The Influence of the Implementation of Android-Assisted Experiential Learning Model-Based Science Learning on Students’ Scientific Literacy

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Abstract. This study aims to determine the effect of implementing an android application which was based on Experiential Learning Model (ELM) on students’ scientific literacy in terms of knowledge, competencies, and attitude. This research was a quasi-experiment with pre-post research of non-equivalent control group design. The population of the study were students of grade VII Junior High Schools in Kotawaringin Timur Regency. The sample was selected by stratified random sampling technique based on school stratification, which included high, medium, and low category schools. Research data of scientific literacy knowledge and competencies were measured using test instrument, while scientific research literacy attitude data was measured using non-test instrument (self-assessment questionnaire). The data analysis technique used was one-way manova with significance level of .05. The result of the data analysis showed that science learning which was based on Experiential Learning Model (ELM) with android support has significant influence on the scientific literacy, covering some aspects: knowledge, competencies, and attitude of students of grade VII Junior High Schools in Kotawaringin Timur Regency.

Keywords: Android, Learning Model, Science Learning, Scientific Literacy

1. Introduction

The characteristics of 21st century learning include the integration of model of innovative and creative learning with the most current technological media. It aims to equip students with knowledge for technology-driven world, and then apply the knowledge in the real-life context. The number of scientific and technological products is growing rapidly. This is a factor that requires a person to have scientific literacy. The importance of training students on this skill is seen from OECD’s assessment on scientific literacy in PISA [1]. It is important to apply the most appropriate learning model in order to achieve that goal. One of the suggested learning models is experiential learning model (ELM). Apart from that, another learning component that is perceived to be essential in achieving satisfying learning outcomes is the use of appropriate learning media. In today’s digital era, students are better known as digital native since they are exposed to the utilization of computer media and the internet. One of the learning media which can be effectively applied in this modern day is smartphones with Android OS. Based on these rationales, this study aims to analyze the influence of ELM-based science learning using Android on students’ scientific literacy. Android is a Linux-based mobile operating system (OS) developed by Google and is designed for touch-screen mobile devices such as smartphones, tablets, televisions (android TV), cars (android auto), and watches (android wear) [2]. The learning materials applied in
ELM science lessons are Environmental Pollution and Global Warming. These learning materials are given to grade VII students of Junior High School in the even semester. Global Warming material taught since 1980s, focusing on three aspects, namely: scientific mechanism, influence factors, and policy decision. The scientific and influence factors aspect require students’ conceptual understanding [3]. The learning media used is the implementation of Hi_Science. This app can be run in Android smartphone. By adopting LKPD (students worksheet) [3], a concept proposed by Taufik, Hi_science app was developed. Hi_Science has been designed in such a way that all stages of the ELM are facilitated in this application. According the validation result: (1) material aspects of Hi_Science has obtained the average value 4.72 that means Hi_Science on the material aspects is in excellent category, (2) media aspects has obtained the average value 4.53 that means Hi_Science on the media aspects is in excellent category. The result of these validation showed Hi_Science as instructonal media can be applied in the junior high school [4].

2. Method

This research is a quasi-experiment with pre-post research design of non-equivalent control group design. Selection of research sample was done by stratified random sampling technique based on school stratification, i.e.: school with high, medium, and low category. The categorization of schools was based on the average score of the National Exam on science subject in the last three years. Based on the analysis of the National Exam on Science subject average score, the researchers selected 4 schools, namely: SMPN 1 Sampit representing high category school, SMPN 3 Sampit and SMPN 1 MHS representing medium category schools, and SMPN 2 MHS representing low category school. In each school, random sampling was done by cluster sampling technique, then categorizing the students into two classes: experimental class and control class. The experimental class was given a treatment in the form of implementation of ELM-based Science learning using android application. While in the control class, conventional learning process was applied. The test instrument used to measure the scientific literacy was adopted from a research conducted by Taufik [3]. The scientific literacy tool of the knowledge aspect consists of 20 items of multiple choices with the mean value of INFIT MNSQ was .99 and SD .25. The scientific literacy components of the competency aspect consist of 20 multiple choice questions with MNSQ’s INFIT value of 1.00 and SD 0.17 [3]. This result shows that all the questions on the instrument were considered fit within the acceptance limit ≥ .77 to ≤ 1.30, meaning that all test items were of good quality. Scientific literacy attitude aspect was measured using student attitude questionnaire, consisted of 15-point statement using likert scale. The grid of scientific literacy ability in this research was presented in Table 1, Table 2, and Table 3.

| Table 1. The framework of scientific literacy on knowledge aspect |
|---------------------------------|-----------------|
| **Indicators**                  | **Cognitive dimension** |
| 1. Defining environmental pollution | C1               |
| 2. Mentioning factors causing environmental pollution | C1               |
| 3. Mentioning the influence of pollution on living things | C2               |
| 4. Mentioning how to cope with environmental pollution | C1               |
| 5. Describing the definition of greenhouse gas | C2               |
| 6. Mentioning examples of greenhouse gases and their sources | C1               |
| 7. Describing the process of greenhouse effect | C2               |
| 8. Explaining the impact of global warming | C2               |
| 9. Analyzing the data of experimental results of systematic greenhouse effect | C4               |
| 10. Addressing global warming prevention efforts | C1               |
Table 2. The framework of scientific literacy on competence aspect

| Indicator             | Criteria                                                                 | Cognitive dimension |
|-----------------------|---------------------------------------------------------------------------|---------------------|
| Identifying scientific issues | 1. Generating keywords to search for scientific information | C2                  |
|                       | 2. Identifying the key forms of scientific inquiry                        | C2                  |
| Describing scientific phenomena | 3. Applying scientific knowledge on the given situation                   | C3                  |
|                       | 4. Describing scientific phenomena and predicting scientific changes      | C4                  |
|                       | 5. Identifying appropriate description and explanation                      | C2                  |
| Using scientific evidence | 6. Interpreting scientific evidences                                      | C4                  |
|                       | 7. Making and conveying conclusion                                         | C4                  |
|                       | 8. Identifying assumption, evidences and reasoning behind conclusion.      | C2                  |

Table 3. The framework of scientific literacy on attitude aspect

| Indicator                      | Criteria                                                                                                                                 |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Interest in scientific issues | 1. Curiosity in science and scientific issues.                                                                                           |
|                               | 2. Availability to acquire additional scientific knowledge and skills, using various resources and methods.                               |
| Scientific inquiry support    | 3. Commitment to provide empirical evidences as the basis of the explanatory beliefs of the world.                                       |
|                               | 4. Commitment to a scientific approach to the statement at the right moment.                                                             |
| Environmental awareness       | 5. A concern for environment and sustainable living.                                                                                     |
|                               | 6. Students’ belief that human actions can contribute to maintain and improve the environment.                                           |

The feasibility of Hi_Science learning media had been assessed by 7 validators, consisting of 2 experts (lecturers) and 3 practitioners (teachers). The results of the assessment showed an average score of 4.64, which encompassed in the excellent category. It indicated that Hi_Science application was very feasible to be applied in the learning process.

3. Results and Discussion

3.1. Pre-test and post-test results of scientific literacy ability

Pre-test and post-test results of scientific literacy ability in four schools shows in Table 4.

Table 4. Results of scientific literacy ability test

| School: SMPN 1 Sampit (experimental class: 31 students and control class: 26 students) |
|---------------------------------|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                                  | Knowledge | Competencies | Attitude        |                  |                  |                  |                  |
| Result                          | Experiment | Control     | Experiment | Control | Experiment | Control | Experiment | Control |
| Pre Post                         | Pre Post   | Pre Post    | Pre Post   | Pre Post | Pre Post   | Pre Post | Pre Post   | Pre Post |
| Gain                            | 24.46      | 17.29       | 28.9       | 15.3     | 12.32      | 3.50    |
| N-gain                          | .35        | .23         | .36        | .21      | .35        | .07     |
| Category                        | medium     | low         | medium    | low      | medium    | Low     |

School: SMPN 3 Sampit (experimental class: 36 students and control class: 36 students)

| Result                          | Experiment | Control     | Experiment | Control | Experiment | Control | Experiment | Control |
| Pre Post                         | Pre Post   | Pre Post    | Pre Post   | Pre Post | Pre Post   | Pre Post | Pre Post   | Pre Post |
| Gain                            |            |             |            |         |            |         |            |         |
| N-gain                          | .35        | .23         | .36        | .21      | .35        | .07     |
| Category                        |            |             | medium    | low      | medium    | Low     |
Gain   | 22.3 | 15.6 | 25.3 | 15.4 | 19.5 | 10.3 |
N-gain | 0.32 | 0.23 | 0.34 | 0.22 | 0.51 | 0.24 |
Category| medium | low | medium | low | medium | Low |

School: SMPN 1 MHS (experimental class: 27 students and control class: 25 students)

| Result | Knowledge | Competencies | Attitude |
|--------|-----------|--------------|----------|
|        | Experiment | Control      | Experiment | Control      | Experiment | Control      |
| Gain   | Pre Post   | Pre Post     | Pre Post   | Pre Post     | Pre Post   | Pre Post     |
|        | 34.81     | 17.20        | 29.43      | 13.27        | 11.05      | 3.90         |
| N-gain | 0.47      | 0.25         | 0.38       | 0.20         | 0.31       | 0.08         |
| Category| medium | low | medium | low | medium | Low |

School: SMPN 2 MHS (experimental class: 31 students and control class: 26 students)

| Result | Knowledge | Competencies | Attitude |
|--------|-----------|--------------|----------|
|        | Experiment | Control      | Experiment | Control      | Experiment | Control      |
| Gain   | Pre Post   | Pre Post     | Pre Post   | Pre Post     | Pre Post   | Pre Post     |
|        | 39.23     | 23.46        | 28.7       | 14.6         | 12.65      | 7.20         |
| N-gain | 0.43      | 0.29         | 0.34       | 0.20         | 0.39       | 0.20         |
| Category| medium | low | medium | low | medium | low |

Table 4 shows that the average score at all schools in the experimental class is higher than the mean score in the control class in all aspects of scientific literacy. This means that the increase in scientific literacy skills in the experimental class is higher than the control class. The N-gain categorization results indicate that the experimental class was classified as moderate category, while the control class was in the low category at all schools as sample of these research.

3.2. Comparison of scientific literacy improvement

Comparison of students’ literacy improvement can be seen from the normalized average gain score in the experimental class and control class in all school categories. The comparison is shown by the histogram in Figure 1. Figure 1 shows that the highest increase in scientific literacy ability occurs in the experimental class of SMPN 3 Sampit especially on the attitude aspect. While the lowest scientific literacy ability occurs in the control class of SMPN 1 Sampit in attitude aspect. Overall, it can be seen that the improvement of scientific literacy in all aspects of the experimental class is higher than in the control class. These results indicate that there is a significant increase of the implementation of ELM-based science learning to the scientific literacy of class VII students in Kotawaringin Timur regency. This result is reinforced by multivariate test analysis.

**Figure 1.** Histogram of scientific literacy ability

Note: E is experiment class and C is control class.
3.3. Multivariate test results

Prior to the one way manova test on the gain score of the scientific literacy ability of the students, prerequisite tests were first performed which included multivariate normality test and multivariate homogeneity test. Based on data, it is indicated that all significance values in the normality test are lower than .05 in all school categories. This means that the data gain has a normal multivariate distribution. Data also shows that the significance value on the homogeneity test is higher than .05 in all school categories. This means that the covariant matrices in both populations of both experimental and control classes are the same. Therefore, the prerequisite test has been met and can be tested manova. Table 5 shows the results of one way manova test.

| No. | School       | Category of school | Sig.  | Decision       |
|-----|--------------|---------------------|-------|----------------|
| 1   | SMPN 1 Sampit| High                | .000  | H0 is not accepted |
| 2   | SMPN 3 Sampit| Medium              | .000  | H0 is not accepted |
| 3   | SMPN 1 MHS   | Medium              | .001  | H0 is not accepted |
| 4   | SMPN 2 MHS   | Low                 | .005  | H0 is not accepted |

Table 5 shows the significance value of Wilks Lamda manova test for all school categories was less than .05. This means that ELM-based science learning has significant effect on scientific literacy skill of knowledge, competency, and attitude of class VII students in Kotawaringin Timur regency.

4. Discussion

ELM learning indirectly involves students’ experience as the key element in the learning process. The experience is reflected through a series of processes or activities that involve the students’ ability to think, observe, feel, and act, so that their learning experience will be more meaningful. ELM invites students to observe a phenomenon usually encountered in their everyday life, which then conducted a scientific investigation to find their own meaning of the phenomena they learn. Based on the results of research, it can be stated that ELM-based science learning using android significantly influence the scientific literacy of grade VII students of SMPN in Kotawaringin Timur regency in all aspects, namely scientific knowledge, scientific competencies, and scientific attitude. The significant influence is due to the engagement of students’ learning habits. Every student has different learning styles/habit. ELM facilitates a combination of several learning habits such as diverging, accommodating, converging, and assimilating. ELM integrates students’ experience in delivering material. The structured learning process through each ELM phase will make students understand more deeply if they have sufficient background knowledge. In the CE phase, some commonly encountered phenomena were presented to the students. Afterwards, the next stage was RO which provoked the students to reflect the experience / phenomena and then relate it with the material being discussed. Furthermore in the AC phase, students were led to think deeply about some of the concepts of the material presented and then integrate them with their initial knowledge. These three ELM phase sequences basically involve the students’ abilities in: feeling (CE), observing (RO), and thinking (AC) to understand a concept of the material being studied. Those three phases were able to maximize students’ ability to master the concept of the science learning, resulting in a significant increase on scientific literacy knowledge. Sharlanova states that experiential learning involves learners to learn through four ways such as doing, feeling, observing, reflecting, thinking and planning [5]. Students will find it easier to digest the concept of the material through commonly encountered phenomena. In the same vein, Clark state that students’ mastery will be achieved through experiential activities [6]. Aside from the effect on science literacy knowledge aspect, ELM learning can also significantly influence the scientific competencies of learners. It is caused by the next phase of ELM, which is AE (active experimentation). This phase invites students to conduct a series
of scientific inquiry activities. According to Arnold, the active experimentation phase in ELM enables learners to process the application of a principle into a new condition [7]. Thus, in this phase, students are given an opportunity to apply new knowledge and test its accuracy. This phase prioritizes the ability of students to do something, where students apply previously studied theory in decision-making process. The process starts from identifying scientific issues, explaining scientific phenomena, and finding scientific evidence.

The results of other research indicate that ELM learning does not only affect the scientific knowledge and scientific competencies of students, but it can also influence the attitude of the students themselves. This is in line with Kolb’s assertion that ELM is built on believing that the learning process involves not only knowledge but also integrating other skills of learners which include thinking, feeling, perceiving, and behaving [8]. The ELM process involves the learners’ experiences by linking them to emerging scientific issues. Indirectly, such learning process leads to the emergence of students’ interest to learn deeply about the scientific issues. Curiosity is one of the literacy attitudes measured in this study. Through curiosity, learners are motivated to conduct a scientific investigation which can generate a more meaningful sense of what they are studying. The scientific literacy accomplishment of this research is not only based on the use of ELM learning model, but also supported by the use of instructional media that suits the characteristics of students and the demands of the time. The results of Chai and Fan’s research, which implements learning by utilizing social media, show that such learning can make learners more creative and motivated in learning compared to conventional way of learning [9]. In this study, the learning media used is an application called Hi_Science. The Hi_Science application has been designed to facilitate each ELM phase. This application is an innovative learning media running on android-based smartphone. Each section facilitating the ELM stage was designed to be as engaging as possible to boost students’ motivation in learning science. In the same vein, Mehdipour and Zerehkafi suggesting that technology-based learning is one of the solutions to today’s educational challenges which can provide a more effective learning experience and increase students’ literacy [10]. The results of another research that integrate ELM-based learning process with technology utilization was done by Sutirman, which show that the use of ELM-based module can improve students’ cognitive competence, psychomotor, and affective aspects [11]. Gunawan et al. [12] and Hermansyah et al. [13] in their research also stated that computer-based media can support a variety of development of students' thinking skills and conceptual understanding. Each of these factors actively contributes to the development of students' scientific literacy.

The utilization of an Android-based ELM science learning has integrated innovative learning model and learning media which allows students to study the targeted knowledge with ease as well as to meet the demands of the times. This application could also accommodate different learning styles of the students. Thus, a more meaningful learning process which involves the ability to feel, observe, think and do can be achieved. Therefore, this learning can significantly influence the scientific literacy of students (scientific knowledge, competencies, and attitude), especially the seventh grade Junior High School students in Kotawaringin Timur regency.

5. Conclusion

Based on the results of research conducted in East Kotawaringin Regency, it can be stated that the implementation of android-assisted ELM science learning significantly influence the scientific literacy of the seventh grade students of Junior High School in Kotawaringin Timur Regency.

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