

PAPER • OPEN ACCESS

E-Comic mathematics based on STEAM-CC and its effect on students creative thinking ability

To cite this article: Hobri *et al* 2021 *J. Phys.: Conf. Ser.* **1839** 012036

View the [article online](#) for updates and enhancements.



240th ECS Meeting ORLANDO, FL

Orange County Convention Center Oct 10-14, 2021



Abstract submission due: April 9

SUBMIT NOW

E-Comic mathematics based on STEAM-CC and its effect on students creative thinking ability

Hobri¹, S Adeliyanti¹, M Fatekurrahman³, H T Wijaya¹, E Oktavianingtyas¹, I W S Putri¹ and Z R Ridlo²

¹Mathematics Education Department, University of Jember, Jember, Indonesia

²Natural Science Education Department, University of Jember, Jember, Indonesia

³Mathematics and Natural Science Department, University of Jember, Jember, Indonesia

Email: hobri.fkip@unej.ac.id

Abstract. This research aims to create an e-comic mathematics based on Science, Technology, Engineering, Arts, and Mathematics – Caring Community (STEAM-CC) concept as well as to know its effect on the students' creative thinking ability. Creative thinking is heavily influenced by approaching the students' during the teaching and learning process. Moreover, it can be done through conducting small group students as a medium to collaborate, learn, and care each other along Caring Community (CC) in Lesson Study for Learning Community (LSLC). This study was used mixed method, 4D development method by Thiagarajan and experimental research. The result of this study showed that the developed e-comic was valid according to the material and media experts, while STEAM-CC concept was effective and practical way by looking at the students were able to achieve the standard minimum score on the test and observation. This research also found that the media can effect the students' creative thinking ability.

1. Introduction

The massive developing of technology brings huge changes on every life aspect[1][2], such as the innovations of creative and critical thinking[3], communication and collaboration skill[4][5]. On the other hand, preparing creative ideas is essential to stimulate the creative thinking[6][7], in which it generates to the other new diverse ideas[8].

STEM (Science, Technology, Engineering, and Mathematics) has strong disciplines as a basic kinds of Science and Technology discoveries[9][10]. Meanwhile, STEAM (Science, Technology, Engineering, Arts, and Mathematics) offers more than a complex skill yet analytical and creativity skills[11][12]. Thus, the students are needed to implement STEAM (Science, Technology, Engineering, Arts, and Mathematics) during the teaching and learning process[1]. The combination of thinking modelling and approach helps the students to strengthen the way their thinking through studying and both STEM and STEAM approach[13].

Caring Community on Lesson Study for Learning Community (LSLC) enables to minimize students' error during the learning process[14] since they must collaborate one another[10]. The transformation process between individuals and their environment due to creative thinking is affected by the study group around[6][15]. The most importance of requirement to encourage the students to learn is they must be motivated in doing so[16].

Mathematics e-comic is effective to use based on some aspects such as cognitive, psychomotor and affective[17]. The main point in assessing technology implementation during the learning process is



the effectiveness use of application model such as mobile application and other electronic devices[18]. Learning through e-comic character is able to contribute positive effects in motivating the students to study more. In other words, e-comic enables to improve the students' motivation during the teaching and learning process[7][19][20]. Learning approach is needed to support the media used during and one of them is STEAM, that is done to combine disciplines and improving modelling process[1]. The students often face difficulties due to problem solving of mathematic model and function because lack of planning to overcome it. The material involved in this research was linear equation in two variables which was learnt by the eighth-grade students at Junior High School. Most of school had applied this research and scheduled for Lesson Study[21].The use of mathematic e-comic with STEAM-CC concept reinforces the students to learn collaboratively and interactively, so it helps a lot to transform them into creative thinker around.

2. Method

This study involved mixed-method, 4D development method by Thiagarajan and experimental research. 4D development method by Thiagarajan attains the development process instruction such as Define, Design, Develop and Disseminate. The detail of development process research can be seen in Figure1.

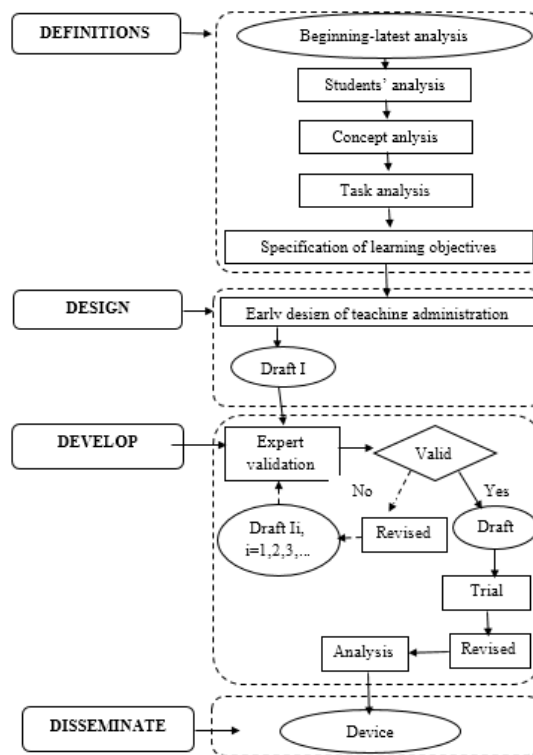


Figure 1. 4-D Diagram Model

The research was done at SMPN 7 Jember among VIII A class which consist of 32 students. The data collection method used was experts' validation, observation, creative skill test and questionnaires. The research data is drawn at Table 1.

Table 1. Research Data

No	Data	Data Collecting
1	Validity	Media is valid if it fulfills validity criteria. The validation was done by two lectures of Mathematis Education Department, Faculty of Teaching Training and Education, University of Jember, along with a mathematic teacher at SMPN 7 Jember.
2	Practical	Media is practical if the observation sheet fulfills the practical criteria. The data was gathered by interviewing and anlyzed observation.
3	Effectiveness	Media is effectiveness once it fulfills three main aspects of cognitive; by looking at the test result, psychomotor; by looking at the students' observation sheet, and

		affective; by looking at the students' questionnaires.
4	Creative ability test	Media contributes positive effect towards creative thinking if the students' creative test achieve the standard score of creative thinking

The population was the VIII grade students that consists of 5 classes with 32 students for each. There were two classes chosen as the research sample for experimental and control group through random sampling cluster method. The research design can be seen at Table 2.

Table 2. Research Design

Class	Pre-test	Treatment	Post-test
Experimental Class	√	e-comic mathematics based on STEAM-CC	√
Control Class	√	Discussion group	√

The data of students' creative thinking skills covers the different levels based on their fluency, flexibility, and novelty[22]. The data analysis was done if all assumptions were fulfilled[23]namely normality and homogeneity test. T-Test two samples using SPSS 24 were included as hypothesis test by testing two right sides to find out the effect on the students' creative thinking ability. The test criteria were if the value of $t_{test} \geq t_{table}$, so H_0 is rejected while H_a is accepted.

3. Result and Discussion

3.1 Research Development

This research generates valid, practical and effective media to know its effect on students' creative thinking. The development process of mathematics e-comic with STEAM-CC concept begun with definition stage, after gathering the students' condition data, the next step was the development stage. It starts by gathering the assessing data on validation sheet done by the three validators. Once it had already valid, the test was done for the students afterwards. The development media involved was mathematics e-comic with STEAM-CC concept using Clip Studio Paint as comic development. Dealing with the supporting tools, Geogebra was included as the supporting tools due to the materials about linear equation in two variables. The materials delivered by e-comic and google classroom that allowed the students to have online discussion. In addition, the comic was developed in three chapters with 12 panels for each. The example developing comic can be seen at this following picture.

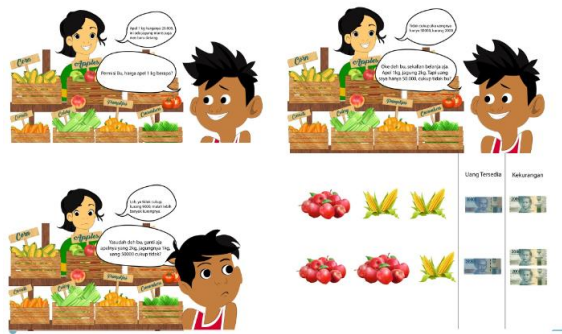


Figure 2. The development of e-comic based on STEAM-CC

Every chapter was inserted to Geogebra by uploading them into geogebra.org. It was used as supporting tools to introduce the system graphic about linear equation in two variables using STEAM approach. The details can be seen on Figure 3. The e-comic was developed by google classroom to get the easiness and accessible towards the materials and to create collaboration between the students in line with Caring Community on LSLC. E-comic was attached on google classroom and the class code was given among the student, the details can be seen on Figure 5. The media accessible if they opened classroom.google.com along with the class code.

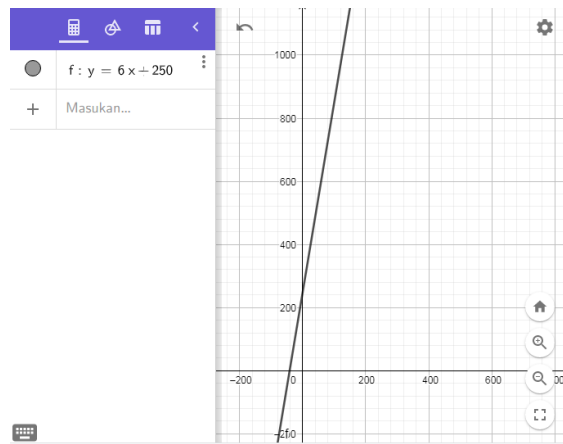


Figure 3. Geogebra website

3.2 Data Analysis

The validation process was done by giving the assessment instrument in the form of validation sheet, manual book, printed comic as well as learning media website. Two validators were experts on mathematic education to assess few aspects, that was the material and the media itself. The validator I gave 95.3% for all aspects which meant excellent while validator II gave 89% which categorized as good.’ On the other hand, Validator III had role to assess the media and he gave 96% which meant the media was excellent. The result of media validation can be seen in detail on Figure 4.

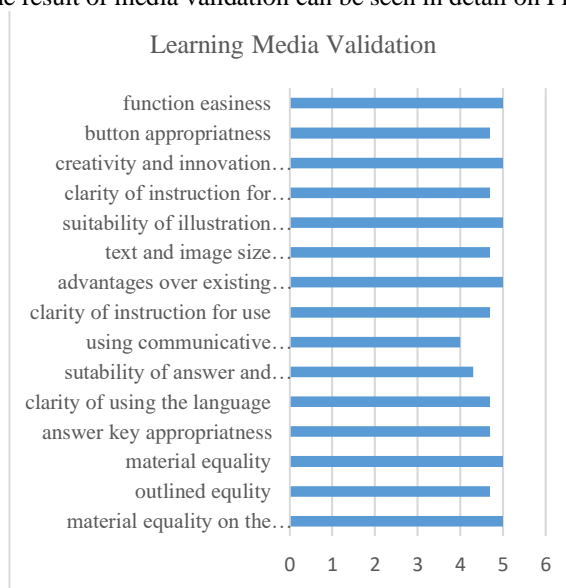
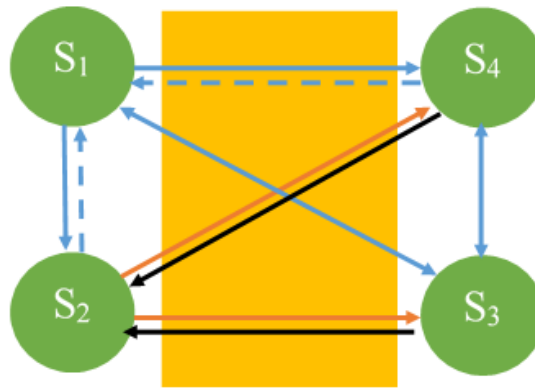


Figure 4. Validation result of learning media

Practical analysis using observation sheet was done towards 4 groups which consists of four people for each. The group was based on LSLC learning in which the students must do the worksheet[21]. The learning illustration can be seen in Figure 6.



Figure 5. Comments view on google classrom



Note :







-  : student- i
-  : discussion interaction
-  : asking question
-  : giving answer
-  : helping othe students
-  : asking for help

Figure 6. The LSLC learning disuccion activity

The observer explained and provided examples of the instructional media usage using student worksheet guides with a learning model. Based on the result of the observation sheet analysis, the practicality analysis was 92% and categorized as very good. The data can be seen in Figure 7.

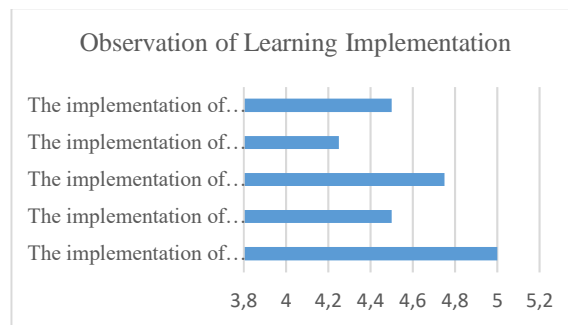


Figure 7. The observation result of learning implementation

Practicality analysis also used an interview with students to find out the problems experienced in solving problems that are not obtained from students' answers in the test, so that the problems found in the level of creative thinking and the developed learning media can be identified. After learning by using math e-comic, based on the result of the interview, students did not experience difficulties in using e-comic media. The problem experienced by the observer was helping students who had difficulty in processing log-in to the Google Classroom by using their existing Google account. According to Mathematics teachers in the school, online learning media are very interesting to use in both face-to-face and online learning remotely.

The test was used to see the effectiveness of the developed STEAM-CC-based math e-comic media. The data of the test results include cognitive, psychomotor, and affective skills[17]. The test was attended by 32 students in the class in which 26 students passed, and six other students did not. The score passing grade above the standard minimum criteria (KKM) reached 81,25% of all students in the class; therefore, the STEAM-CC-based math e-comic media can be considered as effective. The results of the test done by students can be seen in Figure 8.

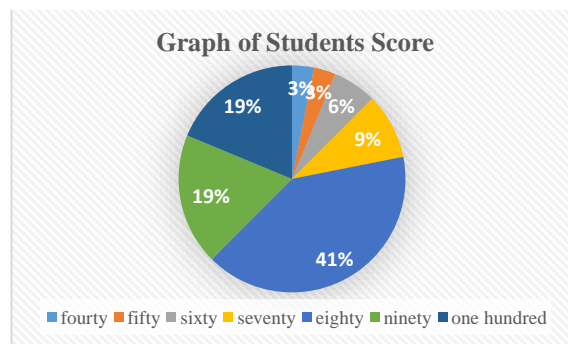


Figure 8. The chart of the students' scores

Psychomotor aspects were obtained through observation sheets covering aspects of students' skills in learning activities using media. Observer conditions five other observers to observe student activities. According to the result of the observation, students' psychomotor aspects reached 89% and were categorized as good. While the third aspect, namely the affective aspect, was obtained through students' questionnaires to see the care between students in learning. Based on the result of the questionnaires, 94% of students were categorized as good. The results of the questionnaire can be seen in Figure 9.

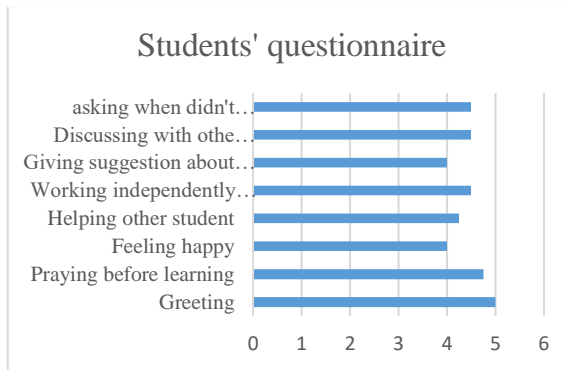


Figure 9. Student’s Questionnaire

Experimental Research

Learning using math e-comic was divided into two classes, namely the experimental class by using STEAM-CC-based math e-comic learning and the control class by using discussion learning, which is usually done in schools. The observer held a pre-test at the beginning and a post-test at the end of the lesson. The pre-test and post-test used creative skill questions.

Based on the research results, the data obtained through the pre-test in the experimental class showed that the mean score of the students was about 26,14 with a standard deviation (SD) = 16.30, while in the control class was about of 26,16 with SD = 16.32. The difference in the mean scores of the two classes was not too far, and the result of creative thinking skill indicated that they were uncreative and quite creative. After students were asked to use STEAM-CC-based math e-comic in the experimental class, they obtained post-test results with the mean score was about 78,45 (SD = 12.45), while the mean score of the students who used discussion learning in the control class and did the post-test was about 40,12 (SD = 10.19). It shows a significant difference between the experimental class and the control class. The results of the pre-test and post-test are presented in Table 3.

Table 3. The comparison of pre-test and post-test mean scores.

Class	The mean score of the Pre-test	The mean score of the post-test
Experimental Class	26,14	78,45
Control Class	26,16	40,12

Descriptions of answers and interviews with students wererequired in this study to measure students' creative thinking skills by fulfilling three indicators of students' creative thinking, namely fluency, flexibility, and novelty. Fluency was fulfilled when students could model into two-variable linear equations, flexibility was fulfilled when students could mention alternative solutions, and novelty was fulfilled when students could provide new ideas in solving problems. Figure 10 shows the answers of students who met the three indicators of creative thinking skills.

Jawaban :

a) - Ara harus mengetahui jika rambut akan tumbuh setiap hari lebih panjang dari sebelumnya

- Ara dapat mengukur rambutnya setiap bulan untuk menemukan perbedaannya menggunakan alat ukur / penggaris

- Jika dalam 1 bulan panjang rambut Ara 6 mm, maka dalam 6 bulan rambut Ara bertambah 36 mm

$y =$ panjang rambut
 $x =$ jumlah bulan
 $y = 6x + 250$
 $y = 6(6) + 250$
 $y = 36 + 250$
 $y = 286$

Jadi panjang rambut Ara selama 6 bulan = 286 mm

grafik :

b) Cara memperkirakan : panjang rambut Ara pada hari - hari selanjutnya dapat menggunakan grafik

x	y
0	250
-116	0

Figure 10. The answer from a student whose creative thinking ability

The data analysis of the test result and interview with students resulted in the percentage of the number of students with the uncreative, quite creative, creative, and very creative thinking skill in the experimental class respectively was about 0%, 20%, 44%, and 36%, while the percentage of students with less creative thinking skill was 72%, and quite creative was 18%.

Based on the results of hypothesis testing with testing criteria $t_{\text{tabel}} = 2,457$ with t_{test} value = 0,181, it was concluded that the t_{test} value $< t_{\text{tabel}}$, then H_0 was accepted, and H_a was rejected. It showed that the development of math e-comic using STEAM-CC-based affected students' creative thinking skills.

Many other researchers have carried out the development of math e-comic. In this study, the learning media used was a STEAM-based math e-comic that contained learning scenarios with the application of LSLC, which focused on the Caring Community by including STEAM's elements. This learning media was also used to determine the effect of students' creative thinking skills in solving a problem that united scientific disciplines, especially mathematics. The relationship between STEAM and Caring Community to show the effect on students' creative thinking is shown in Figure 11.

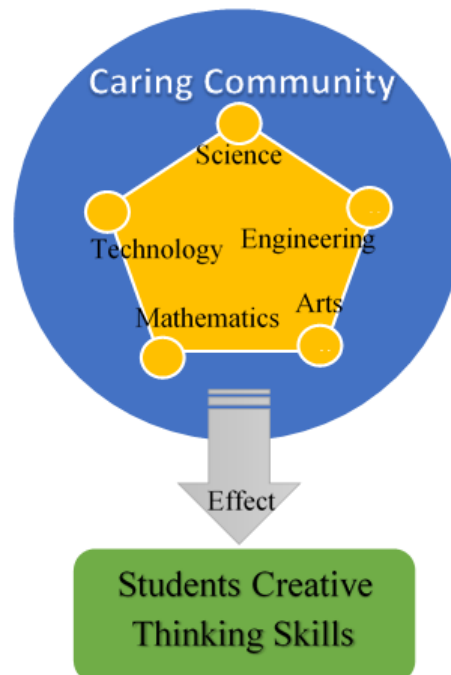


Figure 11. The relationship between STEAM-CC with students' creative thinking ability

The development of STEAM-CC-based math e-comic had the advantage of using an approach in delivering material in the learning media, and it was different from previous researches[7][17]. Besides, this development was also able to be used to determine the effect on students' creative skills. This research was also conducted online in carrying out caring community learning activities in LSLC as what had been developed, namely the development of a comparative material tool with problem-based learning and caring community and its effects on students' connection skills[14].

4. Conclusion

Based on the research that has been done, it can be concluded that the development of STEAM-CC-based math e-comic media produced valid, effective, and practical learning media. The e-comic development process used the 4-D Thiagarajan model, including Define, Design, Develop, and Disseminate. The result of the development showed that it was valid with a percentage of 95,3% of validator I, 89% of validator II, and 96% of validator III with a correlation coefficient of 0.94 categorized as very high. Effectiveness was shown from the passing grade, with a percentage of 81.25% of the 32 students passed. Practical was shown from the observation of the learning implementation with a percentage of 92% in the very good category.

Based on experimental research, the development of STEAM-CC-based math e-comic affected students' creative thinking skills. The pre-test and post-test were carried out in two different classes,

namely the experimental class and the control class, which showed significant differences between the two classes. The mean score of the pre-test in the experimental class was 26,14, and the mean score of the pre-test in the control class was 26.16, while the average post-test score of the experimental class was 78.45 and the average post-test score control class of 40.12. Descriptions of answers and interviews with students' creative thinking skills showed the percentage results in the experimental class with 20% sufficient creative skill, 44% creative skill, and 36% very creative skill. Hypothesis test results with testing criteria indicated that H_0 was accepted.

For future researchers who will conduct similar research, it is necessary to know the difficulties in developing online learning media on an internet network connection. The development should be done with professional and free software.

Acknowledgment

References

- [1] Winarni J Zubaidah S and H S K 2016 STEM: apa, mengapa, dan bagaimana, *Prosiding Seminar Nasional Pendidikan IPA Pascasarjana UM*.
- [2] Tirri K Cho S Ahn D and Campbell J R 2017 Education for Creativity and Talent Development in the 21st Century *Educ. Res. Int.*
- [3] Madden M E *et al.* 2013 Rethinking STEM education: An interdisciplinary STEAM curriculum *Procedia Comput. Sci.***20** p. 541–546.
- [4] Syaibani H A A D and A H 2017 The Analysis of Student's Creative Thinking Skills in Solving "Rainbow Connection" Problem through Research Based Learning *Int. J. Soc. Sci. Humanit. Invent.*
- [5] Lee L H J and Tan S C 2020 Teacher learning in Lesson Study: Affordances, disturbances, contradictions, and implications *Teach. Teach. Educ.***89** p. 102986.
- [6] Sitorus J and Masrayati 2016 Students' creative thinking process stages: Implementation of realistic mathematics education *Think. Ski. Creat.*
- [7] Buchori A and Setyawati R D 2015 Development model of character education through e-comic in elementary school. *International Journal of Education and Research Int. J. Educ. Res.*
- [8] Hidayat T, Susilaningih E and Kurniawan C 2018 The effectiveness of enrichment test instruments design to measure students' creative thinking skills and problem-solving *Think. Ski. Creat.*
- [9] Newton X A and Tonelli E P 2020 Building undergraduate STEM majors' capacity for delivering inquiry-based mathematics and science lessons: An exploratory evaluation study *Stud. Educ. Eval.*
- [10] Kuo H C Tseng Y C and Yang Y T C 2019 Promoting college student's learning motivation and creativity through a STEM interdisciplinary PBL human-computer interaction system design and development course *Think. Ski. Creat.***31** p. 1–10.
- [11] Land M H 2013 Full STEAM ahead: The benefits of integrating the arts into STEM in *Procedia Computer Science*.
- [12] Perignat E and Katz-Buonincontro J 2019 STEAM in practice and research: An integrative literature review *Think. Ski. Creat.***31** p. 31–43.
- [13] Malele V and Ramaboka M E 2020 The Design Thinking Approach to students STEAM projects *Procedia CIRP*.
- [14] Atikurrahman, M Hobri and Yuliati N 2019 The development of comparison material tool with problem based learning based on caring community and its effect on the students' connection ability in *Journal of Physics: Conference Series*.
- [15] Fisher D and Kusumah Y S 2018 Developing student character of preservice mathematics teachers through blended learning in *Journal of Physics: Conference Series*.
- [16] Saito E and Atencio M 2013 A conceptual discussion of lesson study from a micro-political perspective: Implications for teacher development and pupil learning *Teach. Teach. Educ.*
- [17] Hobri Murtikusuma R P and Hermawan L I 2019 Development of e-comic using pixon and kelase web on linear program of two variables assisted by geogebra *J. Phys. Conf. Ser.***1265**, 1.
- [18] Bano M Zowghi, D Kearney, M Schuck S and Aubusson P 2018 Mobile learning for science and mathematics school education: A systematic review of empirical evidence *Comput. Educ.*
- [19] Azeiteiro U M, Bacelar-Nicolau P, Caetano F J P and Caeiro S 2015 Education for sustainable development through e-learning in higher education: Experiences from Portugal in *Journal of*

- Cleaner Production.*
- [20] Wiegerová A and Navrátilová H, 2017, Let's Not Be Scared of Comics (Researching Possibilities of Using Conceptual Comics in Teaching Nature Study in Kindergarden) *Procedia - Soc. Behav. Sci.* **237**, 2016 p. 1576–1581.
 - [21] Chichibu T and Kihara T 2013 How Japanese schools build a professional learning community by lesson study *Int. J. Lesson Learn. Stud.*
 - [22] Siswono T Y E 2011 Level of student's creative thinking in classroom mathematics. Educational Research and Reviews.of student's creative thinking in classroom mathematics *Educ. Res. Rev.*
 - [23] Arikunto S 2010 *Prosedur Penelitian Pendekatan Praktik Edisi Revisi VI.* .