan penelitian lanjutan untuk mengungkap pengaruh model pembelajaran ini secara spesifik terhadap keterampilan berpikir tingkat tinggi lainnya seperti keterampilan berpikir kritis, kreatif, dan keterampilan memecahkan masalah.

Introduction

Learning outcomes are a description of something that is known, understood, and applied by students after going through the learning process (Wagenaar, 2008), categorized into cognitive, affective, and psychomotor domains (Kettunen et al., 2013). As is generally known, the cognitive domain includes aspects of knowledge and dimensions of cognitive processes (Anderson & Krathwohl, 2001), the affective domain refers to feelings and emotions (Krathwohl et al., 1980), and the psychomotor domain refers to motor abilities and skills (Simpson, 1966). Each of these learning outcomes domains has minimum criteria that students must achieve as presented in the basic competencies and set out operationally in the minimum completeness criteria.

In particular, about the cognitive domain, Anderson & Krathwohl (2001) differentiates these domains into aspects of knowledge and cognitive processes dimensions. The knowledge aspect is further divided into factual, conceptual, procedural, and metacognitive knowledge. The cognitive process dimension is divided into remembering, understanding, applying, analyzing, evaluating, and creating. Concerning environmental science which is one of the studies of biology, Ichsan & Rahmayanti (2020) provides a view that the dimensions of analyzing, evaluating, and creating are associated with the ability to criticize, solve environmental problems, and develop innovations about the environment. Meanwhile, Harvey et al. (2019) in emotion-cognition taxonomy explains that the level of cognition includes the ability to describe, understand, construct, and perform critical analysis. Aspects of knowledge and cognitive processes dimensions are the basis for teachers to carry out the learning process and measure students' learning outcomes in the cognitive domain.

The implementation of learning in schools must be consciously and planned to develop knowledge, and students' cognitive processes dimensions. This is so that knowledge belongs to students so that it can last long term (Corebima, 2016). Mastery of knowledge and enhancement of cognitive process dimensions also aims to develop the function of imagination, thinking, and creativity (Dettmer, 2005) which students need to live in the 21st century. One way to measure that the implementation of learning has been done consciously and planned to develop knowledge and cognitive processes dimensions of students are to ensure that student learning outcomes in the cognitive domain exceed the minimum completeness criteria that have been set in the school.

Facts in school indicate that the situation is not yet ideal about developing knowledge and students' cognitive processes dimensions. The preliminary research conducted by analyzing the final assessment score of biology from 253 class X students in one of the public high schools in Denpasar City showed that all students had not reached the minimum score (62).

The cause of the low students' learning outcomes in the subject matter is because students are positioned as listeners without practising the subject matter independently, and teachers still use conventional learning models (Ratih et al., 2013). This study's findings support the interview results with one of the biology teachers at two public high schools in Denpasar City. The first interviewees said that most biology teachers in Denpasar City still rarely use innovative learning models. Also, teachers still tend to only rely on the material in textbooks without exploring the environment in the implementation of learning. The second interviewee also conveyed the same thing. She said that teachers' motivation and commitment to carry out innovative and quality learning must be continuously improved. This explanation indicates that the implementation of biology learning in schools has not been done consciously to prepare students for life in the 21st century and the future, as stated by Corebima (2016).

So far, various learning models have been reported in various educational units to improve students' cognitive learning outcomes. Safitri (2016) reports that Reading Questioning Answering (RQA) learning model can improve students' cognitive learning outcomes. RQA is a learning model that requires students to read, ask questions, and answer those questions independently before the teacher discusses the subject matter in class. This shows that the RQA learning model has its advantages in preparing students to have adequate initial knowledge of the material so that learning objectives are more comfortable to achieve.

In other parts, Suartika et al. (2013) and Puspani (2013) report that cooperative learning can improve learning outcomes and have a positive impact on students' knowledge and experience (Veldman et al., 2020). This is possible because the interaction between students in the learning process can support each other or positively impact each other so that the learning process takes place more meaningfully.

In addition to the QRA and cooperative learning models, contextual and inquiry learning models have also been reported to improve students' learning outcomes. Suastra et al. (2011); Ardan (2016); and Uge et al. (2019) stated that learning with a contextual approach can increase students' knowledge. Meanwhile, Alwi et al. (2017); Hafa et al. (2017); Margunayasa et al. (2019) and Borovay et al. (2019) reported that inquiry-based learning could improve students' learning outcomes.

Some research results that have been reported indicate that the QRA, cooperative, contextual, and inquiry learning can improve students' cognitive learning outcomes partially. However, it is not yet known the effect of them simultaneously if they are combined into one learning model. The integration of them is essential because learning must be carried out using a holistic method to provide meaningful experiences related to students' real-life (Veine et al., 2020).

The Balinese culture-based biology learning model is a learning model that integrates the four types of learning that have been described. This integration is considered an advantage because it combines the positive effects of pre-existing learning into a holistic one. This learning model adopts the QRA learning model's syntax and the principles of inquiry and cooperative learning. This learning model also provides a contextual approach to the *Tri Hita Karana* culture that is owned by the Balinese people. *Tri Hita Karana* means the three causes of a prosperous and harmonious life which consists of three components, namely spiritual (*parhyangan*), social (*pawongan*), and natural (*palemahan*) (Sukarma, 2016). As far as we know, the Balinese culture-based biology learning model is still rarely reported. Furthermore, this model has no known impact on students' cognitive learning outcomes.

The integration of biology learning with the *Tri Hita Karana* culture is something relevant because biology has a field of environmental biology (Jones, 2006) which is in line with the concept of *palemahan* in the *Tri Hita Karana*. Also, Suastra (2005) also explains that in people's lives, learning science requires an exploration of local culture. This study aims to determine the effect of the Balinese culture-based biology learning model on the cognitive learning outcomes of high school students in Denpasar City on the subject matter of Plantae.

Methods

This study was a quasi-experimental study using a non-equivalent pretest-posttest control group design. The research was conducted in the second semester of the 2018/2019 academic year in two public high schools in Denpasar, coded as Groups A and B. This study involved 144 students. Details of the distribution of the research sample are presented in Table 1.

Table 1. Distribution of Sample

Group	Classes	Number of Samples
A	Experimental	36
	Control	36
B	Experimental	36
	Control	36

Before determining the research sample, an equivalence test was carried out on seven classes in Group A and six classes in Group B using the previous semester's test scores. The equivalence test was carried out using the one-way ANOVA test. The one-way ANOVA test shows $p<0.05$, which indicates that there are significant differences between the classes being compared. Therefore, the equivalence test is continued by using the Least Significant Difference (LSD) test aims to partially find the class that has $p>0.05$, which is said to be statistically equivalent. Based on the LSD test, it was found that six classes were equivalent in the two schools, which were then taken two classes in each school randomly.

The two classes are divided into control class and experimental class. The control class is a class that is taught using a learning model as is usually applied by teachers in schools (conventional) while the experimental class is taught using the Balinese culture-based biology learning model.

The Balinese culture-based biology learning model is called the E-RAISE learning model. E-RAISE learning model has a syntax: ***E**xploring problems and cultural value*; ***R**eading & questioning*; ***A**nswering (RQA)*; ***I**nformation processing integrated with cultural value to solve the problems*; ***S**haring*; ***E**valuation*. Students' learning activities in this learning model are presented in Table 2.

Table 2. Students' Learning Activities

Syntax	Students' Activities
RQA (pre-learning Activities)	Read the material to be studied; Compose and answer questions independently based on the reading process that has been done
Exploration of problems and cultural value	• Explore the phenomenon given by the teacher • Formulate problems following the given phenomenon • Formulate investigation procedures • Conduct investigation to answer the problems and relate them with Balinese cultural value
Information processing integrated with cultural value to solve the problems	• Discuss investigation findings • Construct the relationship between investigation findings and Balinese cultural value • Formulate the conclusion of the investigation
Sharing	Present the result of the investigation
Evaluation	Make a reflection of learning activities and self-reflection during learning activities

This learning model has limitations in its application, namely that it cannot be applied to all biology subject matter. Consideration of the scope of material and Balinese cultural values is the basis for its biology learning application. Based on material characteristics and Balinese cultural values, this learning model can be integrated with biology subject matter including 1) Biodiversity, 2) Plantae, 3) Ecosystems and 4) Environmental Preservation.

The instrument used was a multiple-choice cognitive learning outcome test. The test questions consist of 21 items with eight items for lower-order thinking skills (LOTS) (C1-C3) and 13 items for higher-order thinking skills (HOTS) (C4-C6). The items' validity value was compared with the r table (N = 60) of 0.254. Details of the validity of the items are presented in Table 3.

Table 3. Result of Instrument Validation

Indicators	Items	r
Describe the general characteristics of plants that differentiate them from other kingdoms.	1	0.206
Identify the specific characteristics of Bryophytes, Pteridophytes, and Spermatophytes.	2	0.649
Analyze the similarities and differences in the life cycle phases of Bryophytes and Pteridophytes.	3; 4	0.531; 0.640
Describe the similarities and differences characteristic of Gymnosperm and Angiosperm.	5; 6	0.556; 0.475
Classify Bryophytes based on morphological characteristics	7	0.710
Classify Pteridophytes based on morphological characteristics and life cycle phase.	8	0.558
Classify Spermatophytes based on morphological characteristics.	9; 10	0.516; 0.273
Analyze the role of plant in ecosystems	11; 12; 13; 14	0.369; 0.436; 0.494; 0.459
Analyze the role of plants in the industrial, health, and socio-cultural fields for humans	15; 16; 17	0.530; 0.414; 0.677
Analyze the impact of reduced plant diversity on ecosystems and human life	18; 19; 20; 21	0.713; 0.697; 0.768; 0.729

In the validity test, there was one item that had a value of r=0.206 (<r table), but for reasons of the scattering of the question indicators, these items were still used with previous revisions by experts. Meanwhile, the reliability value of the test was 0.830.

The normality test results show the value of p=0.090 and the results of the homogeneity test show the value of p=0.271. The results of the other prerequisite tests are presented in Table 4.

Table 4. Result of ANCOVA Prerequisite Test

Test	Classes		Note
	Control	Experimental	
Linearity	p=0.728	p=0.915	Linear
Auto-correlation	p=0.235	p=0.107	No auto-correlation
Heteros-cedasticity	p=0.056	p=0.112	No heteros-cedasticity

The results of the prerequisite test that has been carried out indicate that the data has met the requirements for hypothesis testing using the ANCOVA test with the pre-test value as covariance. ANCOVA is based on the need to control for other variables that can affect students' cognitive learning outcomes. This is due to the assumption that other variables affect students' abilities even though the equivalence test has been carried out.

In this case, the use of pre-test as covariance because the pre-test scores are seen as an accumulation of the effect of variables other than independent variables on students' cognitive learning outcomes. Therefore, it is necessary to control the impact of the other variables reflected on the pre-test statistically to strengthen the conclusion of the study. Further analysis on LOTS and HOTS was performed using an independent t-test. This data analysis was conducted to determine the difference between LOTS and HOTS in the two learning models being compared. The data analysis process has been performed using SPSS 16.0 for Windows.

Results

Data on students' cognitive learning outcomes were collected from the pre-test and post-test results. The students' pre-test and post-test results in the experimental and control classes are presented in Table 5. These findings show an increase in student cognitive learning outcomes by 40.44% in the experimental class and 20.64% in the control class, as seen by comparing the pre-test and post-test scores.

Descriptively, based on the corrected post-test mean score, it is known that the difference in students' cognitive learning outcomes with Balinese culture-based biology learning models and conventional learning models is 11.74 points. In other words, the Balinese culture-based learning model led to an increase in cognitive learning outcomes by 18.21% from conventional learning models (Table 5).

Table 5. Result of Descriptive Test

Class	N	Pre-test	Posttest	Corrected Posttest Mean
Experimental	72	54.39	76.39	76.20
Control	72	53.28	64.28	64.46

The results of the ANCOVA test, as presented in Table 6 show that the pre-test value as a covariance has a significant effect on the post-test score with F=11.586 and p=0.001. This shows that the assumption of ANCOVA has been fulfilled and other variables that are assumed to accumulate at the pre-test value must be controlled.

Table 6 also shows a significant difference in post-test cognitive learning outcomes between the experimental and control classes with F=42.631 and p=0.000. This shows that after controlling for the pre-test, there are differences in cognitive learning outcomes in students who are taught with the Balinese culture-based biology learning model and students who are taught using conventional learning models.

The relationship between covariance and independent variables in influencing student learning outcomes also showed significant results with F=28.539 and p=0.000 (Table 6). These results indicate that the pre-test and the independent variables simultaneously affect students' cognitive learning outcomes.

Table 6. Result of ANCOVA Test

Data Source	N	F	p	Note
Pretest (covariance)	144	11.586	0.001	Significant
Posttest Experimental-Control Class	144	42.631	0.000	Significant
Corrected Model	144	28.539	0.000	Significant

The results of the LOTS and HOTS analysis, as presented in Table 7 show a p<0.05 for the two thinking skills. These findings reveal that there is a significant difference between LOTS and HOTS in the experimental class and the control class. The results of this analysis show that the Balinese culture-based biology learning model increases LOTS by 8.44% and HOTS by 17.92% compared to conventional learning models.

Table 7. Result of LOTS and HOT Analysis

Data Source	Class	Mean	p
LOTS	Experimental	83.89	0.004
	Control	77.36	
HOTS	Eksperimen	78.54	0.000
	Control	66.60	

Discussions

The results of the data analysis obtained in this study indicate a significant effect of the pre-test, which is positioned as a covariance on students' cognitive learning outcomes. This shows that other variables such as learning motivation, intelligence quotient (IQ), prior knowledge, and student experience before the research is carried out which are assumed to accumulate quantitatively in the pre-test affect students' cognitive learning outcomes.

Furthermore, covariance and independent variables also provide a significant simultaneous effect on students' cognitive learning outcomes. These two exposures further reinforce the notion that other variables are accumulating at the pre-test that affects this study's results.

Based on these circumstances, to obtain valid research results, statistical covariance control is carried out to find the independent variables' pure effect on the dependent variable. The results obtained after controlling covariance using covariance analysis, namely the Balinese culture-based biology learning model, improve high school students' cognitive learning outcomes in Denpasar City. Students who were taught with the Balinese culture-based learning model obtained higher cognitive learning outcomes than students who were taught with the learning model applied in the control class.

Furthermore, LOTS and HOTS's dimensions in students who were taught with the Balinese culture-based biology learning model also showed higher scores than students who were taught using the learning model in the control class. The urgency of increasing HOTS is a critical aspect in addition to cognitive learning outcomes in this study. HOTS is believed to be a necessity in life in the 21st century. However, various research reports stated that students' HOTS still needed to be improved (Ichsan et al., 2019).

Simultaneously, the increase in cognitive learning outcomes with the increase in LOTS and HOST shows that this learning model provides a meaningful learning experience for students. Students' learning experiences through the Balinese culture-based biology learning model cannot be separated from the approach, the learning principles adopted, and the syntax of the learning model.

The contextual approach provides a meaningful learning experience to students because it facilitates students to relate the context learned in the classroom with real-life to apply the concept (Johnson, 2002). This process is indicated to raise students' awareness that what they are learning is not outside their lives so that the material being studied is easier to understand. This finding is consistent with the findings of Suastra et al. (2011); Ardan (2016); Gunawan et al. (2017) and Uge et al. (2019) who reported that learning with a contextual-based approach improved student learning outcomes.

In line with the contextual approach, the principle of inquiry learning also provides students with meaningful learning experiences. The inquiry principle is emphasized in syntax *exploration of problems and cultural value* dan *information processing integrated with cultural value to solve the problems*.

In this activity, students carry out active investigations in the field about the material being studied. Investigations are carried out by field observations and interviews. The investigation includes collecting data about Balinese cultural materials and values related to the subject matter. An example is the classification of plants with flowers in Balinese ceremonial offerings (*canang*). The investigation process facilitates students to carry out active learning that involves themselves directly.

This activity was then continued with information processing activities integrated with cultural values to solve the problems that deepen students' understanding. In this activity, students discuss investigative findings and make a relationship between biology and Balinese cultural values. One example of a constructed relationship is the diversity of plant species needed for Balinese people's lives both in traditional and religious activities so that this diversity must be preserved.

Several previous studies reported findings that are in line with the findings of this study. Lalley & Miller (2007) concluded from various sources that students would remember an average of 75% of the material when they do the material being studied directly. Furthermore, Lee & Fortune (2013) also explained that learning in the field has a role as an active learning process to provide physical and cognitive experiences. The findings of this study are in line with the research of Budur (2013); Fitriyani et al. (2015); Hartati et al. (2015); Alwi et al. (2017); and Hafa et al. (2017) which states that inquiry-based learning can improve students' cognitive learning outcomes. Furthermore, in HOTS, Saputri et al., (2019) explained that the learning model, which provides opportunities for students to explore, discuss, and explain phenomena increases students' higher-order thinking skills.

The principle of cooperative learning adopted in the Balinese culture-based learning model emphasizes student interaction and cooperation to achieve common goals Panitz, (1997) as stated in the full syntax. In its activities, the process of preparing and implementing investigations is carried out in groups. Students are allowed to interact with each other in preparing an investigation plan, determining sources, and discussing the results of the investigation. Besides, in the *sharing* syntax, students present their investigation findings to other students from different groups. Other students are also allowed to provide feedback, questions, and input to the presenter.

This process aims to improve one's competence (Laal, 2013), foster social intelligence (Joyce et al., 1999) develop interpersonal skills, and make learning more productive (Johnson & Johnson, 2002). Increasing self-competence and learning productivity occur because this activity provides space for students to exchange ideas. Students who do not understand can ask other students who better understand the material. This is a positive activity because, in the context of education in Bali, students tend to be reluctant to ask the teacher.

Interaction in exchanging ideas between students can provide students with a more comprehensive understanding of the subject matter. This was also explained by Podschuweit et al. (2016) stated that the complexity of communication in the classroom is related to student learning outcomes. This finding is consistent with the report of Suartika et al. (2013); Puspani (2013); and Yulianingsih et al. (2017) which states that cooperative learning improves students' cognitive learning outcomes.

The RQA stage in the Balinese culture-based learning model is an activity that is carried out before the learning activities in class take place. One week before the learning activity, the teacher assigns students to read the material to be discussed. After reading, students are asked to make questions about the material they have not yet understood. Furthermore, students answer these questions independently by exploring other learning sources.

This activity aims to ensure students have sufficient initial knowledge of the subject matter to be discussed. Initial knowledge is an essential factor affecting student achievement, balanced with specific methods (Nkwo et al., 2008; Yang & Hsu, 2013; Yeh et al., 2012). In this case, students in the experimental class are indicated to have adequate initial knowledge of the material to be discussed so that learning in class takes place more effectively to achieve learning objectives. This finding is consistent with Safitri (2016) and Thalib et al. (2017) who reported that the RQA learning model could improve students' cognitive learning outcomes.

The *evaluation* stage is an activity to evaluate the results and the investigation process carried out by students. In this activity, students are allowed to reflect on their learning activities. This reflection activity facilitates students to find out their strengths and weaknesses during the learning process. Based on these strengths and weaknesses, students then compile a follow-up plan of learning activities to fix their shortcomings. This process is related to the empowerment of metacognition awareness in terms of self-evaluation, which is also a component of higher-order thinking skills (Shavelson et al., 2019; Nussbaum et al., 2020).

Cavilla (2017) explains that qualitatively the empowerment of metacognition in students occurs in the cognitive and affective domains. This is supported by Siswati & Corebima (2017), which states a significant relationship between metacognitive skills and students' understanding of concepts. The findings of this study are consistent with the findings of Lew & Schmidt (2011), which states that self-reflection supports the improvement of students' academic abilities even though they have limited access.

Exposure to students' learning experiences using a Balinese culture-based biology learning model and its empirical support shows that this learning model effectively improves students' cognitive learning outcomes. The results also show that this learning model simultaneously increases LOTS and HOTS.

This finding implies that teachers can use this learning model as an alternative to improve cognitive biology learning outcomes and empower students' thinking skills. Increasing cognitive learning outcomes and empowering thinking skills, especially higher-order thinking skills, is relevant to life in the 21st century to develop quality and prepare students to compete competitively in the modern era.

Conclusions

Based on the study results, it can be concluded that there are significant differences in biology cognitive learning outcomes between students who are taught with the Balinese culture-based biology learning model and students who are taught using conventional learning models. The Balinese culture-based learning model increased students' cognitive learning outcomes by 18.21% compared to conventional learning models. In the cognitive dimension, there were also significant differences in the LOTS and HOTS aspects. The Balinese culture-based learning model increased LOTS by 8.44% and HOTS by 17.92% compared to conventional learning models. Furthermore, this study also opens opportunities for further research on the effect of this learning model on other HOTS variables such as critical thinking skills, creative thinking, and problem-solving skills that are relevant to 21st-century thinking skills.

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