International Journal of Instruction *October 2018 ● Vol.11, No.4*
e-ISSN: 1308-1470 ● www.e-iji.net *p-ISSN: 1694-609X*
pp. 287-302

Received: 05/03/2018
Revision: 06/06/2018
Accepted: 11/06/2018

Android-Assisted Mobile Physics Learning Through Indonesian Batik Culture: Improving Students' Creative Thinking and Problem Solving

Shabrina
Yogyakarta State University, Indonesia, *shabrina.hanani@gmail.com*

Heru Kuswanto
Yogyakarta State University, Indonesia, *herukus61@uny.ac.id*

This study produced an Android-assisted mobile physics-learning program to increase high school students' abilities in creative thinking and problem solving. The learning materials were based on local batik-making culture and included physics material on heat. The Research and Development (R & D) method was based on the 4D model-define, design, develop, and disseminate-with a experimental and control groups pretest-posttest design. For the operational field-testing, the participants were 60 students. The non-test research instruments included product and material validations, and the test instruments included pre- and post-tests. The data analysis techniques included descriptive statistics, N-Gain analysis, Hotelling's Trace multivariate statistical test, and analysis of effect size. The results showed that Android-assisted mobile physics learning, supported by local batik culture, is feasible for high school physics learning. Furthermore, based on the assessment by experts, teachers, and their peers, it lies in the "very good" category. The program was significantly effective in improving students' creative-thinking and problem-solving abilities based on gain scores of 0.81 and 0.96 in the "high" category and on effect-size analysis with scores of 0.268 and 0.269, interpreted as "large" effect sizes.

Keywords: physics mobile learning, local culture (batik), android, creative thinking ability, problem solving ability

INTRODUCTION

In the 21st century, the importance of education is increasing because we must ensure that students have the skills to learn, to innovate, and, especially, to use technology and information media so that they can work and make a living. Therefore, the Ministry of Education and Culture of the Republic of Indonesia has adapted three 21st century educational concepts in developing a new curriculum: 21st Century Skills (Trilling & Fadel, 2009), the Scientific Approach (Dyer, Gregersen, & Christensen, 2009), and Authentic Assessment (Wiggins & McTighe, 2011). These concepts were adapted to

Citation: Shabrina, & Kuswanto, H. (2018). Android-Assisted Mobile Physics Learning Through Indonesian Batik Culture: Improving Students' Creative Thinking and Problem Solving. *International Journal of Instruction*, 11(4), 287-302.

achieve conformity among the concepts and students' capacity, along with the competence of the educational staff and educators.

In the learning of physics, the goal is to produce competent problem solvers (Ding, Reay, Lee, & Bao, 2011), who use higher-order thinking skills that become the central component of the learning of physics (Docktor & Mestre, 2014). Students' attitudes toward problem solving in physics might influence their motivation to learn and to develop the necessary skills (Mason & Singh, 2010). Although students might learn to solve quantitative problems by incorporating numbers into algorithmic equations, they do not necessarily develop skills that transfer into more complex understanding and problem solving (Walsh, Howard, & Bowe, 2007). The depth of learning is still relatively shallow when students face a problem only until they figure out a solution (Witat, Eric, & Timothy, 2011).

Finding solutions to problems, or problem solving, occurs through higher-order thinking skills (Nitko & Brookhart, 2011). Problem solving requires thinking skills, including observing, reporting, describing, analyzing, classifying, interpreting, criticizing, predicting, drawing conclusions, and generalizing—all based on collected and processed information (Moore, 2012). However, the number of teachers who are fully aware of the complexity of problem solving and who adequately teach basic problem-solving skills is limited. By teaching problem-solving skills, we hope students develop their ability to address problems faced during the learning process further, both in and out of school.

The development of high-quality human resources who are skillful in the thinking process needs improvement in every aspect congruent with the 21st century conceptual framework for education (Boonjeam, Tesaputa, & Sri-Ampai, 2017). Indeed, thinking is one of the most important aspects of human life. A human being is the only creature on earth born with the unlimited creativity that profoundly affects human civilization. In fact, human civilization's development depends on new inventions that stimulate others' new, creative inventions. Moreover, creativity serves as a function of education (Wilson & Peterson, 2006), for it is possible to teach someone to think more flexibly, to solve problems creatively, and to explore science (DeHaan, 2009).

In the 21st century, creativity and the use of technology are crucially important skills (Henriksen, Mishra, & Fisser, 2016). Creativity involves identifying problems, finding solutions, evaluating them, and communicating results (Ayob, Hussain, & Majid, 2013). Using and teaching information and communication technology may help maximize thinking ability (Mokaram, Al-Shabatat, Fong, & Abdallah, 2011). The training to maximize creativity involves developing the individual, approaching the training process itself creatively, and optimizing learning (Ren & Tang, 2008). In fact, a creative learning environment influences academic achievement, motivation, involvement, and thinking skills (Davies, Snape, Collier, Digby, Hay, & Howe, 2013).

However, nowadays, a gap has appeared between the need for creativity and its implementation, especially in school education, which is oriented more toward the development of intelligence than of creativity (Munandar, 2014). Educators seem to have less understanding of creativity and how to develop it within the educational environment. Efforts to develop students' creativity requires improving the learning environment in certain ways (Toka, Bahtiyarb, & Karalökc, 2015), for example, through a direct learning environment and through encouraging open, flexible thinking without fear and shame (Louca, Marouchou, Mihai, & Konis, 2014). Furthermore, creativity provides an important contribution to learning. By attending to the emotional response in learning, creativity enhances understanding and encourages cognitive development (Beetlestone, 2013).

Certainly, due to technological development, the world's educational system is becoming more innovative, interactive, and effective (Ismail, Azizan, & Azman, 2013). In fact, the past few decades have provided some evidence regarding the positive effect of rapid technological change on education (Chen et al., 2012). Internet technology and technological developments have affected the adoption of innovations in various areas of human life, for our purposes here, especially in mobile learning. Mobile learning provides various application programs that students can access, for example, Android programs (Abildinovaa, Alzhanova, Ospanovab, Taybaldievac, Baigojanovaa, & Pashovkina, 2016). Android mobile learning may improve the teaching and learning process by emphasizing students' acquisition of knowledge (Shanmugapriya, 2012), and, furthermore, create opportunities to improve thinking skills and ability and problem solving (Dekhan, Xin, & Tsoi, 2013; McCann, 2015).

In addition, the rapid growth of technology significantly affects learning about cultural heritage (Hestiasari, Heidi, & Michael, 2016). Unfortunately, technology can affect the loss of traditional knowledge, so that local knowledge, wisdom, and skills must be preserved purposely and carefully (Mungmachon, 2010). Cultures affect the teaching and learning process; however, this now includes the notion that cultures need to adapt to scientific concepts (Yuenyong & Yuenyong, 2012). Within this context, UNESCO has designated Indonesia Batik as cultural heritage of Indonesia, that is, as Intangible Cultural Heritage (Wulandari, 2011). *Membatik*, the process of making batik, may be defined as technological because the process of waxing a pattern onto the cloth requires a tool named *canting* or *klowong* (Lisbijanto, 2013). Additionally, the process of making batik includes: boiling, *nyorek*, *nyanting / nglowong*, *nembok*, *nerusi*; coloring, *ngerok*, *ngelorod*; and drying (Samsi, 2011). For this study's mobile learning program, these processes were integrated into physics-teaching materials on heat (Figure 1) because culture-based or locally based learning models can improve students' creativity and learning outcomes (Pamungkas, Subali, & Lunuwih, 2017).

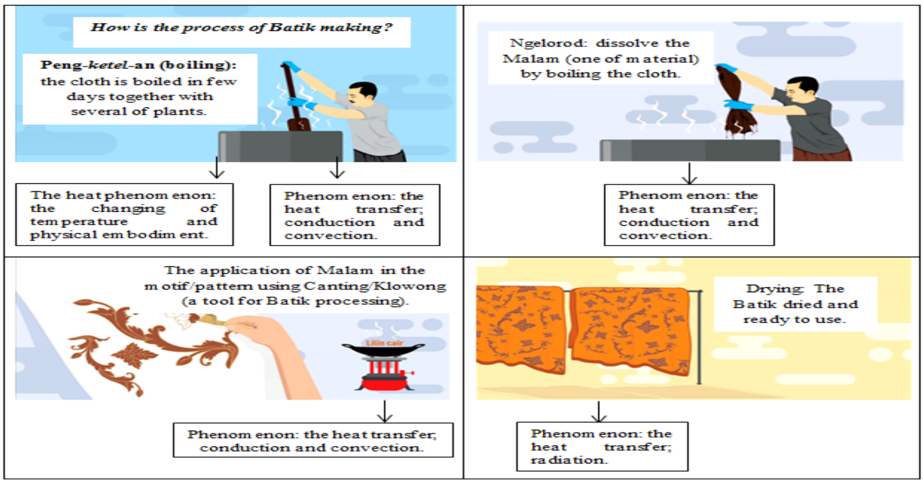


Figure 1
Physical Studies Review of the Batik-Making Process

Based on the background above, this research focuses on the development of Android-assisted physics mobile learning, employing Indonesia's local culture of batik making, to increase high school physics students' abilities in creative thinking and problem solving.

METHOD

This study used a Research and Development (R & D) method, specifically, the 4-D development model consisting of four main stages: (1) define; (2) design; (3) develop; and (4) disseminate. Tables 1 and 2 present a matrix of the Android-assisted mobile physics-learning program that employs local batik culture.

Table 1
Matrix of Integrated Media Development in Creative Thinking Ability

Indicator	Material			
	Temperature Change	Heat Transfer		
		Conduction	Convection	Radiation
Fluency:	Presented image of temperature change in the *pengketelan* (boiling) process.	Presented image of conduction heat transfer in the *Nyanting* process.	Presented image of convection heat transfer in the *Ngelorod* process.	Presented image of radiation heat transfer in the drying process.
Flexibility:	Presented a narrative of the concept of temperature change in the *pengketelan* (boiling) process.	Presented a narrative of the concept of conduction heat transfer in the *Nyanting* process.	Presented a narrative of the concept of convection heat transfer in the *Ngelorod* process.	Presented a narrative of the concept of radiation heat transfer in the drying process.
Originality:	Presented the formulation of a physical factor that affects the heat size through the *pengketelan* (boiling) process.	Presented the formulation of a physical factor that affects conduction heat size through the *Nyanting* process.	Presented the formulation of a physical factor that affects convection heat size through the *Ngelorod* process.	Presented the formulation of a physical factor that affects radiation heat size through the drying process.

Elaboration:	Presented the problem of temperature change in the *pengketelan* (boiling) process.	Presented the problem of conduction heat transfer in the *Nyanting* process.	Presented the problem of convection heat transfer in the *Ngelorod* process.	Presented the problem of radiation heat transfer in the drying process.

Table 2
Matrix of Integrated Media Development in Problem-Solving Ability

Indicator	Material			
	Temperature Change	Heat Transfer		
		Conduction	Convection	Radiation
Identifying and Formulating the Problem	Presented the problem of temperature change in the *pengketelan* (boiling) process.	Presented the problem of conduction heat transfer in the *nyanting* process.	Presented the problem of convection heat transfer in the *ngelorod* process.	Presented the problem of radiation heat transfer in the drying process.
Formulating the Hypothesis	Based on the problem statement, formulate a hypothesis about heat level in the *pengketelan* (boiling) process.	Based on the problem statement, formulate a hypothesis about conduction heat transfer in the *nyanting* process.	Based on the problem statement, formulate a hypothesis about convection heat transfer in the *ngelorod* process.	Based on the problem statement, formulate a hypothesis about radiation heat transfer in the drying process.
Hypothesis Testing: Collecting and Analyzing Data	Presented the experiment simulation on heat level in the process of *pengketelan* (boiling).	Presented the experiment simulation on conduction heat transfer in the *nyanting* process.	Presented the experiment simulation on convection heat transfer in the *ngelorod* process.	Presented the experiment simulation on radiation heat transfer in the drying process.
Make a Decision/ Draw a Conclusion.	Explained the factor that affects heat level in the *pengketelan* (boiling) process.	Explained the factor that affects the level of conduction heat transfer in the *nyanting* process.	Explained the factor that affects the level of convection heat transfer in the *ngelorod* process.	Explained the factor that affects the level of radiation heat transfer in the drying process.

Validation of research instruments was conducted using V Aiken analysis with a rater who is an expert lecturer. Scores from the rater were calculated using V Aiken's formula according to equation (1):

$$V = \frac{\sum s}{n(c-1)}, \text{with } S = r - l_o \quad (1)$$

Where: r is the number given by an assessor; l_o is the lowest validity score; n is the number of the assessor; and c is the highest validity score.

The scores obtained were converted into four criteria with V Aiken's index range from 0–1 (Table 3).

Table 3
Criteria of Validity

Validity Result	Criteria of Validity
$0.8 < V \leq 1$	Very Good
$0.6 < V \leq 0.8$	Good
$0.4 < V \leq 0.6$	Adequate
$0.2 < V \leq 0.4$	Less than Adequate

Reliability was calculated by determining the percentage of rater agreement using the Borich formula according to equation (2):

$$R = \{1 - \frac{(A-B)}{(A+B)}\} \times 100\% \tag{2}$$

Where: R is the percentage of expert agreement; A is the highest score; and B is the lowest score. The validation result for Android mobile learning is reliable if the reliability score is greater than 75%. The assessment result of Android mobile learning was analyzed by calculating the average score assessment from expert lecturers and teachers. Each component's average score was calculated according to equation (3):

$$\bar{X} = \frac{\sum X}{n} \tag{3}$$

Where: $\bar{X}$ is the mean score; $\sum X$ is the total score of each component; and n is the number of assessors. Table 4 presents the score change references.

Table 4
Criteria of Assessment

Quantitative Score Categories	Category
$X > \bar{X}_i + 1.8\ sb_i$	Very Good
$\bar{X}_i + 0{,}6\ sb_i < X \leq \bar{X}_i + 1.8\ sb_i$	Good
$\bar{X}_i - 0{,}6\ sb_i < X \leq \bar{X}_i + 0.6\ sb_i$	Good Enough
$\bar{X}_i - 1{,}8\ sb_i < X \leq \bar{X}_i - 0.6\ sb_i$	Less Good
$X \leq \bar{X}_i - 1.8\ sb_i$	Very Less Good

Where: X is the empirical score; $\bar{X}_i$ is the average of ideal scores calculated from $(\frac{1}{2})$ (ideal maximum score + ideal minimum score); sb_i is the ideal score of standard deviation calculated from $(\frac{1}{6})$ (ideal maximum score –ideal minimum score); the ideal maximum score is $\sum$ item criteria x the maximum score; and the ideal minimum score is $\sum$ item criteria x the minimum score.

The task for creative thinking ability and problem solving was validated both by an expert lecturer and by an empirical process. The analysis was conducted using the QUEST program to determine the number of questions fit for use. To determine students' achievement ability after they used the Android-assisted mobile physics learning, we calculated the percentage of students' scoring results using equation (4):

(4)

$$\bar{X} = \frac{\sum Si}{S} \; x\ 100\%$$

Where: $\bar{X}$ is the percentage score; $\sum Si$ is the number of scores obtained by each indicator; and S is a maximum score for each indicator.

This research was conducted in Yogyakarta, Indonesia. The study's participants were 30 high school students in the limited field trial and 60 for the operational field test. The research instruments consisted of test instruments, including a pre- and post-test, and non-test instruments, including product and material validation. The data analysis techniques were descriptive statistics, N-Gain analysis, Hotelling's Trace multivariate statistical test, and analysis of effect size. Pre-test and post-test analysis was obtained by gain score. The criteria for interpretation were based on *gain* according to gain score criteria (Table 5), and the gain score was obtained using equation (5):

$$g = \frac{\bar{x}\ score\ of\ posttest - \bar{x}\ score\ of\ pretest}{Maximum\ scale\ - \bar{x}\ score\ of\ pretest} \qquad (5)$$

Table 5
Category Conversion of Gain Score

Limit	Category
$g > 0.70$	High
$0.30 \leq g \leq 0.70$	Medium
$g < 0.30$	Low

The influence of the developed product (Android-assisted physics mobile learning with local batik culture) on improving students' creative thinking and problem solving was calculated by using effect size, which is a measurement of a variable's effect on other variables, with the difference or the association between variables independent of the sample size's influence. Effect size is obtained by calculating Cohen's f score from the score transformation of the eta square in the table of test between-subject effects when conducting Hotelling's Trace analysis (Table 6). Cohen's f score can be calculated using equation (6):

$$f = \sqrt{\frac{\eta^2}{1-\eta^2}} \qquad (6)$$

Table 6
Score Interpretation of Effect Size

Cohen's f	Interpreted Effect Sizes
0.00–0.10	Small
0.11–0.25	Medium
0.26–0.40	Large

FINDINGS AND DISCUSSION

The instrument validity test was conducted using V Aiken's test for two assessors, experts and physics teachers. The assessment instrument's reliability test was conducted using Borich's formula. Table 7 presents each assessment instrument's validity and reliability.

Table 7
Result of Instrument Validity and Reliability Testing

No.	Data Collection Instrument	Coefficient of V Aiken	Explanation	Reliability
1.	Task Assessment Sheet	1.00	Valid	Reliable
2.	Product Assessment Sheet	1.00	Valid	Reliable

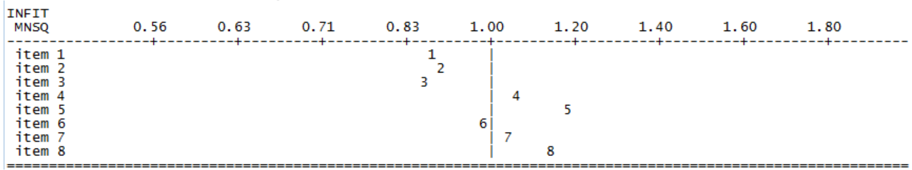
The results of product assessment were compiled based on a scale from 0 to 3, validated by expert lecturers. Table 8 presents assessment results of Android-assisted mobile physics learning.

Table 8
Assessment Result of Android-Assisted Mobile Physics Learning

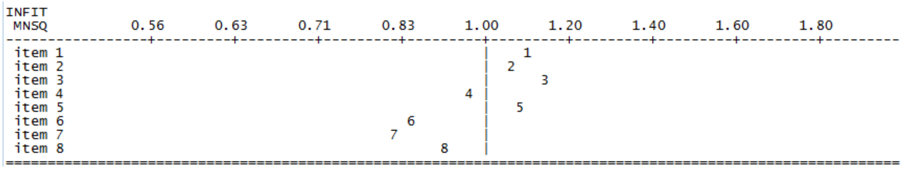
No.	Aspect	Assessment Result	Category
Material			
1.	Learning	2.94	Very Good
2.	Content Completeness	2.96	Very Good
3.	Material and Task	2.84	Very Good
Media			
4.	Program Operation	2.63	Very Good
5.	Navigation Using	2.88	Very Good
6.	Display Quality	3.00	Very Good
7.	Illustration Quality	2.75	Very Good
8.	Software development	3.00	Very Good
Average Score		2.88	Very Good

As Table 8 shows, the average assessment score for feasibility of the Android-assisted mobile physics-learning program was 2.88 in the "very good" category.

After the instrument validity test, we continued to the instrument reliability test to measure students' creative-thinking and problem-solving abilities. The instrument consisted of 16 items, eight each for the pre- and post-test. The instrument's pre- and post-test tasks consisted of four items each on creative-thinking and problem-solving abilities. As Figure 2 shows, the task item fit with PCM or was feasible. The infit mean square score was in the range of 0.77 to 1.33.



(a) Creative-Thinking Test



(b) Problem-Solving Test

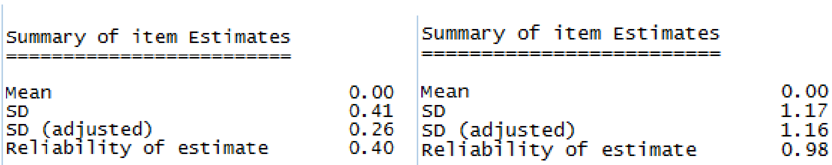
Figure 2
Analytical Results of Empirical Trial

The QUEST program and internal consistency were used to conduct the reliability test of creative-thinking and problem-solving ability. The instrument's internal consistency score showed its overall reliability score, and Table 9 presents the interpretation of the instrument reliability scores.

Table 9
Interpretation of Reliability Scores

Reliability Score	Interpretation
0.00–0.20	Less Reliable
> 0.00–0.40	Approximately Reliable
> 0.40–0.60	Adequately Reliable
> 0.60–0.80	Reliable
> 0.80–1.00	Very Reliable

As Figure 3 shows, the empirical test results show the reliability score of creative-thinking and problem-solving items; scores were 0.40 in the "adequately reliable" category and 0.98 in the "very reliable" category.


Summary of item Estimates

	(a)	(b)
Mean	0.00	0.00
SD	0.41	1.17
SD (adjusted)	0.26	1.16
Reliability of estimate	0.40	0.98

(a) Creative-Thinking Test (b) Problem-Solving Test

Figure 3
Analytical Results of Empirical Tests

The operational field trials were conducted in two classes: an experimental and a control class. Tables 10 and 11 present the data for pre- and post-test creative-thinking and problem-solving abilities.

Table 10
Creative-Thinking Ability Test Result

Class	Average of Creative-Thinking Ability		Average of Gain Score	Category
	Pre-test	*Post-test*		
Experimental	34.44	87.78	0.81	High
Control	36.11	61.11	0.39	Medium

Table 11
Problem-Solving Ability Test Result

Class	Average of Problem-Solving Ability		Average of Gain Score	Category
	Pre-test	*Post-test*		
Experimental	50.20	98.33	0.96	High
Control	45.63	78.96	0.62	Medium

Figures 4 and 5 present the results of enhancing creative-thinking and problem-solving abilities in the experimental and control classes.

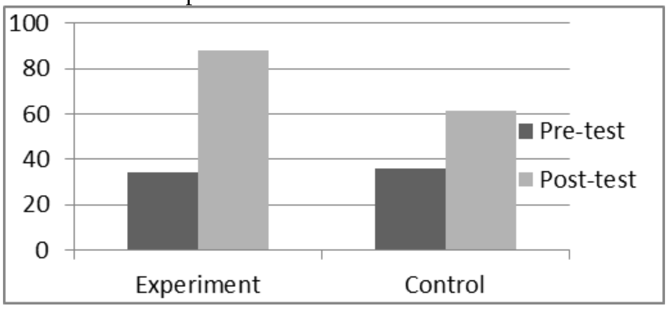


Figure 4
Creative-Thinking Ability Enhancement

Based on Figure 4, the average score for pre- and post-test of creative thinking ability in the experimental class increased to the “high” category. Dekhane’s research, Xu and Tsoi (2013), and Crompton (2017) indicated that mobile applications could increase students’ thinking and problem-solving abilities. The pre- and post-test analysis indicated a significant increase in students’ thinking ability on a particular problem. The results of our study confirm that culture-based or locally based learning models can improve students’ creativity and learning outcomes (Pamungkas, Subali, & Lunuwih, 2017).

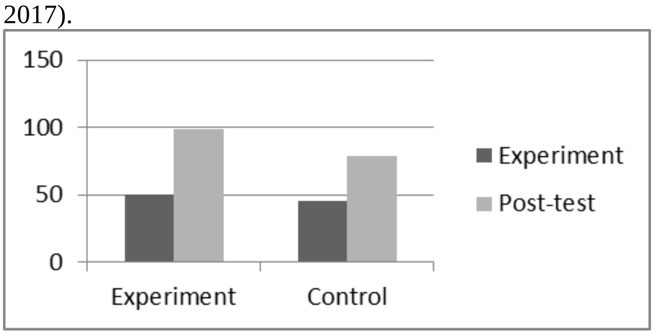


Figure 5
Problem-Solving Ability Enhancement

Based on Figure 5, the average score for pre- and post-test problem-solving ability in the experimental class increased to the “high” category. These results are similar to those of

Yadiannur and Supahar (2017), who stated that mobile learning applications could improve problem-solving ability in electrical circuitry.

Statistical testing was conducted on the mobile physics-learning program's influence by using multivariate analysis (MANOVA). The data in the MANOVA test includes the gain score data for each variable, i.e., creative-thinking and problem-solving ability. The gain score data for the control and experimental classes can be analyzed by MANOVA if the requirements for normality and homogeneity tests are met. The normality test indicates whether the data is normally distributed or not. As Table 12 shows, the Pearson correlation test obtained the score of sig. 0.000, more than $\alpha = 0.05$; according to the significance level of $\alpha = 0.05$, then, data from both classes were normally distributed.

Table 12
Normality Test Result

Class	Pearson Correlation	Significance
Experimental	0.901	0.000
Control	0.966	0.000

The homogeneity test determines the homogeneity of the dependent variable's variances matrix (Table 13).

Table 13
Homogeneity Test Result

Variable	Box's M	F	df1	df2	sig.
Ability in Creative Thinking and Problem Solving	3.486	1.119	3	605520.0	0.340

As Table 13 shows, the score of sig. is 0.340, more than $\alpha = 0.05$; then, according to the significance level of $\alpha = 0.05$, the dependent variable's covariance variant is homogeneous.

Hotteling's Trace multivariate test was used to determine differences between the two experimental classes in two variants. Based on the test function, we calculated students' improvement in creative thinking and problem solving from the use of the mobile physics program for the experimental class and the use of macromedia flash media for the control class (Table 14).

Table 14
Result of Hotteling's Trace Multivariate Test

Effect	Significance	Decision Criteria
Hotteling's Trace	0.000	sig. < 0.05

As Table 14 shows, the sig. score was 0.000, less than $\alpha = 0.05$; then, according to the significance level of $\alpha = 0.05$, the two classes' averages differed significantly.

Next we calculated the effect size of the mobile physics-learning program's influence on creative thinking and problem solving. Table 15 presents the results of Cohen's f calculations.

Table 15
Calculation Results of Effect Size on Creative Thinking and Problem Solving

Variable	Eta Squared	Cohen’s f	Interpretation
Creative Thinking	0.259	0.268	Large Effect Size
Problem Solving	0.260	0.269	Large Effect Size

As Table 15 shows, Cohen’s f scores were 0.268 and 0.269, a “large” effect on both variables. In other words, the Android-assisted mobile physics-learning program with local batik culture greatly influenced students’ improved creative thinking and problem solving.

The following figures (6–10) display some sample pages from the Android-assisted mobile physics-learning program.

Figure 6
Title page of the Android-assisted mobile physics-learning program

Figure 7
Menu display page, including introduction, competence, material, evaluation, literature, and glossary functions

The Introduction contains narrative material on heat, heat transfer, and a concept map on heat material integrated with local batik culture. Competence contains the measured abilities of creative thinking and problem solving. The material consists of heat and heat transfer (conduction, convection, and radiation). The evaluation consists of the two tests on creative thinking and problem solving. The literature contains a list of sources, and the glossary consists of a list of terms.

Figure 8
Heat materials display page

Figure 9
The display of the creative-thinking test, which consists of four essay items representing fluency indicators (fluency, flexibility): creating ideas from different perspectives, originality, and elaboration.

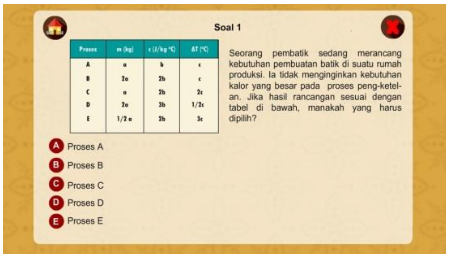


Figure 10
The display of the problem-solving test, which consists of four multiple-choice items as indicators of (A) identifying and formulating the problem, (B) formulating hypotheses, (C) hypothesis testing, (D) collecting and analyzing data, and (E) making decisions / drawing conclusions.

CONCLUSION

The developed product—Android-assisted mobile physics learning with local batik culture—has the following characteristics: (1) The software product is operated in an Android device. (2) Students can use the program both in the classroom during learning activities and outside the classroom. (3) The developed program contains a menu of competencies, subject material, and tasks / evaluation, all integrated with batik-making material on heat. (4) Content and tests effectively improved students' creative-thinking and problem-solving abilities.

REFERENCES

Abildinovaa, G. M., Alzhanova, A. K., Ospanovab, N. N., Taybaldievac, Z., Baigojanovaa, D. S., & Pashovkin, N. O. (2016). Developing a mobile application "educational process remote management system" on the android operating system. *International Journal Of Environmental & Science Education*, *11*(12), https://files.eric.ed.gov/fulltext/EJ1115632.pdf

Ayob, A., Hussain, A., & Majid, R. A. (2013). A review of research on creative teachers in higher education. *International Education Studies*, *6*(6), http://dx.doi.org/10.5539/ies.v6n6p8

Beetlestone, F. (2013). *Creative Learning* (Translate by Narulita Yusron). Bandung: Nusa Media

Boonjeam, W. Tesaputa, K., & Ampai, A. S. (2017). Program development for primary school teachers' critical thinking. *International Education Studies, 10*(2), http://dx.doi.org/10.5539/ies.v10n2p131

Chen, S., Lo, H.C., Lin, J.W., Liang, J.C., Chang, H.Y., Hwang, F.K., Chiou, G.L., Wu, Y.T., Lee, S.W.Y., Wu, H.K., Wang, C.Y. & Tsai, C.C. (2012). Development and implications of technology in reform-based physics laboratories. *Physical Review Special Topics - Physics Education Research*, *8*(2), http://dx.doi.org/10.1103/PhysRevSTPER.8.020113

Crompton, H. (2017). Using mobile learning to support students' understanding: A design-based research study. *Educational Technology & Society*, *20*(3), http://www.jstor.org/stable/26196131

Davies, D, Snape, D. J, Collier, C., Digby, R, Hay, P., Howe, P. (2013). Creative learning environments in education—A systematic literature review. *Thinking Skills and Creativity 8*, https://doi.org/10.1016/j.tsc.2012.07.004

DeHaan, R. L., (2009). Teaching creativity and inventive problem solving in science. CBE—Life Sciences Education, *8*, http://dx.doi.org/10.1187/cbe.08 –12– 0081

Dekhane, S., Xu, X, & Tsoi, M. Y. (2013). Mobile app developmpent to increase student engagement and problem solving skill. *Journal of Information Systems Education*, *24*(4), https://www.learntechlib.org/p/156711/

Ding, L.. Reay, N., Lee, A., & Bao, L.(2011). Exploring the role of conceptual scaffolding in solving synthesis problems. *Physical Review Special Topics-Physics Education Research*, *7*, https://doi.org/10.1103/PhysRevSTPER.7.020109

Docktor, J. L., & Mestre, J. P. (2014). Synthesis of discipline-based education research in physics. *Physical Review Special Topics - Physics Education Research*, *10*(2), http://dx.doi.org/10.1103/PhysRevSTPER.10.020119

Dyer, J. H.; Gregersen, H. B., & Christensen, C. M. (2009). *The Innovator's DNA*. Harvard Business Review

Henriksen, D., Mishra, P., & Fisser, P. (2016). Infusing creativity and technology in 21st century education: A systemic view for change. *Educational Technology and Society*, *19*(3), 27-37, http://www.ifets.info/journals/19_3/4.pdf

Hestiasari, R., Heidi, S., & Michael, L. (2016). A preliminary design of batikids: A game-based learning to support children learning the process of producing traditional batik in museum context. *International Journal of Information and Education Technology*, *6*(7), http://dx.doi.org/10.7763/IJIET.2016.V6.755

Ismail, I., Azizan, S. N. & Azman, N. (2013). Mobile phone as pedagogical tools: Are teachers ready? *International Education Studies*, *6*(3), http://dx.doi.org/10.5539/ies.v6n3p36

Louca, E. P., Marouchou, D. V., Mihai, S., & Konis, E. (2014). Teaching for creativity in universities. Journal of Education and Human Development http://dx.doi.org/10.15640/jehd.v3n4a13

Walsh, L. N., Howard, R., & Bowe, B. (2007). Phenomenographic study of students' problem solving approaches in physics. *Physical Review Special Topics-Physics Education Research, 3,* https://doi.org/10.1103/PhysRevSTPER.3.020108

Lisbijanto, H. (2013). *Batik*. Yogyakarta: Graha Ilmu

Mason, A. & Singh, C. (2010). Surveying graduate students' attitudes and approaches to problem solving. *Physical Review Special Topics-Physics Education Research,* https://doi.org/10.1103/PhysRevSTPER.6.020124

McCann, S. (2015). Higher order mlearning: critical thinking in mobile learning. MODSIM World, 028, http://www.modsimworld.org/papers/2015/Higher_Order_mLearning.pdf

Mokaram, A. A. K., Al-Shabatat, A. M., Fong, F.S., & Abdallah, A. A. (2011). Enhancing creative thinking through designing electronic slides. *International Education Studies*, *4*(1), https://files.eric.ed.gov/fulltext/EJ1066383.pdf

Moore, K. D. (2012). *Effective instructional strategies from theory to practice* 3rd *ed.* USA: Sage Publications, Inc

Munandar, U. (2014). *Pengembangan kreativitas anak berbakat.* Jakarta: Rineka Cipta

Mungmachon, R. (2010). Knowledge and local wisdom: community treasure. *International Journal of Humanities and Social Science*, *2*(13), http://www.ijhssnet.com/journals/Vol_2_No_13_July_2012/18.pdf

Nitko, A. J. & Brookhart, S. M. (2011). *Educational assesment of student sixth edition.* USA: Pearson

Pamungkas, A., Subali, B., & Lunuwih, S. (2017). Implementasi model pembelajaran IPA berbasis kearifan lokal untuk meningkatkan kreativitas dan hasil belajar siswa. *Jurnal Inovasi Pendidikan IPA*, *3*(2), http://dx.doi.org/10.21831/jipi.v3i2.14562

Ren, L. J. & Tang, Z. (2008). An exploration of creative talents training. *International Education Studies, 1*(2)

Samsi, S. S. (2011). *Teknik dan Ragam Hias Batik.* Yogyakarta: Titian *Foundation*

Shanmugrapiya, M. (2012). Developing a mobile adaptive test (mat) in an m-learning environment for android based 3G mobile devices, *4*, http://www.enggjournals.com/ijcse/doc/IJCSE12-04-02-074.pdf

Toka, S., Bahtiyarb, S., & Karalökc, S. (2015). The Effects of Teaching Mathematics Creatively on Academic Achievement, Attitudes towards Mathematics, and Mathematics Anxiety. *International Journal of Innovation in Science and Mathematics Education, 23*(4), 1-24

Trilling, B. & Fadel, C. (2009). *21st century skills.* USA: Jossey-Bass

Wiggins, G., & McTighe, J. (2011). *The understanding by design guide to creating highquality units.* Alexandria, VA: ASCD

Wilson, S. M. & Peterson, P. L. (2006). Theories of learning and teaching what do they mean for educators?Washington: National Education Association

Witat, F., Eric, P., & Timothy. (2011). What students learn when studying physics practice exam problems. *Physical Review Special Topics-Physics Education Research, 7,* http://dx.doi.org/10.1103/PhysRevSTPER.7.010107

Wulandari, A. (2011). *Batik nusantara: makna, filosofis, cara pembuatan, dan industri batik.* Yogyakarta: Andi

Yadiannur, M. & Supahar. (2017). Mobile learning based worked example in electric circuit (WEIEC) application to improve the high school students' electric circuits interpretation ability. *International Journal of Environmental & Science Education,* https://files.eric.ed.gov/fulltext/EJ1141565.pdf

Yuenyong, J. & Yuenyong, C. (2012). Connecting between culture of learning in Thai contexts and developing students' science learning in the formal setting. *Procedia - Social and Behavioral Sciences*, *46*, https://doi.org/10.1016/j.sbspro.2012.06.441