2019,_ICEMT_09.pdf

by

Submission date: 06-Aug-2020 09:53PM (UTC+0800)
Submission ID: 1366570407
File name: 2019,_ICEMT_09.pdf (1.3M)
Word count: 7421
Character count: 50623

Proceedings of
2019 3rd International Conference on Education and Multimedia Technology (ICEMT 2019)

Nagoya, Japan
July 22-25, 2019

ISBN: 978-1-4503-7210-7

The Association for Computing Machinery
2 Penn Plaza, Suite 701
New York New York 10121-0701

ACM ISBN: 978-1-4503-7210-7

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2019 3rd International Conference on Education and Multimedia Technology (ICEMT 2019)

Preface

This volume contains papers presented at 2019 3rd International Conference on Education and Multimedia Technology (ICEMT 2019), which was held in Nagoya, Japan during July 22-25, 2019.

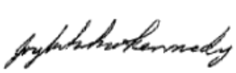
ICEMT provides a scientific platform for both local and international scientists, engineers and technologists who work in all aspects of Education and Multimedia Technology. The volume includes 84 selected papers which were submitted to the conference from universities, research institutes and industries. These papers cover the topics range from Educational Research and Practice, Special Education, E-Learning and Information Technology and Education. Each contributed paper has gone through a rigorous blind peer-review process. The proceedings tend to present to the readers the newest researches' results and findings in the related fields.

We invited Prof. Joy Kutaka-Kennedy, National University, USA, to give a keynote speech, entitled "The Future of Multimedia Technology in Education"; Assoc. Prof. Eric C.K. Cheng, The Education University of Hong Kong, Hong Kong for "Knowledge Management in Higher Education Institutes: Promoting Video-Based Learning Communities in a Teacher Education University"; and Prof. Budsaba Kanoksilapatham, for "Local Thai Culture Represented in English Multimedia Teaching Materials for Young Learners". Their excellent speeches were well received by the audience and great contributions to this conference.

Meanwhile, we sincerely thank the contributions made by session chairs and reviewers. The chairperson of each session played an important role in guiding the sessions in a timely and efficient manner. Furthermore, the success of this conference could not be done without the reviewers, who volunteered their time in helping select high quality papers and provided invaluable constructive criticism to improve these papers.

We truly believe that the participants will find the discussion fruitful and enjoy the opportunity for setting up future collaborations.

Best Regards



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An Effective Learning Model Derived from Integration Problem-Based Learning and Digital Mind Maps to Enhance Students' Creativity

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ABSTRACT
In the present study, Problem-Based Learning and Digital Mind Maps (PBLDMM) were integrated to enhance five aspects of creativity that are originality, elaboration, fluency, flexibility, and risk-taking. This study adopted the Plomp research and development model which was performed in three stages; (1) the preliminary research phase, (2) development or prototyping phase, and (3) assessment phase. Course outline, lesson plans, student worksheets, and a checklist were developed to evaluate the implementation of the learning model. The effect of the learning model on students' creativity was analyzed using N-Gain, while the model's reliability was examined using regression analysis. The results showed that the PBLDMM model was valid (3.78) and had been consistently implemented in the classroom (F = 48.71). Students' responses (81.05) towards PBLDMM also confirmed the practicality of the learning model. The significant improvement in students' creativity was shown by the average pretest score (38.77) and posttest score (63.31) with N-Gain (0.41). This study has proven that PBLDMM model is valid, practical and effective in enhancing students' creativity.

CCS Concepts
• Applied computing→Education →Collaborative learning.

Keywords
Creativity; Digital Mind Maps; Problem-Based Learning

1. INTRODUCTION

ICEMT 2019, July 22–25, 2019, Nagoya, Japan

ACM ISBN 978-1-4503-7210-7/19/07…$15.00
https://doi.org/10.1145/3345120.3345138

The rapid development of the 21st century has brought a significant impact on the workforce. The demand for innovative and creative workers has actually increased [1]. Therefore, as an education provider, universities have a responsibility to design learning that is able to empower and enhance the creativity of students so that they are able to compete in the work field [2]. The design of learning should facilitate the stimulation of students' eagerness to discover, understand, analyze and apply knowledge in new situations [3] and the development of students' high-order thinking skills [4] because information memorization will not be able to empower creativity [5].

Being creative means being able to produce new products by involving interactions between capabilities and processes [6]. Creativity can also be interpreted as the act of developing new solutions [7] by examining separate concepts [8]. Creativity starts from the exploration of ideas so that ideas become the basis of creativity [9]. Mishra, Yadav, & Deep-Play Research Group [10] put novelty, effectiveness, and wholeness as key parts of creativity. Creativity does not only involve cognitive dimensions but also relates to common skills needed in everyday life such as ideas association, perceptions, analytical thinking, and structured problem discovery [11].

Creativity plays a crucial role in the 21st century as it triggers the advancement of civilization [12]. New ideas and new ways have been discovered to improve the productivity and standard of living. In fact, one's creativity can determine his/her success [13] because creativity may help him/her respond to and resolve complex problems [6]. Therefore, higher education needs to facilitate the development of students' creativity.

However, low-creativity students have been identified in some parts of Indonesia [14, 15]. The students' poor performance in creativity may be affected by the learning atmosphere that does not facilitate students' freedom in expressing ideas [13]. Instead, learning is mostly focused on acquiring knowledge through memorization [16]. Thus, it can be concluded that learning models implemented in the classrooms have not been effective in empowering the students' creativity [17]. One of the examples of effective learning models that can improve students' creativity is Problem-Solving Learning (PBL). PBL introduces real-world problems to students. It also allows students to evaluate and reflect on the problem-solving process [18, 19].

A number of studies have reported the effectiveness of PBL in promoting creativity in the classroom [20, 21] despite some insignificant improvements in certain aspects of creativity. For example, Sihaloho, Sahyar, & Ginting [22] showed that PBL and conventional only differed by 0.06 points in fluency and 0.38 points in flexibility. Other studies reported no significant difference between PBL and conventional in originality and scientific knowledge [23, 24].

As an active learning model, PBL consists of beneficial activities, but the shortcomings of the model have also been observed in PBL classrooms, such as the students' unpreparedness and lack of interest in studying the materials [25]. Since problems introduced in PBL are not always diverse and since some details might be slipped from the teacher's delivery of instruction, the students are unable to master the topics in their entirety [26, 27]. In addition to that, Moutinho, Torres, Jonana, Fernandez, & Vasconcelos [28] explained that PBL had not been able to develop students' creativity related to the nature of science.

These shortcomings can be overcome by incorporating mind mapping into PBL. A mind map is a representation of one's thoughts. It can be created using a graphic design [29]. Mind maps can be developed in a digital form. Digital mind maps (DMM) integrate the use of information technology in mind-mapping. Through DMM, students can represent their ideas using images, colors, and interesting fonts [30, 31].

The integration of PBL and DMM as active learning is expected to be able to improve university students' creativity. Digital mind-mapping encompasses brainstorming activity and deep analysis of materials so that a connection between concepts can be established [29]. Students' creativity can be boosted through the creation of a combined fascinating concept-image [31]. Envisaging the significance of integrating DMM into PBL in improving students' creativity, the current study thus aimed to develop the integrated Problem-Based Learning and Digital Mind Maps (Integrated PBLDMM) model.

2. METHOD

2.1 Research Design

The Plomp [32] research and development design was used in this study. It consisted of three following stages: (1) preliminary research phase, (2) development or prototyping phase, and (3) assessment phase. A group of students from the Department of Biology, Islamic University of Riau, who were studying Human Anatomy and Physiology, were involved as the subjects.

2.2 Research Instruments

The development of the research instruments and the data collection procedures was adjusted to the purpose of each development stage:

2.2.1 Preliminary Research

An interview and observation were performed to analyze learning activities. A questionnaire was also distributed to the students to elicit their responses. The findings were then used as the basis of the development of the learning model prototype. A literature review was also conducted at this stage.

2.2.2 Development or Prototyping

In the second phase, a model book and learning tools were designed. Course outline, lesson plans, student worksheet, and assessment rubric were developed as the tools to facilitate the learning process. A tryout was conducted to the prototype and the learning tools. Validation sheets and learning tools were the instruments used in this phase.

2.2.3 Assessment

To investigate the practicality and effectiveness of the model in improving students' creativity, it was tried out to a group of biology students for one semester. The instruments used at this stage were observation sheets, a questionnaire, and a creativity test. The creativity test had been confirmed valid (a significance level of 0.000) and reliable (0.75) using Cronbach's Alpha.

2.3 Data Analysis

Data obtained using the validation sheet were analyzed descriptively. The results of the analysis showed the validity of the model based on the following categories: invalid ($1.00 \leq V_a \leq 1.60$); less valid ($1.60 < V_a \leq 2.20$); moderately valid ($2.20 < V_a \leq 2.80$); valid ($2.80 < V_a \leq 3.40$); and highly valid ($3.40 < V_a \leq 4.00$). In addition, the practicality of the model was analyzed using a regression test, while the effectiveness of the model was examined using N-Gain. The results of the N-Gain analysis were described in three categories: high ($g > 0.7$), medium ($0.3 < g \leq 0.7$), and low ($g \leq 0.3$).

3. RESEARCH FINDING

3.1 Preliminary Research

The results of the observation showed that the majority of the students were "not ready" to engage in the process of learning, so when the lecturer asked them a question, only a few of them were able to answer it. When asked, the students admitted that they never read nor studied the materials at home. Therefore, we concluded that a mind-mapping task should be given to the students to help them better understand the materials in an organized way.

The learning process, indeed, had accommodated the students' cooperative skills. However, the task given to the students had not challenged the students' ability to solve problems. As a result, students' creativity had not been completely developed. The observation also showed that the students performed a lack of skills in explaining how to dive to the maximum depth of 20 meters. Their answers were mostly similar due to their unfamiliarity with the topic and inability to use creativity to cope with a certain complex problem.

These empirical findings, thus, provided insights for the study of theories underlying the process of developing the PBLDMM model. The review covered the theories of learning, learning models, and the findings of previous studies. Based on the results of the observation, interviews, survey, and literature review conducted at this stage, we finally learned how to incorporate Digital Mind Maps (DMM) into Problem-Based Learning (PBL) to produce a learning model that can empower students' creativity.

3.2 Development or Prototyping

The design of the PBLDMM model was based on the initial study when preliminary research. This model was designed by studying the PBL model phase and mind maps used in the learning process

Table 1. The Results of the Expert Validation of PBLDMM

No	Aspects to Evaluate	Average Scores
1	Rationalization of model	4 (highly valid)

No	Aspects to Evaluate	Average Scores
2	Theoretical Foundation	3.9 (highly valid)
3	Components of the Model	3.9 (highly valid)
4	Language Use	3.25 (valid)

No	Aspects to Evaluate	Average Scores
	Validity	**3.76 (highly valid)**

Prior to the implementation stage, the design of the learning model was discussed with some experts. The experts were invited to provide feedback and suggestions on several aspects (Table 1) and the design of the learning is presented in Table 2.

Table 2. The Phases of learning in PBLDMM

No	Phase	Learning Activities	
		Teacher	**Student**
1	Review of prior knowledge and the building of connection between the knowledge to the materials being learned using DMM	a. Asks students to present their DMM b. Asks some questions related to the concepts written on the DMM c. Explains the learning objective(s)	a. Pays attention to the DMM and the lecturer's explanation b. Provides answers to the lecturer's questions c. Listen to the lecturer's explanation
2	The orientation of the problem	Introduces students to the problem(s) by presenting some actual issues	Listens to the lecturer's explanation and attempts to formulate the problem(s)
3	Students' organization	a. Assigns students to work in groups b. Helps students to define the task(s) c. Asks students to prepare learning resources	a. Sits in groups b. Prepares the task (s) in groups c. Prepares all references relevant
4	Individual or group investigation	a. Motivates students to gather information b. Asks students to discuss the problem(s)	a. Collects relevant information b. Discusses the solution(s)
5	Presentation of the results of the investigation and the addition of more details into the DMM	a. Asks students to write down the information b. Asks students to utilize the information to enrich their DMM c. Asks students to present their work d. Opens a discussion after the presentation	a. Writes a report that contains problem(s) and the solution(s) b. Adds new information to the DMM c. Presents the result d. Be ready for the question and answer
6	Analysis and evaluation of the problem-solving process	a. Directs students to do reflection or evaluation b. Provides reinforcement c. Wraps up the lesson and assigns them a DMM task as homework	a. Reflects or evaluates the problem-solving process b. Listens to the lecturer's explanation c. Listens to the lecturer's explanation

3.3 Assesment

The PBLDMM model was implemented for six months. The practicality test results can be seen in Figure 1.

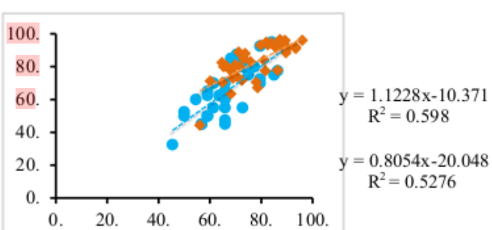

Figure 1. The Results of Regression PBLDMM Model

The results of the analysis showed that both lines were linear (not overlapping). It indicated that the PBLDMM model had a consistent feasibility pattern, where $F_{calculated}$ of linearity was 2.44 (a significance level of 0.12 (> 0.05)) and $F_{calculated}$ of overlap was 4.89 (a significance level of 0.01 (< 0.05)). The effectiveness of the model in improving students' creativity was examined using N-Gain (Table 3).

Table 3. The Results of the N-Gain Analysis

Score		N-Gain	Category
Pretest	**Posttest**		
38.77	63.31	0.41	Medium

The results of the N-Gain analysis presented in Table 3 showed that there was a difference in the students' creativity scores before and after the implementation of the PBLDMM model. The N-Gain score was categorized into the medium category (0.41).

4. DISCUSSION

The Integrated PBLDMM model developed in this study has been proven valid. Validity is one of the key aspects of Research and Development since it indicated the ability of an instrument to measure what it is supposed to measure [33]. The validity of the PBLDMM model in general covers the validity of the rationale for developing the model, of theories underlying the development of the model, of the components of the model, and of the language used.

The experts were invited to provide feedback and suggestions for improving the prototype. Some of the experts' advice is related to the addition of recent learning theories and more detailed explanation on teacher's and students' responses to the components of the model reaction principle. Based on the experts' suggestions, it can be concluded that theories underlying the model development consist of constructivism theory, social-cognitive theory, socio-cultural theory, and information acquisition theory. Learning theories which attempt to describe how humans learn help construct an understanding of a complex process of learning [34]. In this case, each of the learning theories mentioned earlier supports the phases of learning in PBLDMM model. They are explained as follows.

The first phase encourages students to create a DMM by connecting their prior knowledge to the materials being learned. The constructivism theory underlying the activity mentions that learners build their understanding based on individual experiences and implement this knowledge directly to their surrounding [35, 36]. The second phase is the orientation of problems. The foundation of this phase is Bruner's theory. This theory explains that, in order for learning to be effective, educators should provide scaffolding. Normally, this type of learning is carried out with certain patterns such as beginning the lesson with an inquiry from the instructor [37].

The third phase is the students' organization. Cooperative learning activity conducted at this phase is based on the cognitive apprenticeship concept. In the groups, students create an interaction which facilitates the exchange of ideas [38]. The fourth phase is guided individual or group investigation. Bandura [39] through his cognitive social theory argues that people learn from observing other people and the environment. Therefore, the teacher's or instructor's assistance is crucial in this phase.

The fifth phase is to develop the existing DMM by adding more details to it and to present the result. The practice of delivering a presentation is inseparable from the use of language. Thus, this phase basically refers to the socio-cultural theory which suggests that language enables social interactions to exist and one's thoughts to be understood [40]. The sixth is the analysis and evaluation of the problem-solving process. The experiential learning theory suggested by Kolb [41] underlying this activity suggests that all experiences gained by students in the learning process will be one of the guides for students to act in the future.

The practicality of the PBLDMM model was examined by disseminating the model into the field. The results showed that the feasibility pattern of PBLDMM was consistent. Consistency refers to the continuous and right implementation of the model [42]. Since all the procedures to conduct PBLDMM learning has been written in an organized manner in the guidance book, the lecturer could perform learning based on the order.

Student responses to the PBLDMM model are also very positive. Students feel motivated to learn more about the materials being studied with the use of DMM. Problem orientation can help students find solutions in group discussions. Students also claim to be able to convey ideas systematically. The various advantages found in the Integrated PBLDMM model are in accordance with the explanation of Chan and Yuen [17] who state that flexible learning conditions can improve students' creativity. In addition, the use of DMM with attractive graphics representation can also help students brainstorm ideas and concepts [31].

The effectiveness of the PBLDMM model was examined using N-Gain. The results of the N-Gain analysis showed that PBLDMM was effective in improving students' creativity. In PBLDMM, students are given an opportunity to express their ideas on DMM. At the first phase, where the students are asked to draw a mind map before coming to the classroom, their creativity is challenged. They need to add as many details as possible to the DMM. This type of learning atmosphere which establishes learning flexibility and autonomy can promote students' creative potentials. On the other hand, rigid, fixed, and scheduled learning can inhibit creativity [24].

Another reason that causes the PBLDMM model can improve creativity because in the learning process involves students in understanding the problem. Students themselves must formulate problems and find solutions. The activities can train students' thinking and creativity skills. The findings of this study are in line with previous research findings which have also proven the effectiveness of PBL in improving students' creativity [21, 24]. PBL is a learning model that is oriented to problem-solving. The existence of a problem can trigger one's deep thinking. Problem-solving involves individuals in an active search for meaningful information [43].

The effectiveness of PBL and mind map in improving creativity has been reported by many studies across disciplines [44, 45]. The goal is that the whole set of ideas can be transferred into various other situations. PBLDMM is also flexible in terms of utilizing a variety of ways of thinking, such as generating new ideas from different perspectives [2]. The PBLDMM model has been proven able to improve student creativity. The integration of problem-solving with the freedom of expressing ideas through DMM is the main property of PBLDMM as an active learning model. In addition to improving creativity, the PBLDMM model can also be proven to improve student learning outcomes. An overview of the results of the study that examines the PBLDMM model and learning outcomes will be presented in our other writings.

5. CONCLUSION

A valid, practical, and effective learning model has been generated in this study. This learning model is the result of the integration of Problem-Based Learning and Digital Mind Maps or the Integrated PBLDMM. The PBLDMM model has been proven effective in improving students' creativity. Therefore, it is highly recommended to use the model in the classroom, especially at universities. In addition, it is advisable for future researchers to investigate the effectiveness of PBLDMM in improving other skills, such as critical thinking, science literacy, and many others.

6. ACKNOWLEDGEMENTS

This research was supported by the Educational Fund Management Institution (LPDP), the Ministry of Finance with number FR2712018124893, and the the Ministry of Research, Technology & Higher Education of Indonesia.

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