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Analogipedia: An Android-Based Module Utilizing PBL Model Based on Analogical Approach to Improve Students' Creativity

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The creativity of high school students in Indonesia has not met the demands of 21st century because in general the students' thinking ability has not reached high-level thinking ability. The objectives of this study are: first, utilizing android technology to develop an Analogipedia module containing ecosystem teaching materials for high school students, and second, testing the effectiveness of using analogipedia module in improving students' creativity. This research is development research. To measure the effectiveness of the product (module) in improving students' creativity, nonrandomized subject research design, pretest-posttest control-group design was employed. The study involved 88 high school students as the experimental class and 87 students as the control class. The data were collected using questionnaires and open-ended questions. The results show that: first, the experts on materials and teaching; peer reviewers; and biology teachers assess that analogipedia module belong to a very good category. In addition, students assess that the module is classified in a good category. Second, the score of students' creativity that utilizes analogipedia module is different from the score of the students that uses student's worksheet. This is indicated by the t-test showing the significance level of 0.043, which means that the analogipedia module is effective to improve the creativity of high school students. Different results are also indicated by the increase of creativity test score in which the experimental class reaches 96.48% and the control class is 85.24%. The contribution of this research is to enrich android-based learning media. The analogipedia module can be used in all biology subjects for ecosystem materials, especially at the high school level through the application on the Playstore.

Keywords: android module, PBL, analogical approach, creativity, students' creativity

INTRODUCTION

The 21st century is a medieval age which is characterized by the escalating of the interrelatedness of the world of science. The utilization of information and communication technology in education is still narrower indicated by the "space and time", which is believed to drive the success of science mastery, has been melting (Human Development Report, 2019; National Education Standard Agency, 2010; OECD/Asian Development Bank, 2015).

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Learning in the 21st century is intended to produce gold generations who have a thinking skill in learning. The skills include: first, critical thinking and problem solving which require the students to solve their problems independently; second creativity and innovation that direct the students to develop creativity and produce innovative breakthroughs; third, collaboration that guides students in order to have the ability to cooperate in groups, adapt, empathize, respect differences of views, and be able to place themselves; and fourth, communication which demands the students in order to be able to understand, manage, and create effective communication (Human Development Report, 2019; Lambart, 2017; National Education Association, 2012).

In the United States, the standard of education in 21st century is guiding students to achieve content understanding and apply knowledge through high-level capabilities. In Singapore, it is directed to a better students' improvement in taking the advantages of global opportunities. In China, it aims at developing students in order to able to communicate and work in groups; acting and solving problems; and learning to learn (Saavendra & Opfer, 2012). In Indonesia, the standard of education in the 21st century is to enhance students in order to able to find information from various sources, formulate problems, perform analytical thinking and cooperation, and collaborate in solving problems (Research & Development of Kemendikbud, 2013).

The strategies to achieve the educational objectives based on the National Education Standard Agency (2010) include: first, utilizing educational technology; second, transforming the mindset into "the world is my class"; third, using creative learning methods; fourth, developing contextual teaching materials; fifth, changing the paradigm of learning from teacher-centered to student-centered; from passive to active; from abstract to concrete; from individual to collaborative; from single learning media to multimedia-based learning; and from factual thinking to critical and creative thinking (School Drug Education & Road Aware (SDERA), 2013).

Implementation of learning to achieve 21st century learning objectives (stated above) must integrate high-level abilities (HOT) of students in classroom learning. HOTs are needed as media for enhancing students' thinking and learning habits. Creative thinking as part of HOTs is required to generate fresh ideas and enhance the learners to be wise in dealing with incoming information. Especially in the millennial era like today, information can easily be taken from different sources. It is a concern for parents if their child absorbs information that is not supposed to. Hoping that critical and creative thinking can be a solution to every problem, one of which is sorting out incoming information (Wahyudi et al., 2018).

Batey (2011) states that creativity is an essential need for the future. It is often found that every success achieved by someone, for example a businessman, developer, etc., begins with his creativity to find innovation in developing his business products. The power of creativity should be based on advanced thinking, new ideas, and different from existing products. If they are able to maximize creativity to give birth to an innovation, then the business or business they manage will be able to look different compared to other similar businesses. Creativity and innovation are prioritized strategies in the organization of the world and creativity is part of everyday work. Therefore creativity should be implemented in learning, including in biology learning (Baciu, 2021; Daikoku et al., 2021).

In fact, the creativity of high school students in Indonesia has not met the demands of the 21st century because in general students' thinking ability has not reached high-level thinking ability. It is still rarely found by students who are able to think at higher levels (HOTs), namely thinking that no longer memorizes and understands verbally, but also interprets the nature of what is contained (Ernawati, 2017). In addition, biology learning devices directed to the achievement of high-level thinking ability are not appropriate yet. With regard to this, the appropriate example of learning device is required (Paidi et al., 2013). The results of research conducted by Rofi'uddin (2000) show that the creative thinking ability of the students from primary education to college is still low because education which

enhances high-level thinking ability has not been implemented properly. Therefore, creativity is required to be integrated in every subject (Daikoku et al., 2021).

The competence of high school students of grade X on biology subjects from semester 1 has not yet indicated the achievement of higher thinking level. They only master the ability to describe, present and identify biological subjects (National Education Standard Agency, 2010). So far, teachers focus on the achievement of basic competencies. Moreover, learners are seldom trained to develop their creativity. Teachers focus on preparing students in order to succeed in dealing with tests such as mid-semester examination (UTS), School Final tests (UAS), and UN (National Examinations) of which competency is limited to the ability to memorize and understand the concept of biological materials (Risnani & Subali, 2016).

Literature Review

Generally speaking, creativity can be learned. Dyers, Gregersen and Christensen (2011), assert that 1/3 of innate creativity is born while the remaining 2/3 is gained through the educational process. Creativity is the ability to think to find original ideas beyond boundaries and to enable learners to produce divergent answers. Baer (1993) states that creative thinking is synonymous with divergent thinking. Creativity can help a person out of the ordinary way of solving problems (Sefertzi, 2000). This unconventional way is meant to be unique, doesn't follow the solutions that most people use, but hits the spot.

There are four indicators of divergent thinking that lead to one's creativity: (1) fluency (ability to generate many ideas), (2) flexibility (ability to generate varied ideas), (3) originality (capability to generate new ideas or ideas that do not exist before), and (4) elaboration (ability to develop or add ideas resulting in detailed ideas) (Adams, 2006; Bai et al., 2021; Villalba, 2008).

The characteristics of learning that provide the widest opportunity to students include emphasizing the process rather than outcomes, providing questions with diverse answers, tolerating student responses that are different from others, and applying learning models based on creativity recommended to improve student creativity (Burke, 2007; Research & Development of Kemendikbud, 2013; Subali, 2013).

Based on these facts, an integrated learning intended to improve the student creativity is important. As the realization of the strategy to deal with the 21st century, Problem-Based Learning module utilizing android and analogy approach becomes an innovation to improve the creativity of high school students. The android-based module is chosen because it is more joyful and interactive than print modules. Also, it can display images with high resolution, it supports audio and video formats, it is capable of displaying animations, it enables users to transfer materials in the form of processes or cycles, and it supports hyperlinks to enrich references. The module is popularized using the name of analogipedia module.

The analogipedia module is an android-based module containing learning materials on ecosystems for high school students of grade X. The development of analogipedia module utilizes Problem Based-Learning (PBL) model based on analogy approach. The PBL syntax includes: 1) defining the problem, 2) collecting data, 3) identifying alternatives, 4) rating alternatives, and 5) choosing the best alternatives (Moore, 2015).

In the module, PBL acts as preliminary idea to guide the students in order to perform creative thinking through problem solving. The problems are presented in contextual case. They are arisen from the region of Bantul, Yogyakarta, Indonesia in 2016 consisting of bad weather which caused the failure of pepper plants and the flood which happened due to abrasion of the Opak River.

The analogy approach is carried out based on inductive reasoning by comparing the phenomena, facts, or symptoms found in one biological object with that of another biological object. The process includes: comparing, identifying, collecting data about ecosystems that are close to students and the ecosystems that are far from them. In this case, analogies are presented functionally rather than structurally by comparing a concrete object with another concrete object (Dikmenli, 2015). For example, the analogy between the school yard ecosystem and the ricefield ecosystem. The grass is found in the school yard ecosystem while rice plants are found in the ricefield ecosystem. Both grass and rice plants serve the same functions in the same ecosystem namely as a producer. In the module, the analogy approach is presented in the form of a series of student activities.

The objective of this research is to develop an analogipedia module containing ecosystem materials for grade X of high school students based on 2013 Curriculum. The module is developed utilizing Problem Based Learning (PBL) model based on analogy approach. In addition, the effectiveness of analogipedia module in improving the creativity of high school students of grade X based on divergent thinking patterns is tested.

Research Questions

The research questions can be formulated as follows:
1. Does the developed analogipedia module meet the eligibility of teaching materials on ecosystem?
2. How is the effectiveness of using analogipedia module in improving students' creativity?

METHOD

This research is a design and development research as presented by Richey and Klein (2007). Its design of development consists of analyzing, designing, developing, and evaluating product development (Analogipedia Module). The first phase is analyzing the need assessment on the android system and prototype of module design which includes literature studies, local ecosystem surveys as material content, and observations in high schools. The second stage is decoding the prototype module such as creating a storyboard, composing navigation, and creating a conceptual module framework. In addition, a module assessment instrument, observation instrument, and pre-posttest were also developed. The third stage is a validation stage which consists of expert judgments (content, learning, and module layout), limited trials, and field trials.

The validation tests performed by experts on learning materials aim at validating the substance of the material on ecosystems. Meanwhile, the validation tests conducted by the experts on learning and media are intended to validate the construct of analogipedia module. Peer reviewers and biology teachers assess the module in terms of its substance, development, and module layout. In addition, students assess the module in terms of its substance, development, layout, and language.

Participants

The respondents of validation test and the reviewers of analogipedia module consist of: two experts who validate the module (an expert on ecosystem learning material; and an expert on learning and media), three peer reviewers, four biology teachers, 31 high school students of grade XI in limited test, and 88 high school students of grade X on large-scale test.

The subjects of the limited trials include 31 students of grade XI of SMA N 1 Bantul to assess the eligibility of the module in a limited way. Moreover, field tests were addressed to the students of grade X of SMA N 1 Jetis, SMA N 2 Bantul, and SMA N 1 Sewon. The subjects consist of 88 students in the experimental class and 87 students in the control class.

The final stage (evaluation) is designed to evaluate the results of validation, module assessment, and the quality of the analogipedia module. First, data collection and triangulation are applied (Denzin,

2005). Data triangulations are performed through face and construct validity of the experts, peer reviewers, biology teachers, and students. The data were collected and the products were revised based on inputs obtained. Second, product evaluation aims at analyzing the quality, efficiency, and usefulness of analogipedia module.

Description of the research design

This research design uses a quasi-experiment employing nonrandomized subject, pretest-posttest control-group design. The research design is presented in Table 1 below.

Table 1
Research design

	Pretest		Posttest
The experiment class :	O_1	X	O_2
The control class :	O_3	-	O_4

Note:
O_1, O_3 : *pre-test* of the experiment and control class
O_2, O_4 : *post-test of* the experiment and control class
X : treatment utilizing an analogipedia module
- : conventional, using student's worksheet

The instruments for data collection consist of questionnaires to gather data on students' responses regarding the assessment of the module. The questionnaires utilize Likert scales which are addressed to peer reviewers and biology teachers consisting of 3 scales: 1) improper, 2) less proper, and 3) proper. Meanwhile, the questionnaire for the students consists of 4 criteria: 1) strongly agree, 2) agree, 3) disagree, and 4) strongly disagree. Questionnaires are composed of open-ended questions in order to receive respondents' suggestions and criticism.

The pretest and posttest data are in the form of open-ended questions utilizing divergent thinking test design (Subali, 2016a) to measure students' creativity (Adams, 2006; Subali, 2016). The questions were developed based on some requirements regarding its substance/materials, development, and language aspects (Subali, 2016b). These three aspects for consideration in the preparation of the test instrument.

Instrument validation techniques include a face validity (Subali, 2016b) performed by experts on content and learning. In addition, empirical validity is tested using SPSS version 21 to measure the prerequisites (normality and homogeneity test), and using the QUEST program version 90 by (Adams & Toon, 1996) to measure the difference between pre and posttest of student creativity (Al-Balushi & Al-Abdali, 2014). The result based on the *mean score of INFIT MNSQ* shows a score range of 0.77 to 1.30 (Subali, 2016b). The data were analyzed using an independent sample t-test at a significance level of 0.05 (Priyanto, 2012).

FINDINGS

The quality of analogipedia module is determined based on the results of assessments performed by experts, peer reviewers, biology teachers and students. The data of the research indicates that: first, based on the results of validations performed by the experts on learning materials, analogipedia module has met the eligibility criteria as additional biological materials. The explanation of ecosystem materials shows the relevance between the fact and the concept of ecosystem, the completeness and depth of the ecosystem materials have been appropriate, and the ecosystem material is relevant to the learning outcomes. The percentage from total score of the expert judgements on the material is 88.89%, which means that the module is classified in a good category. Second, based on validation results carried out by the experts on learning in terms of module development/content and layout,

analogipedia module has gained an accuracy in terms of its constructs, learning objectives formulations, PBL syntax, quality of creativity, illustrations, grammar and languages, the suitability of the layout and graphic quality, depth of materials and the ease of using the module. Those categories are classified as excellent by the learning experts indicated with the percentage score of development 95.83% and the layout 97.92%.

Peer reviewers and biology teachers assess the module from the aspects of substance, development, module layout, and grammar. The assessment performed by students in limited trials to the aspects of substance, development, and module layout shows a good category. Meanwhile, their assessment on language use indicates a very good category. In addition, the student's assessment on all aspects of the module operationalization indicates a good category.

In addition, the grammatical aspects include the following indicators: the use of communicative language, the ease of the language use, unambiguous language use, the accuracy of diction to the characteristics of high school students, and the use of formal and standard language. Table 2 presents the data on the quality of assessing the analogipedia module.

Table 2
Data of assessing analogipedia module

Respondents	Assessment aspect	Score percentage	Category	Suggestions
Expert materials	Substances/ Contents	88.89%	Very good	Revision on materials, grammar, lesson plan, creativity test, glossary
Expert teaching	Construct	95.83%	Very good	Lesson plan, revision sentence in creativity test
	Media	97.92%	Very good	
Peer Reviewer	Substances	100%	Very good	Construct and module performance
	Construct	100%	Very good	
	Media	98.61%	Very good	
Biology teachers	Substances	100%	Very good	
	Construct	100%	Very good	-
	Media	98.96%	Very good	
Students (preliminary field)	Substances	79.26%	Good	Module performance, questionnaires, and quiz
	Construct	79.61%	Good	
	Media	77.74%	Good	
	Grammar	81.85%	Very good	
Students (operational field testing)	Substances	74.76%	Good	Student's worksheets, module performance, references, tools
	Construct	74.84%	Good	
	Media	74.72%	Good	
	Grammar	73.78%	Good	

Table 3
The differences between the pre and posttest creativity result

Aspect	Total number			
	Experiment class		Control class	
Total students	88 students		87 students	
Normality test	0.082			
Homogeneity test	0.154			
t-test	0.043			
Creativity score	Pretest	Posttest	Pretest	Posttest
Highest score	72	100	76	98
Smallest score	10	36	8	32
Average score	38.9	76.43	39.29	71.78
Increase (%)	96.48%		85.24%	

Table 3 shows the difference between the pretest and posttest results in the experimental class that utilizes analogipedia module and control class that uses student worksheet. The limited trial was addressed to 31 students of grade XI. The data were tested using the Liliefors test employing the Kolmogorov-Smirnov normality test at a significance level of 0.082. Also, the data were tested using Levene's test to know the homogeneity of the samples. The test results show that the level of significance is 0.154, meaning that according to the criteria for variance, a significance value of more than 0.05. It can be said that the variance of the two data groups is the same (homogeny). To determine the difference between pretest and posttest on creativity, t-test was employed using the data obtained from large-scale trials in three high schools. The results of t-test show the significance of 0.043. This means that there is a difference between the use of analogipedia module and student's worksheet, as stated by (Priyanto, 2012). Moreover, another difference is the increase of creativity test scores in which in the experimental class is 96.48%, while in the control class reaches 85.24%.

DISCUSSION

In carrying out teaching and learning activities in order to achieve the goals set, the teacher should prepare learning well, starting from preparing the syllabus, compiling lesson plans, compiling teaching materials, preparing media and instruments that will be used during the learning process. According to Suhardi (2012), that the teaching materials are important to be well prepared by teachers. The implementation of the android module using a problem-based learning model in biology learning effectively increases the creativity of high school students compared to students who are treated using worksheets. The development of the android module is a form of teacher innovation in the digitization of education in Indonesia. Moreover, when biology teachers utilize innovative teaching materials based on technological developments in the classroom, they should be more joyful, interesting, supporting traditional learning, and stimulating the materials delivery (Campbell et al., 2015). For example, using web based-technology (Varma, Husic, & Linn, 2008; Barak, 2017), Moodle LMS (Learning Management Systems) (Al-Balushi & Al-Abdali, 2014), software module, learning media with Adobe Flash (Astatin & Nurcahyo, 2016), as well as learning that integrates an android mobile learning (Aminatun & Subali, 2016).

Previous studies that developed a module with android-based mobile learning on ecosystem materials in classroom practice have been performed by Meliana (2017); Dwiyani (2017); Masing, (2017); Prihartina (2016). Based on Prihartina's research (2016), the development of online android module through web on ecosystem materials using problem solving learning model can improve divergent thinking of high school students. In this research, semi-offline module development employs a Problem-Based Learning (PBL) model based on analogy approach. The module was then popularized using the name of Analogipedia Module. This module is more efficient and economical than online version module because the analogipedia module does not always require internet connection.

The android-based module is easy to operate as practiced by the students in the classroom. Students simply download the Analogipedia application through the google playstore, then install the application. After it is installed students can start studying the instructions for using the Analogipedia module, then follow the directed learning syntax. The menus and sub menus are clear and students can choose the menu as they like. However, to optimally utilize analogipedia module, biology teachers should monitor and facilitate the students by ensuring that they really focus on working with the module because the use of android enable students to focus on other things, for example, games, social media, entertainment, online shopping, and so on. The teacher facilitates students to understand the real problems that have been presented, namely identifying what they know, what they need to know, and what needs to be done to solve the problem.

The use of android enhances students to be more active in searching relevant literature through hyperlinks and search engines. It enables them to understand the ecosystem materials easily, because

android is able to display images and video especially smartphone android which is more practical and fun. However, android in this context is still semi offline which means that students must be online to access certain parts of the module for example videos and student responses in which sometimes it uses data from the internet.

In addition, students can not be interactive to work on the activities in the module. The analogipedia module does not optimally support the monitoring of the students competencies achievement, unlike the web version of the online module developed by Dwiyani (2017). Therefore, the use of analogipedia module in the classroom teaching still requires a worksheet to work on.

The implementation of problem-based learning model enables students to actively contribute their ideas (brainstorming). According to Hirça (2011), the PBL process encourages students to make learning materials more enjoyable. PBL can improve the student independent learning and concept understanding (Haji et al., 2015; Supriyanti et al., 2015). In classroom practice, the PBL process is the opening stage before proceeding to the next activity of learning the ecosystem materials using an analogy approach.

It is important to note that an analogy approach makes students perform extra works such as defining ideas, collecting data, and making reports, because analogy approach compares one ecosystem with another. Students have a little chance to play outside of their work because the analogipedia module consists of various activities to find concepts, therefore, their creativity increases as stated by Alvira, Hidayah, and Chusniah (2016). Students also get a lot of experiences. This makes them understand better the ecosystem materials (Aziri & Ahmad, 2014). Students generally cannot find many relationships between different topics, so analogy reasoning may overcome this difficulty (Diki, 2013).

A quantitative analysis to determine the differences between experiment and control class has been performed based on t-test and creativity score differences. The results show that the student's creativity is significantly improved when analogipedia module is utilized. According to Alghafri and Nizam Bin Ismail (2014), the use of teaching strategies, for example, using brochure of the strategy, the implementation guide, and the lessons plans based on thinking skills enhance the levels of creativity. Research Enikanolaye (2021) also shows that there is a significant difference between the experimental group taught using multimedia and the control group teaching using conventional methods. The positive impact of this multimedia can help reconstruct understanding and concretize learning.

Creativity in biology learning may help students improve their learning outcomes, as well as prepare student's future careers (Diki, 2013). Creativity prepares students to survive in the era of technology and globalization and to solve more problems than that of global problems (Saavendra & Opfer, 2012). Creativity also prepares students to be wiser in dealing with technological developments, in selecting received information and not to depend on techonolgy. Wisdom in this case means that students are taught to be more busy using useful technology, filtering all incoming information through technological devices, and directing their mindset to be creative in using technology so that they are able to develop something useful for life.

CONCLUSION

Based on the findings and discussions, the conclusions are: first, the development of analogipedia modules assessed by the experts on materials and experts on learning, peer reviewers, and biology teachers, is classified in a very good category. Moreover, the module is assessed by students with a good category. Second, there is a difference between creativity test scores of students utilizing analogipedia module and students using worksheets. This can be seen from the results of t-test of which significance level reaches 0.043. This means that analogipedia module significantly improves

the creativity of high school students. The difference is also indicated by the increase of creativity test scores in the experimental class which reach 96.48%, while control class reaches 85.24%. This research contributes in increasing the repertoire of biology learning media. The analogipedia module can be applied to all high school students in the Biology subject ecosystem. As a recommendation for this research, the android module can be further developed in other materials.

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