The Development Of Stem Mobile Learning Package Ecosystem

by Sri Ngabekti

THE DEVELOPMENT OF STEM MOBILE LEARNING PACKAGE ECOSYSTEM

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ABSTRACT

This study aims to: develop and test the validity, legibility and effectiveness of STEM Mobile Learning Package ecosystems on students' science and technology literacy using R & D research design. STEM Mobile Learning Package was validated by media experts and material experts. The level of legibility is measured by questionnaire through the results of a small-scale trial of a Biology student class. The effectiveness of the application was measured in wide-scale test for biology and natural science students. Data were analyzed using descriptive quantitative. The results showed the the validity on learning package from experts showed valid in 83,6%. Some revisions are needed especially on video aspect which will be better filled with not only text but also voice. Base on data collected from 47 students who have completely filled 12 statements in questionnaire, about 78,7% students stated they could understand the questions very well. Most of students (97,8%) agreed that the use of STEM enhanced their science literacy. Percentage of students that agreed on 12 statements ranged from 74,5% to 100%. Thus those result indicated a high level of legibility Although learning packages can be studied independently, certain topics still requiredto be directly discussed. This learning package is effective on student scientific literacy ranging from 64.6 to 98.6. While the highest achievement of student technology literacy is 92 with an average of 70.32. This study concludes that STEM Mobile Learning Package Ecosystem has good validity and legibility, as well as effective on students' science and technology literacy.

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Keywords: ecosystem, mobile learning, STEM

INTRODUCTION

The 2013 national curriculum in Indonesia has been seen as the new competency-based curriculum with the limited quality implementation. This curriculum has not been well implemented to inculcate character education and students are not prepared for global and future competition. It, therefore, needs other teaching approaches that can be used to support student competency for facing the changing world. One of the promising teaching approaches called STEM, derived from Science, Technology, Engieneering, and Mathematics, has been the focus of educational reform in United States and has been popular accross the world (Harland, 2011; Curtis, 2014; Eskin et al., 2018).This is an integrated teaching approaches which provide students with emphasis on integration of science, technology, engieneering, mathematics and problem-based learning. The fundamental goal of this approach is to create a leader for future that can bring a positive change on the community.

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Torlakson (2011) underlined that the integration of the 4 aspects of learning is necessary, since students are provided with the real problems and problem-based teaching. This approach was considered as a new of model of teaching that can create a cohesive and active teaching system. Students are also able to integrate the four dimentions. A chalenge for science educators is to create a educational system that can provide students with connecting skills of knowledge and skills. (Osman et al., 2013; Pfeiffer et al., 2013) mentioned that under STEM teaching sytem students use knowledge and skills integratedly. Students can link every dimension of STEM and this is a good indicator that students can metacognitively integrate all aspects of teaching, such as (1) science as knowledge about facts, concepts, rules, laws, that should be understood; (2) technology as a skill used for managing community, organisation, knowledge, and articial tools for easying jobs; (3) engineerig as knowledge about operationalisation or design of procedure for solving problems; and (4) mathematics as knowledge about integration of numbers, rooms with logical reasoning without emperical evidences. All these knowledge will be meaningful when integrated.

Teaching science with STEM approaches direcly provide studens with direct practice in integrating all aspects of learning. This integration makes students easily learn them. Bybee (2010) believed that this approach encouraged students to easily understand knowldege of concepts in authentic problems. In physical science teaching, students use technology to conduct an scientific experiment to prove scientific law or concepts. All findings are then supported by data management supported by mathematical reasoning.

Universitas Negeri Semarang (Unnes) already has an adequate internet network and technology. Every single classroom provides LCD and wifi network. Students have been using network actively as they have laptops and smartphones. Meanwhile, most lecturers have not used internet to support the learning process. Internet and technology usage can overcome limitations on learning process such as time and learning material. Besides, ICT competency is an important skill that should be developed as one of 21st century skills. With adequate internet connection and technology-literate students at Unnes, lecturers should utilize those potentials to enhance students performance. Barokati & Annas (2013); Chandra & Mills (2015; Fitriyadi (2013); and Yazdi (2012) stated that the use of internet and technology in classroom: (1) help students to obtain and study learning materials effectively and attractively without limited time, distance, and meetings and (2) support lifelong learning. Muhson (2010), Sudarsana (2018) also explained that internet is a reliable communication media for students and teacher.

Mobile learning package as defined by Quinn (2000) is a model of teaching using Information Communication   Technology. All technology tools are involved, namely computers, MP3 player, notebooks, mobile telephone and tablets. Focus of this mobile learning are on students with their interaction with portable technology. As Kozma (2008) stated the use of ICTs encourages learner-centered learning; active, exploratory, inquiry-based learning; collaborative work among learners and teachers; and creativity. Thus, students have opportunity to enhance their ICT competency.

The biology topics, ecoystems,   require students to use natural environment as the authentic learning resources. The use of natural environments usually take expensive cost and time. However, this learning package can overcome this limitations, and students can maximise the use of learning package every time that they are in need. Based on this reasoning, this study was aimed to identify the effectiveness of the use of STEM mobile learning package on ecoystem in providing students with basic concepts of ecoystem, environmental and scientific literacies.

METHODS

This research has been conducted in Biology Department, FMIPA UNNES Semarang from January to December 2018. This study implemented Research and Development (R & D) as a research method used to develop certain products. The developed product in this study is STEM mobile learning package on ecosystem. It has been uploaded in the EDMODO application. The development products can be monitored by e-mail sringabekti.stem@gmail.com with password: biologiunnes.

Preliminary information (data) of developing mobile learning package was collected and shared with Thai researchers with similar interst, conservationist,   Kasesart University, Bankok Thailand. First step of the study was focused on the developement of valid and reliable the learning package assessed by the media and biology content experts. After undergo some revisions, it was then tested to measure its legibility level. Then, its praticability (legibili-

ty) was validated by Unnes students. Legibility formula follows the Fry Graph formula that has been adapted to Indonesian language rules by Harjasujana and Mulyati (Anih & Nurhasanah, 2016; Fadilah, 2016).

Field testing was then implemented by the use of EDMODO that can be online accessed by biology students undertaking a course subject Ecology. Second step was then focused on experimental design. A group of biology students taking ecology with both theory and practicum were treated as experimental groups. Another group of natural science student, taking similar subject (only ecology without practicum) was treated as the control one, never introduced with ecology tools. Thid diffrent treatment was used to identify the effect of STEM model of teaching upon students' science and technological literacies. One shoot case design of research was used and parametric t- test was implemented.

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RESULTS AND DISCUSSION

The Validity of STEM Mobile Learning Package

The validity of the learning package was assessted out by two e-learning education media experts who are familiar with the EDMODO application. The validity on learning package from experts showed valid in 83,6%.Percentage of each aspect validity diagram is showed in Figure 1.
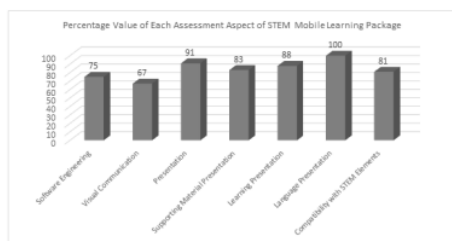
Figure 1. Assessment Aspect of STEM Mobile Learning Package from Validator Judgement

Percentage of each aspect represents valid in 3 aspects (software engineering, social communication, and compatibility with STEM elements). The other aspects showed very valid result in presentation, supporting material presentation, learning and language presentation. Hereby some suggestions from learning material expert used for revision.

Aspect 3: to engaged with the STEM elements, an illustration/ scheme of the relationship between Science, Technology, Engeenering, and Mathemathic should be given in the first meeting. Problem Based Learning (PBL) or Project Based Learning (PjBL) could be chosen as a model that emphasized open-real problems to students. Thus problem solving on STEM will be seen in the learning process.

Aspect 4, in advance organizer step, it is necessary to add real phenomena related to ecology that can be obtained from videos, research articles, and others.

Practice Questions needed to be adjusted to STEM characteristics. It could be done by giving High Order Thinking Skill (HOTS) questions to practice critical and creative thinking skills.

Learning material validator suggested that STEM Mobile Learning Package should be revised and completed with videos of real phenomena related to ecology ("Planaria Hunting" on the Semirang River), research articles, etc. Practice questions also needs to be enriched with HOTS problem. It was still necessary to consider students academic performance whose were normally distributed, so few memorization and comprehension questions still needed on evaluation.

To assess students mathematical understanding, mathematical questions that were originally combined with science questions were then separated from science essay questions. All questions should be done in 100 minutes.

The media validator explained some aspects from learning package that needed to be revised: (1) observation guide should be easily found on worksheet; (2) background song of videos should be focused on observation procedure explanation; (3) engeneering as one of STEM components shoud be more emerged. Students should be able to perform technical ability in learning process; (4) An introduction to STEM learning was needed. It provided purpose and benefits explanation for students by using the learning package; and (5) The information on the video should be clarified. The video should be preceded by an introduction to the purpose of activities and specific things that should be noticed.

The learning package has been revised based on media validator suggestion. The worksheet guide could be found immediately. Exploration videos are not filled with sounds, but have subscribed to explain the image. As a complement, " Planaria Hunting on Semirang River" video has been added. Engeenering aspect was not yet appear on video because students' technical performance in using some devices has not been recorded, but the impact of device utili-

zation has been tested.

This learning package has not been applied in the learning process because the course schedule has ended when the application has been completed. Therefore, the learning package was revised to make it better and could be used in even semester 2018/2019 of Ecology courses in Unnes. Another effort to implement the package was looking for ecology course that run in the odd semester 2018 from another university e.g UNY. Nevertheless, UNY informed that ecology courses there are also run in the even semester.

The package presentation needs to be adjusted to the STEM components. In the first lecture, an illustration/ scheme of the relationship between Science, Technology, Engeenering, and Mathemathic should be given. Along with STEM approach, Problem Based Learning (PBL) or Project Base Learning (PjBL) as a model that emphasized open-real problems to students. Thus problem solving on STEM will be seen in the learning process. Torlakson (2011) agreed that four components on STEM have harmonious relationship with real-world problems and problem-based learning.

STEM approach in education has the aim of preparing students to be able to study independently and be ready to compete in various fields. Research conducted by the research institute Hannover shows that the main goal of STEM Education is an attempt to perform holistic knowledge between STEM subjects. Integration in STEM learning is considered successful if all components of STEM are found in each learning process for each subject.

All four components of STEM has been attempted to be included in the developement of learning material. It was interesting to learn science using STEM approach on ecosystem while observe natural environment as a source of learning. Abiotic factor measurement could be done using recent modern device. The use of measuring devices requires certain steps according to engeneering aspects. Exploration and measurement results were then processed and analyzed quantitatively using mathematical principles.

Legibility of STEM Mobile Learning Package

STEM Mobile Learning Packageon Ecosystem was visited by 164 out of 180 (91%) students who have been taking Ecology class. Figure 2 shows the number of students participated in using STEM.
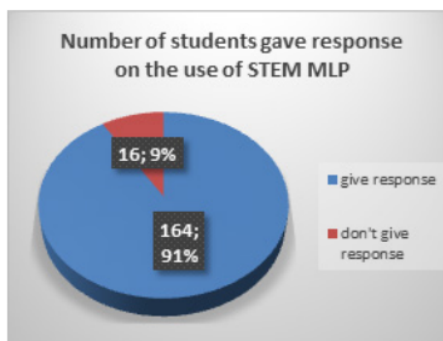

Figure 2. Number of Students Gave Response on the Use of STEM MLP

By randomly downloading the legibility questionnaire at EDMODO, data collected from 47 students who have completely filled 12 statements in questionnaire About 78,7% students stated they could understand the questions very well. Most of students (97,8%) agreed that the use of STEM enhanced their science literacy. Percentage of students that agreed on 12 statements ranged from 74,5% to 100%. There are two statements, number 6 and 11, that all of students agree with. Thus those result indicated a high level of legibility in line with Rahman et al., (2014); Vinothkumar (2018); Knezek et al., (2013); Izzo & Bauer (2015) explained that the use of technology on STEM learning improving students achievement, motivation and perception. The completed percentage value of 12 statements is showed on Figure 3.
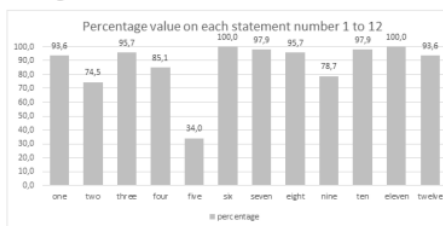

Figure 3. Statements from Students Response Questionnaire of Using STEM Mobile Learning Package

As for the 3 statements that most of them answered 'no', the students gave reasons such as the following: (1) statement number 2 "STEM MLP on Ecosystem is communicative so that it is easy to learn" is answered no, because most of students claimed MLP is efficient in time but in certain subjects it cannot be studied independent-

ly; (2) on statement number 5 "STEM MLP on Ecosystem has a clear voice" most of students answered 'no' with no reason or wrote they listened the less clear voice. However, this problem could be overcome by the existence of subtitle matches the voice given; and (3) many students disagreed with statement number 9 "STEM MLP on Ecosystems is easy to understand" with no reason or confirmed they often found some sentences are difficult to understand

Legibility level is also measured using the Fry chart. There are 4 reading texts in the STEM to be analyzed: 1) Article "Introduction to STEM in EDMODO"; 2) Handbook "Ecology with JAS approach", chapter ecosystem; 3) Article "Ecosystem problem in Wanawisata Semirang, Semarang district"; and 4) Surber net and Eckman Grab SOP. Calculation of number of sentences and number of syllables from four samples of the reading texts are summarized in Table 1.

Table 1. Calculation of Number of Sentences and Number of Syllables

STEM MLP Content	Part	NuS	NuSy (*0,6)
Article "Introduction to STEM in EDMODO"	1 par	6,11	172,2
Handbook "Ecology with JAS approach", chapter ecosystem	beginning	6,54	157,2
	Middle	3,38	153,6
	Ending	6,31	156,6
Article "Ecosystem problem in Wanawisata Semirang, Semarang district"	1 par	7,38	162
Surber net and Eckman Grab SOP	1 par	5,55	139,2
Summary		35,27	801,6
Average		7,054	160,32

Information:
Par: paragraph; NuS : Number of Sentences; NuSy: Number of Syllables

The average number of sentences is 7.054 rounded to 7. The average number of syllables is 160.32 rounded to 160. This result was then plotted into the Fry Graph as shown in Figure 4.
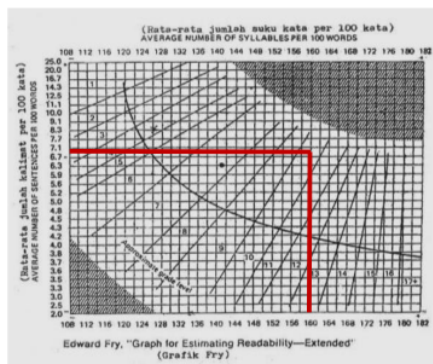
Figure 4. Plotting Calculation into Fry's Graph

On the Fry chart, regions 1 to 17+ show grade levels. If the meeting point is in region 1, the readability level of a text is appropriate for grade 1 students. If the plotting results show intersection is below 12, the text is more appropriate for the level of secondary school students. If the price of the meeting point is above 15, undergraduate students have difficulty to understand content from texts. Figure 4 shows that the intersection of number of sentences and number of syllables is in region 13. It means legibility level of STEM reading text is suitable for grades 12, 13, and 14 which is suitable for undergraduate students. Thus, reading texts uploaded on STEM ecosystem material were understood by undergraduate students very well. The results of the Fry chart analysis also support the results of legibility questionnaire analysis. Otherwise, reading texts of STEM on ecosystem has shown a good level of legibility and is suitable for use by undergraduate students.

The legibility level of a book or module is an element that needs attention. Fadilah (2016) stated that the legibility level influences the level of readers' understanding. The higher the legibility level, the higher the reader's understanding of a module's content. Wellington & Osborne (2001) explains that there are two general factors that influence the legibility level namely language and display factors. Language factors include word selection, sentence structure, paragraph arrangement, and other language elements. Display factors are typography such as type and size of letters, line density, width and other display elements. In ecology courses, especially in ecosystem subject, students use STEM in the learning process.

The Effectiveness of STEM Mobile Learning Package

The STEM mobile learning package on ecosytem (STEM-MLP) integrated in EDMODO was successfully uploaded. This package consists (1) introduction, goal and steps of learning is presented; (2) learning materials of ecology, narrated vidio of ecoystem in Wana Wisata Semarang, observation tools, as well as demonstration video on how to use these tools; and (3) evaluation tools such as tests and questionaires.

This EDMODO aplication was then uploaded five days before ecology examination tests. Wibowo (2018) explained teacher should guide students use mobile learning to learn about ecosystem. Thus, keeping contact with students was implemented via WhatsApp (WA) to make sure that every students of ecology have access to EDMODO. Students were invited to read all the materials presented, from introduction, learning materials, supplemented audio and visual media, and examination test materials. Finally, students were also to fulfil questionaires of readibility and practicability. Time restriction was implemented to motivate students in learning.

The effectiveness of this teaching model will be more significantly clear after this model is tested under large scale field testing. However, this field testing is not yet completed because the academic year 2017/2018 is not yet finished. Under the limited field testing, the temporary findings showed that (1) minimum score of science literacy was 48,9, and the highest one was 98.8; the average score was 72.18. Sum of questions to be addressed was 60 items, and the question number 51 -60 was the one relating to mathematic calculation; and (2) minimum score of technology literacy was 38 and the highest one was 88, its average score 70.32. All these score were collected after students completed the tests of the use of ecology tools, including steps of using that techology, (3) the average score for both literacies was 43.2 to 87.2 (61.25) with the similar criteria. Among 50 students involved in this research were (1) 34 students were ones from biology education department and another 16 was from integrated science departement. The big diffrence between the low and the highest score was caused by the diffrence in Semester Unit System (SKS) between biology education departement.

The next screening was focused on the average score of practicum and problem exercises among 40 biology education department and natural science department students. Finding

showed that due to the Mann Whytney test, there was no diffrence between average scores (scienceliteracy) among those students, but there was a diffrence score of technology literacy among them (asymp.sig. 0,00 < 0,05).

What can be learnt from these findings? First, the final product of the blended learning was validated and legibility by three different parties, one media experts and biology content expert and students. In Indonesia the use of internet for learning has been increasing. This is the reason of why the mobile learning package was officially welcomed by students. The number of students using computers (laptop, notebooks) at Unnes campus has been increasing significanly during the last 5 years. In terms of ecology content, all validators had approved the quality of learning material presented because of the familiarity of the content.

Ecosystem is the major topic that many university teacher are familiar with.Second, though the process of study is not completed yet, but there is a tendecy that the nature of STEM teaching approach affect students' learning achievement. Many reserch findings has also underlined the similar results. STEM approach improve students' knowledge and skills in developing career (Eskin et al., 2018). STEM seems to be able to provide students with integrated knowledge and understanding of authentic problems through both hands- and mind-on activities. The use of IT can motivate and satisfy the needs of Net generation (Eskin et al., 2018; Barak, 2014). Third, change is not a simple business, it is related to other multi factors responsible for it. Goldhaber et al., (2017) stated the implementation of STEM depends on other supporting factors, both internal and external ones. The implementation of STEM education is corelated with teachers' understanding of STEM itself. STEM education in school was also colored by teachers' attitude to STEM and it school context. Stem application on mobile learning also improves information search and literacy from both students and teachers (Hu & Garimella, 2014; Subekt et.al., 2018; Thibaut et al., 2018). Changes in students' belief and gateaway course achievent be continuously monitored to make sure that STEM promotes students' understanding and learning achievements, scientific and technology literacy (Dai & Cromley, 2014; Khaeroningtyas et al., 2016). Finally, this model of STEM integrated in ecosytem teaching learning could be expected to be one of the integrated science teaching at Unnes campus. Many research findings on STEM supports the implementation of STEM in schools. Similar results showed that students participating in STEM programs ex-

perienced a better knowledge or skills of understanding of science and technology. Students involved in STEM education in China would be accepted by labor market and awarded with better financial earnings (Hu & Hibel, 2015)

CONCLUSION

The research conclusion is presented briefly, narrative and conceptual which describes the research findings and its impacts. Please avoid using bulletsThe validity of STEM Moble Learning Package on Ecosistem could be obtained from two expert validators. It showed very valid category. Hence with some revisions, its performance could be better.

The legibility level that measured using students response and Fry graph indicated STEM Moble Learning Package on ecosystem has a high legibility level.

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FINAL GRADE

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GENERAL COMMENTS

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