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RANDAI Learning Model to Enhance Pre-Service Biology Teachers' Critical Thinking Skills

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The current study aimed to investigate the effectiveness of RANDAI learning model that was produced from the integration of Minangkabau culture and Problem Based Learning (PBL), in enhancing pre-service biology teachers' critical thinking skills. This experimental study used a nonequivalent pretest-posttest control group design and involved 107 pre-service biology teachers from Universitas Negeri Padang (State University of Padang), Indonesia. The data were gathered using the critical thinking essay tests. A critical thinking rubric was used to assess the participants' answers, and the results were analyzed using ANCOVA at a significance level of 0.05. The statistical results showed that RANDAI learning model affected pre-service biology teachers' critical thinking skills. The LSD test result confirmed that there was a significant difference in terms of critical thinking performance between the participants in RANDAI, Problem Based Learning, and conventional classes. Therefore, RANDAI learning model can be used to enhance the pre-service biology teachers' critical thinking skills.

Keywords: design of learning, development of learning, cultural integrated learning, RANDAI, student's critical thinking

INTRODUCTION

Pre-service biology teachers are the key resources and important agents in science education transformation (Kadir, 2017). Pre-service biology teachers are involved in the

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process of nurturing and promoting student interest in biology. Therefore, they are expected to own the knowledge and skills to think critically in facing and understanding the challenges of society changes (Valli & Buese, 2007). To become a reliable facilitator, training in critical thinking skills needs to be carried out for pre-service biology teachers (Nessipbayeva, 2012), to teach analytical skills, to create changes, to produce learning creativity and innovations (Valli, Perkkilä, & Valli, 2014) and to master technology and information (Cretu, 2017) to enter the professional world (Suwono et al., 2017). Pre-service teachers must be competent in critical thinking since education basically aims to support the development of students' critical and creative organizing and problem-solving abilities (Serin, 2013).

Critical thinking involves cognitive processes or strategies to solve problems and draw conclusions (Halpern, 1999; Facione, 2011) to be a priority part of universities (Badger, 2019; Al-Mahrooqi & Denman, 2020) and is necessary for academic success (Alkharusi, Sulaimani & Neisler, 2019). Zubaidah, et al., (2018) explain critical thinking helps pre-service biology teachers become skilled independently in solving problems. Having good critical thinking skills makes pre-service teachers able to investigate assumptions, understand concepts to develop knowledge effectively

Some established facts in the field show that the learning process in higher education in Indonesia has not entirely focused on promoting critical thinking in pre-service teachers (Evens, Verburgh, & Elen, 2014). Pre-service teachers have not been optimally empowered to think critically (Farcis, 2016) even though it has been recognized that through critical thinking, pre-service teachers are encouraged to discover new ideas and thoughts in solving learning problems as well as to practice analyzing and selecting various opinions. The lack of satisfactory critical thinking skills possessed by pre-service biology teachers has been revealed in previous research (Amin et al., 2017), Thus, it is necessary to optimize efforts in empowering their critical thinking skills (Syam & Efwinda, 2018). Research findings by Fitriani et al., (2019) proved that the pre-service biology teachers from IKIP Mataram had poor critical thinking. A survey Arsih et al., (2020) also provide information that it is necessary to develop critical thinking for pre-service Biology teachers at Padang State University (Arsih, Zubaidah, Suwono, & Gofur, 2020). Therefore, the improvement of critical thinking skills is paramount in the national education system, especially in biology classrooms (Fuad et al., 2017; Afandi et al., 2019).

Problem Based Learning (PBL) is a learning approach that has the potential to empower critical thinking skills (Zubaidah, 2017). PBL is a student's guide to more meaningful science learning that is relevant to life. PBL has an effect on student critical thinking. Problem-Based Learning (PBL) assumes that problems can be used as a starting point to obtain or integrate new knowledge (Barrett, 2013); therefore, PBL helps students develop their analytical skills on scientific concepts as scientific knowledge and build creativity. (Moutinho, et al. 2015). This learning strategy challenges pre-service teachers to be able to find solutions to a problem (Birgili, 2015). Furthermore, Temel (2014) explains that critical thinking correlates with intelligence, problem solving skills. Anazifa (2016) discovered that PBL had an effect on cognitive achievement and critical thinking.

However, some of the limitations of PBL in empowering students' critical thinking in science have also been identified (Moutinho et al., 2015; Hidayati et al., 2019). Research has uncovered the weaknesses of Problem-Based Learning (Batdi, 2014; Demirel & Dagyar, 2016), such as Fitriani et al., (2019), who explained that individual or group PBL activities could not always improve student achievement in biology at all levels of education. Besides, PBL syntax was found to be ineffective in motivating students who lacked preparedness in dealing with psychological pressures. The students' lack of readiness also led to low confidence in organizing and solving problems (Nijhuis, Segers & Gijselaers, 2005). Therefore, the PBL syntax needs to be modified and adjusted to the learning conditions and situations in Indonesia so that students' motivation and critical thinking can improve accordingly. Proper modifications can include incorporating local culture into education. Cultivating cultural values during the educational process serves as a medium in motivating students to apply the knowledge they have acquired. (Ibe, 2017). The culture-integrated learning can also encourage students' imaginative, metaphorical and creative processes as well as promote students' cultural awareness, performance, and interest in biology (Davison & Miller, 1998; James 2006: Caballero, 2015)). The integration of local culture into the school curriculum also contributes to the effort of preserving the local Indonesian values that have begun to fade and be abandoned by the students who have a poor understanding of the local culture values (Uge, Neolaka, & Yasin, 2019).

Cultural values can be incorporated into learning materials or learning models (Anwar, Suardika, T, Suleiman, & Syukur, 2018), such as Problem-Based Learning. Empirical research explicitly explains the direct effect of the culture-and-art-integrated curriculum on science learning (Hardiman, JohnBull, Carran, & Shelton, 2019; Suardana et al., 2018; Fadli & Irwanto, 2020). Findings from Dhanapal, Kanapathy, & Mastan (2014) indicate that art takes part in individual development. Researchers suggest that the integration of art into science learning at all levels of education can empower students to think critically and develop 21st century skills. Turkka, Haatainen, & Aksela (2017) conducted a survey on science learning practices and discovered that arts-integrated science education could involve students in creative projects and encourage them to express science in many ways. In short, art-integrated pedagogy can improve students' performance in science.

Randai Minangkabau is one of Indonesia's local art performances that can potentially be integrated into Problem-Based Learning method. *Randai* traditional arts in the form of *pamenan adaik* (art game) formulated on the elements of *kaba* (story) and played by several people in a circle. The stories in *Kaba* used to be popular in the past. Educational messages from *Kaba* are conveyed in the form of figurative sentences or cryptic words (Arsih, Zubaidah, Suwono, & Gofur, 2019). Pedagogically, *Randai* can serve as a learning medium for *Minangkabau* people. Some educational values of *Randai* that can be incorporated into a learning model include *barundiang* (willing to discuss), *bulek kato dek mufakaik*, *bakarajosamo* (cooperative), *barani bapandapek* (assertive), *kaba* (story telling), *garak malingka* (moving in circle) and the dramatic actions *kato nan ampek* that reflect politeness in speaking (Arsih, Zubaidah, Suwono, & Gofur, 2019).

The integration of Randai cultural values into PBL thus generates a learning model called **RANDAI (Reciting, Analyzing the problem, Narrating the solution, Doing the solution, Assessing the solution and Implementing the solution)**. RANDAI learning model is constructed on the elements of drama and of *Kaba*/story (Arsih et al., 2019). Stories can improve learning memory capacity (Dahlstrom, 2014) and critical thinking (Csikar & Stefaniak, 2018). They can also function as an effective communication tool in learning process (Giorgetti et al., 2017). Pedagogically, RANDAI learning model teaches democracy and collaboration principles through creating a circle in the show (Arsih et al., 2019).

Based on the above arguments, we assume that the RANDAI learning model has the opportunity to empower critical thinking skills. The hypothesis in this study is that the RANDAI learning model is effective in improving the critical thinking skills of biology pre-service teachers

LITERATURE REVIEW

Critical Thinking Skills

Critical thinking skills are the ability of individuals to analyze and solve problems, process data, and evaluate information so that they can generate new ideas as a form of resolution. (Kopzhassarova, Akbayeva, Eskazinova, Belgibayeva, & Tazhikeyeva, 2016). Critical thinking involves identification, analysis and evaluation skills to draw an appropriate conclusion (Watson and Glaser, 2012).

Pre-service biology teachers need to have critical thinking skills as they are relevant to their responsibility to instill critical thinking in students (Bahr, 2010; Allammakhrah, 2012). Pre-service biology teachers who have been equipped with critical thinking skills can teach material correctly and accurately based on scientific development (Saefi, Suwono, & Susilo, 2016) and are accustomed to self-reflection (Weissinger, 2004). Qualified teacher candidates always strive to improve the quality of their learning and in the end will produce quality graduates (Gedik, 2013).

The habituation of critical thinking skills can be done in several ways (Bahr, 2010; Farcis, 2016) as described by Radulović & Stančić (2017), including through classroom instruction (explicit instruction), integrated with material content and mixed programs. Explicit instruction or general programming involves various learning activities that are carried out on purpose to stimulate students' critical thinking. An example of explicit instruction is a learning model developed by a teacher to improve students' thinking ability. Research by (Kuhn, 2000; Moseley et al., 2005) shows that students' critical thinking that is trained through explicit instructions embedded in a learning model or design can provide a satisfying result.

Furthermore, critical thinking can also be trained by integrating critical thinking skills indicators into the content of certain learning materials. In these programs, teachers can deliberately select learning content that can stimulate students' critical thinking. In contrast, mixed programs combine specific learning content and teaching activities. Through blended programs, teachers can implement lesson plans and instructional

materials that help improve students' critical thinking. In mixed programs, teachers are also allowed to select materials and design learning activities sheets as a medium.

RANDAI Learning Model

RANDAI is a learning model produced from the integration of *Minangkabau Randai* cultural values into problem-based learning. *Randai* is a traditional art performance from West Sumatera. RANDAI learning model adapts the principles of problem-based learning that refer to the constructivism theory using a contextual approach. The combination of the constructivism theory, approach, and principles makes RANDAI a relevant learning model for 21st century education. RANDAI learning model facilitates the development of pre-service biology teachers' ability to deal with contextual problems found in everyday life (Arsih, Zubaidah, Suwono, & Gofur, 2019).

RANDAI as a cultural integrated learning model creates a learning process that serves as an exploration arena for pre-service teachers to achieve rational scientific knowledge in a particular discipline (Suastra, 2017). The integration of culture into a learning model can promote the development of learners' thinking ability and character values (Williams, 2016).

RANDAI learning model is characterized by *kaba* or *bakaba* (telling a story) and drama that is packaged in the form of stage performance. RANDAI learning model draws on the principle that problems wrapped in *kaba* (stories) can be used as a starting point to obtain knowledge from the materials being studied. *Bakaba* encourages information processing. Rehalat (2014) explains that information processing refers to the ways individuals collect or accept stimuli from the environment, solve problems, discover concepts, and use verbal symbols. Information processing is also a part of elaboration activity (Barden & Tormala, 2014) that facilitates pre-service teachers to develop concept understanding (Duran & Duran, 2014), acquire more information, and apply it in a real-life context (Liewellyn, 2013). Overall, the syntax of RANDAI learning model is comprised of six stages: (1) Reciting, (2) Analyzing the problem, (3) Narrating the solution, (4) Doing the solution, (5) Assessing the solution, and (6) Implementing the solution (Arsih, Zubaidah, Suwono, & Gofur, 2019).

Figure 1
The scheme of the RANDAI learning model syntax

METHOD

Research Design

This study is a quasi-experimental study using a pretest-post-test nonequivalent control group design (Cohen, Manion, & Morrison, 2011) and involved three sample groups (experimental, positive control, negative control). RANDAI learning model was applied to the experimental class, which is the development of integrated PBL learning with Minangkabau cultural values. PBL learning was implemented in the positive control class while the negative control group was carried out without using a special learning model (conventional/direct learning). Meanwhile, critical thinking skills are the dependent variable. Table 1. shows the design of this study

Table 1
Research design in the assessment phase

Pretest	Treatment Group	Number of students	Posttest
O_1	RANDAI	38	O_2
O_3	PBL	33	O_4
O_5	Konvensional (direct learning)	36	O_6

Research Samples

This experimental research was carried out on fifth-semester students registered in the 2018/2019 academic year. It involved 107 pre-service biology teachers aged between 19-20 years old. The participants had been registered in a "Human Anatomy and Physiology" course at a university in West Sumatera, Indonesia. Homogeneity testing was performed to determine the samples. The sample class was selected randomly. The analysis of the homogeneity test result was conducted using SPSS 23.0 for Windows.

Instrument

This research is supported by learning tools in the form of lesson plans and student worksheets. The research instrument was a critical thinking essay test with as many as 15 questions and an assessment rubric. The test tool is categorized as valid with a validity value of 0.453-0.693 and reliable with a value of 0.795-0.838. The students' scoring of the answers given refers to the rubric. The rubric for assessing critical thinking skills refers to Finken and Ennis (2001) with the FRISCO indicator (focus, reason, conclusion, situation, clarity, and general description) modified by Zubaidah (2015) with a reliability value of 0.896.

Data collection begins with the validation process of learning tools and instruments. This validation was carried out by five experts on biology learning and cultural integrated learning who were invited to validate the syllabus, lesson plans, worksheets, and critical thinking rubrics. The results of the validation show that the supporting learning devices are categorized as valid with respective values of 4.51, 4.58, 4.68, and 4.60.

Procedures

Each of the classes was taught using different learning models (RANDAI, PBL, and conventional).

RANDAI learning model was implemented in the experimental class. Learning was conducted by (1) Reciting; the students introduced a problem through the performance of *kaba* (story), (2) Analyzing the problem; the students identified and analyzed the problem implied in the *kaba* (story) told by an individual student, (3) Narrating the solution; the students *barudiang* (discussed) the problem and designed an investigation, (4) Doing the solution; the students *saliang bakarajosamo* (worked cooperatively) to solve the problem, (5) Assessing the solution; every group *barundiang* (discussed the problem) based on *bulek kato dek mufakat* principle and reflected, assessed and evaluated the strengths and shortcomings of the investigation activity, (6) Implementing; the students applied the solution in their daily life. The students in this classroom conducted learning in groups and implemented the cultural values that had been integrated into the learning model.

In the positive control class, Problem-Based Learning (PBL) was applied. The stages of PBL suggested by Wood (2004) consisted of the following activities: (1) students were divided into small groups and asked to solve a problem, (2) the students decided the steps to solving the problem, (3) the students communicated the problem-solving result, (4) In the final section, the students reflected on their performance.

Meanwhile, the learning process in the conventional class was dominated by classroom discussions and question and answer sessions. The process was initiated by the teacher's presentation of the material summary. Then, guidance was provided for the students to discuss the material in groups and ask questions to other groups who were delivering group presentation. Before the end of the lesson, the teacher provided material reinforcement and formulates conclusions, in this session students listen carefully to the teacher's explanation. In this class, learning is more teacher-centered.

Data analysis

The research data were analyzed through the ANCOVA and LSD (Least Significant Difference) tests using the SPSS for windows version 22.0 application and followed by the LSD test to test the significance of these effects. However, previously the Kolmogorov-Smirnov test and Levene's test were carried out to obtain data normality and homogeneity.

FINDINGS

The Results of the Normality and Homogeneity Tests of the Pre-Service Biology Teachers' Critical Thinking Scores

The results of the prerequisite tests (normality and homogeneity tests) showed that the pre-service biology teachers' critical thinking scores were distributed normally and homogeneously (Table 2). The prerequisite test results (normality and homogeneity tests) show that the pre-service biology teacher critical thinking scores are normally distributed and homogeneous (Table 2).

Table 2
The results of the normality and homogeneity tests of the pre-service teachers' critical thinking scores

Treatment Group	N	Normality	Homogeneity
Critical thinking pretest	107	0.641	0.159
Critical thinking post-test	107	0.496	0.202

The effect of RANDAI learning model on the pre-service biology teachers' critical thinking skills

Table 3. shows the results of the analysis of the application of RANDAI in improving the critical thinking skills of pre-service biology teachers

Table 3
The effect of the learning models on the participants' critical thinking skills

Source	Type III sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1364.042a	3	454.681	17.067	0.000
Intercept	13128.240	1	13128.240	492.774	0.000
pretest	384.791	1	384.791	14.443	0.000
Class	1290.900	2	645.450	24.227	0.000
Error	2744.073	103	26.641		
Total	623849.775	107			
Corrected Total	4108.115	106			

Table 3 contains information on the difference among the learning models implemented in the study (F calculated= 24.227 with p-value = 0.000. P-value <α (α = 0.05). The figures suggest that the hypothesis "RANDAI learning model has an effect on pre-service biology teachers' critical thinking skills" can be accepted. After proving the hypothesis, the LSD test was run. The test results are summarized in Table 4.

Table 4
Summary of the LSD test results based on learning models

Class	Pretest	Post-test	Difference	Increase (%)	Corrected Item-Total	LSD Notation
Conventional	52.78	72.41	19.63	37.19	71.52	a
PBL	47.84	76.02	28.18	57.08	76.24	b
RANDAI	45.89	79.68	33.79	73.63	80.34	c

The critical thinking skills of participants in the RANDAI class differed significantly from the PBL and conventional classes, which was indicated by the difference in notation between the three learning models. Table 4 also shows that there is a difference in the average corrected score between the three learning models. The RANDAI value (80.34) was higher than the PBL (76.24) and conventional (71.52) learning models. The RANDAI learning model shows better results than students who are taught using the PBL and conventional learning models. Based on these findings, the RANDAI learning model can be used as an alternative to improve the critical thinking skills of pre-service biology teachers.

DISCUSSION

Statistical analysis showed that RANDAI learning model affected the pre-service biology teachers' critical thinking skills. The implementation of RANDAI has facilitated the improvement of the pre-service biology teachers' critical thinking skills. The post-test scores indicate that the RANDAI learning model is able to significantly increase the achievement of critical thinking values. The significant improvement of the participants' scores was affected by the syntax of RANDAI that was focused on problem-based learning while upholding the *Minangkabau* cultural values and principles. RANDAI learning model was also able to stimulate the participants' interest in learning, provide an opportunity for them to not only accept and imitate information (Pannen & Sardjiyo, 2005) and allow them to experience more meaningful culture-integrated learning (Fadli & Irwanto, 2020). Meaningful learning can be obtained through the active involvement of pre-service teachers in constructing knowledge based on learning experience and interactions with the environment and nature surrounding them (Kanhadilok & Watts, 2013). According to Serin (2013), education and the learning environment contribute to empowerment towards improving the critical thinking skills of pre-service teachers.

RANDAI learning model adapts the principles of Problem-Based Learning (PBL) that incorporates local culture using constructivism learning theory and contextual approach. RANDAI learning model facilitates pre-service biology teachers to practice solving contextual problems. Through RANDAI, pre-service biology teachers are actively engaged in exploring thinking skills either individually or collaboratively in groups (Arsih, Zubaidah, Suwono, & Gofur, 2019)

Bakaba helps pre-service teachers creatively use imagination, discuss stories, and make the knowledge appealing (Giorgetti, Campbell, & Arslan, 2017). Hardiman et al. (2019) also stated that the cultural values embedded in learning instructions contribute to strengthening academic concepts and making them more interesting. There is a positive correlation between the integration of multicultural content into learning and student achievement, motivation, self-efficacy, creativity, critical thinking, collaboration, and engagement in biology learning. In line with past studies, this meta-analysis provides support for the possibility that the integration of art and culture in improving student achievement in the cognitive domain, including in problem-solving and critical thinking. Research has also indicated that the integration of art and culture into learning can serve as a tool to bridge the gap between the underachievers and high-achievers in the classroom.

The second syntax of RANDAI is Analyzing the problem. The activities performed at this stage include identifying and analyzing problems as a means to stimulate critical thinking. Pre-service biology teachers will become independent and critical when they are trained to analyze, evaluate, and synthesize information from various sources and present the information according to their own interpretation (El-Shaer & Gaber, 2014). The exploration of information to identify problems contributes positively to the development of students' critical thinking (Bassham et al. 2011). When pre-service teachers struggle to find and discuss problems to solve a task, they are building the procedural and conceptual understanding of a concept (King, 2019).

The third syntax of RANDAI is narrating and executing the solution, where the pre-service biology teachers in this study performed a *barundiang* (discussion) activity based on *saliang bakarajo samo* (collaboration) principles in designing an investigation. This syntax is known to stimulate the discovery and investigation processes that can empower students to think critically. Through *barundiang* activity, the pre-service biology teachers interacted with each other to apply the cultural values of *duduak basamo balapang-lapang* (sit together), *barundiang* (discussion) and *bakarajosamo* (collaboration). In groups, the pre-service biology *barundiang* (discussed) ideas on the problem solution. Every individual was allowed to deliver their thoughts and explain the result of the analysis conducted in the previous stage. This syntax is in line with Gagne, 1980 (Temel, 2014), who states that education primarily aims to teach individuals how to think and solve problems effectively so that they can contemplate, research, and produce solutions to the problems they face in real life.

Assessing the solution is the last stage in RANDAI that allows pre-service teachers to communicate the investigation results as well as to reflect and evaluate the strengths and weaknesses of the whole investigation process. Assessing the solution aims to provide feedback to the entire problem-solving process. This activity is based on the opinion of Moreno (2010), who mentions that student involvement in reflection and evaluation provides an opportunity for them to promote the ability to analyze, criticize, and draw a conclusion which results indirectly in their critical thinking development.

The discrepancy in the critical thinking scores between RANDAI, PBL, and conventional classes was also caused by the different learning environments that influenced the participants' motivation in learning. The relaxed learning atmosphere in RANDAI due to the performance of *kaba* (stories) was able to motivate the students. Motivation plays an important role in the classroom, students who have excellent learning orientation or high motivation will be able to easily achieve higher-order thinking (Suwono & Dewi, 2019).

The results of this study are corroborated with the findings of Anazifa (2016), who explains that Problem-Based Learning can affect students' critical thinking skills. The integration of culture into PBL contributes to the development of students' critical thinking. Saragih, Napitupulu, & Fauzi (2017) have reported the effectiveness of the integration of local culture and student-centered learning in improving students' thinking ability. Another study has also proven that culture-integrated PBL can improve student academic achievement. Also, Arwita et al. (2017) found that integrating the social interaction system of *Dalihan Na Tolu* into PBL able increase student achievement. Besides, research by Parwati et al. (2018) also shows that learning models that are oriented to local wisdom are effective in improving student problem-solving skills as an indicator of critical thinking. The learning culture that incorporates local wisdom has a significant effect on students' ability to solve problems (Fadli & Irwanto, 2020), which constitutes part of critical thinking skills. On the one hand, the findings of this study are relevant to the previous research in terms of supporting the development of the 21st century skills. On the other hand, RANDAI learning model enables pre-service teachers to prevent *Minangkabau* culture from being washed away due to globalization.

Therefore the RANDAI learning model can function as a strategy in preserving culture and enhancing the critical thinking skills of pre-service biology teachers.

This study was limited to a particular variables and subjects at the higher education level. In order to more measure the effectiveness of the Randai model, further study can be carried out by implementing the RANDAI model in other courses and at the high school level.

CONCLUSIONS

The findings showed that the RANDAI learning model had a more significant effect on the critical thinking skills of pre-service biology teachers in improving critical thinking with an average score of 80.34. Thus it can be concluded that the thinking ability of pre-service biology teachers can be empowered through the RANDAI model.

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